

OPERATIONS LOGIC SHEETS

August 31/07

CLIENT

Husky Energy

Consultant:

IMV Projects

Battery Description:

Tank VRU

LSD No:

11-36-49-20-W3M

Unit Type:

Tank VRU

Compressor Model:

Fuller, FLSmith C70

60HP x 1200 RPM

Natural Gas Engine

Arrow VRG330U 68 HP

VaporTech Job No:

5252

August 31/07

Sheet Title:

Job No:

OL-0	LEGEND	5252
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Sheet Title:

Job No:

OL-1	SYSTEM SCOPE	5252
Scope:	Conserve low pressure gas venting from battery storage tanks.	
Tanks:	Primary systems to hold tank farm pressure between 0 and 1.721 kpa (4 oz) (6.92 in wc)	
Gas Medium:	Tank Vapours, Sweet gas (Propane 30%, CO2 70%)....(1.52 Gravity) (44.04 MW) (50C(122F) Inlet Temp)	
VRU Capacity:	Design: @ 20 PSIG Discharge Press. : 354 Mscfd 26HP @796RPM Design: @ 40 PSIG Discharge Press. : 354 Mscfd 40HP @839RPM	
Disch Press:	276 Kpag. (40 psig), HP rated to full comp speed.	
Performance:	(Refer OL-10 Performance Curves)	
Back-up:	Venturi option not taken.	
Details:	Refer primary drawings (P&ID Flowsheet) (General Arrangement) and (Bill of Materials) in drawing section of VRU manual.	
Contact:	VaporTech Energy Services: 1-800-485-7175	

OL-2	Sheet Title: START PROCEDURE	Job No: 5252
1.	Confirm all process and auxilliary valves are in their normal run positions.	
2.	When the VRU is shutdown, it is the responsibility of the client to maintain and control the tank pressure.	
3.	Record any shutdown or "Faults", and take corrective action.	
4.	Press the "Acknowledge" function key on the HMI.	
5.	Press F5 "Reset" function key" to achieve "Ready Status" a. Units will auto start if tank press exceeds "Restart" setpoints. b. Press F1 (K-930) manual start button. c. The HMI will show - STARTING MODE	
6.	Compressor inlet ESD valve, (ESDV-139) opens and blow down valve (BDV-139) closes after 3 seconds allowing gas into the VRU.	
7.	Start the engine - Push and hold the START button until the engine starts. The engine should start within 15 seconds; if the engine fails to start, use the duty cycle recommended by the starter manufacturer : 15 sec on, 1 min. off, 3 attempts, 30 min. rest.	
8.	Engage the clutch and adjust the engine speed.	
9.	If compressor speed does not stop the drop in tank pressure, the recycle valve (PCV-9600) opens, to satisfy the conditions for running the compressor at minimum speed	
10.	Failure of gas to hold setpoint will result in soft setpoint "Stop to Standby" and/or "Low Tank Press SD"	
11.	Tank gas production and PLC Logic setpoints will determine the running mode of the package.	
NORMAL RUN CONDITIONS		
Tank Press	0.215 to 1.723 kpa (0.5- 4 oz) (0.86 - 6.92 " w.c.)	
Suct Press:	Approx 0.646 kpa (1.5 oz) (2.59" wc) less than tank press.	
Suct Temp:	50C (122F)	
Disch Press:	276 Kpag (40 PSIG)	
Disch Temp:	(Estimated) 150 to 200 F (66 to 93 C) (Shutdown at 325F, 163C)	
JW Temp:	120-135 F (49 to 57 C)	
Speed:	@ compressor 796-839	

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OL-3a

STOP

5252

1. Confirm pressures and temperatures are normal and documented.
2. Press F6 (or push the VRU ESD located on the Control Panel), which deenergizes the Engine Enable relay that grounds the ignition and stops the engine. Once the compressor have stopped, the inlet ESD valves will close and after 5 seconds the blowdown valves will open, depressurizing and isolating the VRU. A manual purge can be done opening the ball valves from sweet gas site supply lines.(see Purge System tab)
3. Sweet bearing gas purge (1 SCFM-40 PSIG) will continue to flow into the stopped compressors to prevent H2S contamination in the seals and bearings.
4. Unit may be left in this condition indefinitely. Refer to Shut-In OL-3b below if unit must be opened for maintenance.

OL-3b	SHUT-IN (Maintenance)	5252
<p>HUSKY ENERGY TO DRAFT SHUT-IN PROCEDURE IN COMPLIANCE WITH SAFETY POLICY.</p>		

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OL-4

TANK PRESSURE CONTROL

5252

1. Tank pressure is controlled by a two pressure transmitters (PIT-1120, PIT-1121) sensing the common suction header at the tank farm. VRU PLC has "High Select" logic for speed control and "Low Select" for make up control. These transmitters are redundant to one another which allows either one to be bypassed in the HMI for calibration or servicing without affecting the operations of the VRU.

2. Transmitters PIT-1120 & PIT-1121 are calibrated **0 - 10 oz (17.92"wc) (4.31 kPa) (VTES standard).**

3. PY 9600 is a DVC-6010 smart transducer/positioner, PID controlled, direct acting (4-20 mA) 6-30 PSIG output to pressure control valve PCV-6000. The valve opens gradually 0 to 100 % when the tanks pressure decreases from 1.75 oz to 1.15 . The recycle valve opens to satisfy the requirement for tank blanket and compressor minimum speed.

4. PY-1122 is a Fisher DVC-6010 smart transducer/positioner PID controlled from tank pressure transmitters with direct 6-30 output to PCV-1122 sweet fuel gas make-up. Initial set point (0.9 oz)(1.55 "wc) (0.389 kPa)

5. VFD (Variable Speed Drive) is our primary capacity control, providing a total VRU capacity range from 412 Mscfd (486 SCMH) to 822 Mscfd (970 SCMH) over the design speed range of the two compressors.

6. **Tank pressure controls logic. All discrete and PID set points are adjustable (password req'd) in HMI. The set points will be finalized at the time of commissioning.**

FALLING TANK PRESSURE LOGIC

Ounces

- 6.0 High Tank Pressure Alarm
- 4.0 } PID 1, 2 speed turndown both compressors in parallel.
- 3.0 }
- 2.5 Lag Compressor Stop to Standby
- 1.75 } PID 3 (low select), As the tank pressure decreases, the recycle valve PCV-9600 throttles open (1.75 to 1.15 oz), then make up valve PCV-1122 throttles open when the tank pressure is in the 1.25 to 0.9 oz range to maintain tank blanketing pressure requirements.
- 0.9 }
- 0.75 Lead Compressor Stop to Standby "Low Tank Pressure Standby"
- 0.50 "Low Tank Pressure Shutdown".

*Lead and Lag Compressor selectable at VRU HMI (PLC Panel)

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OL-4a

TANK PRESSURE CONTROL

5252

OZ RISING TANK PRESSURE LOGIC FROM VRU STANDBY

Ounces

0.9

} Recycle valve PCV-130 throttles closed

1.25

1.50

} The engine speed will be adjusted to the desired discharge pressure and to maintain minimum 0.75 Oz @ the tank.

4.00

If the tank pressure rises above 6 oz, the VRU runs (both trains) at maximum speed to reduce the pressure from the tanks. VTES suggests no VRU shut down on high tank pressure.

*Lead and Lag Compressor selectable at VRU HMI (PLC Panel)

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OL-5

LUBRICATION

5252

1. Lube Source:

65 Gallon Reservoir, lube oil supply, gravity feed directly into lubricator pumps.

2.

Lubricator..... Premier # 7012-1, 4 pint, 115-1 internal drive ratio, left hand, end rotary.

3.

Lube Pumps..... (1) Premier # 91202-1/4", direct inlet oil feed from lube tank to pump inlet c/w visi flex-vent.

4.

Divider Block.... Trabon # MSP multi-point.

5. LUBE OIL TYPE:

Lubricator Box: SAE 10-30 Standard Oil. (Replace Yearly)

Compressor: ESSO 264

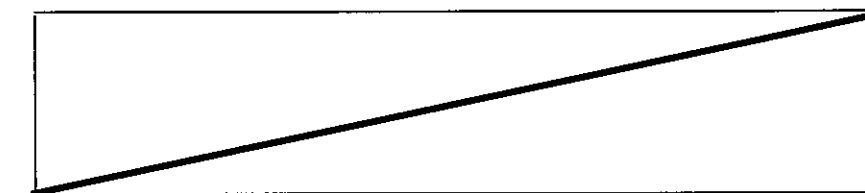
6. LUBE CYCLE TIME:

Seconds

Pints/Day

30
50
70
90

6
5
4
3



Min

Max

Compressor Speed (RPM)

7. LOW FLOW SHUTDOWN:

Lube flow sensor is a Trabon Hydraulic block with a plunger pin action. Normal flow has pin retracted and Dual Snap sensor clear (NC Contacts). Loss of flow drops pin to trip Dual Snap sensor.

A cycle indicator is mounted to the lube block to calculate cycle time per above speed / time curve. At min speed max cycle time is 110 Seconds.

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OL-6**CONDENSATES****5252****1. SUCTION SCRUBBER:**

Suction scrubber is a 16" Dia x 60" S/S long horizontal ASME Section VIII, Division 1, vessel built to sour gas specifications c/w: (9# x 4" thk 316SS mist extractor).

2. SCRUBBER PUMPS (P-932, P-942)

Wilden PX 200, 1" npt, diaphragm pump, Stainless Body-Teflon Trim, 13 USGPM at 60 Psig signal, 10 SCFM air consumption.

3. LOGIC

When the fluid rises to the LSH-135 control switch point, a single shot PLC timed output will energize the pump solenoid run for a 30 second time duration. If the level switch does not clear, PLC logic will perform (2) additional 30 second dumps with a 20 second delay between each.

If the level still has not cleared after the 3rd dump attempt the logic will lockout and call-out, requiring manual reset at the skid panel.

4. Manual Dump:

Press the HMI F3 function key to initiate a single, manual 30 second dump cycle.

5. AIR-LOCK VENTING:

A 1/4" needle valve is located near the pump suction to allow for gas lock venting (if req'd). Generally this pump is self-priming.

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OL-7**COMPRESSOR COOLING SYSTEM****5252****CLOSED LOOP COOLING:****1.****COMPONENTS:**

- * Circulation Pump
- * AIR-X-LIMITED COOLER
- * JW Surge Tank

2.**CIRCULATION LOOP:**

Surge tank bottom outlet feeds the J.W. circ pump inlet. Pump outlet enters the bottom of the compressor with branch valve for low-point drain and system fill. Outlet from the top of the compressor is piped common to the exchanger inlet back to the pump suction. An overhead surge tank blankets the pump suction.

3.**Shut-down**

When the temperature of the J.W. reaches 160 deg F a temperature switch (TSHH-130B) shuts down the VRU.

4.**TEMPERATURES:**

J.W. pump is belt driven by the compressor drive shaft and runs continuous when-ever either of the VRU compressors is running.

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OL-8**PURGE SYSTEM****5252****1. FUNCTION:**

Blanket and sweep bearing housings with N2. Pressure blanket the front and rear seal glands.

2. COMPONENTS:

- * COMMON OUTLET FLOW INDICATOR (0 to 50 SCFH)
- * FIXED .031" ORIFICE at each point.
- * OUTLET CHECK VALVES.

3. FLOWRATE:

- a. PURGE RATES TO BEARINGS ARE FIXED BY THE SWAGelok .031" ORIFICE FOR A FLOWRATE OF 1/2 SCFM.
- b. PURGE RATE TO THE SEAL WILL ALSO BE 1/2 SCFM.

4. GAS FLOW:

- a. DURING RUN THE PURGE GAS FLOWS INTO THE BEARINGS, ACROSS THE HEAD SEAL, AND COMBINES WITH VRU DISCHARGE GAS.
- b. DURING SHUTDOWN THE GAS WILL CONTINUE TO FLOW INTO THE COMPRESSOR AND EXIT TO FLARE THRU BDV130
- c. EACH COMP HAS IT'S OWN PURGE ISOLATION VALVE THAT MUST BE CLOSED PRIOR TO MAINTENANCE.

5. FLOW TEST:

- a. A SINGLE VISI-FLOW INDICATOR IS MOUNTED TO THE OUTLET OF THE PURGE GAS REGULATOR TO INDICATE COMBINED FLOW TO EACH COMPRESSOR. ISOLATE COMP ONE AT A TIME TO CONFIRM FLOW LOSS TO TEST IF ORIFICES ARE FLOWING.

6.

SYSTEM PURGE USES SWEET FUEL GAS FROM SITE SUPPLY (125 PSIG) REGULATED DOWN TO 40 PSIG. A MANUAL BALL VALVE LOCATED ON THE SUCTION LINE CAN BE OPERATED FOR MANUAL PURGE THE PROCESS LINES (INLET SCRUBBER, COMPRESSOR, DICHARGE LINES. THE MANUAL PURGE OPERATION CAN BE DONE AFTER THE UNIT IS STOPPED, ESDV CLOSED AND BLOWDOWN VALVES OPEN.

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OL-9**PANEL LOGIC****5252**

- 1** The PLC control system is the critical element of our VRU design and we absolutely require a client PLC programmer or operator to become familiar with our complete programming concept and control methods. Program back-up and routine recording of "Soft Setpoints" is necessary.

We have developed our PLC program as an "OPEN PLATFORM" and fully expect our clients to tune the system from it's original setpoints. We have included a special feature to "Recover" and "Store" "Soft Setpoint" values between the Panelview and PLC program without the use of a laptop and program software.

RECOVER SETPOINTS FROM MEMORY.

If un-recorded changes are made to the panelview and the system does not work properly the original stored values can be recovered from the PLC back to the panelview. Press selected function key on Set-Point Screen. Panel will flag "Stored Values Recovered from Memory". The original valves will now control the unit.

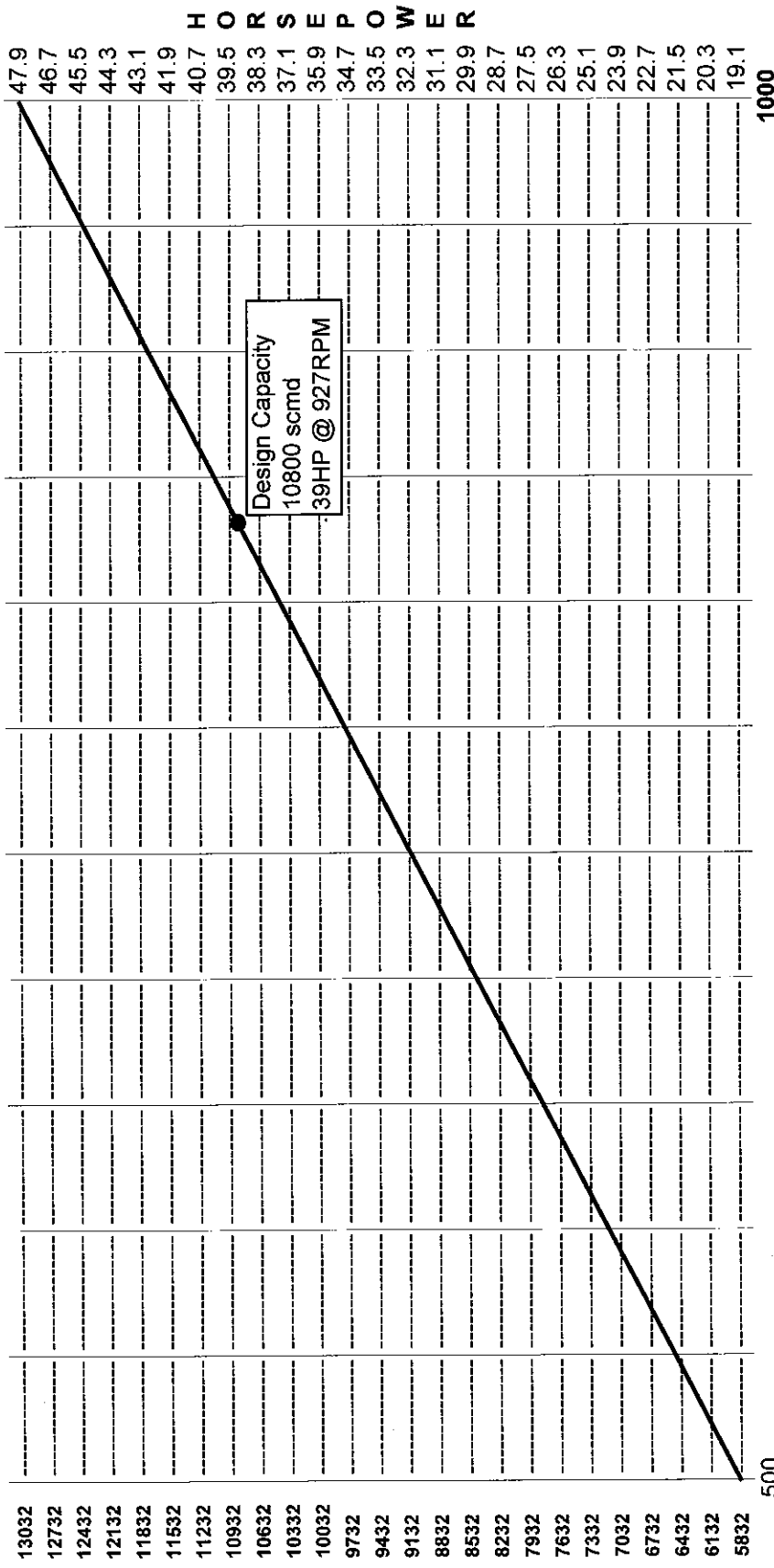
STORE NEW SETPOINTS TO MEMORY.

Any edit to "Setpoints" or "PID Loops" should be verified that they operate satisfactory then saved into the PLC memory. Press selected function key on Set-Point Screen, "New Setpoints Stored to Memory" will banner.

CAUTION:

This function must be restricted to "Authorized Personnel" who are responsible for keeping a current (dated) hardcopy record of setpoints.

The values listed in "Operations / Logic Sheets" are a general starting point and will definitely be changed. The softcopy files (Excel) for these logic sheets has been provide to operations and should be edited regularly (with rev date) to include current panel settings.



Design Capacity
10800 scmd
39HP @ 927RPM

COMPRESSOR SPEED
RPM

Suction Temp: 50 C
Suction Press: 0 kpag
Discharge Press: 276 kpag
Discharge Temp: TBD C

End User: Husky Energy
Site: Tank Farm
Tag: K-130

Site Elevation: 2674 FASL (13.3 PSIA)
Specific Gravity: 1.52 (44.04 MW)

FLSmidth COMPRESSOR
PERFORMANCE CURVE

VaporTech Energy Services **C70** **0 - 276 kpag**

11640 42.70
5832 19.11
300 1.20

OL-11

ENGINE CONTROLS

5252

1. FUNCTION:

The natural gas engine is the driver of the compressor, lube pump, lubricator and the cooler fan. It has an electric charging system (12 VDC) and a electric starting system (12 VDC starter c/w two 12 V batteries in paralel).

2. COMPONENTS:

- * FUEL SYSTEM (NATURAL GAS)
- * ENGINE OIL (GMA-40)
- * INTAKE / EXHAUST DUCTS

3. SHUTDOWNS

- a. OIL PRESSURE - There is a pressure switch monitoring the engine oil pressure that is calibrated @ 10 PSIG decreasing.
- b. COOLANT TEMPERATURE - TSHH 142 is a temperature switch set to shut the unit down if the temperature is higher than 220 deg F.
- c. VIBRATION - For protection against vibration there is a vibration switch tht will stop the engine if the level of vibration exceeds the set point (adjustable).

4. FUEL SYSTEM

- a. The fuel gas is supplied by the client (at the skid edge) through a scrubber, a pressure regulator a fuel shut off valve (pneumatically controlled by the PLC) to the engine's carburator.

- b. _____
- c. _____

- 5. _____

OZ Conv

Tank Pressure
Analog Scaling

0.2491 kpa	1.729 OZ	0.400 wc	2.50 ma	%
0	0	0	4.00	0
0.108	0.25	0.43	4.40	3
0.215	0.5	0.86	4.80	5
0.323	0.75	1.30	5.20	8
0.431	1	1.73	5.60	10
0.538	1.25	2.16	6.00	13
0.646	1.5	2.59	6.40	15
0.754	1.75	3.03	6.80	18
0.861	2	3.46	7.20	20
0.969	2.25	3.89	7.60	23
1.077	2.5	4.32	8.00	25
1.184	2.75	4.75	8.40	28
1.292	3	5.19	8.80	30
1.400	3.25	5.62	9.20	33
1.507	3.5	6.05	9.60	35
1.615	3.75	6.48	10.00	38
1.723	4	6.92	10.40	40
1.830	4.25	7.35	10.80	43
1.938	4.5	7.78	11.20	45
2.046	4.75	8.21	11.60	48
2.153	5	8.65	12.00	50
2.261	5.25	9.08	12.40	53
2.369	5.5	9.51	12.80	55
2.476	5.75	9.94	13.20	58
2.584	6	10.37	13.60	60
2.692	6.25	10.81	14.00	63
2.800	6.5	11.24	14.40	65
2.907	6.75	11.67	14.80	68
3.015	7	12.10	15.20	70
3.123	7.25	12.54	15.60	73
3.230	7.5	12.97	16.00	75
3.338	7.75	13.40	16.40	78
3.446	8	13.83	16.80	80
3.553	8.25	14.26	17.20	83
3.661	8.5	14.70	17.60	85
3.769	8.75	15.13	18.00	88
3.876	9	15.56	18.40	90
3.984	9.25	15.99	18.80	93
4.092	9.5	16.43	19.20	95
4.199	9.75	16.86	19.60	98
4.307	10	17.29	20.00	100

Tank Pressure
Analog Scaling

0.2491 kpa	1.729 OZ	0.400 wc	2.50 ma	%
0	0	0	4.00	0
0.022	0.05	0.09	4.40	3
0.043	0.1	0.17	4.80	5
0.065	0.15	0.26	5.20	8
0.086	0.2	0.35	5.60	10
0.108	0.25	0.43	6.00	13
0.129	0.3	0.52	6.40	15
0.151	0.35	0.61	6.80	18
0.172	0.4	0.69	7.20	20
0.194	0.45	0.78	7.60	23
0.215	0.5	0.86	8.00	25
0.237	0.55	0.95	8.40	28
0.258	0.6	1.04	8.80	30
0.280	0.65	1.12	9.20	33
0.301	0.7	1.21	9.60	35
0.323	0.75	1.30	10.00	38
0.345	0.8	1.38	10.40	40
0.366	0.85	1.47	10.80	43
0.388	0.9	1.56	11.20	45
0.409	0.95	1.64	11.60	48
0.431	1	1.73	12.00	50
0.452	1.05	1.82	12.40	53
0.474	1.1	1.90	12.80	55
0.495	1.15	1.99	13.20	58
0.517	1.2	2.07	13.60	60
0.538	1.25	2.16	14.00	63
0.560	1.3	2.25	14.40	65
0.581	1.35	2.33	14.80	68
0.603	1.4	2.42	15.20	70
0.625	1.45	2.51	15.60	73
0.646	1.5	2.59	16.00	75
0.668	1.55	2.68	16.40	78
0.689	1.6	2.77	16.80	80
0.711	1.65	2.85	17.20	83
0.732	1.7	2.94	17.60	85
0.754	1.75	3.03	18.00	88
0.775	1.8	3.11	18.40	90
0.797	1.85	3.20	18.80	93
0.818	1.9	3.29	19.20	95
0.840	1.95	3.37	19.60	98
0.861	2	3.46	20.00	100



Recommended Spare Parts

Client:	HUSKY ENERGY C/O IMV PROJECTS	Motor(s)	Arrow	Serial #
Project:	5252A		VRG330U	C-2613
Location:	SASKATCHEWAN, LLOYDMINISTER			
Date:	Septmeber 30, 2007	Compressor(s)		Serial #
Quote #:		1	FULLER C70	07-10210-10
Quoted By:	Dan Boonstra			

Thank you for allowing us the opportunity to recommended spare parts for your unit. VaporTech Energy Services Inc. is pleased to provide you with the following list of recommended spare parts for your consideration.

Commissioning/Start-up Spares

Quantity Recommended	Description	VaporTech Part Number	Quantity Ordered
Motor Arrow VRG330			
1	16" Fan Belt Set	A10300-1600-3D	
1	Water Pump Belt	A10300-1543-37	
2	Ignition Coil	A10300-011A-AW	
Compressors			
FULLER C70(BM27879)			
2	Seal Rings	A10300-CC67-04	
1	Rotor Blades	A10300-CC67-01	
1	Cylinder Head Gaskets	A10300-CC67-03	
1	Front Bearing(Fixed)	A10300-CC67-02	
1	Rear Bearing (Expansion)	A10300-CC6E-02	
1	Seal Cover Gasket	A10300-CC67-05	
1	Rotary Seal Rotating Sub-Assy	A80000-CC67-00	
Miscellaneous			
1	Omega Coupler ES40	A600001-0000-40	

1 year Maintenance Spares

Quantity Recommended	Description	VaporTech Part Number	Quantity Ordered
Motor Arrow VRG330			
1	Water Pump	A10300-1606-0A	
2	Ignition Coil	A10300-011A-AW	
12	Spark Plugs	A10300-RTN7-9G	
2	Ignition Lead Recore Wire	A10300-022R-EC	
6	Oil Filter	A10300-6270-9A	
	Water Pump Belt	A10300-1543-37	
2	Air Filter	A10300-2424-FN	
FULLER C70(BM27879)			
1	Rotor Blades	A10300-CC67-01	
1	Front Bearing(Fixed)	A10300-CC67-02	
1	Rear Bearing (Expansion)	A10300-CC6E-02	
2	Hub Seal Rings	700609-CC67-00	
2	Seal Ring Retainers	A10300-CC67-04	
1	Cylinder Head Gaskets	A10300-CC67-03	
1	Front Bearing Shims	A10300-CC67-06	
3	Bearing retainer gaskets	700606-CC67-5V	
1	Rotary Seal Rotating Sub-Assy	A80000-CC67-00	

1	Seal Cover Gasket	A10300-CC67-05	

Miscellaneous

Critical Maintenance Spares

Quantity Recommended	Description	VaporTech Part Number	Quantity Ordered
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Motor Arrow VRG330

1	ARROW VRG330U GAS ENGINE		
1	Water Pump	A10300-1606-0A	
1	Water Pump Belt	A10300-1543-37	
2	Ignition Coil	A10300-011A-AW	
2	Ignition Lead Recore Wire	A10300-022R-EC	
1	Altronic Magneto	A10300-6A34-AW	
1	Valve Cover Gasket	A10300-2086-15	
1	Oil Filter	A10300-6270-9A	
1	Air Filter	A10300-2424-FN	
1	Ign Pack(Sprk plugs, coils, harnes,mag,mag drive)	N/A	
1	Head Gasket Kit	A10300-9792-32	
1	Cylinder Head(new)	A10300-2171-02	
1	Cylinder Sleeve(kit)	A10300-9322-62	
1	Rod Bearing (pair)	A10300-2160-10A	
1	Connecting Rod	A10300-A216-01	
1	Twin Disc Clutch	A10300-111H-P3	

FULLER C70(BM27879)

1	C70 ROTARY VANE COMPRESSOR		
1	Seal Cover Gasket	A10300-CC67-05	
1	Rotary Seal Rotating Sub-Assy	A80000-CC67-00	
1	Rotor Blades	A10300-CC67-01	
1	Front Bearing(Fixed)	A10300-CC67-02	
1	Rear Bearing (Expansion)	A10300-CC6E-02	
2	Hub Seal Rings	700609-CC67-00	
2	Seal Ring Retainers	A10300-CC67-04	
1	Cylinder Head Gaskets	A10300-CC67-03	
1	Front Bearing Shims	A10300-CC67-06	
3	Bearing retainer gaskets	700606-CC67-5V	

Miscellaneous

1	Omega Coupler ES40	A600001-0000-40	
1	Coupling,4J ES	A600003-EMSO-00	
2	Coupling,4J 1/2 ES	A600003-0500-00	

Notes:

Quote is valid for 30 days.

GST is not included in quoted prices.



Recommended Spare Parts

Client:	HUSKY ENERGY C/O IMV PROJECTS	Motor(s)		Serial #	
Project:	5252B	Arrow	VRG330U	C-2614	
Location:	SASKATCHEWAN, LLOYDMINISTER				
Date:	Septmeber 30, 2007	Compressor(s)		Serial #	
Quote #:		1	FULLER C70	07-10210-103-4	BM27880
Quoted By:	Dan Boonstra				

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Quantity Recommended	Description	VaporTech Part Number	Quantity Ordered
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1	Water Pump Belt	A10300-1543-37	
2	Ignition Coil	A10300-011A-AW	
Compressors			
FULLER C70(BM27879)			
2	Seal Rings	A10300-CC67-04	
1	Rotor Blades	A10300-CC67-01	
1	Cylinder Head Gaskets	A10300-CC67-03	
1	Front Bearing(Fixed)	A10300-CC67-02	
1	Rear Bearing (Expansion)	A10300-CC6E-02	
1	Seal Cover Gasket	A10300-CC67-05	
1	Rotary Seal Rotating Sub-Assy	A80000-CC67-00	
Miscellaneous			
1	Omega Coupler ES40	A600001-0000-40	

1 year Maintenance Spares

Quantity Recommended	Description	VaporTech Part Number	Quantity Ordered
Motor Arrow VRG330			
1	Water Pump	A10300-1606-0A	
2	Ignition Coil	A10300-011A-AW	
12	Spark Plugs	A10300-RTN7-9G	
2	Ignition Lead Recore Wire	A10300-022R-EC	
6	Oil Filter	A10300-6270-9A	
	Water Pump Belt	A10300-1543-37	
2	Air Filter	A10300-2424-FN	
FULLER C70(BM27879)			
1	Rotor Blades	A10300-CC67-01	
1	Front Bearing(Fixed)	A10300-CC67-02	
1	Rear Bearing (Expansion)	A10300-CC6E-02	
2	Hub Seal Rings	700609-CC67-00	
2	Seal Ring Retainers	A10300-CC67-04	
1	Cylinder Head Gaskets	A10300-CC67-03	
1	Front Bearing Shims	A10300-CC67-06	
3	Bearing retainer gaskets	700606-CC67-5V	
1	Rotary Seal Rotating Sub-Assy	A80000-CC67-00	

1	Seal Cover Gasket	A10300-CC67-05	

Miscellaneous

Critical Maintenance Spares

Quantity Recommended	Description	VaporTech Part Number	Quantity Ordered
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Motor Arrow VRG330

1	ARROW VRG330U GAS ENGINE		
1	Water Pump	A10300-1606-0A	
1	Water Pump Belt	A10300-1543-37	
2	Ignition Coil	A10300-011A-AW	
2	Ignition Lead Recore Wire	A10300-022R-EC	
1	Altronic Magneto	A10300-6A34-AW	
1	Valve Cover Gasket	A10300-2086-15	
1	Oil Filter	A10300-6270-9A	
1	Air Filter	A10300-2424-FN	
1	Ign Pack(Sprk plugs, coils, harnes,mag,mag drive)	N/A	
1	Head Gasket Kit	A10300-9792-32	
1	Cylinder Head(new)	A10300-2171-02	
1	Cylinder Sleeve(kit)	A10300-9322-62	
1	Rod Bearing (pair)	A10300-2160-10A	
1	Connecting Rod	A10300-A216-01	
1	Twin Disc Clutch	A10300-111H-P3	

FULLER C70(BM27879)

1	C70 ROTARY VANE COMPRESSOR		
1	Seal Cover Gasket	A10300-CC67-05	
1	Rotary Seal Rotating Sub-Assy	A80000-CC67-00	
1	Rotor Blades	A10300-CC67-01	
1	Front Bearing(Fixed)	A10300-CC67-02	
1	Rear Bearing (Expansion)	A10300-CC6E-02	
2	Hub Seal Rings	700609-CC67-00	
2	Seal Ring Retainers	A10300-CC67-04	
1	Cylinder Head Gaskets	A10300-CC67-03	
1	Front Bearing Shims	A10300-CC67-06	
3	Bearing retainer gaskets	700606-CC67-5V	

Miscellaneous

1	Omega Coupler ES40	A600001-0000-40	
1	Coupling,4J ES	A600003-EMSO-00	
2	Coupling,4J 1/2 ES	A600003-0500-00	

Notes:

Quote is valid for 30 days.

GST is not included in quoted prices.



Recommended Spare Parts

Client:	HUSKY ENERGY C/O IMV PROJECTS	Motor(s)		Serial #	
Project:	5252C	Arrow	VRG330U		C-2615
Location:	SASKATCHEWAN, LLOYDMINISTER				
Date:	Septmeber 30, 2007	Compressor(s)		Serial #	
Quote #:		1	FULLER C70		07-10210-103-3 BM27879
Quoted By:	Dan Boonstra				

Thank you for allowing us the opportunity to recommended spare parts for your unit. VaporTech Energy Services Inc. is pleased to provide you with the following list of recommended spare parts for your consideration.

Commissioning/Start-up Spares

Quantity Recommended	Description	VaporTech Part Number	Quantity Ordered
Motor Arrow VRG330			
1	16" Fan Belt Set	A10300-1600-3D	
1	Water Pump Belt	A10300-1543-37	
2	Ignition Coil	A10300-011A-AW	
Compressors			
FULLER C70(BM27879)			
2	Seal Rings	A10300-CC67-04	
1	Rotor Blades	A10300-CC67-01	
1	Cylinder Head Gaskets	A10300-CC67-03	
1	Front Bearing(Fixed)	A10300-CC67-02	
1	Rear Bearing (Expansion)	A10300-CC6E-02	
1	Seal Cover Gasket	A10300-CC67-05	
1	Rotary Seal Rotating Sub-Assy	A80000-CC67-00	
Miscellaneous			
1	Omega Coupler ES40	A600001-0000-40	

1 year Maintenance Spares

Quantity Recommended	Description	VaporTech Part Number	Quantity Ordered
Motor Arrow VRG330			
1	Water Pump	A10300-1606-0A	
2	Ignition Coil	A10300-011A-AW	
12	Spark Plugs	A10300-RTN7-9G	
2	Ignition Lead Recore Wire	A10300-022R-EC	
6	Oil Filter	A10300-6270-9A	
	Water Pump Belt	A10300-1543-37	
2	Air Filter	A10300-2424-FN	
FULLER C70(BM27879)			
1	Rotor Blades	A10300-CC67-01	
1	Front Bearing(Fixed)	A10300-CC67-02	
1	Rear Bearing (Expansion)	A10300-CC6E-02	
2	Hub Seal Rings	700609-CC67-00	
2	Seal Ring Retainers	A10300-CC67-04	
1	Cylinder Head Gaskets	A10300-CC67-03	
1	Front Bearing Shims	A10300-CC67-06	
3	Bearing retainer gaskets	700606-CC67-5V	
1	Rotary Seal Rotating Sub-Assy	A80000-CC67-00	

1	Seal Cover Gasket	A10300-CC67-05	

Miscellaneous

Critical Maintenance Spares

Quantity Recommended	Description	VaporTech Part Number	Quantity Ordered
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Motor Arrow VRG330

1	ARROW VRG330U GAS ENGINE		
1	Water Pump	A10300-1606-0A	
1	Water Pump Belt	A10300-1543-37	
2	Ignition Coil	A10300-011A-AW	
2	Ignition Lead Recore Wire	A10300-022R-EC	
1	Altronic Magneto	A10300-6A34-AW	
1	Valve Cover Gasket	A10300-2086-15	
1	Oil Filter	A10300-6270-9A	
1	Air Filter	A10300-2424-FN	
1	Ign Pack(Sprk plugs, coils, harnes,mag,mag drive)	N/A	
1	Head Gasket Kit	A10300-9792-32	
1	Cylinder Head(new)	A10300-2171-02	
1	Cylinder Sleeve(kit)	A10300-9322-62	
1	Rod Bearing (pair)	A10300-2160-10A	
1	Connecting Rod	A10300-A216-01	
1	Twin Disc Clutch	A10300-111H-P3	

FULLER C70(BM27879)

1	C70 ROTARY VANE COMPRESSOR		
1	Seal Cover Gasket	A10300-CC67-05	
1	Rotary Seal Rotating Sub-Assy	A80000-CC67-00	
1	Rotor Blades	A10300-CC67-01	
1	Front Bearing(Fixed)	A10300-CC67-02	
1	Rear Bearing (Expansion)	A10300-CC6E-02	
2	Hub Seal Rings	700609-CC67-00	
2	Seal Ring Retainers	A10300-CC67-04	
1	Cylinder Head Gaskets	A10300-CC67-03	
1	Front Bearing Shims	A10300-CC67-06	
3	Bearing retainer gaskets	700606-CC67-5V	

Miscellaneous

1	Omega Coupler ES40	A600001-0000-40	
1	Coupling,4J ES	A600003-EMSO-00	
2	Coupling,4J 1/2 ES	A600003-0500-00	

Notes:

Quote is valid for 30 days.

GST is not included in quoted prices.



Recommended Spare Parts

Client:	HUSKY ENERGY C/O IMV PROJECTS	Motor(s)		Serial #	
Project:	5252D	Arrow	VRG330U	C-2658	
Location:	SASKATCHEWAN, LLOYDMINISTER				
Date:	Septmeber 30, 2007	Compressor(s)		Serial #	
Quote #:		1	FULLER C70	07-10210-103-6	BM27882
Quoted By:	Dan Boonstra				

Thank you for allowing us the opportunity to recommended spare parts for your unit. VaporTech Energy Services Inc. is pleased to provide you with the following list of recommended spare parts for your consideration.

Commissioning/Start-up Spares

Quantity Recommended	Description	VaporTech Part Number	Quantity Ordered
Motor Arrow VRG330			
1	16" Fan Belt Set	A10300-1600-3D	
1	Water Pump Belt	A10300-1543-37	
2	Ignition Coil	A10300-011A-AW	
Compressors			
FULLER C70(BM27879)			
2	Seal Rings	A10300-CC67-04	
1	Rotor Blades	A10300-CC67-01	
1	Cylinder Head Gaskets	A10300-CC67-03	
1	Front Bearing(Fixed)	A10300-CC67-02	
1	Rear Bearing (Expansion)	A10300-CC6E-02	
1	Seal Cover Gasket	A10300-CC67-05	
1	Rotary Seal Rotating Sub-Assy	A80000-CC67-00	
Miscellaneous			
1	Omega Coupler ES40	A600001-0000-40	

1 year Maintenance Spares

Quantity Recommended	Description	VaporTech Part Number	Quantity Ordered
Motor Arrow VRG330			
1	Water Pump	A10300-1606-0A	
2	Ignition Coil	A10300-011A-AW	
12	Spark Plugs	A10300-RTN7-9G	
2	Ignition Lead Recore Wire	A10300-022R-EC	
6	Oil Filter	A10300-6270-9A	
	Water Pump Belt	A10300-1543-37	
2	Air Filter	A10300-2424-FN	
FULLER C70(BM27879)			
1	Rotor Blades	A10300-CC67-01	
1	Front Bearing(Fixed)	A10300-CC67-02	
1	Rear Bearing (Expansion)	A10300-CC6E-02	
2	Hub Seal Rings	700609-CC67-00	
2	Seal Ring Retainers	A10300-CC67-04	
1	Cylinder Head Gaskets	A10300-CC67-03	
1	Front Bearing Shims	A10300-CC67-06	
3	Bearing retainer gaskets	700606-CC67-5V	
1	Rotary Seal Rotating Sub-Assy	A80000-CC67-00	

1	Seal Cover Gasket	A10300-CC67-05	

Miscellaneous

Critical Maintenance Spares

Quantity Recommended	Description	VaporTech Part Number	Quantity Ordered
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Motor Arrow VRG330

1	ARROW VRG330U GAS ENGINE		
1	Water Pump	A10300-1606-0A	
1	Water Pump Belt	A10300-1543-37	
2	Ignition Coil	A10300-011A-AW	
2	Ignition Lead Recore Wire	A10300-022R-EC	
1	Altronic Magneto	A10300-6A34-AW	
1	Valve Cover Gasket	A10300-2086-15	
1	Oil Filter	A10300-6270-9A	
1	Air Filter	A10300-2424-FN	
1	Ign Pack(Sprk plugs, coils, harnes,mag,mag drive)	N/A	
1	Head Gasket Kit	A10300-9792-32	
1	Cylinder Head(new)	A10300-2171-02	
1	Cylinder Sleeve(kit)	A10300-9322-62	
1	Rod Bearing (pair)	A10300-2160-10A	
1	Connecting Rod	A10300-A216-01	
1	Twin Disc Clutch	A10300-111H-P3	

FULLER C70(BM27879)

1	C70 ROTARY VANE COMPRESSOR		
1	Seal Cover Gasket	A10300-CC67-05	
1	Rotary Seal Rotating Sub-Assy	A80000-CC67-00	
1	Rotor Blades	A10300-CC67-01	
1	Front Bearing(Fixed)	A10300-CC67-02	
1	Rear Bearing (Expansion)	A10300-CC6E-02	
2	Hub Seal Rings	700609-CC67-00	
2	Seal Ring Retainers	A10300-CC67-04	
1	Cylinder Head Gaskets	A10300-CC67-03	
1	Front Bearing Shims	A10300-CC67-06	
3	Bearing retainer gaskets	700606-CC67-5V	

Miscellaneous

1	Omega Coupler ES40	A600001-0000-40	
1	Coupling,4J ES	A600003-EMSO-00	
2	Coupling,4J 1/2 ES	A600003-0500-00	

Notes:

Quote is valid for 30 days.

GST is not included in quoted prices.



Recommended Spare Parts

Client:	HUSKY ENERGY C/O IMV PROJECTS	Motor(s)		Serial #	
Project:	5252E	Arrow	VRG330U		C-2617
Location:	SASKATCHEWAN, LLOYDMINISTER				
Date:	Septmeber 30, 2007	Compressor(s)		Serial #	
Quote #:		1	FULLER C70		07-10210-103-5 BM27881
Quoted By:	Dan Boonstra				

Thank you for allowing us the opportunity to recommended spare parts for your unit. VaporTech Energy Services Inc. is pleased to provide you with the following list of recommended spare parts for your consideration.

Commissioning/Start-up Spares

Quantity Recommended	Description	VaporTech Part Number	Quantity Ordered
Motor Arrow VRG330			
1	16" Fan Belt Set	A10300-1600-3D	
1	Water Pump Belt	A10300-1543-37	
2	Ignition Coil	A10300-011A-AW	
Compressors			
FULLER C70(BM27879)			
2	Seal Rings	A10300-CC67-04	
1	Rotor Blades	A10300-CC67-01	
1	Cylinder Head Gaskets	A10300-CC67-03	
1	Front Bearing(Fixed)	A10300-CC67-02	
1	Rear Bearing (Expansion)	A10300-CC6E-02	
1	Seal Cover Gasket	A10300-CC67-05	
1	Rotary Seal Rotating Sub-Assy	A80000-CC67-00	
Miscellaneous			
1	Omega Coupler ES40	A600001-0000-40	

1 year Maintenance Spares

Quantity Recommended	Description	VaporTech Part Number	Quantity Ordered
Motor Arrow VRG330			
1	Water Pump	A10300-1606-0A	
2	Ignition Coil	A10300-011A-AW	
12	Spark Plugs	A10300-RTN7-9G	
2	Ignition Lead Recore Wire	A10300-022R-EC	
6	Oil Filter	A10300-6270-9A	
	Water Pump Belt	A10300-1543-37	
2	Air Filter	A10300-2424-FN	
FULLER C70(BM27879)			
1	Rotor Blades	A10300-CC67-01	
1	Front Bearing(Fixed)	A10300-CC67-02	
1	Rear Bearing (Expansion)	A10300-CC6E-02	
2	Hub Seal Rings	700609-CC67-00	
2	Seal Ring Retainers	A10300-CC67-04	
1	Cylinder Head Gaskets	A10300-CC67-03	
1	Front Bearing Shims	A10300-CC67-06	
3	Bearing retainer gaskets	700606-CC67-5V	
1	Rotary Seal Rotating Sub-Assy	A80000-CC67-00	

1	Seal Cover Gasket	A10300-CC67-05	

Miscellaneous

Critical Maintenance Spares

Quantity Recommended	Description	VaporTech Part Number	Quantity Ordered
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Motor Arrow VRG330

1	ARROW VRG330U GAS ENGINE		
1	Water Pump	A10300-1606-0A	
1	Water Pump Belt	A10300-1543-37	
2	Ignition Coil	A10300-011A-AW	
2	Ignition Lead Recore Wire	A10300-022R-EC	
1	Altronic Magneto	A10300-6A34-AW	
1	Valve Cover Gasket	A10300-2086-15	
1	Oil Filter	A10300-6270-9A	
1	Air Filter	A10300-2424-FN	
1	Ign Pack(Sprk plugs, coils, harnes,mag,mag drive)	N/A	
1	Head Gasket Kit	A10300-9792-32	
1	Cylinder Head(new)	A10300-2171-02	
1	Cylinder Sleeve(kit)	A10300-9322-62	
1	Rod Bearing (pair)	A10300-2160-10A	
1	Connecting Rod	A10300-A216-01	
1	Twin Disc Clutch	A10300-111H-P3	

FULLER C70(BM27879)

1	C70 ROTARY VANE COMPRESSOR		
1	Seal Cover Gasket	A10300-CC67-05	
1	Rotary Seal Rotating Sub-Assy	A80000-CC67-00	
1	Rotor Blades	A10300-CC67-01	
1	Front Bearing(Fixed)	A10300-CC67-02	
1	Rear Bearing (Expansion)	A10300-CC6E-02	
2	Hub Seal Rings	700609-CC67-00	
2	Seal Ring Retainers	A10300-CC67-04	
1	Cylinder Head Gaskets	A10300-CC67-03	
1	Front Bearing Shims	A10300-CC67-06	
3	Bearing retainer gaskets	700606-CC67-5V	

Miscellaneous

1	Omega Coupler ES40	A600001-0000-40	
1	Coupling,4J ES	A600003-EMSO-00	
2	Coupling,4J 1/2 ES	A600003-0500-00	

Notes:

Quote is valid for 30 days.

GST is not included in quoted prices.

Consumable Lubricants

Engines

Engine Oil

Reciprocating Engines – Esso GMA Plus 15W40

Engine Glycol

Ucotherm 50/50

Compressors

Compressor Oil

Reciprocating Compressors – Esso GMA 40

Rotary Vane Compressors – Esso 264

Triple Scroll Compressors – PetroCanada SPX-5000

Compressor Glycol

Ucotherm 50/50

DISCLAIMER: Use of lubricants that do not **SPECIFICALLY** meet that of the manufacturer's specified lubricant may void the equipment's warranty. Use of non-OEM recommended lubricants (or lubricants which are not guaranteed to meet or exceed OEM lubricants for the specified use) is at the risk and liability of the VRU's owner, not the author or publisher of this article. Use of the above mentioned products for this purpose constitutes acceptance of this disclaimer.