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Project ID Number:	Report Number:	Office Location:	Date:
1835793	MS1835793	Houston, Texas	14 February 2008

DIXIE IRON WORKS, Inc
MSI TI-600 Unit
Operational Test Witness

THIS IS TO CERTIFY that the undersigned representative of ABS Consulting Inc. did on 06 December 2007, and on subsequent dates at the request of Dixie Iron Works. attend for survey of one (1) MSI TI-600 Pump Unit located at the Dixie Iron Works facility, located at 300 West Main St., Alice Texas, in order to examine and report upon the operational test status of this equipment.

Description Of Equipment:

The MSI TI-600 is a 600 horsepower triplex pump. This pump is suited for oil field service applications.

The TI-600 is composed of three main components: Power Frame, Fluid End, and a Gear Reducer. The pump is designed for sixteen left and right-hand configurations of the Gear Reducer without removing the crankshaft. The pump is also available with a Long Drive Gear Reducer that allows the driveshaft to cross over or under the pumps' power frame.

The Power Frame is composed of the crankshaft, the crossheads, the crosshead guides, connecting rods, bearings, lubrication lines, and diaphragm seal housings in a high-strength steel frame.

The patent pending Fluid End is composed of the valves, valve stops, springs, packing assembly, intake manifold, discharge flanges, tension bolts, and various access covers. The Fluid End is machined from a one-piece, high-strength steel forging. The two Fluid Ends will accept plunger sizes from 2.75 to 3.00 inches and 3.25 to 4.50 inches in diameter. A different packing assembly is required when switching between plunger sizes. The Fluid End is bolted to the Power Frame with 8 bolts. All bolts come with a preload indicator built into the face of the bolt to indicate when proper tension is achieved.

The Gear Reducer is composed of a fully supported helical AGMA #10 precision ground pinion and gear in a high strength steel case. The Gear Reducer's reduction ratio is 4.61:1 in the standard and Long Drive unit.

Pump Unit.

The following Dixie Iron Works/MSI Pump Unit was present at the survey. Pump Assembly A456982, Fluid End Assembly A457286, Gear Reduction Assembly A457566, and Power End Assembly A456985. With serial numbers as attached on each Part History Report.

Hull, P&I, Machinery, & Cargo Surveys / Owner's Representation / Class Record Reviews

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CONDITIONS NOTED

It is to be clearly understood that the conditions and/or status of items reported upon herein below are strictly the opinion of the undersigned and fairly reflect the finding made during the course of this survey. All statements of condition are made in comparison with new condition, as follows:

Our inspection incorporated witnessing one (1) newly manufactured 600hp triplex pump completing 1 million cycles at a full rod load of 100,000lbf.

Upon completion of the million cycle test, the pump was tested to Norsok Specification D-001 Rev 2, dated July 1998, for Drilling Facilities – Classification Norsok II (wells up to approximately 10.000m MD) Annex C requirements for Cementing Systems.

The witnessing was carried out both onsite and remotely via a camera that had been set up at the test location.

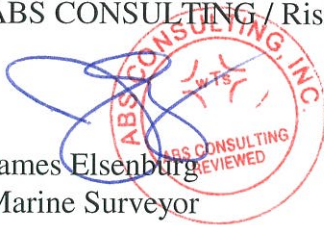
At the conclusion of the test, the undersigned surveyor did attend the disassembly of the pump to verify serial numbers with parts list provided at the start of the test. It was reported that the fluid end had been changed out at 581,726 cycles; however the fluid end was not considered part of the million cycle endurance test.

During the disassembly it was noted that the bearing race on the crank shaft at the gear reduction assembly had separated with no apparent damage to the bearings. There were no other deformities noted.

ISSUED WITHOUT PREJUDICE

ABS CONSULTING / Risk Consulting Division

James Elsenburg
Marine Surveyor



Attachments: Manufacturers Description
Manufacturers Test Procedures
Test results and check sheets

Hull, P&I, Machinery, & Cargo Surveys / Owner's Representation / Class Record Reviews

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Pump Endurance Test Procedure

*1,000,000 Cycles at Full Rod Load
&
NORSOK D-001 II*



TI-600 WELL SERVICE PUMP



MSI is a Division of Dixie Iron Works, Ltd.
300 West Main St.
Alice, TX 78332
(800) 242-0059
www.diwmsi.com



VARIABLE INPUT VALUES

Gear Reduction Ratio		$GR := 4.611$
Stroke Length		$L_s := 6.0\text{in}$
Plunger Diameter		$D_p := 3.0\text{in}$
Number of Plungers		$P_{no} := 3$
Mechanical HP (max input)		$HP_{in} := 600\text{hp} \quad HP_{in} = 447\text{ kW}$
Maximum Pinion Speed	$\text{rpm} := 2\pi \frac{\text{rad}}{\text{min}}$	$Pinion_{max} := 2100\text{rpm}$
Max Rod Load		$F_{rod} := 100000\text{lbf}$
Mechanical Efficiency		$ME := 90\%$

CALCULATED OUTPUT VALUES

Hydraulic Horsepower (max output)		$HP_{out} := ME \cdot HP_{in}$
		$HP_{out} = 540\text{ hp} \quad HP_{out} = 403\text{ kW}$
Rod Pressure Area		$A_{rod} := \frac{\pi D_p^2}{4}$
Max Pressure		$P := \frac{F_{rod}}{A_{rod}}$
		$P_{max} := \begin{cases} P & \text{if } 15000\text{psi} \geq P \geq 0 \\ 15000\text{psi} & \text{otherwise} \end{cases}$
		$P_{max} = 14147\text{ psi}$
Maximum Crankshaft Speed		$Crank_{max} := \frac{Pinion_{max}}{GR}$
		$Crank_{max} = 455\text{ rpm}$
Gallons per Revolution of Crank	$\text{rev} := 2\pi\text{rad}$	$Volume := A_{rod} \cdot L_s \cdot P_{no} \cdot \frac{1}{\text{rev}}$
		$Volume = 0.551 \frac{\text{gal}}{\text{rev}}$

MSI BREAK-IN PROCEDURE

Stage I

Length of Test	$Time_{33} := 60\text{min}$
Rod Load	$F_{33} := F_{rod} \cdot 33\%$ $F_{33} = 33000 \text{ lbf}$
Crankshaft Speed	$Crank_{33} := 143\text{rpm}$
Flowrate at Speed	$Q_{33} := \text{Volume} \cdot Crank_{33}$ $Q_{33} = 79 \text{ gpm}$
Pressure at 33% Load	$P_{33} := \frac{F_{33}}{A_{rod}}$ $P_{33} = 4669 \text{ psi}$
Power (Hydraulic)	$HP_{33} := P_{33} \cdot Q_{33}$ $HP_{33} = 214 \text{ hhp}$
Cycles at Speed	$Cyc_{33} := Crank_{33} \cdot Time_{33}$ $Cyc_{33} = 8580 \text{ rev}$

Stage II

Length of Test	$Time_{67} := 60\text{min}$
Rod Load	$F_{67} := F_{rod} \cdot 67\%$ $F_{67} = 67000 \text{ lbf}$
Crankshaft Speed	$Crank_{67} := 75\text{rpm}$
Flowrate at Speed	$Q_{67} := \text{Volume} \cdot Crank_{67}$ $Q_{67} = 41 \text{ gpm}$
Pressure at 67% Load	$P_{67} := \frac{F_{67}}{A_{rod}}$ $P_{67} = 9479 \text{ psi}$
Power (Hydraulic)	$HP_{67} := P_{67} \cdot Q_{67}$ $HP_{67} = 228 \text{ hhp}$
Cycles at Speed	$Cyc_{67} := Crank_{67} \cdot Time_{67}$ $Cyc_{67} = 4500 \text{ rev}$

Stage III

Length of Test	$\text{Time}_{100} := 60\text{min}$
Rod Load	$F_{100} := F_{\text{rod}} \cdot 100\%$ $F_{100} = 100000 \text{ lbf}$
Crankshaft Speed	$\text{Crank}_{100} := 57\text{rpm}$
Flowrate at Speed	$Q_{100} := \text{Volume} \cdot \text{Crank}_{100}$ $Q_{100} = 31 \text{ gpm}$
Pressure at 100% Load	$P_{100} := \frac{F_{100}}{A_{\text{rod}}}$ $P_{100} = 14147 \text{ psi}$
Power (Hydraulic)	$\text{HP}_{100} := P_{100} \cdot Q_{100}$ $\text{HP}_{100} = 259 \text{ hhp}$
Cycles at Speed	$\text{Cyc}_{100} := \text{Crank}_{100} \cdot \text{Time}_{100}$ $\text{Cyc}_{100} = 3420 \text{ rev}$

Stage IV

Length of Test	$\text{Time}_{20} := 30\text{min}$
Rod Load	$F_{20} := F_{\text{rod}} \cdot 20\%$ $F_{20} = 20000 \text{ lbf}$
Crankshaft Speed	$\text{Crank}_{20} := 143\text{rpm}$
Flowrate at Speed	$Q_{20} := \text{Volume} \cdot \text{Crank}_{20}$ $Q_{20} = 79 \text{ gpm}$
Pressure at 20% Load	$P_{20} := \frac{F_{20}}{A_{\text{rod}}}$ $P_{20} = 2829 \text{ psi}$
Power (Hydraulic)	$\text{HP}_{20} := P_{20} \cdot Q_{20}$ $\text{HP}_{20} = 130 \text{ hhp}$
Cycles at Speed	$\text{Cyc}_{20} := \text{Crank}_{20} \cdot \text{Time}_{20}$ $\text{Cyc}_{20} = 4290 \text{ rev}$

ENDURANCE TEST

Total Cycle Count

$$\text{Cycles} := 1000000 \text{ rev}$$

Stage 1, 50% of Cycles

Cycles at Full Rod Load

$$\text{Cyc}_1 := \text{Cycles} \cdot 50\%$$

$$\text{Cyc}_1 = 500000 \text{ rev}$$

Crankshaft Speed

$$\text{Crank}_1 := 120 \text{ rpm}$$

Hours at Speed

$$\text{Time}_1 := \text{Cyc}_1 \cdot \text{Crank}_1^{-1}$$

$$\text{Time}_1 = 69.4 \text{ hr} \quad \text{Time}_1 = 4167 \text{ min}$$

Flowrate at Speed

$$Q_1 := \text{Volume} \cdot \text{Crank}_1$$

$$Q_1 = 66 \text{ gpm}$$

Pressure at Full Rod Load

$$P_1 := P_{\text{max}}$$

Power at Test (Hydraulic)

$$\text{HP}_1 := Q_1 \cdot P_1$$

$$\text{HP}_1 = 545 \text{ hhp} \quad \text{HP}_1 = 407 \text{ kW}$$

Rod Load at Test

$$F_1 := P_1 \cdot A_{\text{rod}}$$

$$F_1 = 100000 \text{ lbf}$$

Stage 2, 50% of Cycles

Cycles at Full Rod Load

$$\text{Cyc}_2 := \text{Cycles} \cdot 50\%$$

$$\text{Cyc}_2 = 500000 \text{ rev}$$

Crankshaft Speed

$$\text{Crank}_2 := 140 \text{ rpm}$$

Hours at Speed

$$\text{Time}_2 := \text{Cyc}_2 \cdot \text{Crank}_2^{-1}$$

$$\text{Time}_2 = 59.5 \text{ hr} \quad \text{Time}_2 = 3571 \text{ min}$$

Flowrate at Speed

$$Q_2 := \text{Volume} \cdot \text{Crank}_2$$

$$Q_2 = 77 \text{ gpm}$$

Pressure at Full Rod Load

$$P_2 := P_{\text{max}}$$

Power at Test (Hydraulic)

$$\text{HP}_2 := Q_2 \cdot P_2$$

$$\text{HP}_2 = 636 \text{ hhp} \quad \text{HP}_2 = 475 \text{ kW}$$

Rod Load at Test

$$F_2 := P_2 \cdot A_{\text{rod}}$$

$$F_2 = 100000 \text{ lbf}$$

Completion of Test

Total Cycles at Full Rod Load

$$\text{Cyc}_{\text{SLB}} := \text{Cyc}_1 + \text{Cyc}_2$$

$$\text{Cyc}_{\text{SLB}} = 1000000 \text{ rev}$$

NORSOK D-001 II INTERMITTENT REQUIREMENTS

Stage A, 120 min Cycle Time

Pressure at Test	$P_A := 345 \text{ bar}$	$P_A = 5004 \text{ psi}$
Flowrate at Test	$Q_A := 45 \frac{\text{m}^3}{\text{hr}}$	$Q_A = 198 \text{ gpm}$
Crank Speed	$\text{Crank}_A := Q_A \cdot \text{Volume}^{-1}$	
	$\text{Crank}_A = 360 \text{ rpm}$	
Operating Time	$T_A := 120 \text{ min}$	
Cycles at Test	$\text{Cyc}_A := \text{Volume}^{-1} \cdot Q_A \cdot T_A$	
	$\text{Cyc}_A = 43165 \text{ rev}$	
Rod Load at Test	$F_A := P_A \cdot A_{\text{rod}}$	
	$F_A = 35370 \text{ lbf}$	
Power at Test (Hydraulic)	$\text{HP}_A := Q_A \cdot P_A$	
	$\text{HP}_A = 578 \text{ hhp}$	$\text{HP}_A = 431 \text{ kW}$

Stage B, 120 min Cycle Time

Pressure at Test	$P_B := 690 \text{ bar}$	$P_B = 10008 \text{ psi}$
Flowrate at Test	$Q_B := 24 \frac{\text{m}^3}{\text{hr}}$	$Q_B = 106 \text{ gpm}$
Crank Speed	$\text{Crank}_B := Q_B \cdot \text{Volume}^{-1}$	
	$\text{Crank}_B = 192 \text{ rpm}$	
Operating Time	$T_B := 120 \text{ min}$	
Cycles at Test	$\text{Cyc}_B := \text{Volume}^{-1} \cdot Q_B \cdot T_B$	
	$\text{Cyc}_B = 23022 \text{ rev}$	
Rod Load at Test	$F_B := P_B \cdot A_{\text{rod}}$	
	$F_B = 70740 \text{ lbf}$	
Power at Test (Hydraulic)	$\text{HP}_B := Q_B \cdot P_B$	
	$\text{HP}_B = 617 \text{ hhp}$	$\text{HP}_B = 460 \text{ kW}$

Stage C, 120 min Cycle Time

Pressure at Test

$$P_C := 1035 \text{ bar} \quad P_C = 15011 \text{ psi}$$

Flowrate at Test

$$Q_C := 14 \frac{\text{m}^3}{\text{hr}} \quad Q_C = 62 \text{ gpm}$$

Crank Speed

$$\text{Crank}_C := Q_C \cdot \text{Volume}^{-1}$$

$$\text{Crank}_C = 112 \text{ rpm}$$

Operating Time

$$T_C := 120 \text{ min}$$

Cycles at Test

$$\text{Cyc}_C := \text{Volume}^{-1} \cdot Q_C \cdot T_C$$

$$\text{Cyc}_C = 13429 \text{ rev}$$

Rod Load at Test

$$F_C := P_C \cdot A_{\text{rod}}$$

$$F_C = 106109 \text{ lbf}$$

Power at Test (Hydraulic)

$$\text{HP}_C := Q_C \cdot P_C$$

$$\text{HP}_C = 540 \text{ hhp} \quad \text{HP}_C = 403 \text{ kW}$$

Completion of Test

Total Cycles

$$\text{Cyc}_{\text{NORSOK}} := \text{Cyc}_A + \text{Cyc}_B + \text{Cyc}_C$$

$$\text{Cyc}_{\text{NORSOK}} = 79616 \text{ rev}$$

Scheduled Hours of Testing

$$\text{Time} := \text{Time}_{33} + \text{Time}_{67} + \text{Time}_{100} + \text{Time}_{20} + \text{Time}_1 + \text{Time}_2 + T_A + T_B + T_C$$

$$\text{Time} = 138 \text{ hr}$$