URS

May 2, 2011

Mr. Steven F. Nightingale, P.E.
Manager, Permit Section
Illinois Environmental Protection Agency
Bureau of Land
1021 North Grand Avenue East
Springfield, Illinois 62794

Subject: **Construction Completion Report**
Roxana, Illinois
119115002 – Madison County
Equilon Enterprises LLC d/b/a Shell Oil Products US
Log No. B-43-CA-16 and 18

Dear Mr. Nightingale:

On behalf of Shell Oil Products US, URS Corporation is submitting the enclosed Construction Completion Report for the groundwater depression and oil recovery systems at the WRB Refining LP Wood River Refinery. Submittal of this report was required by Conditions 16 and 17 of the Agency's letter dated August 5, 2010.

If you have any questions during your review, please contact Kevin Dyer, SOPUS project manager, at kevin.dyer@shell.com (618/288-7237), or me at bob_billman@urscorp.com (314/743-4108).

Sincerely,

Robert B. Billman
Senior Project Manager

Enclosures: RCRA Corrective Action Certification and Report (original plus 2 copies)

Cc: Kevin Dyer, SOPUS
Eric Petersen, ConocoPhillips

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REPORT

CONSTRUCTION COMPLETION REPORT

WRB REFINING LP
WOOD RIVER REFINERY
ROXANA, ILLINOIS

Prepared for

Shell Oil Products US
17 Junction Drive
PMB #399
Glen Carbon, IL 62034

May 2011

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SECTION ONE Introduction

This Construction Completion Report (CCR) presents information regarding the Wood River Refinery (WRR) groundwater depression and oil recovery systems, as requested by the Illinois Environmental Protection Agency (IEPA) in a letter dated August 5, 2010, and in accordance with required contents included therein.

1.1 SITE BACKGROUND

The WRR was operated by Shell Oil Company and subsequent owners until ownership changed to ConocoPhillips (COP) effective June 1, 2000. WRB Refining LLC (WRB), formed January 1, 2007, was a 50/50 joint venture between COP and EnCana US Refineries, LLC. On December 31, 2010, WRB Refining LLC was converted into a limited partnership named WRB Refining LP with limited partners COP and Cenovus US Refinery Holdings. This conversion has the legal effect similar to a name change only. WRB is now the legal owner of the Wood River Refinery (WRR). Over 800 COP employees currently operate the facility. Equilon Enterprises LLC (d/b/a Shell Oil Products US (SOPUS)) retains its pre-sale environmental liabilities at the site. SOPUS remains as a co-operator for certain assets at the site, and is working with the assistance of COP on several environmental projects and programs.

The WRR is located at 900 South Central Avenue in Roxana, Illinois. The refinery occupies approximately 1,800 acres in Wood River Township, Madison County. The location of the site is shown in **Figure 1**. The facility is composed of five areas:

- North Property – This area contains storage tanks and most of the current and past waste management areas. The northern, undeveloped acreage of this property is leased out as farmland. A process water well field, called the "North Property Wells," is also located in this area.
- Main Property – This area contains the main refinery process units, maintenance shops, and administrative buildings.
- Southwest Property – This area contains the crude oil storage tanks and a storm water pond. A small portion of this property is leased out as farmland.
- West Property – This area contains the Wastewater Treatment Plant (WWTP), sulfur recovery units and storage tanks.

- Riverfront Property – This area contains the effluent polishing lagoons and barge loading facilities. A process water well field, called the "River Wells," is also located on this property.

The current crude oil processing capacity of the refinery is over 300,000 barrels (bbl) per day (bpd), and is expected to increase to over 360,000 bpd after the current expansion projects are completed.

COP's process for refining crude oil requires approximately 10,000 gallons per minute (gpm) of water. A variable portion of this is supplied by groundwater depression wells on the North and Main Properties.

2.0 GEOLOGY AND HYDROGEOLOGY

The site and surrounding area are located within the Mississippi River flood plain in the northernmost extension of an area known as American Bottoms.

2.1 GEOLOGY

Over geologic time, the river has meandered over its floodplain, depositing various layers of fine and coarse material. This has resulted in recent alluvial deposits consisting of a complex, heterogeneous sequence of interbedded sands, silts, and clays throughout the floodplain. Valley fill in the vicinity of the WRR has a thickness ranging from 100 to 170 feet, composed mostly of recent alluvium and glacial valley-train material. The permeable sands and gravels in the unconsolidated valley fill provide a large supply of groundwater.

Regional floodplain material consists of recent alluvial deposits overlying Pleistocene glacial outwash. Subsurface conditions underlying the WRR generally consist of two primary strata, a layer of shallow silty clay, underlain by sands with occasional interbedded silt or clay layers. An examination of cross-sections through the vicinity indicates the presence of fine to medium sands with increasing silt and clay content near the surface. The underlying glacial outwash deposits consist of more uniform sands and gravels that extend to bedrock.

Moisture content, bulk density, grain size distribution, and hydraulic conductivity measurements were completed on many previously collected soil samples. Atterburg limits were determined for samples that were of sufficient plasticity (generally clay and silt samples). Results of these analyses are provided in **Table 1**. Additional details regarding site geology and hydrogeology are included in the May 30, 2008 RCRA Post Closure Permit Application.

These alluvial and glacial materials overlie Mississippian and Pennsylvanian Age bedrock, primarily limestone and dolomite, interbedded with lesser amounts of sandstone and shale. Numerous wells and other test borings have been drilled on the WRR property. The results of various deep borings on the WRR property have shown the depth to bedrock to range from 100 to as much as 170 feet below ground surface.

A summary of groundwater well construction information is included as **Table 2**. Boring logs and the well construction details for groundwater depression wells are provided in **Appendix A.**

2.2 HYDROGEOLOGY

Glacial outwash sand deposits of the American Bottoms Aquifer underlying the WRR are a primary source for large volume water production. The depth to groundwater within the aquifer is typically measured at approximately 25 to 40 feet bgs, resulting in a 15 to 30 foot thick vadose (unsaturated) zone within the sand.

Though compiled for this report, the following information was originally presented in a Resource Conservation and Recovery Act (RCRA) Part B permit:

- Previous shallow hydraulic conductivity determinations were conducted in a laboratory under confining pressures approximating the depth from which the samples were collected. These conductivity values provided an indication of the relative differences between horizons within the sands and clays of the vadose zone. Due to the orientation of the sample when collected and when analyzed in the laboratory, the values may be more representative of vertical conductivity than horizontal conductivity. Hydraulic conductivities determined for the surface 3 to 6 feet of soil indicate a range of 1.43×10^{-6} to 6.15×10^{-4} cm/sec.
- Slug tests have been conducted on existing WRR monitoring wells to provide a more representative measurement of horizontal in-situ hydraulic conductivity for depths greater than 6 feet. Hydraulic conductivity values determined from slug tests provide a measurement that is representative of the volume of aquifer material in the immediate vicinity of the screened interval of the well. The medium sands below 6 feet in depth show conductivities of 1.35×10^{-4} to 8.19×10^{-4} cm/sec, similar to values for the deeper sands (3.33×10^{-3} to 1.57×10^{-5}).

Due to historical pipeline and tank leaks, a hydrocarbon plume is present on the aquifer under the North Property area. As a result, hazardous constituents have been detected in groundwater at statistically significant concentrations when compared to the background wells. A Corrective Action Program (CAP) for Main and North properties of the WRR has been in place for a number of years to mitigate potential impact on human health and the environment. This program was formalized with the issuance of a RCRA Part B permit in November 1989, including groundwater corrective action, which has required extensive groundwater monitoring efforts. The Part B permit was revised and re-issued in October 2010.

The current CAP includes continued pumping of site groundwater depression wells to maintain an inward gradient for on-site containment of any hazardous constituents entering the groundwater. Pumping of water in the interior production wells contributes to creation of a cone of depression, which subsequently provides an inward gradient at site boundaries.

2.3 GROUNDWATER LEVELS

Groundwater at the site and surrounding area is recharged by precipitation and surface water infiltration from bodies of water within the vicinity. Though groundwater is hydraulically connected with the Mississippi River, given the large distance (approximately 1.5 miles) from the river, along with high-volume groundwater pumping at the WRR and BP facilities, water level fluctuations due to river rise take longer to occur, and the magnitude of the fluctuations are muted in comparison to observations at locations further west (**Figure 2**).

The site hydraulic gradients are largely a manifestation of the effects of groundwater pumping centers. Based on the observed pattern of the water table, groundwater flow (as indicated by individual flow lines that are normal to the equipotential lines) is toward cones of depression created at the pumping centers. Gradients created by continued groundwater pumping subsequently capture potential contaminants within these cones of depression.

Depth to groundwater level measurements have been routinely collected on a quarterly basis since 1989 in many monitoring wells on the WRR property, and are summarized by water level contour maps. The water level contours show the effects of individual pumping centers and the cumulative effects on the local configuration of the water table. Hydraulic gradients for the region and WRR for recent years are shown in **Table 3**. A list of monitoring wells used to measure depth to groundwater at the WRR, and subsequently monitor hydraulic gradient is included in **Table 4**.

SECTION THREE Detailed As-Built Drawings

Plan views of the WRR groundwater depression and oil recovery wells are included in **Figures 3** and **4**. Additional equipment details and respective drawings are included in **Appendices B** and **C**.

COP bases the groundwater pumping rate on their need for process water at a given time. Generally, COP needs between ~2,500 to 4,000 gpm from the Main and North Properties, but that rate fluctuates seasonally based on ambient temperature and cooling water demand. The required water amount dropped to approximately 2,600 gpm in January 2011. The 1st quarter 2011 gauging was conducted on January 13-14, 2011. The groundwater contour map developed from this gauging information does not show control along the west fence line of North Property. At the request of SOPUS, COP subsequently increased pumping in order to improve gradient control (**Figure 2**), and weekly gauging has been conducted to monitor changes in same.

4.1 GROUNDWATER DEPRESSION WELLS

There are currently 17 water wells on-site, of which 12 are operating continuously to provide cooling water for refinery operations. These wells range in depth from approximately 100 feet to 140 feet. Wells located within the interior of North property contain pumps rated at 500 gpm, with current flow ranges of 230 to 440 gpm, while wells along the west fence line of North Property contain pumps rated at 135 gpm, with current flow ranges of 100 to 130 gpm. Well construction information, along with pump/motor specifications, is included in **Table 2**. Monthly water pumping rates are included in **Table 5**.

In an effort to contain any hydrocarbons on-site via hydraulic gradient control, operation of groundwater depression wells provides a cone of depression created on the North Property that extends outward toward the WRR property boundary. This containment is monitored by the generation of contour maps (**Figure 5**). Similar contour maps have been developed on a periodic basis (typically quarterly) and submitted to the IEPA since the beginning of the current RCRA permit in 1989. An operating manual for the groundwater depression wells is provided in **Appendix B**. In addition to providing WRR with cooling water, the operation of this system of pumping wells is intended to also satisfy condition IV(A)(1) of the of the RCRA Part B Permit which states "…control of horizontal and vertical groundwater flow in the uppermost aquifer such that groundwater flow is towards the interior of the facility along the combined boundaries of North and Main properties."

4.2 OIL RECOVERY WELLS

Condition IV(A)(4) of the of the RCRA Part B Permit requires "…removal of a hydrocarbon layer present on top of the water table beneath portions of the North and Main Properties….."

SECTION FOUR Technical Specifications

A cone of depression created by pumping centers causes free phase petroleum hydrocarbons sitting on top of the water surface to migrate toward, and accumulate at, or near the pumping center. As a result, 16 recovery wells and pumps have been installed adjacent to the groundwater depression wells to remove light non-aqueous phase liquids (LNAPL, a/k/a "oil"), where present, from the uppermost aquifer within the WRR, in accordance with a RCRA Part B Permit requirement for LNAPL recovery. The wells are fully screened 6-inch diameter stainless steel wells, approximately 80 to 100 feet in depth. The top 10 feet of well casing is riser, with the remaining length comprised of slotted casing to allow flow into the well. The locations of the oil recovery wells are shown on **Figures 3** and **4**.

Recovered LNAPL is pumped directly from the recovery wells via Grundfos submersible pumps into Tank F-67 where the LNAPL is dewatered. The separated water is pumped into the benzene National Emission Standards for Hazardous Air Pollutants (NESHAP) header for treatment in the National Pollutant Discharge Elimination System (NPDES) permitted Waste Water Treatment Plant (WWTP). The recovered LNAPL is then reprocessed in the Distilling unit. Monthly quantities of recovered oil are presented in **Table 6**.

Increases in Tank F-67 levels are monitored and used in a computer algorithm to determine, and subsequently log the amount of oil recovered per day. In addition, the total oil pumped to the Distilling unit is measured with a flow meter. Almost 330,000 bbl have been recovered by this oil recovery system since 1995. Tank F-67 was taken out of service in May 2009 for planned inspections and maintenance. As of August 2010, Tank F-67 was back in service. As of the date of this submission, three skimming wells are currently feeding the recovery system and the NESHAP header is available to send water to the WWTP. An operating manual for the oil recovery wells is provided in **Appendix C**.

SECTION FIVE Deviation from Conceptual Design

The current groundwater depression and oil recovery systems have evolved throughout the past 70 years in conjunction with operation of the WRR. Therefore, there cannot be a comparison to the conceptual design.

SECTION SIX Construction Quality Assurance/Quality Control

On-site work has been, and will be directed by employees operating the WRR. As such, any maintenance, repair or installation activities will be managed by COP personnel. However, future well/pump maintenance or well installation may require the use of a drilling subcontractor. The selected drilling subcontractor will report directly to COP operations personnel for technical quality control and project oversight.

Quality Assurance/Quality Control criteria are established for well installation/repair activities as part of the job setup.

SECTION SEVEN Schedule

Installation of water and oil recovery wells has been ongoing, as needed by WRR production over the last 70 years. Schedules are developed for project scopes of work as they arise.

SECTION EIGHT Waste Management

Investigative derived waste (IDW) potentially including soil cuttings, decontamination/cleaning fluids, personal protective equipment (PPE), and expendable materials will be collected and disposed of in accordance with SOPUS and WRR requirements, and managed by COP personnel. Expendable materials having a low probability of contamination (e.g., disposable equipment, such as gloves and tubing) will be collected in trash bags and disposed as municipal waste.

Impacted expendable materials and soil cuttings will be collected and placed in labeled and sealed 55-gallon drums or roll-off containers for disposal. Purge water from any of the wells, along with cleaning and/or decontamination fluids will be collected and disposed, per a COP permit, through the refinery's NPDES-permitted WWTP. Soil cuttings and fluids may be sampled for waste characterization as part of the disposal profile process.

SECTION NINE Permitting

SOPUS and COP require certain permits for work conducted at WRR. Appropriate permits will be determined, coordinated, and generated by WRR personnel for each scope of work.

SECTION TEN Operations and Maintenance

With the exception of water wells W-84 and W-85, the site groundwater depression wells range from ~10 to ~30 years in age (**Table 2**). The flow from each of the operating groundwater depression well ranges between 100 and 440 gpm. Emphasis will shift to strengthening the cone of depression within the interior of the WRR, rather than on the west fence line. Due to the loss of well W-82, it will be replaced in the second quarter of 2011, based on the following planned schedule (new well will be referred to as W-86):

- 4/12/11: Hydro-excavate well location to confirm no obstructions.
- Week of 4/25: Drill test hole down ~115' – 125' below ground surface (bgs)
- 5/2 – 5/13: Order Casing, analyze data, etc.
- Week of 5/16: Drill test well
- 5/23 – 5/26: Install well casing and grout
- 5/30 – 6/3: Pump test
- 5/30 – 6/29: Install piping and complete E/I scope.

In addition, well W-76 was taken off line for cleaning and found that the casing has collapsed. An attempt to reline the well is scheduled for the week of May 2, 2011. Replacement of well W-82 and repairs to well W-76 will both increase water production and facilitate better gradient control. Once new W-86 replacement well is online, and W-76 is again operating, the additional capacity will allow for shut down of other wells for inspection and maintenance activities in accordance with the maintenance plan.

Information and additional details related to current operation and maintenance of the groundwater depression wells and the oil recovery system are available in **Appendices B** and **C**, respectively.

SECTION ELEVEN References

Illinois Environmental Protection Agency (IEPA). August 5, 2010. Letter sent to Shell Oil Products US and ConocoPhillips.

Shell Oil Products US and ConocoPhillips. May 30, 2008. *RCRA Post-Closure Permit Application*. Prepared by URS Corporation.

Shell Oil Products US and WRB Refining LP Wood River Refinery. September 23, 2010. *RCRA Post-Closure Permit*.

Tables

Table 1
Soil Properties

Boring ID	Sample Depth	Material Classification		Moisture Content	Bulk Density	Porosity	Hydraulic Conductivity	Atterberg Limits		% Passing #200 Sieve
	(ft bgs)	USCS	Description	(% dry wt)	(lbs/ft^3)	(%)	(cm/sec)	Liquid Limit	Plasticity Index	
B-1	0.5 - 1.5	ML	Fine Sandy Silt	9.4	--	--	--	--	--	58.9
	3.0 - 3.5	SM	Silty Fine Sand	5.9	108.1	34.7	$1.43x10^{-6}$	--	--	41.5
	6.0 - 6.5	SP	Medium Sand	15.8	--	--	--	--	--	6.4
	8.0 - 8.5	SP	Medium Sand	19.4	98.7	40.3	$4.53x10^{-4}$	--	--	9.3
	11.0 - 11.5	SP	Medium Sand	20.2	--	--	--	--	--	3.2
	13.0 - 13.5	SP	Medium Sand	14.5	101.2	38.8	$5.89x10^{-4}$	--	--	1.8
B-2	10. - 1.5	SM	Silty Fine Sand	11.3	--	--	--	Non-Plastic		40.0
	3.0 - 3.5	SP	Medium Sand	7.7	107.1	33.9	$3.58x10^{-5}$	Non-Plastic		23.2
	6.0 - 6.5	SC	Clayey Medium Sand	14.2	--	--	--	--	--	24.9
	8.0 - 8.5	SP	Medium Sand	15.8	106.6	34.8	$5.59x10^{-5}$	--	--	7.3
	11.0 - 11.5	SP	Medium Sand	23.4	--	--	--	Non-Plastic		29.9
	13.0 - 13.5	SP	Medium Sand	12.6	103.4	36.8	$8.58x10^{-4}$	--	--	2.1
B-3	1.0 - 1.5	CL	Silty Clay w/ Fine Sand	10.4	--	--	--	18	2	65.8
	3.0 - 3.5	CL	Sandy Clay	10.2	101.1	38.9	$1.35x10^{-5}$	--	--	66.4
	6.0 - 6.5	SP	Medium Sand	4.9	--	--	--	--	--	3.8
	8.0 - 8.5	SP	Medium Sand	16.9	96.6	41.6	$5.40x10^{-4}$	--	--	6.1
	10.5 - 11.0	SP	Medium Sand	18.1	--	--	--	--	--	5.0
	13.0 - 13.5	SP	Medium Sand	23.2	--	--	--	--	--	4.1
B-4	1.0 - 1.5	ML	Fine Sandy Silt	11.0	--	--	--	--	--	67.4
	3.0 - 3.5	CL	Silty Clay	20.2	102.2	37.5	$9.12x10^{-8}$	Non-Plastic		83.2
	6.0 - 6.5	SP	Medium Sand	11.1	--	--	--	40	21	20.1
	8.0 - 8.5	SP	Medium Sand	7.7	89.9	45.0	$3.78x10^{-3}$	--	--	2.4
	10.5 - 11.0	SP	Medium Sand	19.1	--	--	--	--	--	5.0
	13.0 - 13.5	SP	Medium Sand	11.1	--	--	--	--	--	2.1
B-5	1.0 - 1.5	SM	Silty Fine Sand	9.6	--	--	--	Non-Plastic		43.3
	3.0 - 3.5	SM	Silty Fine Sand	10.4	93.4	43.5	$6.15x10^{-4}$	--	--	44.1
	6.0 - 6.5	SP	Medium Sand	4.1	--	--	--	--	--	3.1
	8.0 - 8.5	SP	Medium Sand	6.7	99.5	39.9	$33.3x10^{-3}$	--	--	2.0
	10.5 - 11.0	SP	Medium Sand	5.9	--	--	--	Non-Plastic		1.1
	13.0 - 13.5	SP	Medium Sand	6.2	--	--	--	--	--	1.3
D-1	6.0 - 6.5	SP	Medium Sand	16.9	99.4	39.9	$1.57x10^{-5}$	--	--	4.0
	21.0 - 21.5	SW	Medium Sand	13.2	112.8	.1.8	$6.53x10^{-4}$	--	--	1.3
	40.5 - 41.0	SP	Fine Sand	20.9	98.6	39.7	$4.97x10^{-4}$	--	--	1.9
	66.5 - 67.0	SP	Fine Sand	16.1	107.9	34.0	$1.35x10^{-4}$	--	--	4.8
	96.5 - 97.0	SW	Clayey Sand	10.9	125.8	23.1	$1.55x10^{-6}$	--	--	8.5
	116.5 - 117.0	SP	Clayey Sand	15.9	113.7	30.5	$5.32x10^{-5}$	--	--	11.6
	135.5 - 136.0	CL	Silty Sand	14.9	118.9	27.3	$1.07x10^{-7}$	--	--	75.1
D-2	6.5 - 7.0	ML	Fine Sandy Silt	38.3	77.1	53.4	$7.00x10^{-7}$	--	--	94.4
	117.0 - 117.5	ML	Clayey Silt	15.3	121.9	25.5	$1.46x10^{-7}$	--	--	71.5
D-3	18.5 - 19.0	SP	Fine to Medium Sand	19.4	100.3	39.4	$5.07x10^{-4}$	--	--	3.2
	62.5 - 63.0	SP	Fine to Medium Sand	14.6	109.4	33.1	$2.96x10^{-4}$	--	--	2.4
D-4	25.5 - 26.0	SP	Fine to Coarse Sand	26.4	87.9	46.9	$8.19x10^{-4}$	--	--	11.2
	97.5 - 98.0	SW	Fine to Coarse Sand	14.4	110.6	32.4	$3.91x10^{-4}$	--	--	2.3
	117.5 - 118.0	SW	Fine to Coarse Sand	19.1	107.9	34.0	$8.08x10^{-4}$	--	--	6.7

Notes:
Source: Shell Oil Company, WRMC, November 15, 1988
bgs = below ground surface
USCS = Unified Soil Classification System
Dash indicates analysis not performed for sample

Table 2
Water Well Construction Information

Well #	Date Installed	Well Screen Material	Well Diameter (in)	Total Depth (ft bgs)	Screened Interval (ft bgs)	Screen Length (ft)	Estimated Ground Surface Elevation (ft MSL)	Estimated Screened Interval Elevation (ft MSL)	Average Flow (GPM)	Pump Rating Flow at Head	Pump Manufacturer	Pump Model	Pump Stages	Motor (Horsepower)	Motor Manufacturer	Status
Main Property Well																
W-68	12/1/1968	SS	20	130.00	90.00 - 130.00	40	441	351 - 311	250	500 GPM @ 300 FT	Byron Jackson	10MQL	8	60	Byron Jackson	Operating
North Property Wells																
Interior Wells																
W-39	8/1942	PC	30	137.00	67.00 - 137.00	70	444	377 - 307	230	500 GPM @ 300 FT	Johnston (now Sulzer)	12AC	8	60	Hitachi	Out of service (1)
W-42	8/5/1942	PC	20	138.00	68.00 - 138.00	70	445	377 - 307	440	500 GPM @ 300 FT	Johnston (now Sulzer)	12AC	5	60	Hitachi	Operating
W-69	3/25/1978	SS	20	140.00	90.00 - 140.00	50	445	355 - 305	300	500 GPM @ 300 FT	Byron Jackson	VC-1KH	8	60	Byron Jackson	Operating
W-70	8/1978	SS	20	136.50	96.50 - 136.50	40	445	349 - 309	NA	500 GPM @ 300 FT	Byron Jackson	10MQL	8	60	Byron Jackson	Operating
W-72	7/26/1982	SS	20	137.00	97.00 - 137.00	40	445	348 - 308	NA	500 GPM @ 300 FT	Byron Jackson	10MQL	8	60	Byron Jackson	Operating
W-73	8/16/1982	SS	20	135.00	95.00 - 135.00	40	445	349 - 309	230	500 GPM @ 300 FT	Byron Jackson	10MQL	8	60	Byron Jackson	Out of service (1)
W-75	12/1987	SS	20	140.00	110.00 - 140.00	30	445	335 - 305	440	500 GPM @ 300 FT	Byron Jackson	10MQL	9	60	Byron Jackson	Operating
W-76	12/1987	SS	20	140.00	110.00 - 140.00	30	443	333 - 303	230	500 GPM @ 300 FT	Byron Jackson	10MQL	8	60	Byron Jackson	Out of service (2)
W-82	12/10/2002	SS	20	120.00	100.00 - 120.00	20	445	345 - 325	NA	NA	NA	NA	NA	NA	NA	Out of service (3)
W-84	6/2008	SS	20	137.00	106.00 - 136.00	30	445	339 - 309	NA	500 GPM @ 300 FT	Johnston (now Sulzer)	10MQL	5	15	Hitachi	Operating
West Fence Line Wells																
W-77	4/30/1990	SS	20	142.00	112.00 - 142.00	30	444	332 - 302	100	135 GPM @ 235 FT	Johnston (now Sulzer)	7BC	14	15	Hitachi	Operating
W-78	5/2/1990	SS	20	138.33	108.33 - 138.33	30	443	335 - 305	130	135 GPM @ 235 FT	Johnston (now Sulzer)	7BC	14	15	Hitachi	Operating
W-79	5/9/1990	SS	20	134.92	104.92 - 134.92	30	443	338 - 308	NA	135 GPM @ 235 FT	Johnston (now Sulzer)	7BC	14	15	Hitachi	Operating
W-80	5/10/1990	SS	20	135.83	105.82 - 135.83	30	443	337 - 307	125	135 GPM @ 235 FT	Johnston (now Sulzer)	7BC	14	15	Hitachi	Operating
W-81	5/14/1990	SS	20	129.00	99.00 - 129.00	30	444	345 - 315	NA	135 GPM @ 235 FT	Johnston (now Sulzer)	7BC	14	15	Hitachi	Operating
W-85	3/2010	SS	24	101.90	76.9 - 101.9	25	444	367 - 342	NA	500 GPM @ 300 FT	NA	NA	NA	NA	NA	Operating

NOTES:

SS = Stainless Steel

PC = Porous Concrete

NA = Not Available

(1) Well is not repairable

(2) Well scheduled for new liner week of May 2, 2011.

(3) Scheduled for replacement 2nd Quarter 2011

Table 3
Groundwater Flow Rate in the Main and North Properties

Quarter	Regional Gradient (ft/ft)	Regional Velocity (ft/day)	WRR Gradient (ft/ft)	WRR Velocity (ft/day)
3Q2008	14 / 7900	0.086115818	4 / 1200	0.161979753
4Q2008	12 / 7770	0.075048534	4 / 1440	0.134983127
1Q2009	13 / 6700	0.094286722	3 / 1100	0.132528888
2Q2009	12 / 8500	0.068603189	4 / 1050	0.185119717
3Q2009	17 / 4900	0.168591171	4 / 2400	0.080989876
4Q2009	16 / 5500	0.141364148	3 / 1850	0.078800961
1Q2010	18 / 5465	0.160053186	3 / 2009	0.072564349
2Q2010	17 / 4675	0.176705185	2 / 2010	0.048352165
3Q2010	17 / 5300	0.155867309	2 / 1960	0.049585639
4Q2010	16 / 5558	0.139888955	2 / 2377	0.04088677

Note:
Data previously presented in semi-annual groundwater monitoring reports

Table 4
Wells to be Gauged Quarterly to Contour Hydraulic Gradient

WELL ID	X-COORD. Easting	Y-COORD. Northing
P-1U	6160.24	674.49
P-4U	5803.48	1286.31
P-5L	5794.42	1558.27
P-5U	5795.22	1558.13
P-6U	5792.81	1810.22
P-7U	5820.98	2055.71
P-8U	5362.26	1956.44
P-9U	4756.98	1927.46
P-11L	5364.07	1292.17
P-11U	5364.6	1291.98
P-12L	7478.65	1250.65
P-12U	7478.02	1250.33
P-13	7474.51	1302.51
P-14	6149.83	676.53
P-15	5801.97	1295.32
P-16	5792.72	1823.83
P-17	6773.71	2521.5
P-43	5412.23	1292.87
P-47	-6369.84	103.57
P-51	-6417.58	548.31
P-52	1154.9	5116.81
P-53	-116.69	3972.87
P-54	-761.34	1658.27
P-55	-5.57	2067.36
P-56	35.41	1072.88
P-57	36.92	554.78
P-58	82.37	181.59
P-59	35.3	1280.51
P-60	18.77	1781.56
P-61	512.71	1284.65
P-62	797.09	1537.03
P-63	1486.39	1542.51
P-64	1864.74	1522.27
P-65	1685.36	772.64
P-66	77.07	-63.3
P-67	775.16	-609
P-68	173.9	1743.06
P-69	255.72	1557.17

WELL ID	X-COORD. Easting	Y-COORD. Northing
P-70	517.57	1476.57
P-71	1012.9	712.66
P-72	1140.39	329.69
P-73	562.91	475.92
P-74	203.84	1333.09
P-75	382.85	-96.68
P-81	-4387.28	-1365.24
P-81A	6740.33	-2765.58
P-81B	6750.86	-2766.53
P-81C	6739.15	-2755.03
P-81D	6749.78	-2756.05
P-82A	1097.3	-2060.43
P-82B	1096.96	-2070.22
P-82C	1098.31	-2081.29
P-82D	1094.8	-2048.3
P-83A	2592.37	3098.77
P-83B	2591.77	3088.05
P-83C	2581.48	3097.55
P-83D	2582.39	3087.58
P-84A	739.06	3265.03
P-84B	752.18	3265.7
P-84C	753.31	3276.01
P-84D	738.72	3275.01
P-85B	6841.96	-565.98
P-85C	6845.75	-558.51
P-85D	6849.49	-548.78
P-86A	7449.7	1259.94
P-86B	7450.42	1270.28
P-86C	7436.79	1257.96
P-86D	7436.46	1270.32
P-87B	6748.59	2520.58
P-87C	6725.77	2524
P-87D	6717.09	2525.37
P-88A	3152.97	-2717.53
P-88B	3163.48	-2718.12
P-88C	3173.19	-2718.32
P-88D	3148.11	-2709.76
P-89B	4537.08	850.39

Table 4
Wells to be Gauged Quarterly to Contour Hydraulic Gradient

WELL ID	X-COORD. Easting	Y-COORD. Northing
P-89C	4535.83	840.4
P-89D	4531.5	870.34
P-90A	2992.75	-722.07
P-90B	3001.81	-785.49
P-90C	3000.62	-796.58
P-90D	2990.67	-792.77
P-91A	2229.65	1730.09
P-91B	2227.97	1763.48
P-91C	2229.4	1751.36
P-91D	2230.08	1741.72
P-92A	1905.43	1015.99
P-92B	1903.92	1026.83
P-92C	1927.51	1014.52
P-92D	1928.5	1025.08
P-93A	62.65	430.03
P-93B	53.47	450.97
P-93C	49.61	439.06
P-93D	50.79	429.5
P-94	4874.36	2656.24
P-95	4729.02	-2769
P-98	7740.03	-100.53
P-99	8072.71	-1465.67
P-102	5096.91	-1379.14
P-103	-2254.67	-4612.14
P-108	-611.34	-4505.7
P-109	465.83	-3938.01
P-114	-1109.32	-341.95
P-115	-1284.12	-496.06
P-116	-1467.87	-458.05
P-117	-1614.34	-335.9
P-118	-2057.47	-409.82
P-119	-367.4	-520.04
P-120	-530.97	-1133.04
P-121	1476.79	-3874.61
P-122	-977.94	-2927.45
P-123	-16.61	-2936.56
P-124	743.18	-2942.03
P-125	-1687.01	-3626.05

WELL ID	X-COORD. Easting	Y-COORD. Northing
P-126	-783.04	-3353.24
P-127	-313.33	-3393.04
P-128	1081.95	-3400.44
P-129	-3141.62	-194.38
S-1	1162.98	666.92
T-1	34	2426
T-2	871	2325
T-3	1817.52	1988.87
T-4	2994.6	1459.3
T-5	1680.63	233.39
T-6	82.16	614.22
T-7	754.12	-608.48
T-8	-2577.63	-2922.46
T-12	24.65	1611.19
T-13	-5.59	2735.65
T-15	1401.53	2686.05
T-17	3946.33	2632.35
T-18	4445.7	594.1
T-19	2995.24	1342.76
T-20	2797.35	-619.73
T-21	5111.41	-2520.18
T-22	2221.46	-2738.04
T-23	902.86	-1839.27
T-24	488.01	1767.82
T-27	3114.26	2867.21
T-37	4528.3	858.23
T-38	5140.33	569.84
T-41	6840.4	-575
T-42	8063.9	-995.55
T-43	7499.13	-1738.35
T-44	7694.41	-1901.51
T-46	1336.32	-3305.05
T-51	8732.42	-1216.96
T-52	8727.14	-375.51
T-58	-2027.62	-4150.5
T-62	-695.65	-788.35
T-63	-1146.78	-834.26
T-64	-1810.41	-849.45

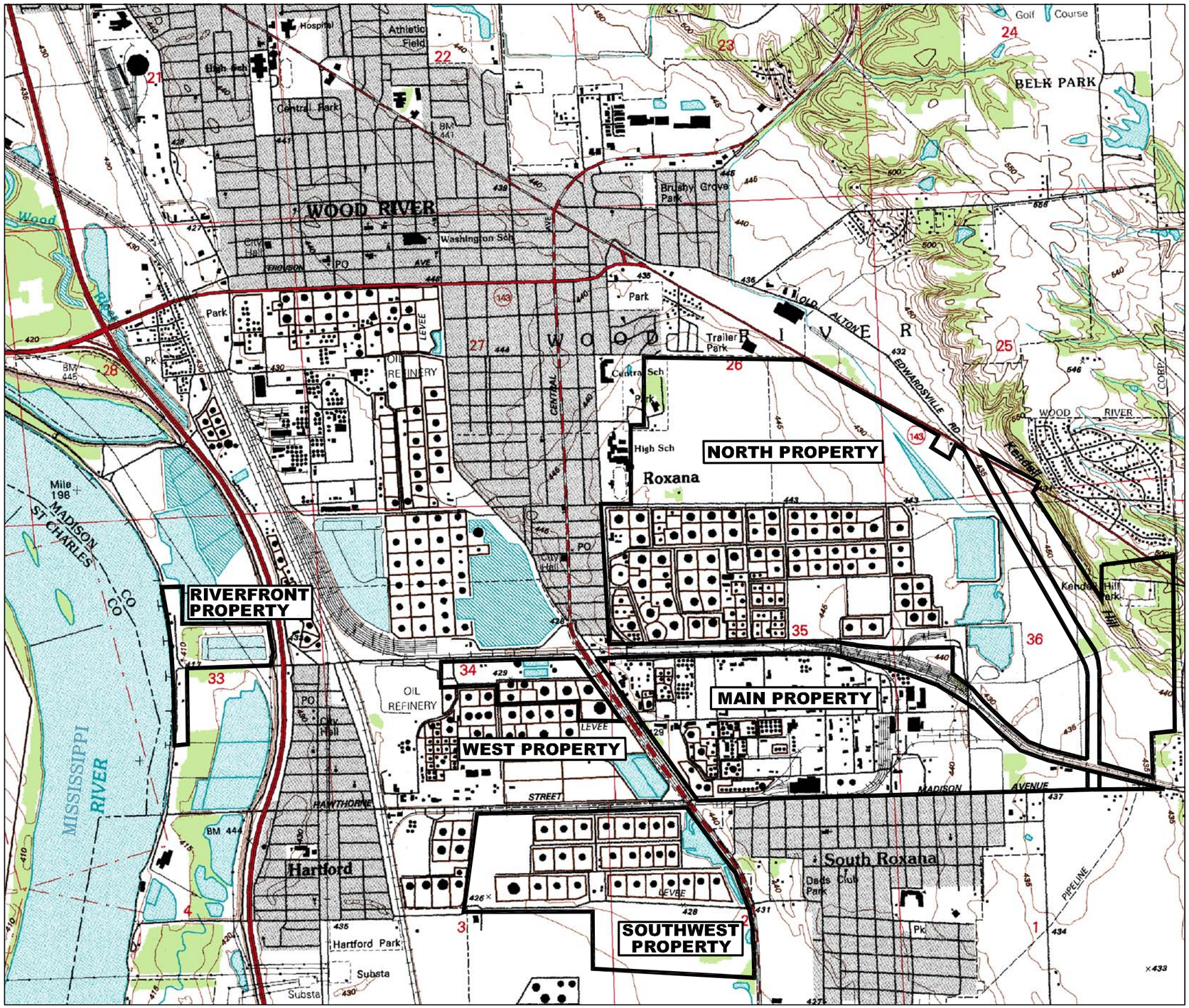
Table 5
Monthly Water Pumping Rates

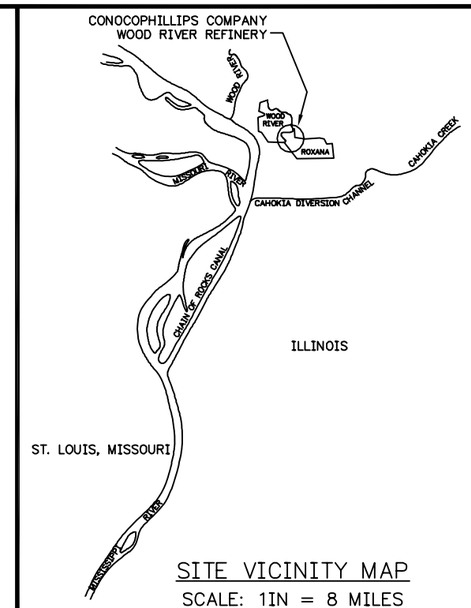
Month	Average Flow (gpm)	Month	Average Flow (gpm)	Month	Average Flow (gpm)	Month	Average Flow (gpm)
January-95	3,393	January-00	3,220	January-05	3,391	January-10	3,308
February-95	3,733	February-00	3,056	February-05	3,351	February-10	3,242
March-95	3,740	March-00	3,063	March-05	3,139	March-10	3,242
April-95	3,373	April-00	3,076	April-05	3,649	April-10	3,355
May-95	3,404	May-00	3,476	May-05	4,269	May-10	3,330
June-95	3,696	June-00	3,387	June-05	4,198	June-10	3,725
July-95	3,851	July-00	3,500	July-05	3,803	July-10	3,836
August-95	3,628	August-00	3,500	August-05	3,694	August-10	3,874
September-95	3,562	September-00	3,400	September-05	3,553	September-10	3,303
October-95	3,554	October-00	3,300	October-05	3,254	October-10	3,304
November-95	3,331	November-00	3,100	November-05	4,002	November-10	3,074
December-95	3,480	December-00	3,200	December-05	3,965	December-10	2,779
January-96	3,245	January-01	3,155	January-06	4,303	January-11	2,819
February-96	3,269	February-01	3,264	February-06	4,204	February-11	3,407
March-96	3,551	March-01	3,459	March-06	4,002	March-11	3,275
April-96	3,722	April-01	4,096	April-06	4,677	April-11	3,327
May-96	3,843	May-01	3,410	May-06	4,805		
June-96	3,937	June-01	3,477	June-06	4,323		
July-96	3,962	July-01	3,622	July-06	3,778		
August-96	4,294	August-01	3,748	August-06	4,405		
September-96	4,054	September-01	3,608	September-06	4,454		
October-96	3,623	October-01	3,248	October-06	4,384		
November-96	3,299	November-01	3,242	November-06	4,262		
December-96	3,441	December-01	3,244	December-06	4,345		
January-97	3,589	January-02	3,281	January-07	4,282		
February-97	3,768	February-02	3,189	February-07	4,291		
March-97	3,372	March-02	3,151	March-07	4,575		
April-97	3,568	April-02	3,486	April-07	4,199		
May-97	3,604	May-02	3,506	May-07	4,345		
June-97	3,945	June-02	3,867	June-07	4,556		
July-97	4,023	July-02	4,193	July-07	4,595		
August-97	3,688	August-02	4,076	August-07	4,447		
September-97	3,509	September-02	3,590	September-07	4,345		
October-97	3,536	October-02	3,678	October-07	3,879		
November-97	3,356	November-02	3,932	November-07	4,003		
December-97	3,461	December-02	3,364	December-07	3,952		
January-98	3,487	January-03	3,770	January-08	4,068		
February-98	3,357	February-03	3,350	February-08	4,228		
March-98	3,422	March-03	3,349	March-08	3,694		
April-98	3,786	April-03	3,558	April-08	3,922		
May-98	4,056	May-03	3,296	May-08	4,248		
June-98	3,633	June-03	3,666	June-08	4,207		
July-98	4,197	July-03	3,952	July-08	4,527		
August-98	4,093	August-03	4,277	August-08	4,543		
September-98	4,092	September-03	4,021	September-08	3,976		
October-98	3,925	October-03	4,022	October-08	4,237		
November-98	3,642	November-03	3,815	November-08	4,096		
December-98	3,116	December-03	3,451	December-08	3,985		
January-99	3,471	January-04	3,470	January-09	3,708		
February-99	3,233	February-04	3,551	February-09	3,668		
March-99	3,400	March-04	3,469	March-09	3,397		
April-99	4,100	April-04	3,436	April-09	3,605		
May-99	4,300	May-04	3,785	May-09	3,466		
June-99	4,800	June-04	4,324	June-09	3,776		
July-99	3,900	July-04	4,225	July-09	3,731		
August-99	4,000	August-04	4,590	August-09	3,649		
September-99	3,900	September-04	4,379	September-09	3,338		
October-99	3,700	October-04	4,137	October-09	3,235		
November-99	3,500	November-04	3,716	November-09	3,291		
December-99	3,300	December-04	3,432	December-09	3,278		

Table 6
Monthly Oil Recovery Totals

Month	Total Recovery (BBL)	Month	Total Recovery (BBL)	Month	Total Recovery (BBL)	Month	Total Recovery (BBL)
1st Quarter 1995	10,300	January-00	1,336	January-05	320	January-10	0
		February-00	1,040	February-05	1,146	February-10	0
		March-00	1,480	March-05	1,224	March-10	0
April-95	3,368	April-00	1,792	April-05	1,072	April-10	0
May-95	4,002	May-00	2,188	May-05	1,102	May-10	0
June-95	3,634	June-00	2,439	June-05	964	June-10	0
July-95	4,267	July-00	2,140	July-05	1,039	July-10	0
August-95	2,493	August-00	4,737	August-05	1,144	August-10	0
September-95	2,579	September-00	3,582	September-05	1,178	September-10	0
October-95	2,422	October-00	2,402	October-05	637	October-10	0
November-95	2,147	November-00	2,479	November-05	739	November-10	0
December-95	2,745	December-00	1,817	December-05	897	December-10	0
January-96	2,638	January-01	1,523	January-06	1,022	January-11	0
February-96	1,402	February-01	1,547	February-06	1,035	February-11	0
March-96	3,649	March-01	1,432	March-06	1,124	March-11	0
April-96	3,733	April-01	868	April-06	1,202		
May-96	3,236	May-01	1,247	May-06	1,338		
June-96	3,024	June-01	2,151	June-06	1,113		
July-96	2,998	July-01	6,112	July-06	1,331		
August-96	3,172	August-01	1,808	August-06	1,099		
September-96	3,015	September-01	2,268	September-06	1,204		
October-96	4,020	October-01	1,960	October-06	1,537		
November-96	3,235	November-01	1,436	November-06	2,176		
December-96	3,645	December-01	1,715	December-06	1,463		
January-97	2,140	January-02	1,890	January-07	1,295		
February-97	2,080	February-02	1,448	February-07	4,481		
March-97	2,211	March-02	1,475	March-07	1,706		
April-97	2,624	April-02	2,018	April-07	130		
May-97	2,677	May-02	1,071	May-07	250		
June-97	2,549	June-02	1,338	June-07	1,028		
July-97	3,653	July-02	332	July-07	1,904		
August-97	2,557	August-02	1,606	August-07	1,835		
September-97	2,237	September-02	2,733	September-07	1,705		
October-97	2,301	October-02	2,817	October-07	1,140		
November-97	2,940	November-02	506	November-07	572		
December-97	3,944	December-02	577	December-07	531		
January-98	3,747	January-03	869	January-08	5,922		
February-98	3,343	February-03	373	February-08	0		
March-98	2,576	March-03	676	March-08	0		
April-98	2,633	April-03	868	April-08	0		
May-98	3,130	May-03	3,137	May-08	0		
June-98	2,598	June-03	654	June-08	0		
July-98	2,566	July-03	624	July-08	0		
August-98	2,421	August-03	667	August-08	0		
September-98	2,432	September-03	819	September-08	0		
October-98	3,409	October-03	701	October-08	0		
November-98	3,152	November-03	1,281	November-08	0		
December-98	2,416	December-03	1,212	December-08	0		
January-99	1,172	January-04	1,404	January-09	0		
February-99	1,640	February-04	734	February-09	0		
March-99	2,358	March-04	766	March-09	95		
April-99	2,397	April-04	626	April-09	2,144		
May-99	490	May-04	1,414	May-09	0		
June-99	0	June-04	3,888	June-09	0		
July-99	480	July-04	9,340	July-09	0		
August-99	2,613	August-04	8,342	August-09	0		
September-99	2,802	September-04	379	September-09	0		
October-99	1,583	October-04	3,156	October-09	0		
November-99	2,054	November-04	344	November-09	0		
December-99	1,568	December-04	3,648	December-09	0		

Figures





SITE VICINITY MAP
SCALE: 1IN = 8 MILES

LEGEND

WOOD RIVER REFINERY PROPERTY BOUNDARY

SOURCE: MAP TAKEN FROM ELECTRONIC USGS DIGITAL RASTER GRAPHIC 7.5 MINUTE TOPOGRAPHIC MAP OF WOOD RIVER, ILL–MO REVISED 1994.

CONTOUR INTERVAL = 5 FT

Ø 2ØØØ

SCALE FEET

N

SHELL OIL PRODUCTS US AT THE WRB REFINING LP WOOD RIVER REFINERY ROXANA, ILLINOIS	PROJECT NO. 21562593
URS	
DRN. BY: djd May 2Ø11 DSGN. BY: djd CHKD. BY: wmp	Site Location Map — FIG. NO. 1

File: P:\ENVIRONMENTAL\SHELL OIL PRODUCT US\C-WRR-COP\21562286 (PART B SUPPORT)\GROUNDWATER CAPTURE AND OIL RECOVERY\CONSTRUCTION COMPLETION REPORT\FIGURES\FIG 1_SITE LOCATION MAP.DWG Last edited: 05/02/11 @ 11:04 a.m. @ WCC-ST.LOUIS

FIGURE 2
WATER ELEVATIONS AND PUMPING RATES

N

Ø 1200

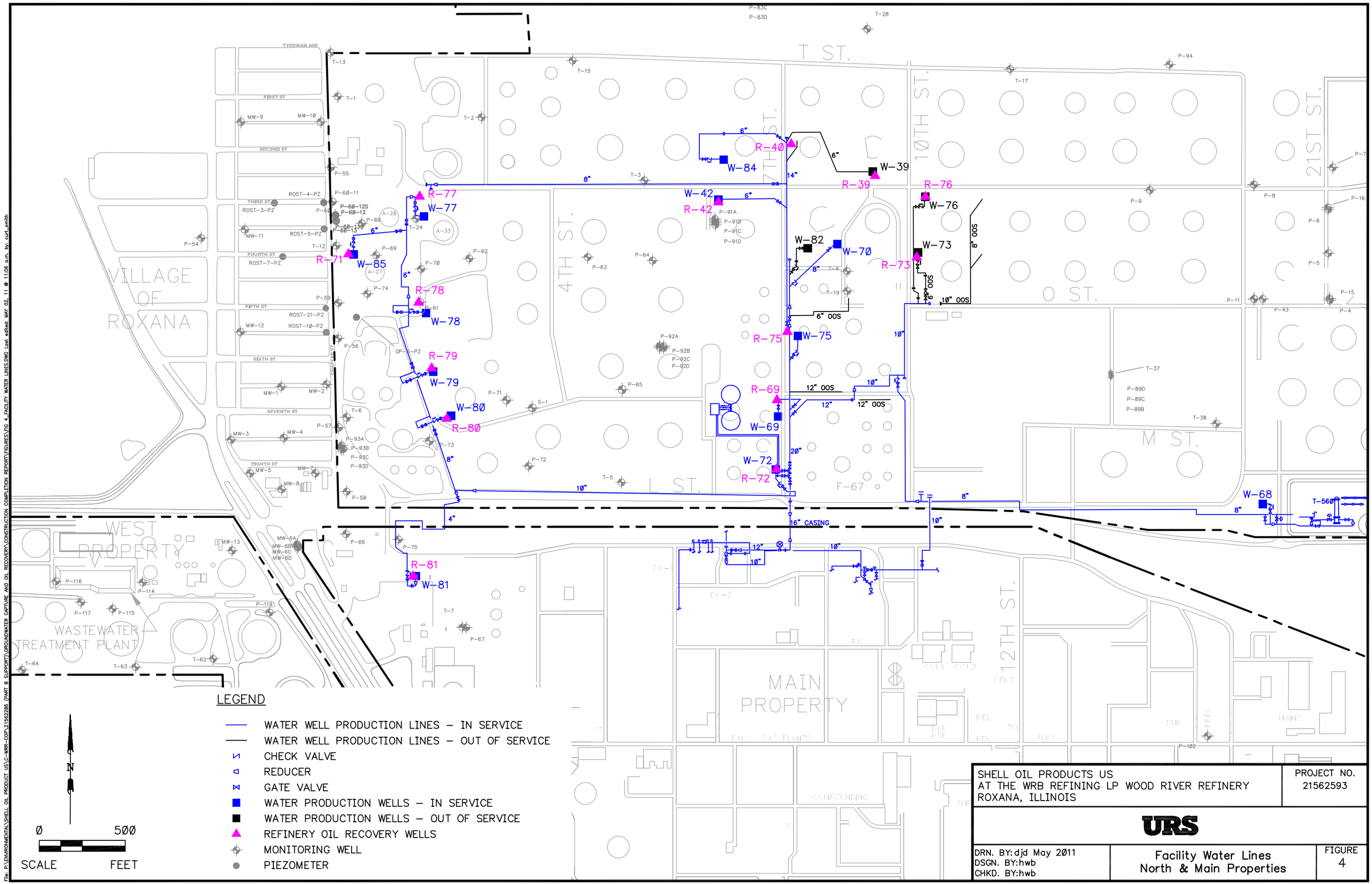
SCALE FEET

LEGEND

- NORTH AND MAIN PROPERTY WATER PRODUCTION WELLS – IN SERVICE
- NORTH AND MAIN PROPERTY WATER PRODUCTION WELLS – OUT OF SERVICE
- NORTH AND MAIN PROPERTY OIL RECOVERY WELLS
- MONITORING WELL
- PIEZOMETER

SHELL OIL PRODUCTS US AT THE WRB REFINING LP WOOD RIVER REFINERY ROXANA, ILLINOIS		PROJECT NO. 21562593
URS		
DRN. BY: djd May 2011 DSGN. BY: dp CHKD. BY: bb,ss	Facility Map with Groundwater Depression Wells Oil Recovery Wells and Monitoring Wells	FIGURE 3

File: P:\ENVIRONMENTAL\SHELL OIL PRODUCT US\C-WRR-COP\21562286 (PART B SUPPORT)\GROUNDWATER CAPTURE AND OIL RECOVERY CONSTRUCTION COMPLETION REPORT\FIGURES\FIG 3_GROUNDWATER PRODUCTION OIL RECOVERY WW WELL LOCATIONS.DWG Last edited: MAY 02, 11 @ 11:05 a.m. by: curt_smith



SHELL OIL PRODUCTS US
AT THE WRB REFINING LP WOOD RIVER REFINERY
ROXANA, ILLINOIS

PROJECT NO.
21562593

URS

DRN. BY: djd May 2011
DSGN. BY: hwb
CHKD. BY: hwb

Facility Water Lines
North & Main Properties

FIGURE
4

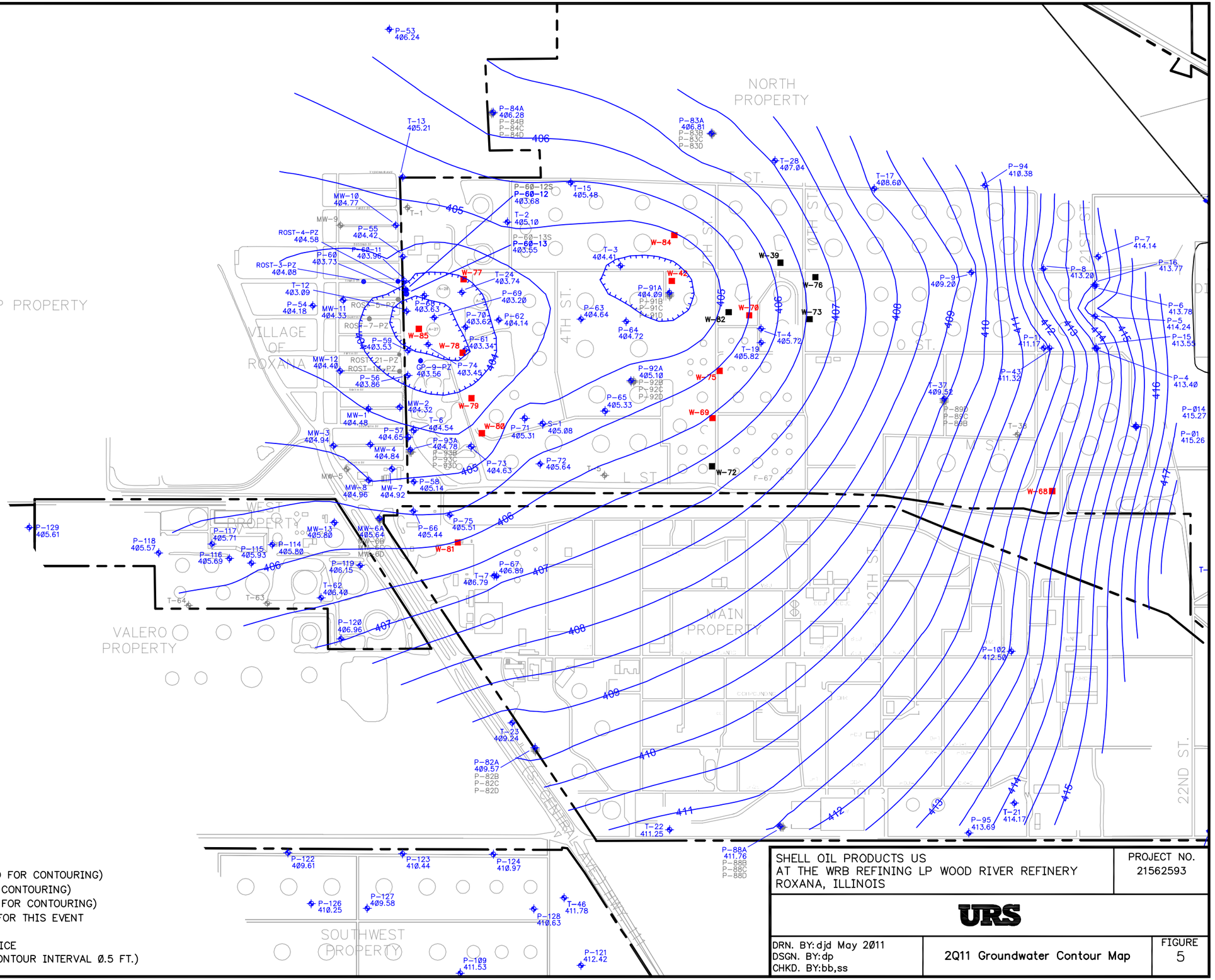
File: P:\ENVIRONMENTAL\SHELL OIL PRODUCT US\C-WRR-COP-21562286 (PART B SUPPORT)\GROUNDWATER CAPTURE AND OIL RECOVERY\CONSTRUCTION COMPLETION REPORT\FIGURES\FIG 4_FACILITY WATER LINES.DWG Last edited: MAY 02, 11 @ 11:06 a.m. by: curt_smith

NOTES:

1) WATER LEVELS WERE OBTAINED DURING THE SECOND QUARTER 2011 ON APRIL 25, 2011, FOR A SUBSET OF THE FACILITY MONITORING WELLS.

2) CONTOUR LINES PRIMARILY GENERATED BY SURFER VERSION 8 MODELING OF GROUNDWATER ELEVATIONS. SOME INTERPRETATION WAS DONE UTILITZING PROFESSIONAL JUDGMENT AND CONTOUR LINES WERE MODIFIED BY HAND.

3) ELEVATIONS ARE RELATIVE TO 1988 USGS DATUM.



LEGEND

- MONITORING WELL LOCATION GAUGED (USED FOR CONTOURING)
- PIEZOMETER LOCATION GAUGED (USED FOR CONTOURING)
- PIEZOMETER LOCATION GAUGED (NOT USED FOR CONTOURING)
- MONITORING WELL LOCATION NOT GAUGED FOR THIS EVENT
- WATER PRODUCTION WELLS – IN SERVICE
- WATER PRODUCTION WELLS – OUT OF SERVICE
- 407 GROUNDWATER SURFACE CONTOUR NGVD (CONTOUR INTERVAL 0.5 FT.)

SHELL OIL PRODUCTS US
AT THE WRB REFINING LP WOOD RIVER REFINERY
ROXANA, ILLINOIS

PROJECT NO. 21562593

URS

DRN. BY: djd May 2011
DSGN. BY: dp
CHKD. BY: bb,ss

2Q11 Groundwater Contour Map

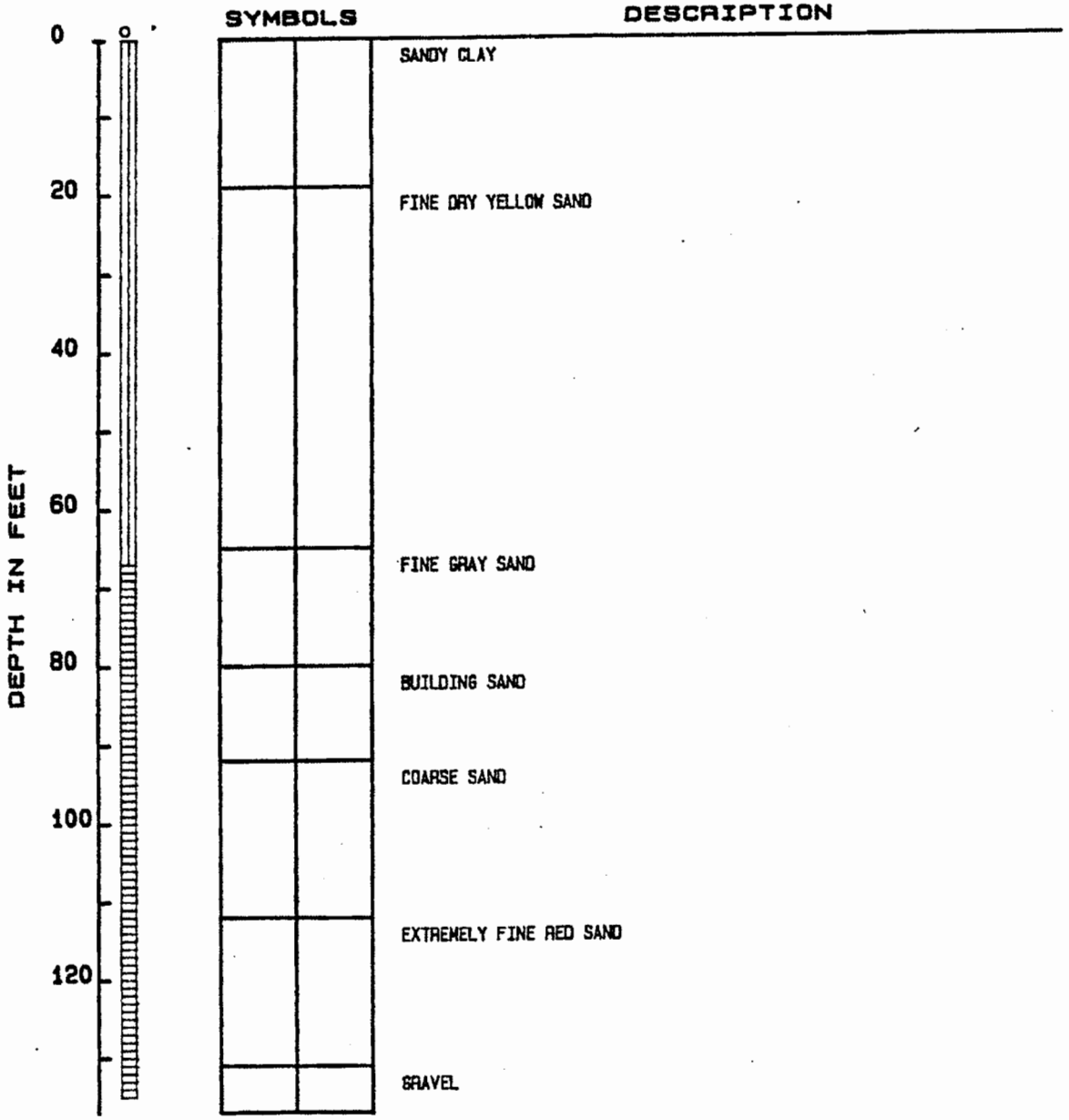
FIGURE 5

File: P:\ENVIRONMENTAL\SHELL OIL PRODUCT US\C-WRR-COP\21562586 (PART B SUPPORT)\GROUNDWATER CAPTURE AND OIL RECOVERY\CONSTRUCTION COMPLETION REPORT\FIGURES\FIG 5_2Q11 GROUNDWATER CONTOUR MAP.DWG Last edited: MAY 02, 11 @ 11:32 a.m. by: curt_smith

APPENDIX A Groundwater Depression Well Construction & Boring Logs

WELL W-39

SHELL OIL
00216-301
8/10/88
KMS



WELL TERMINATED AT 137 FEET ON AUG. 1942.

WELL CONSTRUCTION

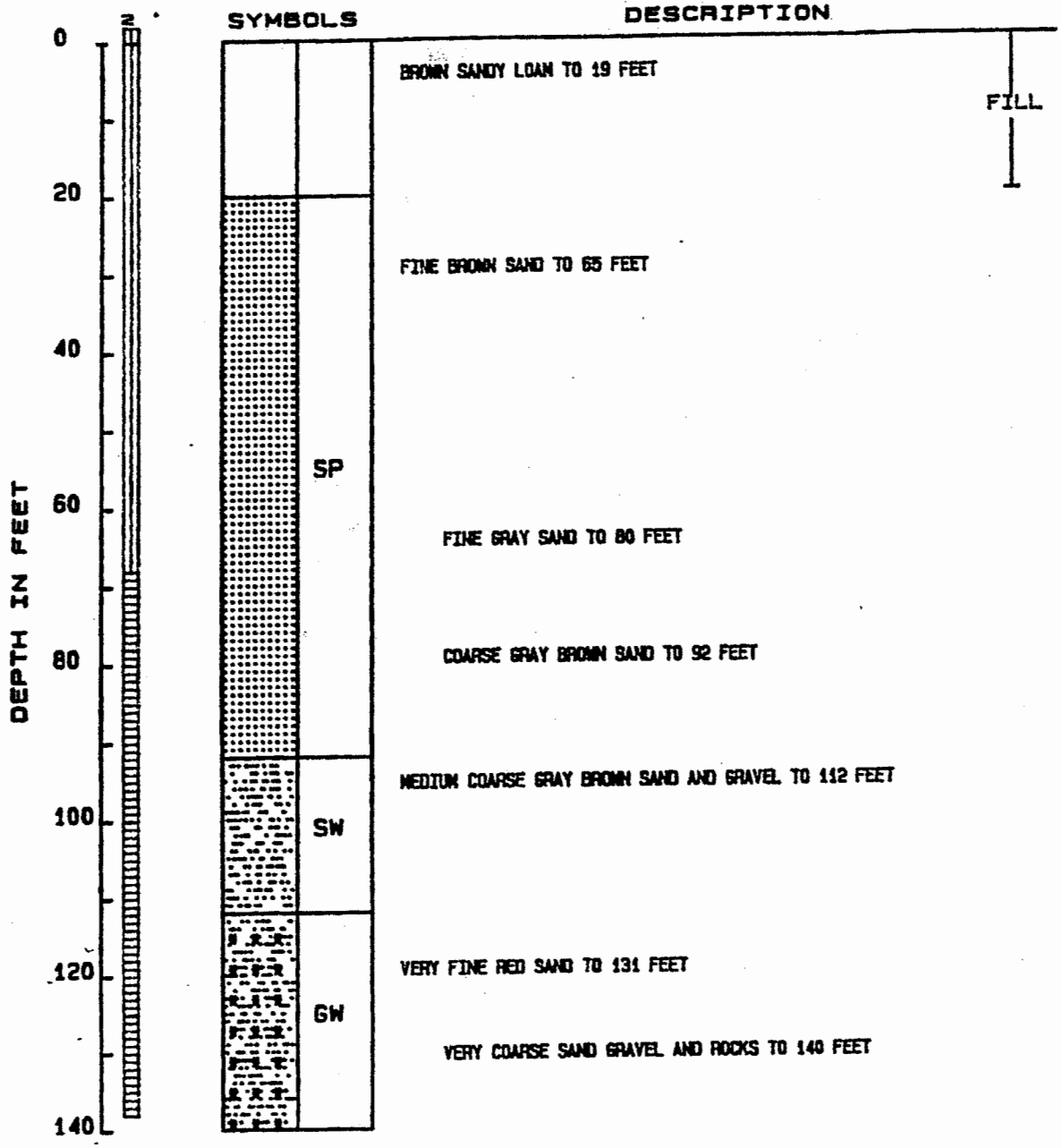
LOG OF WELLS

DAMES & MOORE

FIGURE III-1

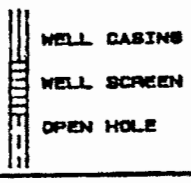
WELL W-42

SHELL OIL
00216-301
7/19/88
KMS



WELL TERMINATED AT 140 FEET ON 8/5/42.

WELL CONSTRUCTION



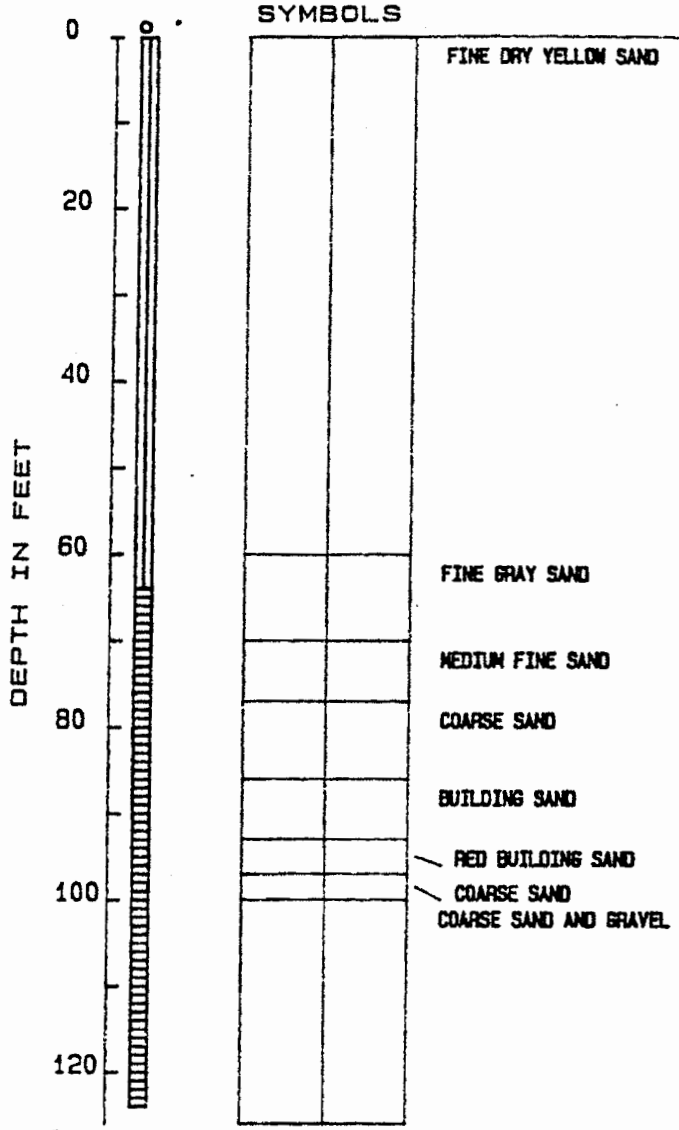
LOG OF WELLS

DAMES & MOORE

FIGURE III-4

WELL W-47

SHELL OIL
00216-301
8/10/88
KMS



WELL TERMINATED AT 126 FEET ON SEPT. 1943.

BOTTOM OF PIEZOMETER ON MUD AND LOOSE ROCK.

WELL CONSTRUCTION

WELL CASING
WELL SCREEN
OPEN HOLE

LOG OF WELLS

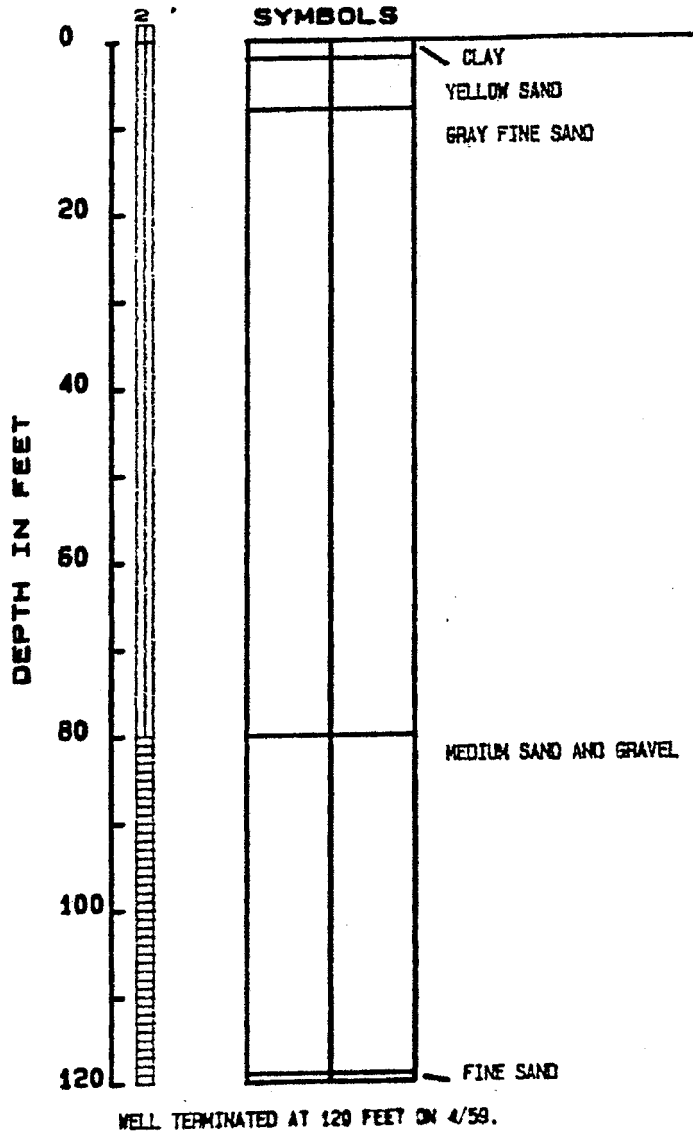
DAMES & MOORE

FIGURE III-5

WELL W-62

SHELL OIL
00216-301
8/9/88
KMS

ELEVATION: 445.2 FEET



WELL TERMINATED AT 120 FEET ON 4/59.

WELL CONSTRUCTION

WELL CASING
WELL SCREEN
OPEN HOLE

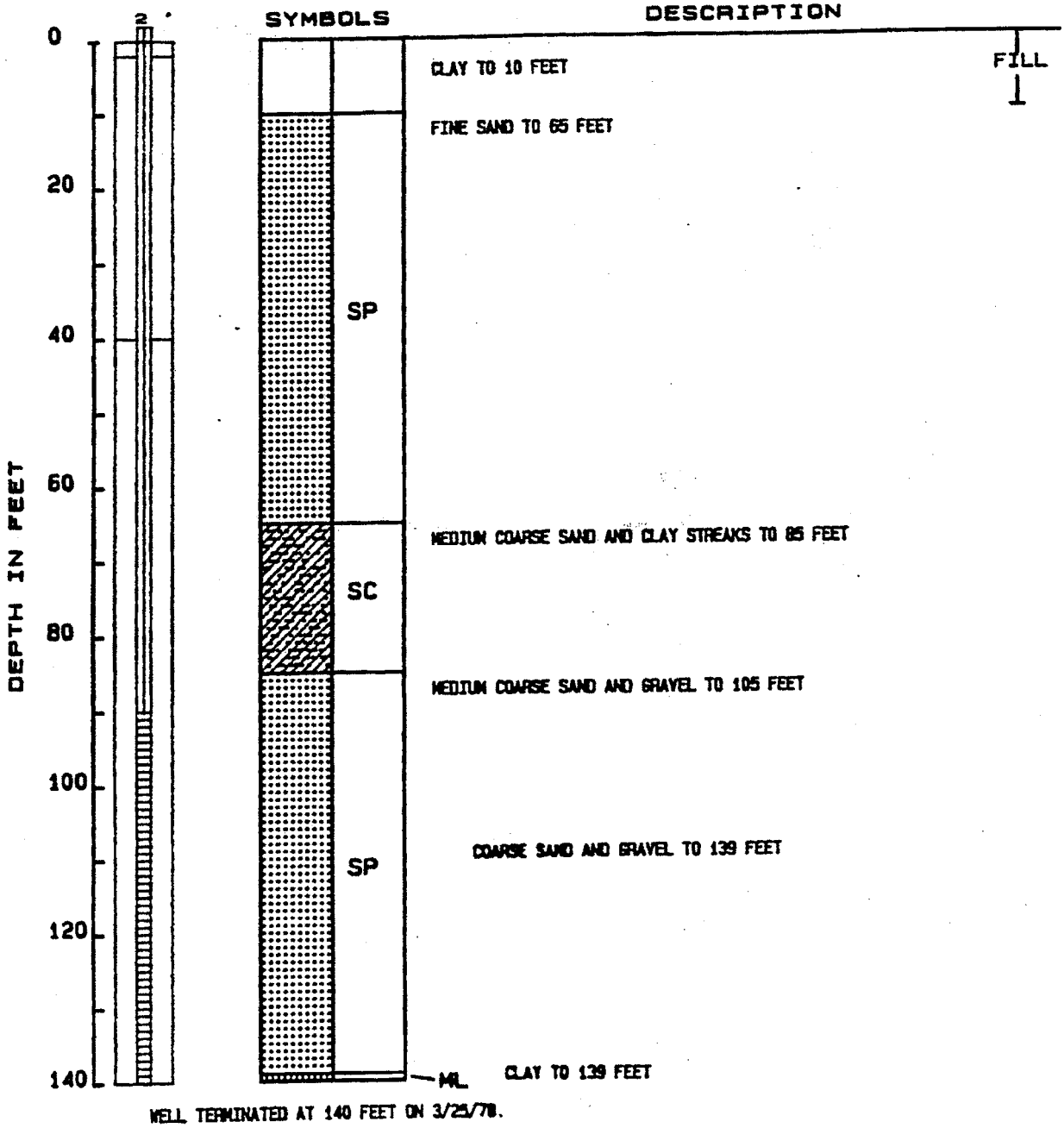
LOG OF WELLS

DAMES & MOORE

FIGURE III-9

WELL W-69

SHELL OIL
00215-301
7/20/88
KMS



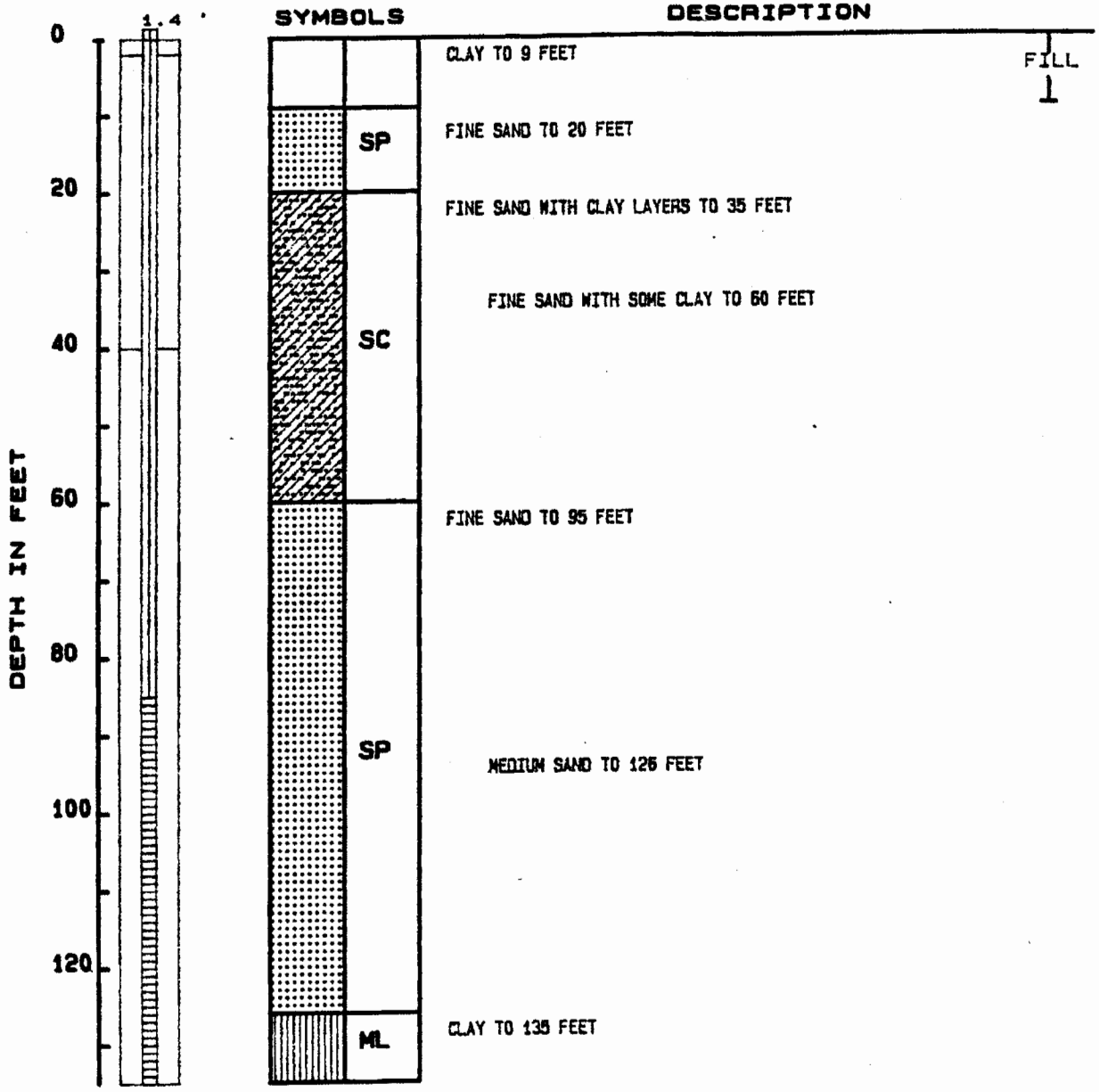
LOG OF WELLS

DAMES & MOORE

FIGURE III-14

WELL W-71

SHELL OIL
00216-301
4/78
KMS



WELL TERMINATED AT 135 FEET ON 4/78.

WELL CONSTRUCTION

WELL CASING
WELL SCREEN
OPEN HOLE

LOG OF WELLS

DAMES & MOORE

FIGURE III-15

DRILLING LOG	Division: Subsurface Const. Co.	Installation	Sheet - of Sheets
1. Project: Shell Oil Co. Wood River, Ill.		10. Size and Type of Bit: 6" Core Bit	
2. Location (Coordinates or Station)		11. Datum For Elevation Shown (TBM or MSL)	
3. Drilling Agency: Sloan Hydronics Inc.		12. Manufacturer's Designation of Drill	
4. Hole No. (As shown on drawing and File No.): [illegible]		13. Total No. of Overburden Samples Taken: Disturbed	Undisturbed
5. Name of Driller: [illegible]		14. Total Number Core Boxes	
6. Direction of Hole ☐Vertical ☐Inclined ____ Deg. From Vert.		15. Elevation Ground Water	
		16. Date Hole: Started 7/26/77	Completed: 7/27/77
7. Thickness of Overburden		17. Elevation Top Of Hole	
8. Depth Drilled Into Rock		18. Total Core Recovery For Boring	
9. Total Depth Of Hole 125 ft		19. Signature of Inspector	

Elevation a	Depth b	Legend c	Classification of Materials (Description) d	% Core Recovery e	Box or Sample No. f	Remarks (Drilling time, water loss, depth of weathering, etc., if significant) g
	9		silt			
	30		Fine Sand			
	45		Med Sand			
	65		Coarse Sand			
	125		Coarse Sand & gravel			
			Coarse Sand & Gravel to Bed Rock			

DRILLING LOG	Division Subgrade Test	Installation	Sheet - of Sheets
1. Project Shell Oil	Wash Plant Test	10. Size and Type of Bit 42" Drag bit	
2. Location (Coordinates or Station)		11. Datum For Elevation Shown (TBM or MSL)	
3. Drilling Agency Stone Engineering		12. Manufacturer's Designation of Drill	
4. Hole No. (As shown on drawing and File No.)	#73	13. Total No. of Overburden Samples Taken	Disturbed / Undisturbed
5. Name of Driller Charles Stone		14. Total Number Core Boxes	
6. Direction of Hole ☒ Vertical ☐ Inclined ____ Deg. From Vert.		15. Elevation Ground Water	
		16. Date Hole	Started 8/16/82 Completed 8/16/82
7. Thickness of Overburden		17. Elevation Top Of Hole	
8. Depth Drilled Into Rock 0'-0"		18. Total Core Recovery For Boring	
9. Total Depth Of Hole 127'-0"		19. Signature of Inspector	

Elevation a	Depth b	Legend c	Classification of Materials (Description) d	% Core Recovery e	Box or Sample No. f	Remarks (Drilling time, water loss, depth of weathering, etc. if significant) g
						Drill time 8:30 - 5:15
	13		Silt			
	47		Fine Sand			Water Loss 50 gpm
	56		~~Med Sand + pea gravel~~			
	65		Coarse Sand			
	127		Coarse Sand & gravel (2")			
	128		Coarse Sand Large gravel - Rock (End)			Water Loss from 20 gpm

Hole No. 14

DRILLING LOG	Division: Subgrade Const Co.	Installation	Sheet - of Sheets
1. Project: Shell Oil Co. Woodriver, Ill.		10. Size and Type of Bit: 12" drag bit	
2. Location (Coordinates or Station)		11. Datum For Elevation Shown (TBM or MSL)	
3. Drilling Agency: Stan Hydraulics		12. Manufacturer's Designation of Drill	
4. Hole No. (As shown on drawing and File No.): #1 74		13. Total No. of Overburden Samples Taken: Disturbed / Undisturbed	
5. Name of Driller: Charles Grant		14. Total Number Core Boxes	
6. Direction of Hole: ☑ Vertical ☐ Inclined _____ Deg. From Vert.		15. Elevation Ground Water	
		16. Date Hole: Started 8/12/82	Completed 8/12/82
7. Thickness of Overburden		17. Elevation Top Of Hole	
8. Depth Drilled Into Rock: 0 ft.		18. Total Core Recovery For Boring	
9. Total Depth Of Hole: 119 ft		19. Signature of Inspector	

Elevation a	Depth b	Legend c	Classification of Materials (Description) d	% Core Recovery e	Box or Sample No. f	Remarks (Drilling time, water loss, depth of weathering, etc. if significant) g
	7		silt			Drill Time 9:00 - 4:00
	27		fine Sand			
	49		Med Sand			Appox 50 gal p min
	54		Coarse Sand + fine gravel			
	65		Coarse Sand			
						Appox 200 g p m
	113		Coarse sand + gravel			
			→ Bed Rock			

GRIFFIN

ATTACHMENT II
DRILL LOG

(WELL #W-77)

Date: April 30, 1990

Rig No.:

Contractor: SHELL OIL COMPANY

Job No.: GNC14041

Job Address: WOOD RIVER (IL) REFINERY

Driller: H. ALBRECHT

Job Phone: (618)251-6172 Helper:

Branch: MIDWEST

No. of wells installed today: 1

Depth of hole: 143'

Dia of borehole: 36"

Length of well: 142'

Dia. of well: 36"

Length of screen: 30'

Type, dia., slot of screen Houston, 20", 30 slot

Well yield: 380 GPM*

Travel Hours -0- Stand by Hours -0-

Revert used: 6 - 50# bags

Man Hours Regular: 8 Drill Hours Reg.: 6 3/4

Total footage drilled today: 143'

Overtime: 5 O.T.: -0-

Delays—Explain: None Delay Hours: -0-

*Pump test results: Initial water level = 53'0"
water level after 1 hour = 59'9"
drawdown = 6'9"

Mileage				
State				

Fuel Supplied By:(check one)
☒ Driller
☐ Contractor

WELL LOG

Depth	Formation	Depth	Formation
0' - 7'	CLAY		
7' - 21'	FINE SAND		
21' - 26'	SANDY CLAY		
26' - 30'	FINE SAND		
30' - 42'	SILTY FINE SAND WITH CLAY LENSES.		
42' - 90'	FINE TO COURSE SAND WITH FINE GRAVEL		
90' - 92'	SANDY CLAY		
92' - 110'	MEDIUM SAND WITH FINE GRAVEL		
110'-132'	FINE SAND		
132'-143'	CLAY		

Harold D Albrecht
Driller

E Ball
Verified Contractor

ATTACHMENT III
DRILL LOG

GRIFFIN (WELL #W-78)

Date: May 2, 1990
Rig No.:
Job No.: GNC14041
Driller: H. ALBRECHT
Branch: MIDWEST

Contractor: SHELL OIL COMPANY
Job Address: WOOD RIVER (IL) REFINERY
Job Phone: (618)251-6172 Helper:
No. of wells installed today: 1
Dia of borehole: 36"
Dia. of well: 36"
Type, dia., slot of screen Houston, 20", 30 slot
Travel Hours -0- Stand by Hours - 0 -
Man Hours Regular: 8 Drill Hours Reg.: 7 2/3
Overtime: 6 O.T.: -0-

Depth of hole: 142'
Length of well: 138'4"
Length of screen: 30'
Well yield: 380 GPM*
Revert used: 6 - 50# bags
Total footage drilled today: 142'

Delays—Explain: None Delay Hours: -0-

*Pump Test Results: Initial Water level = 52'2"
Waterlevel After 1 hour = 58'3"
Drawdown = 6'1"

Mileage					
State					

Fuel Supplied By:(check one)
☒ Driller
☐ Contractor

WELL LOG

Depth	Formation	Depth	Formation
0'-7'	CLAY		
7'-60'	FINE SAND		
60'-71'	FINE TO MEDIUM SAND		
71'-74'	SANDY CLAY		
74'-76'	MEDIUM SAND		
76'-79'	COAL		
79'-125'	FINE TO COARSE SAND WITH		
	FINE GRAVEL		
125'-137'	CLAY		
137'-142'	LIMESTONE		

Harold D Albrecht
Driller

Verified Contractor

ATTACHMENT IV

DRILL LOG

GRIFFIN (WELL #W-79)

Date: May 8, May 9, 1990

Rig No.: _____

Contractor: SHELL OIL COMPANY

Job No.: GNC14041

Job Address: WOOD RIVER (IL) REFINERY

Driller: H. ALBRECHT

Job Phone: (618) 251-6172 Helper: _____

Branch: MIDWEST

No. of wells installed today: 1

Depth of hole: 138'

Dia of borehole: 36"

Length of well: 134'11"

Dia. of well: 36"

Length of screen: 30'

Type, dia., slot of screen Houston, 20" 30 slot

Well yield: 380 GPM*

Travel Hours -0- Stand by Hours -0-

Revert used: 6 - 50# bags

Man Hours Regular: 16 Drill Hours Reg.: 10

Total footage drilled today: 138'

Overtime: 10½ O.T.: -0-

Delays—Explain: Hole collapsed @ 60' on 5/8/90 Delay Hours: 9

* Pump test results: Initial water level = 52'9"

Water level after 1 hour = 60'3"

drawdown = 7'6"

Mileage					
State					

Fuel Supplied By:(check one)

XX Driller

☐ Contractor

WELL LOG

Depth	Formation	Depth	Formation
0'-7'	CLAY		
7'-45'	FINE SAND		
45'-70'	FINE TO MEDIUM SAND		
70'-74'	SAND WITH CLAY LENSES		
74'-125'	FINE TO COARSE SAND WITH		
	FINE GRAVEL		
125'-134'	CLAY		
134'-138'	LIMESTONE		

Harold D Albrecht

Driller

Verified Contractor

GRIFFIN (WELL #W-80)

ATTACHMENT V
DRILL LOG

Date: MAY 10, 1990
Rig No.:
Job No.: GNC14041
Driller: H. ALBRECHT
Branch: MIDWEST

Contractor: SHELL OIL COMPANY
Job Address: WOOD RIVER (IL) REFINERY
Job Phone: (618)251-6172 Helper:
No. of wells installed today: 1
Dia of borehole: 36"
Dia. of well: 36"
Type, dia., slot of screen Houston, 20", 30 slot
Travel Hours -0- Stand by Hours -0-
Man Hours Regular: 8 Drill Hours Reg.: 6
Overtime: 4 O.T.: -0-

Depth of hole: 137'
Length of well: 135'10"
Length of screen: 30'
Well yield: 380 GPM*
Revert used: 6 - 50# bags
Total footage drilled today: 137'

Delays—Explain: NONE Delay Hours: -0-

*Pump test results: Initial Water level = 52'6"
Waterlevel after 1 hour = 61'
Drawdown = 8'6"

Mileage					
State					

Fuel Supplied By:(check one)
☒ Driller
☐ Contractor

WELL LOG

Depth	Formation	Depth	Formation
0'-8'	CLAY		
8'-41'	FINE SAND		
41'-89'	FINE TO COARSE SAND WITH		
	FINE GRAVEL		
89'-124'	FINE TO COARSE SAND WITH		
	FINE TO COARSE GRAVEL		
124'-131'	CLAY		
131'-137'	SHALE		

Harold D Albrecht
Driller

Verified Contractor

ATTACHMENT VI
DRILL LOG

GRIFFIN (WELL #W-81)

Date: May 14, 1990
Rig No.:
Job No.: GNC14041
Driller: H. ALBRECHT
Branch: MIDWEST

Contractor: SHELL OIL COMPANY
Job Address: WOOD RIVER (IL) REFINERY
Job Phone: (618)251-6172 Helper:
No. of wells installed today: 1
Dia of borehole: 36"
Dia. of well: 36"
Type, dia., slot of screen Houston, 20", 30 slot
Travel Hours -0- Stand by Hours -0-
Man Hours Regular: 8 Drill Hours Reg.: 5⅓
Overtime: 6 1/3 O.T.: -0-

Depth of hole: 131'
Length of well: 129'
Length of screen: 30'
Well yield: 380 GPM*
Revert used: 6 - 50# bags
Total footage drilled today: 131'

Delays—Explain: NONE Delay Hours: -0-

*Pump test results = Initial water level = 49'
waterlevel after 1 hour = 56'9"
drawdown = 7'9"

Mileage					
State					

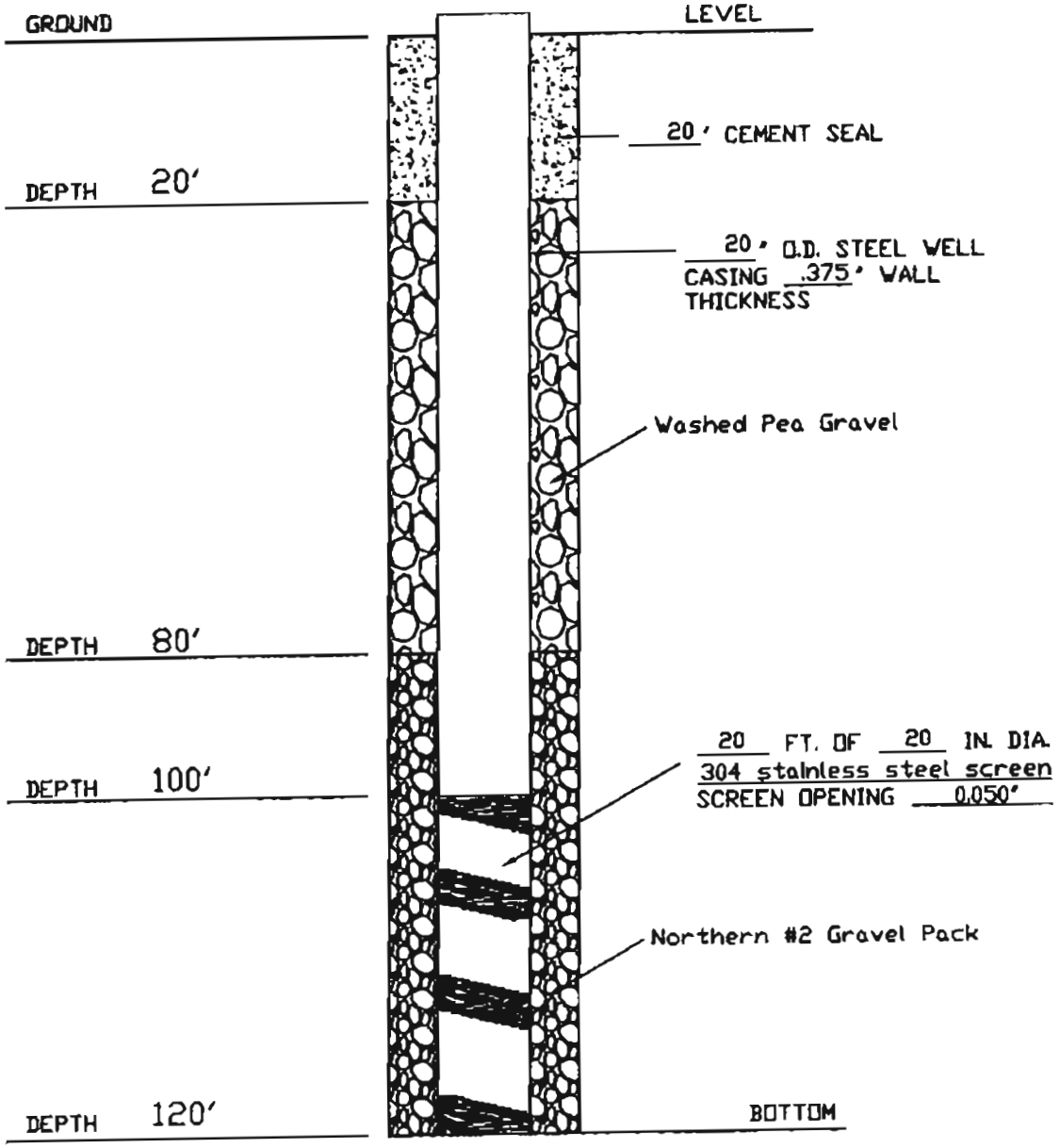
Fuel Supplied By:(check one)
☒ Driller
☐ Contractor

WELL LOG

Depth	Formation	Depth	Formation
0'-12'	CLAY		
12'-35'	FINE SAND		
35'-75'	FINE TO COARSE SAND WITH		
	FINE GRAVEL		
75'-112'	FINE TO COARSE SAND		
112'-120'	FINE TO COARSE SAND WITH		
	FINE GRAVEL		
120'-125'	CLAY		
125'-126'	LIMESTONE		
126'-131'	SHALE		

Harold D Albrecht
Driller

E Ball
Verified Contractor



Wood River - Recovery Wells
Well #82

REYNOLDS, INC.
1301-15 E. MAIN STREET
LOUISVILLE, KENTUCKY 40206

WELL CONSTRUCTION REPORT

Date 1-13-2003

TYPE OR PRESS FIRMLY WITH BLACK INK PEN, THIS FORM MUST BE COMPLETED WITHIN 30 DAYS OF COMPLETION AND SENT TO THE APPROPRIATE HEALTH DEPARTMENT

1. Date Well Completed 12-10-2002
2. Use: [ ] Domestic [ ] Irrigation [ ] Commercial [ ] Livestock
   [ ] Monitoring [X] Other Industrial
3. Type of Well:
   a. Bored Well: Hole Diameter _____ in. Depth _____ ft.
   Casing Diameter _____ in. Buried Slab: [ ] Yes [ ] No
   b. Driven Well: Drive Pipe Diameter _____ in. Depth _____ ft.
   c. Drilled Well: Well Diameter 36 in. Depth 120 ft.
   Casing Diameter 20 in. Type .375 steel Joint welded

Casing Grout:

Kind	Oversized Drill Hole(In)	From(ft)	To(ft)
4000 psi grout	36	5	30

Finished In: Unconsolidated [X] Gravel Pack: [X] Yes [ ] No
Rock [ ] Grain Size _____

4. Well Disinfected? [X] Yes [ ] No
5. Date Permanent Pump Installed 12-10-2002
6. Licensed Pump Contractor John B. Schmidt
   License Number 102-00286-2
7. Pitless Adapter Installed? [ ] Yes [X] No
   Manufacturer _____ Model _____
   Attached to Casing - How? [ ] Screwed On [ ] Welded [ ] Compression
8. Type of Well Cap Flanged Steel Cap
9. Tank Working Cycle _____ gallons Captive Air: [ ] Yes [ ] No
10. Pump and Equipment Disinfected? [X] Yes [ ] No

General Comments: (If dry hole, fill out log & indicate how hole was sealed.)

Illinois Department of Public Health
Division of Environmental Health - 525 W. Jefferson
Springfield, IL 62761

IMPORTANT NOTICE. This State Agency is requesting disclosure of information that is necessary to accomplish the statutory purpose as outlined under Public Act 85-0863. Disclosure of this information is mandatory. This form has been approved by the Forms Management Center.

IL 482-0126

GEOLOGICAL AND WATER SURVEY WELL RECORD

11. Permit Number 119/017/02 Date Issued 8-19-2002
12. Property Owner Conoco Phillips Wood River Refinery Well # 82
13. Drilling Company Name Reynolds, Inc.
14. Name of Person who drilled the well John B. Schmidt
15. Well Site Address 7th Street, [redacted] Roxana, IL
16. Twnshp Name Wood River Land ID# _____
17. Subdivision Name _____ Lot _____ Elevation _____ ft.
18. Location: Cnty Madison Sect 35 Twnshp 5N Range 9W
    SE Quarter of the NE Quarter of the NW Quarter
19. Casing and Liner Pipe:

Dia (In)	Type	From(ft)	To (ft)
20	.375 steel	0	100

20. Screen:
    Diameter 20 in.
    Length 20 ft.
    Slot Size 0.050
    Material stainless steel
21. Water from sand/gravel at depth 51 ft. to 120 ft.
22. Static Level 51 ft. below casing top which is 18 in. above ground level.
    Pumping Level 70 ft. Pumping 600 gpm for 8 hours.
23. Earth Materials Passed Through

Earth Materials Passed Through	Depth Top(ft)	Depth Bottom(ft)
Fill	0	12
Clayey Sand	12	15
Sand w/ Little Gravel	15	90
Fine Sand	90	120

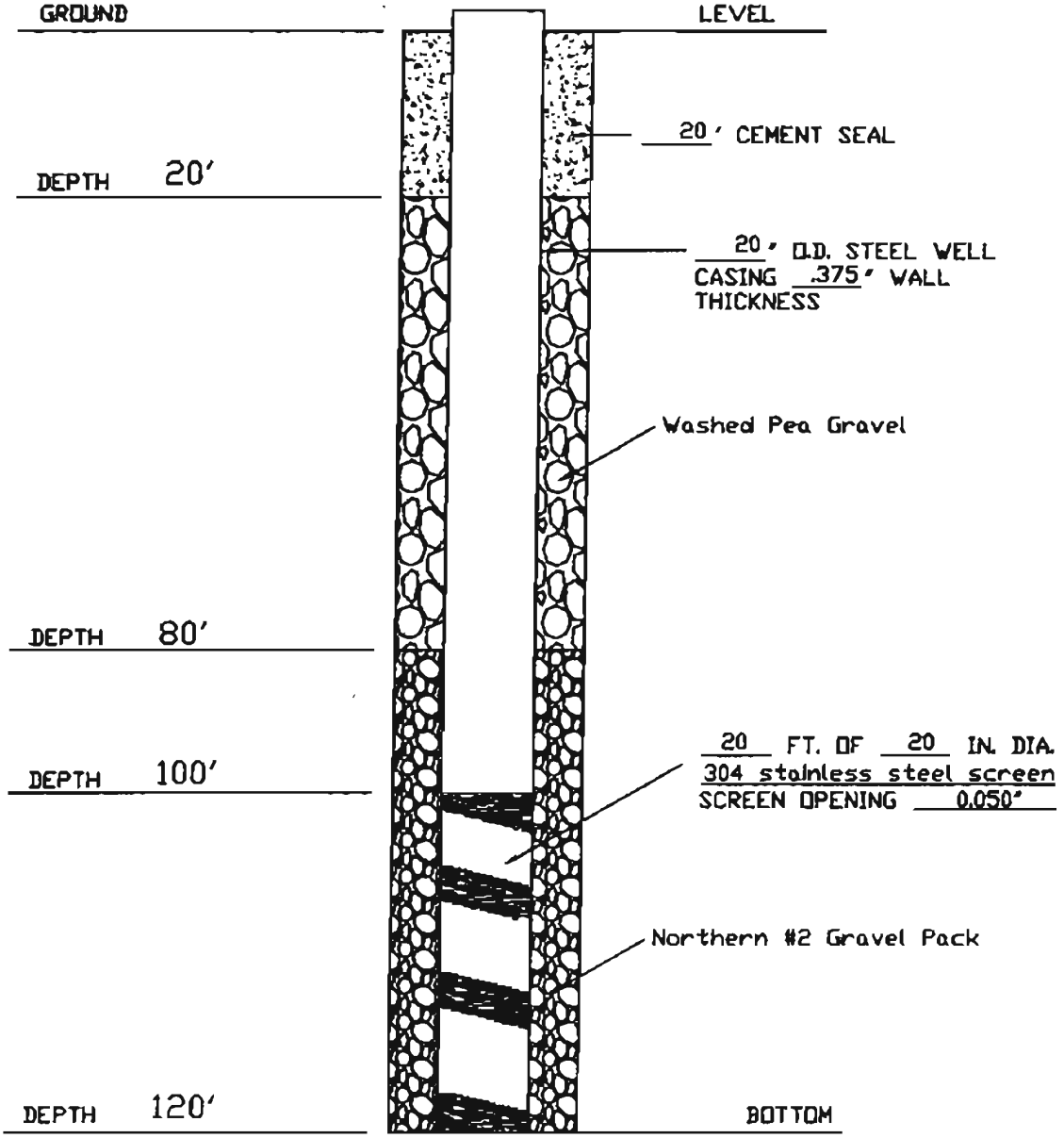
Continue on back of sheet if necessary

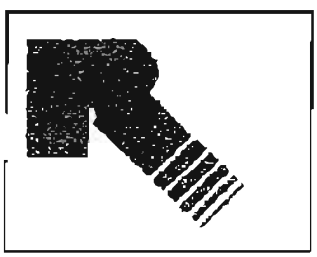
Licensed Contractor Signature

102-00286-2
License Number

11/95

(SEE REVERSE SIDE FOR ADDITIONAL INFORMATION)





Wood River - Recovery Wells
Well #83

REYNOLDS, INC.
1301-15 E. MAIN STREET
LOUISVILLE, KENTUCKY 40206

WELL CONSTRUCTION REPORT

Date 1-13-2003

TYPE OR PRESS FIRMLY WITH BLACK INK PEN, THIS FORM MUST BE COMPLETED WITHIN 30 DAYS OF COMPLETION AND SENT TO THE APPROPRIATE HEALTH DEPARTMENT

1. Date Well Completed 12-10-2002
2. Use: [ ] Domestic [ ] Irrigation [ ] Commercial [ ] Livestock
   [ ] Monitoring [X] Other Industrial
3. Type of Well:
   a. Bored Well: Hole Diameter _____ in. Depth _____ ft.
   Casing Diameter _____ in. Buried Slab: [ ]Yes [ ]No
   b. Driven Well: Drive Pipe Diameter _____ in. Depth _____ ft.
   c. Drilled Well: Well Diameter 36 in. Depth 120 ft.
   Casing Diameter 20 in. Type .375 steel Joint welded

Casing Grout:

Kind	Oversized Drill Hole(In)	From(ft)	To(ft)
4000 psi grout	36	5	30

Finished In: Unconsolidated [X] Gravel Pack: [X]Yes [ ]No
Rock [ ] Grain Size _____

4. Well Disinfected? [X]Yes [ ]No
5. Date Permanent Pump Installed 12-10-2002
6. Licensed Pump Contractor John B. Schmidt
   License Number 102-00286-2
7. Pitless Adapter Installed? [ ]Yes [X]No
   Manufacturer _____ Model _____
   Attached to Casing - How? [ ] Screwed On [ ] Welded [ ] Compression
8. Type of Well Cap Flanged Steel Cap
9. Tank Working Cycle _____ gallons Captive Air: [ ]Yes [ ]No
10. Pump and Equipment Disinfected? [X]Yes [ ]No

General Comments: (If dry hole, fill out log & indicate how hole was sealed.)

Illinois Department of Public Health
Division of Environmental Health - 525 W. Jefferson
Springfield, IL 62761

IMPORTANT NOTICE. This State Agency is requesting disclosure of information that is necessary to accomplish the statutory purpose as outlined under Public Act 85-0863. Disclosure of this information is mandatory. This form has been approved by the Forms Management Center.

11. 482-0197

GEOLOGICAL AND WATER SURVEY WELL RECORD

11. Permit Number 119/018/02 Date Issued 8-19-2002
12. Property Owner Concoco Phillips Wood River Refinery Well # 83
13. Drilling Company Name Reynolds, Inc.
14. Name of Person who drilled the well John B. Schmidt
15. Well Site Address 5th & Main Street, Roxana, IL 62084
16. Twnshp Name Wood River Land ID# _____
17. Subdivision Name _____ Lot _____ Elevation _____ ft.
18. Location: Cnty Madison Sect 35 Twnshp 5N Range 9W
    SW Quarter of the NE Quarter of the SW Quarter
19. Casing and Liner Pipe:

Dia (In.)	Type	From(ft)	To (ft)
20	.375 steel	0	100

20. Screen:
    Diameter 20 in.
    Length 20 ft.
    Slot Size 0.050
    Material stainless steel
21. Water from sand/gravel at depth 44 ft. to 120 ft.
22. Static Level 44 ft. below casing top which is 18 in. above ground level.
    Pumping Level 68 ft. Pumping 800 gpm for 8 hours.
23. Earth Materials Passed Through

Earth Materials Passed Through	Depth Top(ft)	Depth Bottom(ft)
Fill	0	12
Clayey Sand	12	18
Sand w/ Little Gravel	18	102
Sand & Gravel	102	120

Continue on back of sheet if necessary

Licensed Contractor Signature

102-00286-2
License Number

11/95

(SEE REVERSE SIDE FOR ADDITIONAL INFORMATION)

TEST HOLE REPORT

Layne-Western Company, Inc.

Contract Name: CONOCO

Job No.: 878405 Date: 6-4-08

City: WOOD RIVER State: IL

TEST HOLE No.: 84-100

Driller: R BOWLES

Test Hole Location: OLD WELL # 41

Distance and Direction from Permanent Landmark or Previous Test Hole

TEST LOG

Static Water Level _____ Measured _____ Hours After Completion

FROM	TO	MARSH FUNNEL VISCOSITY SECONDS	MUD PIT LOSS INCHES	FORMATION
0	6.0			FILL
6.0	31.0			FINE GREY SILTY SAND
31.0	60.0			FINE GREY SAND
60.0	69.0			FINE GREY SAND TRACE MED
69.0	85.0			FINE GREY SAND TRACE MED & VERY FINE SAND
85.0	101.0	31	3"	FINE & MED GREY SAND WITH COBBLES
101.0	112.0			FINE TO MED TRACE COARSE & COBBLES
112.0	136.0	31	6"	MED & FINE GREY SAND WITH COBBLES & LOTS FINES.

NOTES: Size of Pit _____ X _____ X _____ DEEP

State of Illinois
Department of Public Health

Water Well Construction Report

Complete within 30 days of well completion and send to the appropriate Health Department.

1. Type of Well

a. **Driven Well**: Casing Diameter ____ in. depth ____ ft.

b. **Bored Well**: Buried Slab? No

c. **Drilled Well**: PVC Casing Formation Packer set at a depth of ____ ft.

d. **Drilled Well**: Steel Casing Mechanically Driven? No

e. Hole Diameter 36 in. to 136 ft.; 0 in. to ____ ft.; ____ in. to ____ ft.;

f.

Type of Grout	# of Bags	Grout Weight	From (ft.)	To (ft.)	Tremie Depth
bentonite seal			90	87	90
neat cement			87	0	87

g. Well Finished within Unconsolidated Materials

h.

Kind of Gravel/Sand Pack	Grain Size/Supplier #	From (ft.)	To (ft.)
northern gravel	#1 well pack	136	90

2. Well Use: Commercial

3. Date Well Completed: Jun 4, 2008 Well Disinfected? Yes Driller's Estimated Well Yield 500 gpm

4. Date Permanent Pump Installed: Jul 2, 2008

5. Pump Capicity: 500 gpm Set at (depth) 90 ft.

6. Pitless Adapter Model & Manufacturer: na Attachment to Casing:

7. Well Cap Type & Manufacturer: Layne Christensen Discharge Head

8. Pressure Tank: Working Cycle: na gals. Captive Air? No

9. Pump System Disinfected? Yes

10. Name of Pump Company: Layne Christensen

11. Pump Installer: Layne Christensen License # 102-003837

12. Chris Arnold Date: 8/29/08/08

Licensed Pump Installation Contractor Signature

Illinois Department of Public Health
Divison of Environmental Health
525 West Jefferson Street
Springfield, IL 62761

IMPORTANT NOTICE: This state agency is requesting discolusre of information that is necessary to accomplish the statutory purpose as outlined under Public Act 85-0863. Disclosure of this Information is Mandatory This form has been approved by the Forms Managment Center.

State of Illinois
Department of Public Health

Water Well Construction Report

GEOLOGICAL & WATER SURVEY WELL RECORD

13. Property Owner: Conocophillips — Well # New Well #84

14. Driller: Russel Bowles — License # 092-007277

15. Name of Drilling Company: Layne Western

16. Permit Number: 119/34/08 — Date Issued: Oct 2, 2008

17. Date Drilling Started: Jun 16, 2008

18. Well SITE Address: 200 yds West of 7th and R Streets and 100 yds North of R Street

19. Township Name: Wood River — Land I.D. #

20. Subdivision Name: — Lot #

21. Location: a. County: Adams

b. Township: 2S Range: 9W Section: 14

c. SW Quarter of the NW Quarter of the NE Quarter

d. GPS: Degrees 24 Minutes 45.3 Seconds 13.1 N

Degrees 91 Minutes Seconds W

survey use only

22. Casing and Liner Information

Diameter (in.)	Material, Joint Type	From (ft.)	To (ft.)
24"	Carbon Steel	100	2' above

23. Is the well screened? Yes

If yes, screen information:

Diameter (in.)	Length (ft.)	Slot Size	From (ft.)	To (ft.)
20	30	.040	136	106

24. Water from sand & gravel at a depth of 100 ft. to 136 ft.

a. static water level 56 ft. below casing which is 24 in. above ground

b. pumping level is ft. pumping gpm for hours

25.

Earth Materials Passed Through	From (ft.)	To (ft.)
Fine Gray Sand	0	85
Medium Grey Sand & Cobbles	85	101
Medium Grey to Course Sand & Cobbles	101	112
Medium Grey Sand & Cobbles	112	136
Refusal	137	

(Attach a 2nd page, if necessary) (If DRY HOLE, fill out log & indicate how hole was sealed.)

26. Chris Arnold — License # 092-007277

Licensed Water Well Contractor Signature

State of Illinois
Department of Public Health

WATER WELL CONSTRUCTION REPORT

Complete within 30 days of well completion and send to the appropriate Health Department

Print Form

1. Type of Well

a. **Driven Well**: Casing Diameter (in.) _____ Depth (ft.) _____

b. **Bored Well**: Casing Diameter (in.) _____ Buried Slab? _____

c. **Drilled Well**: PVC Casing Formation Packer Set at Depth of (ft.) NA

d. **Drilled Well**: Steel Casing Mechanically Driven _____

e. Hole Diameter (in.) 48" to (ft.) 102' ; (in.) ___ to (ft.) ___ ; (in.) ___ to (ft.) ___

f.

Type of Grout	# of bags	Grout Weight	From (ft.)	To (ft.)	Tremie Depth (ft.)
NEAT CEMENT	94	32.5 tons	60	0	

g. Well Finished within Unconsolidated Formation

h.

Kind of Gravel/Sand Pack	Grain Size/Supplier #	From (ft.)	To (ft.)
QUICKRETE	#46	102	60

2. Well Use: Conc of Dewatering Well Disinfected? Yes

3. Date Well Completed: 5-6-10 Driller's Estimated Well Yield (gpm): 1000

4. Date Permanent Pump Installed: 5-7-10 Set at Depth (ft.): 60

5. Pump Capacity (gpm): 500

6. Pitless Adapter Model and Manufacturer: NA Attachment to Casing: BOLTED

7. Well Cap Type & Manufacturer: FABRICATED BY LAYNE

8. Pressure Tank Working Cycle (gals.): NA Captive Air? NA 9. Pump System Disinfected: Yes

10. Name of Pump Company Byron Jackson

11. Pump Installer: Layne License # 102-004215

12. _____ Date 6/2/10

Licensed Pump Installation Contractor Signature

Illinois Department of Public Health
Division of Environmental Health
525 West Jefferson Street
Springfield, IL 62761

IL 482-0126
Revised 6/09

IMPORTANCE NOTICE: This state agency is requesting disclosure of information that is necessary to accomplish the statutory purpose as outlined under Public Act-0863. Disclosure of this Information is Mandatory. This form has been approved by the Forms Management Center.

13. Property Owner: Conoco Phillips Well # 65

14. Driller: Layne Rusty Bowles License # 092-007277

15. Name of Drilling Company: Layne 16. Permit Number: 119-02-10

Date Issued: 2-23-10 17. Date Drilling Started 3-15-10

18. Well Site Address: 1st ST. Conoco Property

19. Township Name: Wood River Land I.D. # —

20. Subdivision Name: — Lot # —

21. Location: a. County Madison b. Site Elevation _____ ft. (above msl)

c. Township: 5N Range: 9E Section: 35

d. NW Quarter of the NE Quarter of the NE Quarter

e. GPS: Lat: Degrees 38 Minutes 50 Seconds 41.2 N

Lon: Degrees 90 Minutes 04 Seconds 34.6 W

Survey use only

22. Casing and Liner Information

Diameter (in.)	Material, Joint Type	From (ft.)	To (ft.)
24	WELDED CARBON	-103.9	1.9

	Diameter (in.)	Length (ft.)	Slot Size (in.)	From (ft.)	To (ft.)
23. Is the well screened? Yes	24	25	.050	103.9	78.9

24. Water from Unconsolidated at a depth of (ft.) 103.9 To (ft.) 78.9

a. Static water level (ft.) below top of casing 45 which is (in.) above ground 1.9

b. pumping level is (ft.) 50' pumping (gpm) 500 for (hours) 4

25.

Earth Materials Passed Through	From (ft.)	To (ft.)
Fine Silty Sand	0	-66
Coal layer	-66	-68
med Sand	-68	-75
med Coarse Sand	-78	-85
med Sand trace clay	-85	-103.9

(Attach 2nd page, if necessary) (If DRY HOLE, fill out log & indicate how hole was sealed)

_____ License # 092-007277

Licensed Water Well Contractor Signature

Layne-Western Company

A Layne Company
2399 Cassens Drive • Fenton, Missouri 63026

FIELD BORING LOG

Boring No. TH 85

Project Conoco Phillips Job No. 1096 0769 Date 2-2-10

Location North Property Crew Gary Mills / Chris Mazuka

Drilling Method: ☑ HSA ☐ CFA ☑ Rotary Wash ☐ Rock Coring ☐ Drilling Fluid _____

DEPTH, ft. From	DEPTH, ft. To	DESCRIPTION	Sample Type	Sample Depth, ft.	Sample Recovery	SPT Blows N/6"
0	66	Fine Silty Sand	WASH			
66	68	Coal Layer				
68	75	Med Sand				
75	78	Limestone - Med, Course Sand.				
78	85	Med Course Sand				
85	115	Limestone, Med Sand Mixed — W - Red. Clay				
115	121	Fine - Med Sand with Light Clay				
121	136	Med Sand				
136	138	Med To Course (Dark) Sand.				
138	142	" " "				
	142	Refusal				

WATER LEVEL OBSERVATIONS	NOTES
During Drilling _____ ft.	
At Completion _____ ft.	
After _____ hrs. _____ ft.	
After _____ hrs. _____ ft.	
After _____ hrs. _____ ft.	

Piezometer Installed: ☒ No ☐ Yes - Depth 142 ft.
TOP OF Burm

LW-794 3/90

APPENDIX B Water System Operating Manual

APPENDIX B

NORTH AND MAIN PROPERTY WATER SYSTEM OPERATING MANUAL

A. DESCRIPTION

Though the configuration and location has changed over time, there are currently 17 vertical wells on-site, of which 12 are operating continuously to provide cooling water for refinery operations. Of the 17 wells, 16 are located in North Property and 1 is located in Main Property, along with their associated piping. **Figure 1** shows the current layout of these wells in the North and Main Properties. The wells are nominally rated from 125 to 500 gallons per minute (gpm) capacity and range up to 43 years in age. Well screening material is 304 stainless steel.

All of the wells except W-77, W-78, W-79, W-80 and W-81 (operated manually) can be started and stopped from the Utilities Control Center (UCC) as required in order to hold a fixed pressure. Pressure on the North Property/Main Property Water System is manually controlled by turning additional wells on or off. North Property/Main Property water is normally used only as feed water to the Cooling Water Treater (CWTR). The North Property water is pumped and then piped to an above ground biotreater for biological treatment of benzene and other organics. From the biotreater, the North Property water is pumped to Main Property via a 20-inch diameter line that runs primarily along Seventh Street to the CWTR area below grade. The Main Property well ties into a 10-inch North Property line located on L Street. A portion of the North Property 20-inch header has been reduced to a PVC coated 14-inch line, and uses the original 20-inch line as a sleeve to cross underneath railroad tracks.

Various crossovers exist for cutting the North Property/Main Property Water and River Water Systems together. These interconnections are not provided in this document.

Oil has a deleterious effect on the CWTR, and on process equipment. Therefore, several oil recovery pumps have been installed to remove the oil from the water. Water wells W-42, W-69, W-75, W-76, W-77, W-78, W-79, W-80, W-81, W-82 and W-85 have adjacent recovery wells. Monitoring well P-71 has also been converted to an oil recovery well. The oil recovery wells are shown on **Figure 2**.

Instrumentation on all oil recovery wells is such that the recovery well, after being manually started, will continue to run until discharge pressure falls below the pressure switch set-point (approximately 15 to 18 psig), at which time the recovery well will shut down. Once the recovery well has stopped, it must be manually restarted. Detailed procedures on the oil recovery system are shown in **Appendix C**.

B. OPERATION

1. General

Pressure on the North Property/Main Property Water System is controlled in essentially a manual mode by putting on or taking off additional wells. The sensor for P-2400-UT (North Property water header pressure) is located on the biotreater inlet. Readout on P2400-UT is available at the Utilities Control Center (UCC). The header normally operates at 35 to 50 psig. Low and high header pressure alarms sound at the UCC and are set at 35 psig and 80 psig, respectively.

2. Cone of Depression

The WRR's "cone of depression" is created by continuously pumping a series of water wells (most located near the Seventh Street area of North Property) so that the water table level under the WRR is lower than that of the surrounding area.

The theory behind operation of the cone of depression is that oil and other potential contaminants are "funneled" into the center of the cone, where they are collected with the water from the pumping wells and are then recovered and disposed of in an environmentally sound manner.

3. Oil Recovery

Recovery of oil from North Property wells has been taking place since approximately 1945. Prior to 1953, water for the WRR was supplied exclusively from North Property in volumes up to 10,000 gpm, and the recovery of oil was essentially coincidental to the water removal. In 1953, the Ranney well at the Mississippi River was installed to make use of the softer water available there, and to provide a supplement to the North Property water. Water withdrawal from North Property wells dropped to approximately 2,500 gpm; oil recovery dropped proportionally.

Oil recovery from the North Property dropped following installation of the Ranney well in 1953. Installation of additional oil recovery wells resulted in the gradual rise in recovered oil volume starting in 1968. During this same period, a program was initiated to move the North Property oil recovery piping from below grade to above grade. A decrease in oil recovery in 1974 and general leveling off of recovery through 1981 is attributed to the replacement of these deteriorating lines.

Oil recovery wells/pumps located within or adjacent to water production wells transfer oily water to Tank F-67, where oil and water separate. Tank F-67 is a floating roof tank, 48 feet in diameter, with a nominal capacity of 15,000 barrels. It is located in the northwest comer of the intersection of L-Street and 10th street. Pumps P-23021 and P-23022 take suction on F-67 and pump the water, on level control, to the Benzene National Emission Standards for Hazardous Air Pollutants (NESHAP) header. Once in the Benzene NESHAP header, water flows to the National Pollutant Discharge Elimination System (NPDES) permitted Waste Water Treatment Plant (WWTP) for treatment.

Both pumps have a "HAND-OFF-AUTO" selector switch. During normal operation, both pumps should be in the "AUTO" position. One pump is normally operating while the second pump is a spare.

The pumps are controlled by a level control with the control panel mounted on a starter rack. The level control panel contains a selector switch that determines which of the two pumps operates and which is spare. This switch can be turned once per week to verify operation of the spare pump.

In the AUTO position, the operating pump will start when the water level reaches 5'6" (LSH-1577) and will stop when the water level drops to 2'0" (LSL-1577) or at 1 '6" via a redundant level switch (LSLl579-UT). In manual operation, the operating pump will shut down at 1 '6"(LSL- I579-UT). The total level (water plus oil) is measured by Ll578-UT. Oil from Tank F-67 is manually pumped to tank F-2l to be re-run in the distilling unit using pumps P-230l9 and P-23020. Operation of Tank F-67 is the responsibility of the environmental systems operator.

C. TREATMENT

To maintain optimum performance of the water production wells, they need to be cleaned to remove deposits from the screens. Each well is cleaned every approximately every 1-2 years. The current well cleaning procedure is attached.

Well Cleaning Procedure

SUMMARY

Treatment - Mechanical:

The mechanical treatment consists of pulling the pumping system in one piece using a crane and suspending it temporarily while a Double Sonar Jet Treatment is performed on the well. The pump would then be returned to the well casing and used for the rest of the treatment.

Treatment – Chemical:

Pristine Water Solutions Inc.'s *MP-2000* (Product Data and MSDS attached) will be used to clean the wells. This product is a dispersant specifically formulated to control scale and other filter related problems in potable water systems. MP-2000 is a non-phosphate based product used to clear away oxidized metal build up and scale deposits from a water system. By penetrating the iron oxide deposits, this will allow for biocide, in the form of bleach, to disinfect the well. Additional products may be added to penetrate microbiological masses as well as hydrocarbon fouled surfaces and improve the effectiveness of the cleaning. This product will be added prior to completion of the bleaching step.

OPERATIONAL PROCEDURE

Cleaning will proceed as follows:

a) The first application of chemicals will consist of introducing 440 gallons of 15% Hydrochloric acid, displaced with an additional 1,000 gallons of clean water to the well volume. Acid will be surged between a portable treatment trailer and the well for approximately four hours or until the acid begins to neutralize. If the acid begins to neutralize prior to 4 hours, another barrel of acid will be added. The solution will then be neutralized with approximately one barrel of caustic soda and the solution will be pumped as waste into storage tanks.

b) Perform Specific Capacity test to monitor progress of treatment.

c) Mix 30 gallons of MP2000 with 2,000 gallons of water and 25 gallons of sodium hypochlorite. The chemicals will then be surged for 4 hours and pumped off after neutralization with sodium bisulfate.

d) Notify the cooling water treater (CWTR) operator that the well will be pumping water into the header for 15-30 minutes at a slow rate.
NOTE: If the CWTR experiences an upset in treatment, discontinue sending water into the header and fill the tanker with the well water. Dispose of the tanker water appropriately.

e) Perform Specific Capacity test to monitor progress of treatment.

Conduct Specific Capacity Test after Treatment:

The specific capacity (discharge rate per foot of drawdown) shall be determined by performing a step test ending at the rated capacity of the bowl in the particular well. Each step of the test shall be for 15 minutes and the maximum for a pumping period of one-half hour. This test will be performed with the permanent bowl and column installed pump. This test will help determine the total effectiveness of the treatment.

PRISTINE Water Solutions
Combining the Resources of Stiles-Kem and Pristine Hydrochemical, Inc.

Pristine Water Solutions Inc.
1570 Lakeside Drive, Waukegan, IL 60085
Toll Free: (800) 562-1537 • (847) 689-1100 • Fax: (847) 689-9289
info@pristinewatersolutions.com • www.pristinewatersolutions.com

Product Data

MP-2000 MP-2000 Product Series Dispersants for Potable Water Systems

Description

MP-2000 is a dispersant specifically formulated to control scale and other filter related problems in potable water systems. ***MP-2000*** is a ***non***-phosphate based product that may be used in potable water systems to clear away oxidized metal build up and scale deposits from any part of a water potable system. ***MP-2000*** may be used in conjunction with any **Pristine Water Solutions Inc.** phosphate based products to add extra cleaning power to your system

MP-2000 is made up of items Generally Recognized As Safe (GRAS) under the provisions of Title 21, Code of Federal Regulations, Section 182, and is certified to meet the requirements of ANSI/NSF Standard 60- Drinking Water Chemicals-Health Effects. As such, it is accepted for potable use when administered within the guidelines of federal, state, and local health and environmental agencies.

Typical Properties

Specific Gravity at 72° F	1.02 ± 0.01
Weight	8.5 lbs./gal.
pH 1% Solution at 72° F	4.6
Color	Clear
Odor	None
Taste	None

Feeding and Dosage

MP-2000 is metered into the water using a chemical solution tank and metering pump to provide a treatment range of 1 to 10 ppm measured as product. For the recommended dosage for particular applications, contact your distributor or the manufacturer.

Handling

Keep out of the reach of children. ***Caution:*** May cause irritation to skin and eyes. Avoid prolonged or repeated contact with skin. Do not take internally. In case of contact, wash with soap and water; for eyes, immediately flush with large amounts of water for at least 15 minutes and get medical attention. Remove contaminated clothing and wash before reuse.

Packaging

MP-2000 is available in bulk, 5, 15, 30, and 55-gallon containers.

PRISTINE
Water Solutions
Combining the Resources of Stilas-Kem and Pristine Hydrochemical Inc.

MATERIAL SAFETY DATA SHEET
MP-2000

SECTION I
Product Identification
Product Name: Polymeric non-ionic dispersant (GRAS Title 21, CFR Section 182)
Chemical Family: Sodium salts
Chemical Name: Sodium salts
Hazardous Material Identification System (HMIS) Rating: 1-0-1
Dot Proper Shipping Name: This product is not classified as hazardous by the US Department of Transportation.
DOT Label: Not applicable
SARA Hazard Notification Hazard categories undercriterim of SARA Title III Section 302-303 (40CFR 355): Not applicable
Section 313 Toxic Chemical: Not applicable

SECTION II
Composition/Information on Ingredients Physical Data
Components: Sodium Salts
Bulk Density: 8.5 lbs/gallon
Specific Gravity at 72.F: 1.02 . 0.01
Boiling Point: 101.C
Melting Point: 628.C, 1130.4.F
pH 1%: 4.6
Appearance and Color: Clear solution.
Corrosive Action on Materials: Concentrated liquid solutions (›20%) are mildly corrosive in nature.

SECTION III
Fire and Explosion Hazard Data
Flammability: Not applicable, Non flammable liquid
Flash Point: Non flammable liquid
Extinguishing Media: Not applicable
Hazardous Thermal Decomposition: At temperatures over 550.F ingredients will decompose.
Unusual Fire and Explosive Hazards: Not applicable
Hazardous Chemical(s) under OSHA Hazard Communication Standard: Not applicable

SECTION IV
Health Hazard Data
Procedures First Aid Measures & Threshold Limit Value: Unknown
Skin: Flush thoroughly with water, get medical attention if irritation occurs.
Eyes: Mild to severe irritation, flush thoroughly with water, call a physician.
Inhalation: Remove to fresh air. If breathing difficulty or discomfort occurs and persists obtain medical attention.
Ingestion: Slightly toxic, do not induce vomiting, call physician.
Toxicology Acute Oral LD_{50}: Unknown
Eye Irritation: If persists obtain medical attention.
Acute Dermal Toxicity: Unknown
Primary Skin Irritation: Slight irritant
Acute Inhalation Toxicity: Unknown
Note to the Physician: Large doses may cause vomiting, nausea and extremely rare cases of Acidosis and Hypocalcemic Tetany.

SECTION V
Reactivity Data
Stability: Stable
Incompatibility: Treat as an acid, avoid contact with strong bases.
Hazardous Polymerization: Will not occur
Conditions to Avoid: None

SECTION VI
Spill, Leak or Accidental Release Measures
Release or Spill: Wear protective clothing, eyewear and respirator. Material should be swept up for salvage or disposal.
Waste Disposal Methodology: This product regarding phosphates does not present a danger or hazard for disposal. Salvage, recycle or process maybe disposed in accordance and guidelines of Local, State and Federal Regulations.

SECTION VII
Special Precautions
Respirator Protection (Specified Type): Use Niosh/MSHA approved respirator for splashing solution.
Local Exhaust: Not applicable
Mechanical Ventilation (General): Local exhaust ventilation when necessary.
Protective Gloves: Impervious when in continuous contact.
Eye Protection: Use chemical goggles when airborne dust is expected.
Other Protective Equipment: Maintain a sink, safety shower and eyewash fountain in work area.
Handling and Storage Precaution: This product should be stored in a clean dry area.

1570 Lakeside Drive, Waukegan, IL 60085-8309
Toll Free: (800) 562-1537 • **Tel:** (847) 689-1100 • **Fax:** (847) 689-9289
Email: wverdone@met-pro.com • **Web:** www.pristinewatersolutions.com

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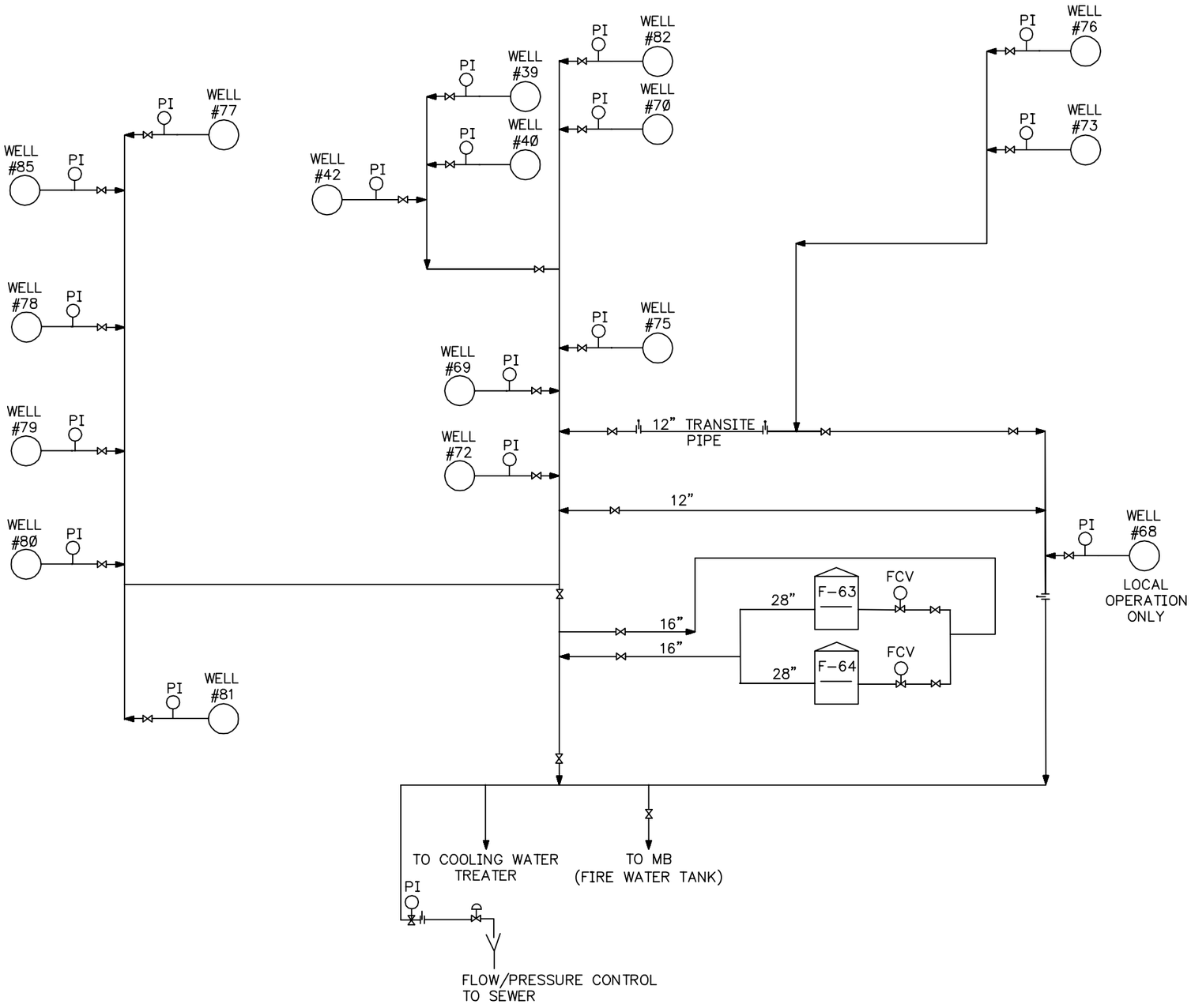
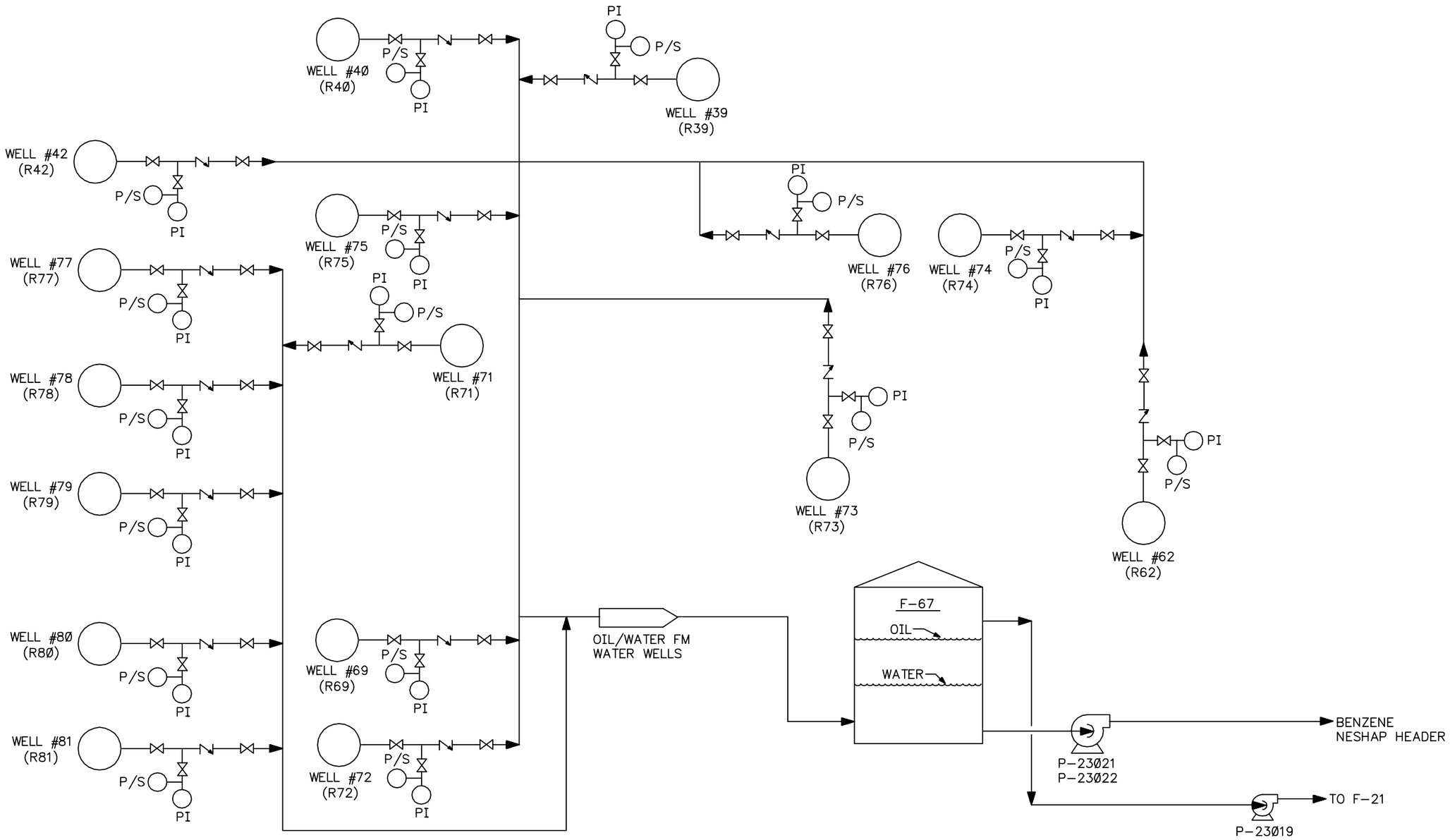
Revised 09/06



REFERENCE: EQUILON WOOD RIVER REFINING COMPANY DRAWING E-37361

SHELL OIL PRODUCTS US AT THE WRB REFINING LLC WOOD RIVER REFINERY ROXANA, ILLINOIS		PROJECT NO. 21562593
URS		
DRN. BY: djd April 2011 DSGN. BY: djd CHKD. BY: hwb	General – Simplified Flow Diagram North Property Water Production Wells	FIG. NO. 1

File: P:\ENVIRONMENTAL\SHELL OIL PRODUCT US\C-WRR-COP\21562288 (PART B SUPPORT)\GROUNDWATER CAPTURE AND OIL RECOVERY\CONSTRUCTION COMPLETION REPORT\APPENDICES\APPENDIX B\FIGURES\FIG 1 - FLOW DIAGRAM-WATER PRODUCTION WELLS.DWG Last edited: APR. 29, 11 @ 09:32 a.m. by: curt_smith



SHELL OIL PRODUCTS US AT THE WRB REFINING LLC WOOD RIVER REFINERY ROXANA, ILLINOIS		PROJECT NO. 21562593
URS		
DRN. BY: djd April 2011 DSGN. BY: djd CHKD. BY: hwb	General – Simplified Flow Diagram North Property Oil Recovery Wells	FIG. NO. 2

PROCESS EQUIPMENT SYMBOLS

MOTOR

PUMP-PROGRESIVE CAVITY

PUMP-CENTRIFUGAL

PUMP-METERING

PUMP, SUBMERGED

BLOWER OR FAN (CENTRIFUGAL)

FILTER

GENERAL SYMBOLS

BALL VALVE

BUTTERFLY VALVE

CHECK VALVE

GATE VALVE

DIAPHRAGM VALVE

3-WAY VALVE

PRESSURE REGULATOR

ARMORED SIGHT GLASS

ROTOMETER

FLEX CONNECTION

REDUCER - CONCENTRIC

REDUCER - ECCENTRIC

SOLENOID

PITOT TUBE (AVERAGING TYPE)

ACTUATOR WITH PNEUMATIC POSITIONER

CALIBRATION COLUMN

SPECTACLE BLIND OPEN / CLOSED

AMB. AIR

CONVENTIONAL INSTRUMENTS

	ANALOG	LOGIC	COMPUTER
NOT OPERATOR ACCESSIBLE (FIELD MOUNTED)	○	◇	⬡
OPERATOR ACCESSIBLE (CONTROL ROOM)	⊖	◈	⬢

DISTRIBUTED SYSTEM (DCS)

NOT OPERATOR ACCESSIBLE

OPERATOR ACCESSIBLE

FUNCTIONAL SYMBOLS

CONVERSION (INPUT IS DESIGNATED IN LEFT SECTION, OUTPUT IS DESIGNATED ON RIGHT SECTION)

A	ANALOG	I	CURRENT
D	DIGITAL	O	ELECTROMAGNETIC OR SONIC
E	VOLTAGE	P	PNEUMATIC
F	FREQUENCY	R	RESISTANCE (ELECTRICAL)
H	HYDRAULIC	MV	MILLIVOLT

SWITCH

INSTRUMENT TAG NAME CONVENTION

EACH INSTRUMENT HAS A UNIQUE INSTRUMENT TAG NUMBER IN THE FORMAT :

PFFFFNNNSSCCUU , WHERE

P = PROCESS VARIBALE,	1 CHARACTER DESCRIBING PRIMARY MEASUREMENT TYPE
F = INSTRUMENT FUNCTION,	1-4 CHARACTERS DESCRIBING INSTRUMENT FUNCTION
N = LOOP NUMBER,	EXACTLY 4 DIGITS (LEADING ZEROS IF REQUIRED).
S = LOOP SUFFIX,	1 CHARACTER FOR DISTINGUISHING MULTIPLE PROCESS MEASUREMENTS OF THE SAME TYPE IN THE SAME LOOP
C = COMPONENT SUFFIX,	0-2 DIGITS FOR DISTINGUISHING MULTIPLE INSTRUMENTS OF THE SAME TYPE IN THE SAME LOOP (TRUNCATE IF NOT REQUIRED).
U = UNIT DESIGNATION,	2 CHARACTERS PER DOCUMENTATION STANDARD DRAWING 59-1840.

PFFFFNNNSSCCUU — FIELD INSTRUMENT

PFFFFNNNSSCCUU — CONTROL ROOM INSTRUMENT

EXAMPLE

TDC TAG NAME CONVENTION

TDC POINT TAG NAMES ARE ALWAYS EXACTLY 8 CHARACTERS IN THE FORMAT

PNNNNSUU , WHERE

P = PROCESS VARIBALE,	1 CHARACTER DESCRIBING PRIMARY MEASUREMENT TYPE
N = LOOP NUMBER,	EXACTLY 4 DIGITS (LEADING ZEROS IF REQUIRED)
S = LOOP SUFFIX,	1 CHARACTER FOR DISTINGUISHING MULTIPLE PROCESS MEASUREMENTS OF THE SAME TYPE IN THE SAME LOOP
U = UNIT DESIGNATION,	2 CHARACTERS PER DOCUMENTATION STANDARD DRAWING 59-1840.

PNNNNSUU

FT1000_02

EXAMPLE

PROJECTIVE INSTRUMENT SYSTEM TAG NAME CONVENTION

EACH PROJECTIVE INSTRUMENT SYSTEM HAS A UNIQUE TAG NAME, EXACTLY 7 CHARACTERS LONG, IN THE FORMAT :

PSNNNUU , WHERE

PS = PROTECTIVE SYSTEM,	ALWAYS PS
N = CRITICAL SYSTEM NUMBER,	EXACTLY 3 DIGITS (LEADING ZEROS IF REQUIRED)
U = UNIT DESIGNATION,	2 CHARACTERS PER DOCUMENTATION STANDARD DRAWING 59-1840

PS NNN UU

PS 001 02

EXAMPLE

PERMAC TAG NAME CONVENTION

ALL INSTRUMENT, TDC AND PROTECTIVE INSTRUMENT SYSTEM TAGS ARE ENTERED IN PERMAC EXACTLY AS THEY APPEAR ON P&ID'S, WITH THE EXCEPTION THAT THEY ALL HAVE AN "I" PREFIX IN PERMAC

EXAMPLE : FT1000_02 IS IFT1000_02 IN PERMAC

INSTRUMENT DESCRIPTION TABLE

LETTER	MEANING FIRST LETTER	MEANING SUCCEEDING LETTER
A	ANALYSIS	ALARM
B	BURNER FLAME	(UNDEFINED)
C	(UNDEFINED)	CONTROL
D	(UNDEFINED)	DIFFERENTIAL
E	VOLTAGE (EMF)	PRIMARY ELEMENT
F	FLOW RATE	RATIO
G	(UNDEFINED)	GLASS
H	HAND (MANUAL)	HIGH
I	CURRENT (ELECTRICAL)	INDICATE
J	POWER	SCAN
K	TIME	CONTROL STATION
L	LEVEL	LIGHT OR LOW
M	(UNDEFINED)	(UNDEFINED)
N	VIBRATION	USERS CHOICE
O	(UNDEFINED)	ORIFICE RESTRICTION
P	PRESSURE	POINT (TEST CONN.)
Q	QUANTITY	TOTALIZE (INTEGRATE)
R	(UNDEFINED)	RECORD OR PRINT
S	SPEED (FREQUENCY)	SWITCH
T	TEMPERATURE	TRANSMIT
U	MULTIVARIABLE	MULTIFUNCTION
V	(UNDEFINED)	VALVE OR DAMPER
W	WEIGHT	WELL
X	STATUS	(UNDEFINED)
Y	CALCULATION	RELAY OR CALCULATION
Z	POSITION	(UNDEFINED)

INSTRUMENT SIGNAL LINES

PNEUMATIC

ELECTRICAL

DIRECT PROCESS CONNECTION

INTERNAL DCS SOFTWARE OR COMMUNICATION LINK

HEAT TRACING AND INSULATED

PIPE DESIGNATORS

4"-CS-AS-0007

4" = IS THE NOMINAL SIZE OF THE PIPE IN INCHES
CS = IS THE PIPING MATERIAL SPECIFICATION (CARBON STEEL)
AS = IS THE SERVICE DESIGNATION (ACTIVATED SLUDGE)
0007 = IS THE LINE NUMBER

PIPING MATERIAL

PIPE MATL. SPEC	DESCRIPTION
CS	CARBON STEEL PER SPECIFICATION 5207
PE	POLYETHYLENE TUBING, PER SPECIFICATION 5700
PVC	SCH. 80 PVC PIPE SPECIFICATION 5401
316SS	316 SS TUBING, PER SPECIFICATION 5201
W316SS	WELDED 316 SS, PER SPECIFICATION 5201

SERVICE DESIGNATION

SERVICE DESIGNATION	DESCRIPTION
AS	ACTIVATED SLUDGE
RAS	RECYCLE(D) ACTIVATED SLUDGE
WAS	WASTE(D) ACTIVATED SLUDGE
RWW	WELL WATER (RAW WATER)
TRW	TREATED WELL WATER
AIR	AERATION AIR (<15 PSIG)
I/A	INSTRUMENT AIR (>40 PSIG)
H_3PO_4	PHOSPHORIC ACAD (50% SOLN)
UREA	UREA (AMMONIUM NITRATE) (50 70% SOLN)
CHEM	DILUTE CHEMICAL FEED

GENERAL NOTES:

1) FOR LEGENDS AND SYMBOLS, GENERAL NOTES AND NOMENCLATURE, SEE DWGS. E-33570, E-33572, E-38482, E-38483, E-38484 AND E-38485.
2) ALL DCS POINTS (BALLOONS WITH SQUARES) WITH SINGLE LINES ARE IN THE DCC TDC SYSTEM - DCS POINTS WITH DOUBLE LINES ARE IN THE LOCAL PLC INTERFACE.
3) INTERLOCK SHUTS DOWN ALL BIOTREATER PROCESS EQUIPMENT WHEN DELUGE "EMERGENCY STOP" PUSH BUTTON IS PUSHED
4) (S) - INDICATES ITEMS TO BE FURNISHED BY SVERDRUP
(V) - INDICATES ITEMS TO BE FURNISHED BY VENDOR

PID-1

— REFERENCE DRAWINGS —

ACCT.NO.	DATE	REVISION	NO.	DR.	CK	APP.	FINAL APP (VZ)	FINAL APP (SVRD)
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Sverdrup ENVIRONMENTAL

Wood River Refining Company
a Division of Equilon Enterprises LLC

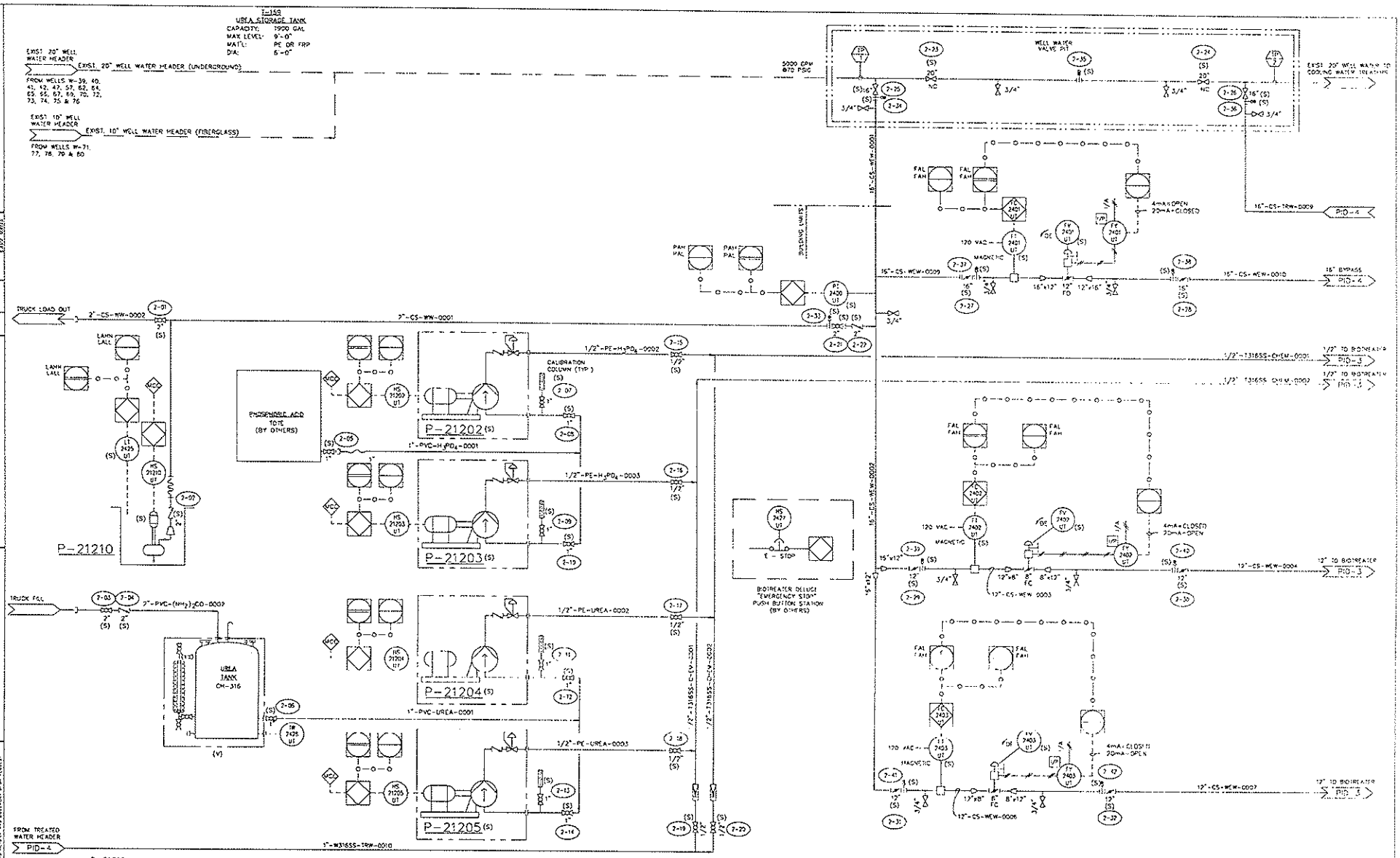
NORTH PROPERTY WELL WATER TREATMENT
PROCESS AND INSTRUMENTATION
DIAGRAM

WOOD RIVER, IL

DEPT	UNIT	AREA	CAT.	DRAWING TYPE
U/L	NORTH PROPERTY GROUNDWATER BIOTREATER	GENERAL	P&ID	DWG

PLOT SCALE: 1:1
SCALE: NONE
SHEET: 01 OF 4
REV: 0

E 51639 10



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Wood River Refining Company
a Division of Equilon Enterprises LLC

NORTH PROPERTY WELL WATER TREATMENT
PROCESS AND INSTRUMENTATION DIAGRAM

WOOD RIVER, IL
PLOT SCALE 1=1
SCALE NONE
SHEET 2 OF 4

DEPT: UTIL CAT: GENERAL
UNIT: NORTH PROPERTY GROUNDWATER BIOTREATER TYPE: P&ID DWG

E 51640 1

PID-2

BIOTREATER–AERATION ZONE

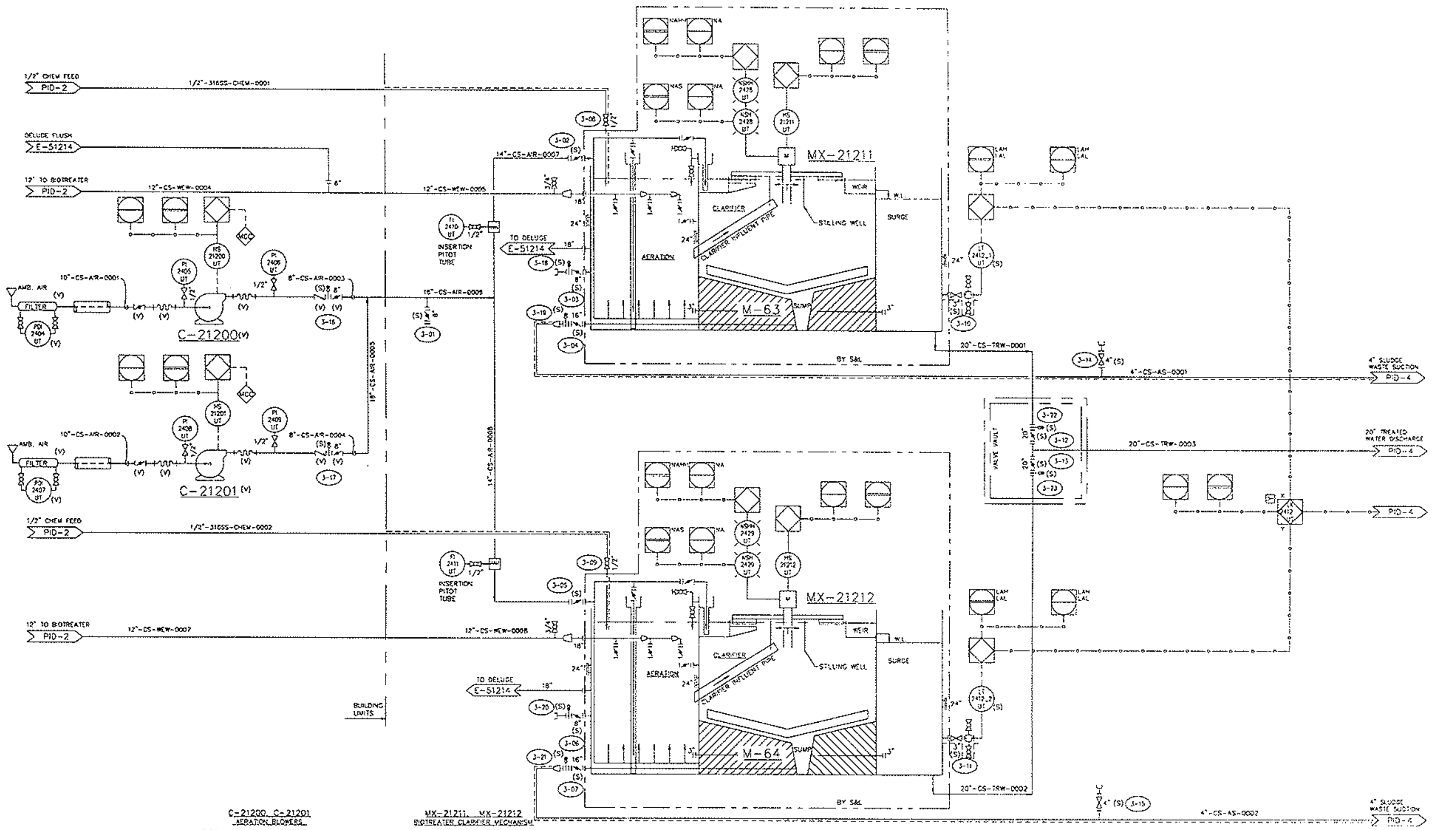
OUTSIDE DIMENSIONS:	110'-0"X24'6"
MAX LEVEL:	23'-10.5"
MAT'L:	CS
VOLUME:	750K GAL

BIOTREATER–CLARIFIER ZONE

DIMENSIONS:	75'-0"X24'-6"
MAX LEVEL @3000 GPM:	23'-2"
MAT'L:	CS
VOLUME	500K GAL

A-157, A-158
BIOTREATER–SURGE ZONE

OUTSIDE DIMENSIONS:	110'-0"X24'-6"
MAX LEVEL	19'-9"
MAT'L:	CS
VOLUME:	90K GAL



C-21200, C-21201
AERATION BLOWERS

TYPE		CENTRIFUGAL
CAPACITY:		2500 SCFM
STATIC PRESSURE:		12.0 PSIG
MAT'L:		
DRIVER	HP:	200 ,RPM: 3600
INSUL:		

MX-21211, MX-21212
BIOTREATER CLARIFIER MECHANISM

TYPE	BI-DIRECTIONAL HYDRAULIC
TORQUE	28,125 ft lbs
DRIVER:	3/4" H.P. ; 1725 RPM
MIXER RPM:	0.048

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	1/99	ISSUED FOR TRAINING	1	JED		

Wood River Refining Company
a Division of Equilon Enterprises LLC

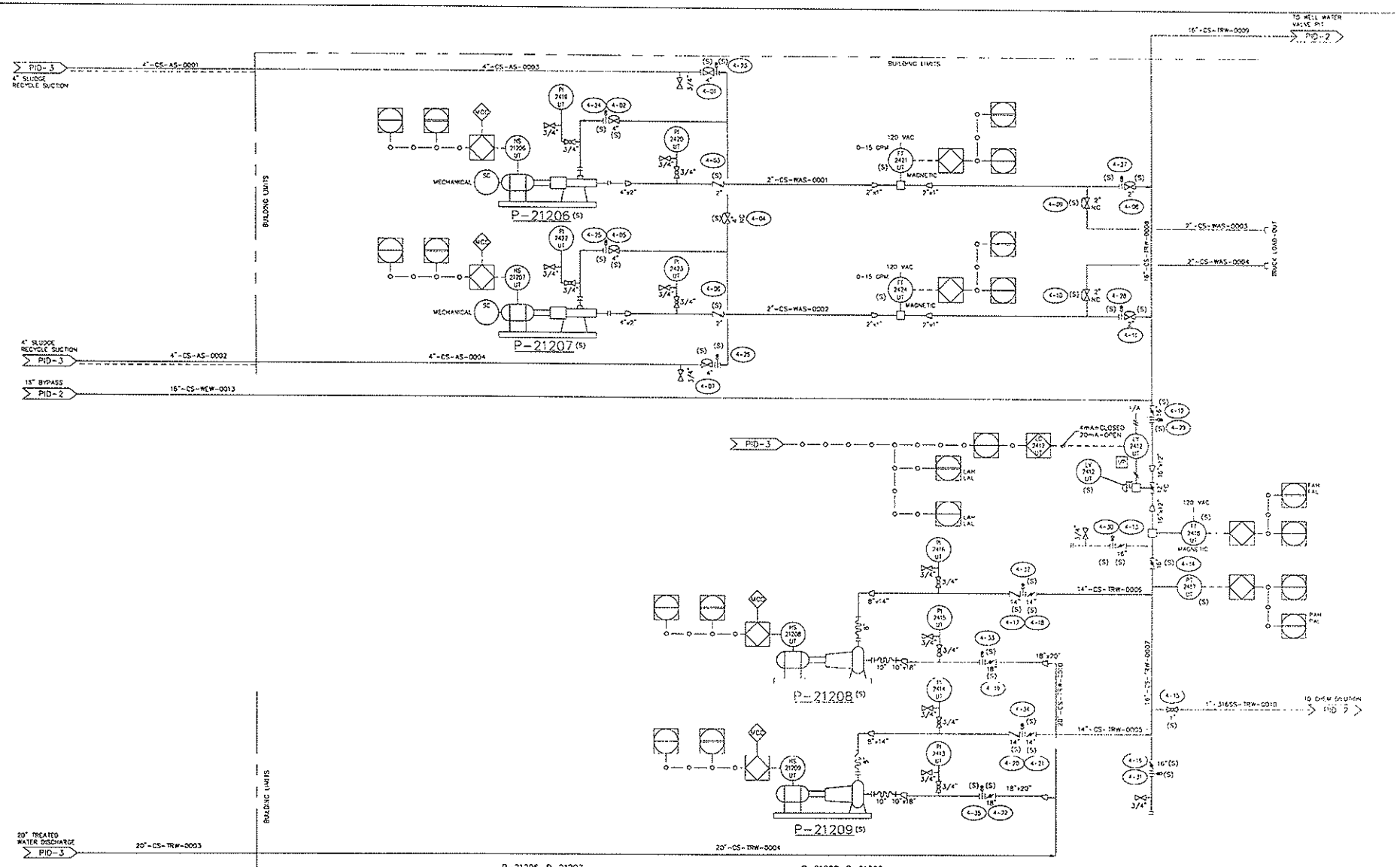
NORTH PROPERTY WELL WATER TREATMENT
PROCESS AND INSTRUMENTATION
DIAGRAM

DEPT: UTIL — UNIT: NORTH PROPERTY GROUNDWATER BIOTREATER — CAT. GENERAL — TYPE: P&ID DWG

PLOT SCALE: 1:1 — SCALE: NONE — SHEET 3 OF 4

E 51641 REV 1

PID-3



P-21206, P-21207
WASTE ACTIVATED SLUDGE PUMPS

DESIGN FLOW:	15	GPM
SUCTION PRESS:	2.3	PSIG
DISCHARGE PRESS:	80	PSIG
MATL:		
DRIVER HP:	5	RPM: 1800

MECHANICAL VARIABLE SPEED 7.5 GPM NORM OPERATING

P-21208, P-21209
EFFLUENT TRANSFER PUMPS

DESIGN FLOW:	4000	GPM
SUCTION PRESS:	0	PSIG
DISCHARGE PRESS:	60	PSIG
MATL:		
DRIVER HP:	200	RPM: 1800

PID-4

— REFERENCE DRAWINGS —

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Wood River Refining Company
a Division of Equilon Enterprises LLC

NORTH PROPERTY WELL WATER TREATMENT
PROCESS AND INSTRUMENTATION DIAGRAM

WOOD RIVER, IL

PLOT SCALE	1=1
SCALE	NONE
SHEET	4 OF 4
REV.	1
DEPT.	UTIL
CAT.	GENERAL
UNIT	NORTH PROPERTY GROUNDWATER BIOREACTER
TYPE	P&ID DWG
	E 51642

FLOWSERVE

Pump Division

Byron Jackson Type M Double Mechanical Seal Submersible Pumping Unit

USER INSTRUCTIONS:
INSTALLATION, OPERATION, MAINTENANCE

PCN=85392711 1042.293/9 • Edition June 2004

CONTENTS

1 INTRODUCTION AND SAFETY

1.1 About the product and these user instructions

NOTE **These user instructions must always be kept close to the product's operating location of operation or directly with the product so that they are available to the operating personnel at any time.**

Flowserve's products are designed, developed and manufactured with state-of-the-art technologies in modern facilities. The pumping unit is produced with great care and commitment to continuous quality control, utilizing sophisticated quality techniques, and safety requirements.

Flowserve is committed to continuous quality improvement and being at service for any further information about the product in its installation and operation or about its support products, repair and diagnostic services.

These instructions are intended to facilitate familiarization with the product and its permitted use. Operating the product in compliance with these instructions is important to help ensure reliability in service and avoid risks. The instructions may not take into account local regulations; ensure such regulations are observed by all, including those installing the product. Always coordinate repair activity with operations personnel, and follow all plant safety requirements and applicable safety and health laws/regulations.

NOTE **These instructions should be read prior to installing, operating, using and maintaining the equipment in any region worldwide.**

The equipment must not be put into service until all the conditions relating to safety, noted in the instructions, have been met.

These user instructions outline the general procedures that must be observed to ensure long, trouble free performance of the pumping unit. However, it is assumed that plant personnel are familiar with the basic principles and tools involved in the installation, operation and maintenance of a pumping unit. Successful pumping unit operation is dependent on careful study of these user instructions and a well planned and observed maintenance program.

In these user instructions, the numbers in brackets are item numbers, e. g.: shaft button screw (806-2). Refer to the drawings in Chapter 8 "Parts list and drawings", Page 59, for the position of the respective item.

1.2 CE marking and approvals

It is a legal requirement that machinery and equipment put into service within certain regions of the world shall conform with the applicable CE Marking Directives covering Machinery and, where applicable, Low Voltage Equipment, Electromagnetic Compatibility (EMC) and Pressure Equipment Directive (PED).

Where applicable, the Directives and any additional Approvals cover important safety aspects relating to machinery and equipment and the satisfactory provision of technical documents and safety instructions. Where applicable, this document incorporates information relevant to these Directives and Approvals.

To check if the approvals apply and if the product itself is CE marked, check the serial number plate markings and the Certification, see Section 9 "Certification", Page 60.

1.3 Disclaimer

Information in these user instructions is believed to be reliable. In spite of all the efforts of Flowserve Pump Division to provide sound and all necessary information the content of these user instructions may appear insufficient and is not guaranteed by Flowserve as to its completeness or accuracy.

Flowserve manufactures products according to International Quality Management System Standards as certified and audited by external Quality Assurance organizations. Genuine parts and accessories have been designed, tested and incorporated into the products to help ensure continued product quality and performance in use.

As Flowserve cannot test parts and accessories sourced from other vendors the incorrect installation of such parts and accessories may adversely affect the performance and safety features of the products. The failure to properly select, install or use authorized Flowserve parts and accessories is considered to be misuse. Damage or failure caused by misuse is not covered by Flowserve's warranty. In addition, any modification of

Flowserve products or removal of original components may impair the safety of these products in their use.

1.4 Copyright

1.5 Duty conditions

This product has been selected to meet the specifications of your purchaser order. The acknowledgement of these conditions has been sent separately to the purchaser. A copy should be kept with these user instructions.

NOTE **The product must not be operated beyond the parameters specified for the application.**

If there is any doubt as to the suitability of the product for the application intended, contact Flowserve for advice, quoting the serial number.

If the conditions of service on your purchase order are changed (for example liquid pumped, temperature or duty) it is requested that the user seeks our written agreement before start up.

1.6 Safety

1.6.1 Safety symbols

These user instructions contain specific safety symbols where non-observance of an instruction would cause hazards.

Safety symbol and safety word	Meaning
 **DANGER**	This symbol indicates an imminent hazardous situation. The situation, if not avoided, will result in death or serious injury.
	This symbol indicates a potentially hazardous situation. The situation, if not avoided, could result in death or serious injury.
 **CAUTION**	This symbol indicates a potentially hazardous situation. The situation, if not avoided, could result in minor or moderate injury.
CAUTION	This word indicates a situation which, if not avoided, could damage the equipment.
NOTE	This sign is not a safety symbol but indicates an important instruction in the assembly process.
The following symbols may be added to the above symbols	
	This symbol indicates a potentially hazardous situation due to hazardous and toxic fluid. The situation, if not avoided, could result in death or serious injury.
 	This symbol indicates a potentially hazardous situation due to strong magnetic field. The situation, if not avoided, could result in death or serious injury to persons with pacemaker implant. Further, the situation could damage instruments and stored data sensitive to magnetic fields.
	This symbol indicates a potentially hazardous situation in an explosive atmosphere according to ATEX. The situation, if not avoided in the hazardous area, could cause an explosion.

Table 1 Safety symbols in these user instructions

1.6.2 General safety instructions

NOTE **Always follow**

- **legal regulations**
- **plant regulations**
- **these user instructions**

concerning safety.

Absolutely heed all information placed directly on the pumping unit and given in Chapter 12.2 "Data sheet", as for example

- rotation arrow
- labeling of connections
- rating plate.

Danger of injury by

- **knocking against parts, tools or equipment**
- **jamming fingers or hands in or between parts, tools or equipment**
- **dropping parts, tools or equipment on parts of the body.**

1.6.3 Personnel qualification, training and protective clothing

Personnel qualification and training

All personnel involved in the operation, installation, inspection and maintenance of the pumping unit must be qualified and authorized to carry out the work involved.

If the personnel in question do not already possess the necessary knowledge and skill, appropriate training and instruction must be provided. If required, the operator may commission the manufacturer / supplier to provide applicable training.

Always co-ordinate repair activity with operations and health and safety personnel, and follow all plant safety requirements and applicable safety and health laws and regulations.

DANGER

All work on the electrical system may only be performed by qualified electricians!

All work on the hydraulic connections may only be performed by qualified fitters.

Protective clothing

During transport, installation and removal of the pumping unit, all personnel must wear

- helmet
- safety boots
- protective gloves

During operation of the pumping unit at the control center, all personnel must wear

- protective gloves

NOTE **Also follow**

- **legal regulations**
- **plant regulations**

concerning protective clothing.

1.6.4 Authorized and prohibited use

The safe operation of the pumping unit can only be guaranteed if it is operated as authorized.

The only authorized utilization of the pumping unit is to pump water from a well. The pumping unit is to be operated submerged in water.

NOTE **Not all components or sub-assemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.**

These user instructions apply only to the components or sub-assemblies supplied by Flowserve in this delivery, see Chapter 12.1 "Scope of delivery".

By not heeding this user instructions, product liability is rendered void.

Non-authorized utilization of the pumping unit includes:

- operating the pumping unit in a known malfunctioning state
- operating the pumping unit in conditions other than those given in Chapter 3.3.1 "Normal operating conditions", Page 15.
- making modifications of the pumping unit that are not authorized by Flowserve
- using spare parts that are not authorized by Flowserve.

CAUTION **Alterations to the pumping unit are only permitted after written permission by Flowserve.**

Only use spare parts that have been authorized by Flowserve.

Flowserve is not liable for any damage caused by the use of parts obtained from third parties.

2 TRANSPORT AND STORAGE

2.1 Consignment receipt and unpacking

A submersible pumping unit consists of

- Motor
- Pump bowl assembly
- Non-return valve
- Power cable
- Riser pipe (discharge column)
- Cable or bracket to fasten the motor power cable onto the riser pipe
- Wellhead (surface plate)
- Terminal box or junction box
- Tools for installation and maintenance.

NOTE **Not all components or sub-assemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.**

These user instructions apply only to the components or sub-assemblies supplied by Flowserve in this delivery, see Chapter 12 "Scope of delivery".

Flowserve generally ships the pumping unit in two packages:

- Main components described in Chapter 3.1.2 "Main Components", Page 14.
- Tools described in Chapter 4.4.4 ”Arrange components for installation", Page 24.

All components and parts are suitably protective wrapped, crated or mounted on skids as appropriate.

The motor is shipped nearly completely filled with oil, with an oil expansion bag (shipping bladder) mounted outside of the motor to allow thermal expansion and contraction of the motor oil.

The power cable, if included in the delivery, is shipped on a reel with a shipping cap or other protective covering installed to protect the connectors.

Immediately after receipt of the equipment

1. Uncrate all parts.

   Check all crates, boxes and wrappings for any accessories or spare parts which may be packed separately with the equipment or attached to side walls of the box or equipment.

2. Check the scope of delivery.

   - Check the delivery against the delivery and shipping documents for its completeness.

     Each product has a unique serial number. Check that this number corresponds with that advised.

     NOTE **Make sure you can always quote each part's serial number in correspondence and when ordering spare parts or further accessories.**

   - Inspect the delivery for transportation damage.

   Immediately report any shortage and or damage to Flowserve and the shipping company.

   Claims must be reported in writing within one month of receipt of the equipment. Flowserve does not accept latter claims.

3. Check the available power against the requirements given on the motor data plate and in Chapter 12.2 "Data sheet".

If the equipment is to be stored

- continue with Chapter 2.3 "Storage and shipping", Page 12.

If the equipment is to be installed

- continue with Chapter 4.4 "Installation", Page 23.

2.2 Transport

2.2.1 Safety instructions

Transport is the process of moving the pumping unit or its components from the installation site to a storage site, maintenance site or repair site, or vice versa.

During transport, always

- Work carefully to avoid accidents.
- Handle equipment carefully.
- Be sure lifting devices are in good condition and are capable of safely handling the weights to be lifted.
- Mark and seal off the transport route so that unauthorized personnel do not enter the danger area.
- Take precautions to prevent foreign materials or dirt from entering the working parts of pump and motor.

Take care that the hoist has an adequate carrying force. For weight see Chapter 12.2 "Data sheet".

Never step under floating load.

Watch for and avoid overhead obstructions including power lines.

2.2.2 Equipment and personnel required

Provide the following equipment for the transport:

- Portable crane with adequate carrying force. For weight see Chapter 12.2 "Data sheet.
- Also see Chapter 4.2 "Equipment and personnel required", Page 19.

Flowserve recommends that 2 persons plus 1 crane operator perform the transport.

2.2.3 Transport of the motor

Do not raise or move the motor by the power cables!

CAUTION **The motor is a dynamically balanced machine and should be handled accordingly.**

Take precautions to prevent foreign materials or dirt from entering the working parts of the motor.

1. Refer to Figure 1.

   Place hitching line under lifting lugs.

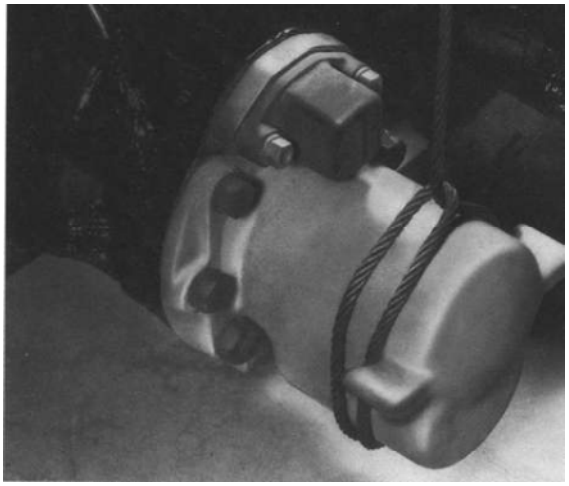

Figure 1 Hitching line under lifting lugs

2. Refer to Figure 2.

   Place a wire around the motor. The wire is to be positioned between stator and lower casing, approx. 1/3 from bottom of motor.

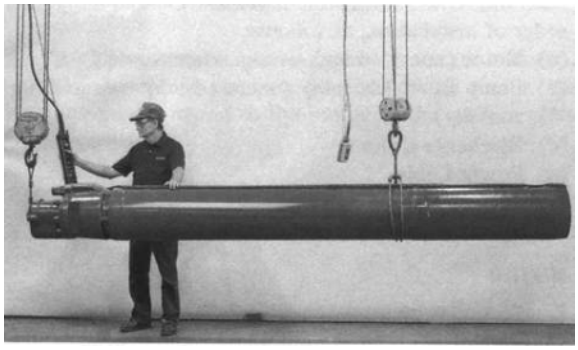

Figure 2 Lifting motor for installation

3. Lift the motor horizontally by 2 points.
4. Transport the motor horizontally to the installation or storage site.
5. Carefully lower the motor at the respective site and place it on the floor.

If the motor is to be stored:

ƒ$ Continue with Chapter 2.3 "Storage and shipping", Page 12.

If the motor is to be installed in a well:

ƒ$ Continue with Chapter 4 "Installation", Page 19.

If the motor is to be maintained:

ƒ$ Continue with Chapter 6 "Maintenance", Page 50.

2.2.4 Transport of the pump bowl assembly

NOTE **Not all components or subassemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.**

These user instructions apply only to the components or subassemblies supplied by Flowserve in this delivery, see Chapter 12.1 "Scope of delivery".

CAUTION **Use care to prevent bumping, pushing, or scraping of pump bowl assembly parts, especially the shafts, or other machined surfaces.**

Take precautions to prevent foreign materials or dirt from entering the working parts of the pump bowl assembly.

NOTE **The following description refers to pumps without auxiliary carriers.**

Should the pump be delivered on an auxiliary carrier, refer to the pump manual for transportation instructions.

1. Connect the pump

   ƒ$ directly to the hoists, or

   ƒ$ to the cross-beam

   of a portable crane.
2. By means of the crane, carefully lift the pump and move it to the desired site.

If the pump bowl assembly is to be stored:

ƒ$ Continue with Chapter 2.3 "Storage and shipping", Page 12.

If the pump bowl assembly is to be installed in a well:

ƒ$ Continue with Chapter 4 "Installation", Page 19.

If the pump bowl assembly is to be maintained:

ƒ$ Continue with Chapter 6 "Maintenance", Page 50.

2.3 Storage and shipping

For the removal of the pump from the well see Chapter 4.5 "Uninstallation", Page 45, if necessary.

Requirements for the storage area

- Safe
- Clean
- Away from extended periods of direct sunlight
- Well ventilated
- Dry
  Air humidity: .....40 % to 60 %
- Cool
  Air temperature for motors
  originally filled by Flowserve: ...+50 °C to -5 °C

CAUTION Always store motor and pump bowl assembly separately.

Prepare motor for storage or shipping after removing the motor from the well

1. Arrange the motor horizontally.
2. If pump and coupling are to be stored or shipped separately: Install coupling components on motor shaft.
3. Install power terminal shipping cap (112), power terminal gasket (744-6), and motor shipping caps (112-1).
4. If the motor is to be stored in a vertical position, proceed as follows:
   a. Remove the adapter bracket (808).
   b. Drill a vent hole in the motor shipping cap (112-1).

      If the motor is returned to factory at a later time, seal the vent hole by a pipe plug.
5. If the motor is to be returned to the factory, proceed as follows:
   a. Remove motor half-coupling (529) or motor one-piece coupling (531).
   b. Lubricate shaft with some form of penetrating oil.
   c. Place coupling and components in motor shipping cap (112-1) with its power terminal gasket (744-6) and bolt cap securely in place.
   d. Elevate motor over a sump or drum to drain oil and water from motor.
   e. Remove lower casing drain plug (806) from bottom of motor, then remove vent plugs (806-4 and 806-5) at top of motor and allow motor to fully drain.
   f. Replace drain and vent plugs.

Prepare pump bowl assembly for storage or shipping

NOTE Not all components or sub-assemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.

These user instructions apply only to the components or sub-assemblies supplied by Flowserve in this delivery, see Chapter 12.1 "Scope of delivery".

NOTE The following description refers to pumps without auxiliary carriers.

Should the pump be delivered on an auxiliary carrier, refer to the pump manual for storage and shipping instructions.

1. Install blocks in the strainer to restrain the pump shaft.

   This prevents shaft end float and possible internal damage during handling.
2. Make sure the bowl assembly is thoroughly dry.
3. Install suitable covers to seal off all openings.

Store pumping unit

NOTE **The following description refers to pumps without auxiliary carriers.**

Should the pump be delivered on an auxiliary carrier, refer to the pump manual for storage and shipping instructions.

Store the pumping unit as follows:

ƒ$ Motor:

Preferably vertically

Filled with oil

ƒ$ Pump bowl assembly with rubber bearing bushes:

Vertically

ƒ$ Pump bowl assembly with other than rubber bearing bushes:

Preferably vertically

DANGER

Horizontally stored motors and pump bowl assemblies must be secured against rolling.

Vertically stored motors and pump bowl assemblies must be secured by appropriate means in this storage position to prevent tipping over.

ƒ$ Power cable:

Leads protected from moisture

NOTE **Do not bend power cable during storage.**

Maintenance during storage

ƒ$ Storage up to four weeks

At the beginning and end of the storage period: Carefully check the motor to be sure there are no signs of oil leakage.

ƒ$ Storage between 1 and 24 months

Maintenance of the motor, every 6 to 8 weeks:

1. Remove the motor shipping cap (112) at the motor.
2. Turn the motor shaft several times by means of a wrench.
3. Mount the motor shipping cap (112) to the motor.

Maintenance of the pump, every 6 to 8 weeks:

1. Remove the discharge housing and the non-return valve for the pump shaft.
2. Turn the pump shaft several times by means of a wrench.
4. Mount the discharge housing and non-return-valve to the pump.

ƒ$ Storage for over 24 months

After a storage of more than 24 months, we recommend a complete visual inspection at our main factory or at your nearest Flowserve representative.

Shipping

Ship motor and pump bowl assembly

ƒ$ in non-airtight protection film

ƒ$ in wooden box or similar transport packaging.

2.4 Recycling and end of product life

At the end of the service life of the pumping unit or its parts, the relevant materials and parts should be recycled or disposed of using an environmentally acceptable method and heeding local regulations.

If the product contains substances which are harmful to the environment, these should be removed and disposed of in accordance with local regulations. This also includes the liquids and or gases in the "seal system" or other utilities.

DANGER

Make sure that hazardous substances are disposed of safely and that the correct personal protective equipment is used.

The safety specifications must be in accordance with the local regulations at all times.

Hazardous substances in the pumping unit are

ƒ$ Motor oil

3 DESCRIPTION

3.1 Configurations

3.1.1 General Description

The Flowserve submersible pumping unit is a combination of

- a vertical, oil filled motor with double mechanical seal
- a vertical pump bowl assembly

designed for sustained operation submerged in water. The motor is positioned directly below the pump bowl assembly.

The rotating element of the pump bowl assembly is driven from the bottom where its extended shaft is connected to the motor shaft by a coupling.

Power is supplied to the motor through a submarine power cable which is fastened to the riser pipe and extends to the starting equipment. Motor and pump bowl assembly are connected to the riser pipe. The riser pipe is threaded or flanged and coupled in random lengths and the entire unit is coupled to a wellhead assembly.

Each pumping unit has been individually manufactured according to the special requirements of the customer. The technical data is given in Chapter 12.2 "Data sheet".

3.1.2 Main Components

A pumping unit consists of

- Motor
- Pump bowl assembly
- Non-return valve
- Power cable
- Riser pipe (discharge column)
- Cable or bracket to fasten the motor power cable onto the riser pipe
- Wellhead (surface plate)
- Terminal box or junction box
- Tools for installation and maintenance.

NOTE **Not all components or sub-assemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.**

These user instructions apply only to the components or sub-assemblies supplied by Flowserve in this delivery, see Chapter 12.1 "Scope of delivery".

3.1.3 Motor serial number

The motor serial number is on the name plate on the stator.

3.2 Design of major parts

The motor is filled with, lubricated and cooled by a special mineral oil of high dielectric strength.

This oil

- allows high efficiency rotor-stator design,
- provides excellent insulation and lubrication qualities, and
- protects the motor from internal corrosion.

CAUTION **The oil used in this pumping unit is specified in Chapter 12.2 "Data sheet".**

Use of other oil

- **may cause damage to the pumping unit**
- **renders Flowserve's warranty void.**

The motor does not require periodic oil changes.

The oil is circulated within the motor by pumping action of the thrust bearing disc. Separation between the motor oil and pump liquid at the shaft exit is maintained by two mechanical seals.

The motor is pressure compensated.

The double mechanical seal system uses a pressure balance process to equalize the pressure differential across the seals, minimizing leakage and providing years of maintenance free service. The inner seal diverts any pumped fluid leakage via a communication line to a storage reservoir at the bottom of the motor. The motor is vented to the well by the balance line. As the oil expands, some oil is pushed out of the motor through the balance tube. As the oil cools down, pumped fluid is drawn back into the lower casing at the bottom of the motor through the balance tube.

3.3 Performance and operating limits

3.3.1 Normal operating conditions

Operating purpose

Submersible pumps serve to transport water under the operating conditions described in the following.

CAUTION Other uses, operating purposes or operating conditions must be agreed upon by Flowserve.

Water characteristics

- Water temperature: .....See Chapter 12.2 "Data sheet"
- Sand content: .....Maximum 25 mg/l

  Also see Chapter 3.4.3 "Development of the well", Page 16, and Chapter 3.4.5 "Effect of pumping sand", Page 16.
- No impurities which could lead to deposits and blockages within the pump or to deposits on the motor surface.

  Also see Chapter 3.4.6 "Effect of air or gas", Page 16 and Chapter 3.4.7 "Oxidizing and corrosive effects of chemicals, air and gases", Page 16.
- No occurrence of water hammer

CAUTION At higher surrounding temperatures and/or lower flow velocities on the external motor surfaces, or if there is risk of clogging, special measures for heat dissipation are required.

Inform Flowserve of the surrounding conditions.

Flowserve will check the suitability of the pumping unit for its planned application and confirm its use, if applicable.

Pumping unit

- Correctly selected and adjusted motor protection

Operation

- Operation within prescribed voltage tolerance, see Chapter 12.2 "Data sheet"
- No operation against closed slide valve
- Permissible operational range: 50 % to 120 % of the optimal delivery rate
- Observation of the maximum permissible starting frequency

Installation position

Take the following criteria into account when determining the installation position and depth:

- Vertical installation in a well above the filter line, so that a perfect flow is guaranteed along the external motor wall.
- Sufficient water cover
- A static water level at least 2 m above the pump exit
- A dynamic water level above the suction housing, taking into account the required net positive suction head for the pump (see Chapter 12.2 "Data sheet")
- Flow rate (see Chapter 12.2 "Data sheet")
- Supply conditions of the pumping medium (dependent upon the installation conditions)

CAUTION The pumping unit should be installed above the well filter.

If this is not possible, prevent direct suction within the filter line by suitable measures (e.g. blind tube in the filter, outer pump mantle, pump with sand protection jacket.

3.3.2 Design changes

Alternation or addition of the pumping unit may only take place

- by Flowserve, or
- after written consent by Flowserve.

3.4 Preconditions at the installation site

3.4.1 Survey of well

Always sound the well to make sure it is deep enough to permit installation of the pumping unit consisting of pump bowl assembly and motor. If the exact diameter and depth of the well casing is not known, "cage" the well following the procedure outlined in Chapter 3.4.2 "Crooked well", Page 16.

Experience indicates that many wells have more that one string of casing installed and frequently the lower sections are smaller in diameter than the surface casing. Be certain the submersible pumping unit will pass into the well freely and hang well above of the well bottom.

3.4.2 Crooked well

A well that is known to be crooked and that has not previously accommodated a pumping unit of comparable size must be "caged" before the submersible pumping unit is installed.

1. Prepare a cage of the same length and diameter as the combined motor and pump bowl assembly, with 12 m to 15 m (40 feet to 50 feet) of the proper size of riser pipe.
2. Lower the cage into the well to the point at which the pumping unit is to be placed.
3. If the cage can be lowered to this point without touching the inner wall of the well, the submersible pumping unit can be installed.

3.4.3 Development of the well

Do not use a new pumping unit to develop the well.

Developing, surging and freeing the well of sand are considered a part of the well drillers contract and should be accomplished by the use of a test pumping unit.

3.4.4 Suction and submergence requirements

Pumping the well at a rate at which the pumping unit breaks suction will cause pump deterioration. It is suggested that a method be provided for keeping a record of the water level above the suction inlet.

The minimum submergence recommended is 3 m (10 feet) of riser pipe submergence below the *maximum* well draw-down level, although some installations may require more submergence.

3.4.5 Effect of pumping sand

Flowserve does not guarantee the pumping unit to be resistant against the erosive action of sand, silt or other abrasive materials suspended in water.

Pumping sand will adversely affect the motor because the vibration produced in a worn pump bowl assembly will be transmitted to the motor and could result in a shortened motor life.

3.4.6 Effect of air or gas

The presence of gases in the water may reduce capacity and head of the pumping unit, thus decreasing the hydraulic performance. Further, air or gas in the water will cause deterioration of materials of the pumping unit sooner than under normal conditions.

3.4.7 Oxidizing and corrosive effects of chemicals, air and gases

Even if the composition of the pumped water is known due to chemical analysis, it is not always possible to predict the corrosive action of water on the metals of the pumping unit.

In addition to chemicals, water may also contain entrained air or gases that have a definite oxidizing or corrosive action of their own. This action is accentuated by high velocities within the pump. Such conditions are not recognizable in the chemical analysis of the water.

Conforming with the Standards of the Hydraulic Institute of the United States and the practice of all reliable pump manufacturers, Flowserve does not guarantee its pumps and motors to be resistant against corrosive or electrolytic action.

Should you require motors or pumps to perform under oxidizing or corrosive conditions, contact Flowserve for further information.

3.5 Electrical requirements

3.5.1 General electrical requirements

The Byron Jackson submersible motor is designed for across-line start, eliminating the need for reduced voltage starting equipment. Maximum current inrush when the motor is connected across the line at full voltage will be limited to about 700 % of the rated load current.

Because starting the motor at full voltage results in high starting torque, the motor accelerates to operating speed very rapidly (within 0.8 seconds, typically), and current consumption correspondingly drops to normal. The rated power requirements of the motor are stated on the pump nameplate located on the wellhead.

Allowed combinations of voltage and frequency variations during operation are classified according IEC 60034 as being either Zone A or Zone B (Figure 3) or according NEMA (see Figure 4).

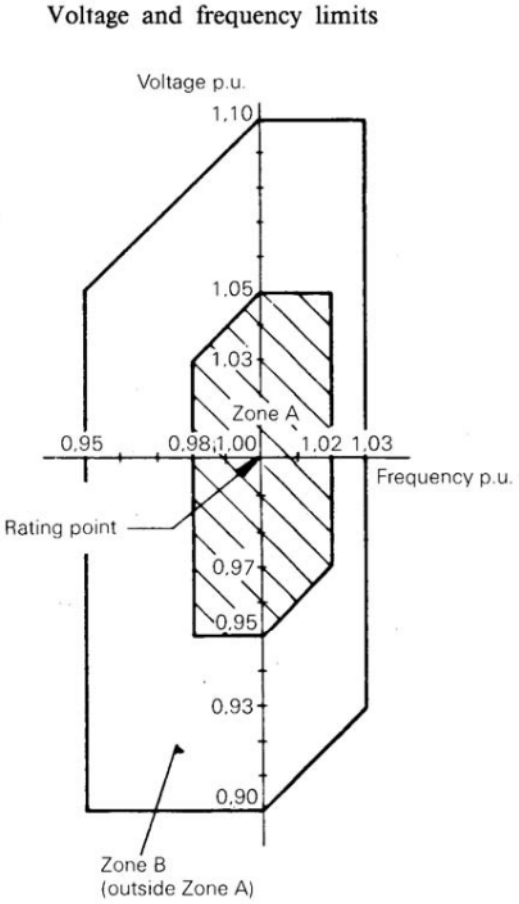

Figure 3 Voltage and frequency limits acc. IEC 60034

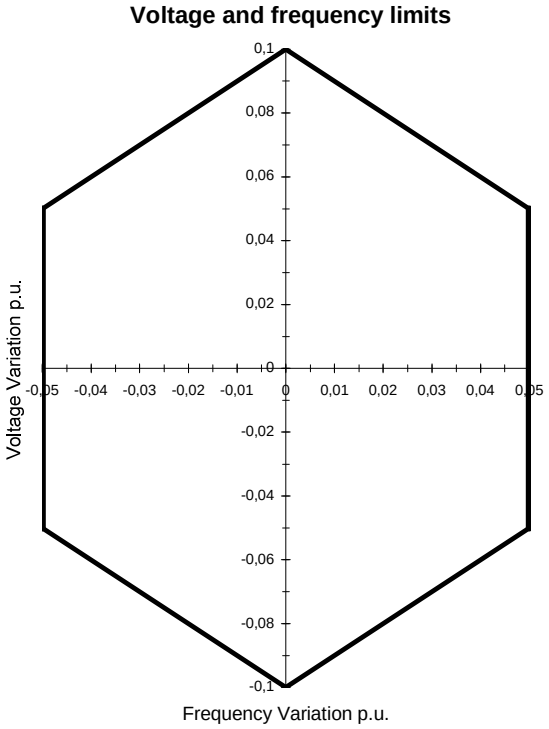

Figure 4 Voltage and frequency limits acc. NEMA

The motor is capable of performing its rated torque continuously within Zone A, but need not comply fully with its performance at rated voltage and frequency (see rated point in Figure 3), and may exhibit some deviations. Temperature rises may be higher than at rated voltage and frequency. For conditions at the extreme boundaries of Zone A, the temperature rises and temperatures may exceed the specified limits of temperature rise and temperature by approximately 10 K.

Operation outside Zone A (within Zone B) may exhibit greater deviations from its performance at rated voltage and frequency than in Zone A. Temperature rises may be higher than at rated voltage and frequency and most likely will be higher than those in Zone A. Extended operation at the perimeter of Zone B is not recommended.

Low voltage is a serious problem since the operating motor current is increased, resulting in additional motor heating. However, the motor is designed to operate continuously at 110 % of rated current, so that some reduction in voltage can be tolerated as long as it is not also accompanied by an overload of the motor.

With variations in voltage, the motor characteristics will, in general, vary as given in Table 2.

Voltage	**110 %**	**90 %**
Speed	Increase 1 %	Decrease 1.5 %
Efficiency (full load)	Increase 0.5 %	Decrease 1 %
Power factor (full load)	Decrease 3 %	No change
Current (starting)	Increase 11 %	Decrease 11 %
Current (full load)	Decrease 8 %	Increase 11 %
Temperature	Decrease 2 %	Increase 5 %

Table 2 Motor characteristics at varying voltage

Rated or full load current refers to the amperage drawn by the motor at nameplate output, frequency and voltage at the motor terminals. The maximum allowable current (except momentarily at start-up) is 110 % of the rated value.

The voltage on all three phases should be evenly balanced as closely as can be read on the usually available commercial voltmeter, because the current unbalance will be in the order of 6 to 10 times the voltage unbalance. Running the motor with the unbalanced voltage will lead to increased temperature and decreased motor life time, and therefore must be avoided.

Poor voltage regulations of an engine-driven generator, if the power is derived from such a source, can be very disadvantageous to the motor. Thus, Flowserve assumes no responsibility for pumping units operated on such equipment unless agreed on in writing.

Also, because of the unpredictable characteristics and past experiences associated with the use of phase converters, Flowserve must void all guarantees for applications that incorporate these devices as a means of obtaining three phase power.

3.5.2 Motor protection

To protect the motor against power overload, an inverse time-lag overload relay must be provided, sensitive to phase failure and which compensates for temperature.

The over current relay for the switchgear and the safety fuses can be adjusted or selected according to Chapter 12.2 "Data sheet".

The adjustment of the motor protection switch (thermally delayed over current relay) must be done according to the value given in Chapter 12.2 "Data sheet".

The value given in Chapter 12.2 "Data sheet", is a standard value for the operating point. If the actual operational current in the operating point of the pump bowl assembly lies under this given value, the switch must be adjusted lower so that there is effective protection and malfunctions can be indicated in time.

DANGER

Do not set the motor protection adjustment higher than the highest permissible value given in Chapter 12.2 "Data sheet".

Do not test the perfect functioning of a motor protection switch by intentional single-phasing.

3.5.3 Short circuit protection

To prevent short circuiting of the power cable and the motor, safety measures must be taken according to local ordinances.

Guide values for the safety fuse sizes can be taken from Chapter 12.2 "Data sheet".

4 INSTALLATION AND UNINSTALLATION

4.1 Fitter

It is recommended that the services of Flowserve be employed for the installation and initial starting of a Byron Jackson pump.

Such service will ensure the purchaser that the equipment is properly installed, and will provide an excellent opportunity for the plant operator to receive special instructions relative to the pumping unit.

4.2 Equipment and personnel required

4.2.1 Equipment and tools supplied with motor

Equipment and tools supplied with motor and half coupling

ƒ$ Hex socket wrench for shaft button screw (806-2)

ƒ$ Hex socket wrench for coupling set screw (806-1)

ƒ$ Hex socket wrench for vent plug (806-4)

ƒ$ Hex socket wrench for vent plug (806-5)

ƒ$ Aligning jig assembly, including the following parts:

- Shim, shaft adjusting (262-6)
- Shim, shaft adjusting (262-7)
- Button, thrust (130)
- Screw, thrust Button (806-2)
- Washer, coupling lock screw (690-4)
- Screw, coupling lock (806-3)
- Aligning jig (265)
- Coupling, driver (529)
- Key, coupling (676-1)
- Screw, set, coupling (806-1)

4.2.2 Equipment and tools to be supplied by operator

Provide the following equipment and tools:

ƒ$ Lifting Equipment.

Must be of sufficient strength and rigidity to lift the complete unit safely, see Table 3, Page 20, and of sufficient height to allow clearance between load hook and foundation. For weight see Chapter 12.2 "Data sheet".

ƒ$ Two pairs of correctly sized pipe elevators

ƒ$ One correctly sized column U-plate

ƒ$ One correctly sized motor U-plate (see Figure 5, Page 21 and Table 4, Page 21)

ƒ$ One 1.2 - 1.8 m (4 - 6 feet) section of column, threaded and coupled, to be attached to the top case and used for handling the pump bowl assembly.

Deduct this length from total column length specifications.

ƒ$ Column

A supply of pipe, in random lengths, threaded and coupled, of correct size to handle the unit capacity and total weight and of adequate length to set the unit at the correct pumping level in the well. The threading is 8 threads per 25 mm (1 inch) and 19 mm (0.75 inch) taper per foot.

ƒ$ One pair of cable reel stands, with axle

ƒ$ One portable insulation resistance tester ("Megger"), 0 - 100 MΩ / 1000 Volts

ƒ$ One clamp-on ammeter

ƒ$ One volt/ohmmeter

ƒ$ Components for water level indicating system

ƒ$ Special banding tool ("Band-it") for cable bands

ƒ$ A length of 1.27 cm (0.5 inch) hemp rope and a cable installation wheel. Diameter must be at least 14 times cable outer diameter.

ƒ$ Ordinary hand tools (mechanical and electrical) used in this kind of work

ƒ$ Two sets of chain tongs

ƒ$ Rubber mat and insulated gloves for electrical work in damp conditions

ƒ$ An adequate supply of approved thread compounds, as follows

- For installation of the short section of column pipe, next to top case or top case flange, use only Loctite 277 (Red) & Primer T or equal.
- For remaining column pipe threads, use a pipe thread compound that is capable of lubricating and sealing.

Column				
Size	**Weight per foot in kg (pounds)**			
	Empty		**Full**	
2-1/2	2.6	(5.8)	3.6	(7.9)
3	3.4	(7.6)	4.9	(10.8)
4	4.9	(10.9)	7.4	(16.4)
5	6.7	(14.8)	10.7	(23.5)
6	8.7	(19.2)	14.4	(31.7)
8	11.3	(25.0)	21.4	(47.2)
10	14.5	(32.0)	30.2	(66.6)
12	20.4	(45.0)	42.6	(93.9)
Bowl Slumps				
Size	**Weight in kg (pounds)**			
	1st Stage		**Additional Stage**	
8MQ	36	(80)	7	(15)
10MQ	79	(175)	17	(37)
11MQ	132	(290)	32	(70)
12MQ	200	(440)	57	(125)
13MQ	284	(625)	79	(175)
15MQ	386	(850)	120	(265)
Cable				
Volts	**Size**		**Weight per foot in kg (pounds)**	
600	8		0.14	(0.30)
	4		0.35	(0.77)
	2		0.50	(1.10)
	300MCM		2.00	(4.40)
	500MCM		3.08	(6.80)
5000	6		0.41	(0.90)
	2		0.54	(1.20)
	1/0		1.00	(2.20)
	4/0		1.54	(3.40)

Motors			
Nominal motor size	**Horsepower**	**Weight in kg (pounds)**	
8"	7-1/2	211	(465)
	10	211	(465)
	20	227	(500)
	25	249	(550)
	30	249	(550)
10"	40	431	(950)
	50	431	(950)
	60	458	(1 010)
	75	458	(1 010)
	100	490	(1 080)
	125	553	(1 220)
12"	125	915	(2 018)
	150	953	(2 100)
	175	1 002	(2 210)
	200	1 027	(2 265)
14"	125	1 170	(2 580)
	150	1 288	(2 840)
	200	1 424	(3 140)
	250	1 485	(3 273)
	300	1 485	(3 273)
17"	300	1 690	(3 725)
	350	1 860	(4 100)
	400	1 928	(4 250)
	450	1 996	(4 400)
	500	1 996	(4 400)
	600	2 087	(4 600)
21"	600	1 950	(4 300)
	800	2 359	(5 200)
	1 000	2 767	(6 100)
	1 200	3 221	(7 100)
	1 500	3 720	(8 200)

Table 3 Component weight chart for calculating foundation, derrick and hoist loads

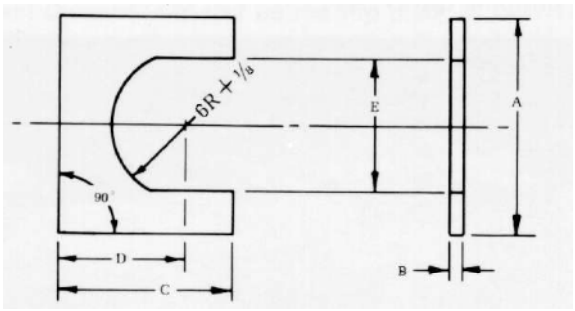

Figure 5 Motor U-plate

Nominal motor size	Dimensions in cm (inches)				
	A	B	C	D	E
8"	38.10 (15)	0.95 + 0.32 (0.375 + 0.125)	25.40 (10)	25.40 (10)	14.61 + 0.32 (5.750 + 0.125)
10"	40.64 (16)	0.95 + 0.32 (0.375 + 0.125)	30.48 (12)	25.40 (10)	18.10 + 0.32 (7.125 + 0.125)
12"	45.72 (18)	1.27 + 0.32 (0.500 + 0.125)	35.56 (14)	25.40 (10)	19.05 + 0.32 (7.500 + 0.125)
14"	50.80 (20)	1.27 + 0.32 (0.500 + 0.125)	35.56 (14)	25.40 (10)	24.77 + 0.32 (9.750 + 0.125)
21"	91.44 (36)	1.27 + 0.32 (0.500 + 0.125)	73.66 (29)	53.34 (21)	42.57 + 0.32 (16.760 + 0.125)

Table 4 Motor U-plate chart

4.2.3 Personnel required

Flowserve recommends that 2 persons plus 1 crane operator perform the installation or uninstallation procedure.

4.3 Hydraulic connection

Exemplary construction of a water supply system is depicted in Figure 6, Page 22. As this shows a basic arrangement, the actual layout must be suited to local and technical conditions.

DANGER

All work on the hydraulic connection may only be done by qualified fitters.

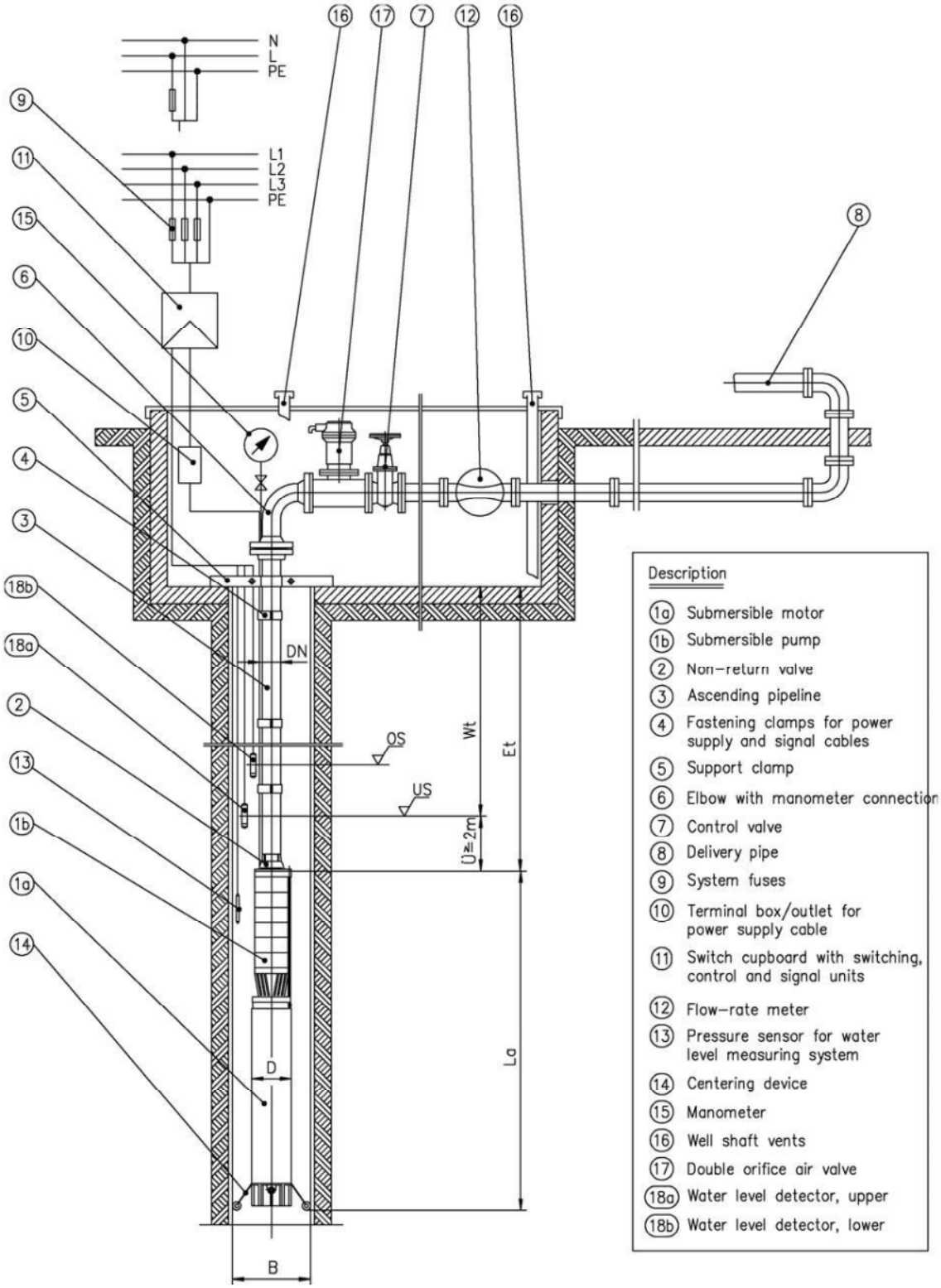

Figure 6 Scheme of water supply system

4.4 Installation

4.4.1 Safety instructions

DANGER

Before starting any installation work or removing any parts of the pumping unit, read Chapter 1.6 "Safety", Page 6.

Tighten all screws in accordance with Chapter 12.3 "Tightening torques".

4.4.2 Sequence of installation

Perform the installation in the following order:

1. Prepare installation site, see Chapter 4.4.3, Page 23.
2. Arrange components for installation, see Chapter 4.4.4, Page 24.
3. Inspect components, see Chapter 4.4.5, Page 25.
4. Install motor, see Chapter 4.4.6, Page 26.
5. Install coupling, see Chapter 4.4.7, Page 27.
6. Install pump bowl assembly, see Chapter 4.4.8, Page 30.
7. Install impeller, see Chapter 4.4.9, Page 32.
8. Vent motor, see Chapter 4.4.10, Page 33.
9. Install power cable, see Chapter 4.4.11, Page 35.
10. Fasten the power cable to the cable guard, see Chapter 4.4.12, Page 39.
11. Install riser pipe, fasten power cable to riser pipe, see Chapter 4.4.13, Page 40.
12. Connect power cable to terminal box, see Chapter 4.4.14, Page 43.
13. Connect terminal box to main power supply, see Chapter 4.4.15, Page 43.

4.4.3 Prepare installation site

1. Verify that the wellhead foundation is poured and cured, if made of concrete.

   The total load on the wellhead foundation will consist of the motor, pump bowl assembly, riser pipe (full of water), wellhead assembly and power cable. See Chapter 12.2 "Data sheet", for weights.
2. Verify that open discharge run-off, ditch, etc. for flushing out well and testing unit is provided for.
3. Verify that a log of the well recording depth, straightness, casing variations, standing water level, rated capacity, pumping level, etc., is at the installation site.
4. Ensure that the well diameter is large enough down to the installation depth so that the pumping unit can be fitted without difficulties. See Chapter 3.4.1 "Survey of well", Page 16.
5. Check the dependability of auxiliary equipment, particularly of hoists.
6. Compare the information in Chapter 12.2 "Data sheet" with that on the rating plate on the motor.
7. Ensure that the line voltage (measured between two phases) is equal to the motor voltage according to the rating plate.

   The maximum permissible voltage fluctuation is given in Chapter 12.2 "Data sheet".

   Greater voltage and frequency fluctuations must be reported to Flowserve and be confirmed by Flowserve in written. In case of doubt, ask Flowserve before starting up the pumping unit.
8. Measure the insulating resistance of the motor according to Chapter 6.8.1 "Insulation test", Page 53.

CAUTION **If the ascending riser pipe is made of flanged pipes, the flanges must have recesses for the power cable if the well diameter is narrowly proportioned.**

4.4.4 Arrange components for installation

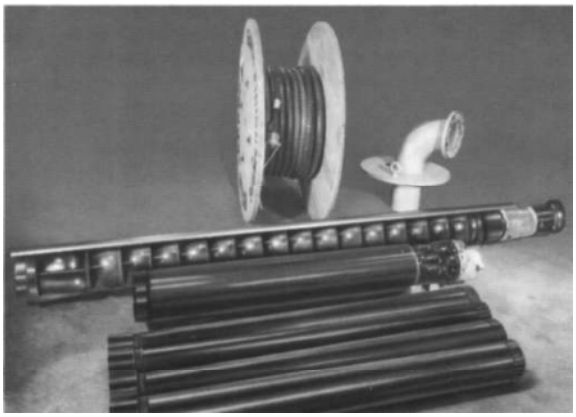

Figure 7 Components arranged for installation

Refer to Figure 7. An orderly arrangement of sub-assemblies will reduce the installation time.

1. Lay out the parts in order of installation, as follows:
   - Motor

     Arranged horizontally.
   - Pump bowl assembly

     Uncrated and arranged horizontally.
   - Riser pipes

     Place all riser pipe sections with coupling end toward the well.

     Check couplings with chain tongs to make sure they are screwed tight.

     Place riser pipe check valve sections so that each will be installed in the proper sequence.
   - Power cable
   - Wellhead
   - Tools for installation, see Chapter 4.2 "Equipment and personnel required", Page 19.
   - U-plate
2. Record the complete motor serial number from the motor, see Chapter 3.1.3 "Motor serial number", Page 14.

NOTE Make sure you can always quote each part's serial number in correspondence and when ordering spare parts or further accessories.

3. Check motor rating, horsepower, poles, volts, and frequency against job requirements.

4.4.5 Inspect components

1. Remove the nuts (003-3) and lock washers (690-3) to remove the motor terminal shipping cap (112), and gasket (747-10).
2. Verify that motor terminal gland plate (111) and power terminals (019) are clean and free of dirt and foreign matter.
3. Megger the motor for ground and continuity (see Figure 8).

   The reading should be 10 MΩ or more.

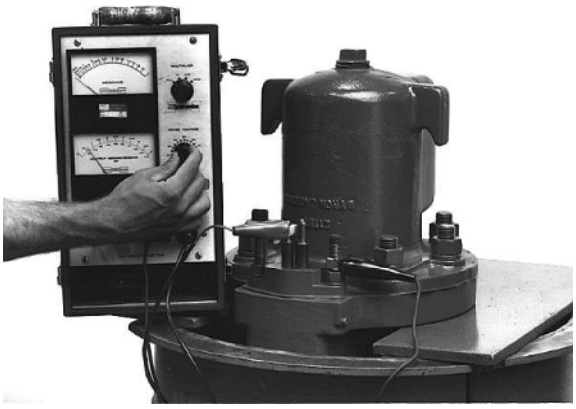

Figure 8 Megger test

4. Remove the shipping cap from the power cable terminal box.
5. Verify that the terminal box and connectors are clean and free of dirt and foreign matter.
6. Verify that the power terminals (019) at the motor will fit the connectors of the terminal box:

   ƒ$ Refer to Figure 9.

   Check position of power terminals (019) against that of connectors.

   The terminals (019) and connectors may be arranged in either an equilateral triangle or a right triangle positioning.

   ƒ$ Check height of terminal against depth of connector to assure proper engagement.

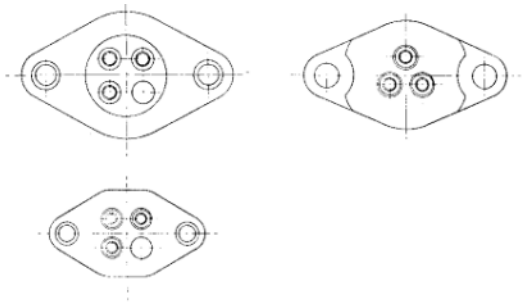

Figure 9 Arrangement of terminals

7. Mount motor power terminal shipping cap (112), gasket (747-10), lock washers (690-3) and nuts (003-3).
8. Reinstall power cable shipping cap.
9. Verify that all riser pipe threads are clean and free of dirt and foreign matter.

4.4.6 Install motor

Transport the motor to the well site, see Chapter 2.2.3 "Transport of the motor", Page 10.

Never step under floating load.

Watch for and avoid overhead obstructions including power lines.

1. Install motor U-plate on foundation.

Use to 2 persons to install the U-plate.

Handle the U-plate carefully.

Danger of injury by dropping the U-plate onto parts of the body.

2. Cover the U-plate and foundation with a tarpaulin.
3. Orient the motor horizontally so that the terminal shipping cap is on top.

   Remove motor shipping cap (112-1), power terminal gasket (744-6), nuts (003-8), and lock washers (690-5). Some oil may be present in the shipping cap.

   Be certain to put the power terminal gasket (744-6) in a safe area until it can be stored in the motor shipping cap (112-1).

NOTE **The power terminal gasket is not used in the unit assembly.**

   Then remove the tools and the power terminal gasket (744-10) from the power terminal shipping cap.

4. Reinstall motor shaft shipping cap (112-1), nuts (003-8), and lock washers (690-5).
5. Lift the motor as described in Chapter 2.2.3 "Transport of the motor", Page 10.
6. Slowly elevate the motor to vertical position.
7. Center the motor over the well casing opening.
8. Lower the motor to rest on the U-plate.

   Refer to Figure 10.

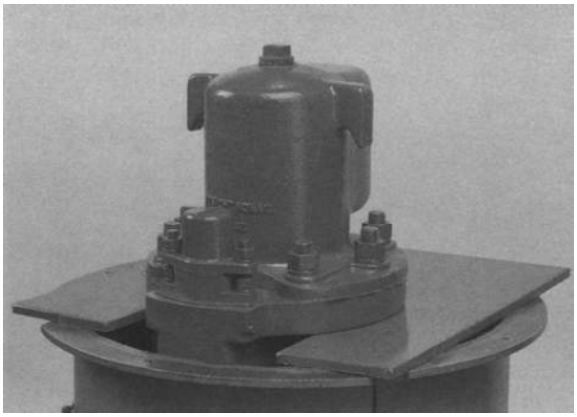

Figure 10 Motor in place on U-plate

9. Remove motor shipping cap (112-1), nuts (003-8), and lock washers (690-5).
10. Cover coupling (529 or 531) and shaft with a clean cloth.

The motor is now ready to receive the coupling.

4.4.7 Install coupling

NOTE **Not all components or sub-assemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.**

These user instructions apply only to the components or sub-assemblies supplied by Flowserve in this delivery, see Chapter 12.1 "Scope of delivery".

The coupling between motor and pump bowl assembly depends on the type of pump bowl assembly delivered.

Flowserve manufactures two coupling variants for the Byron Jackson Double Mechanical Seal Motor:

ƒ$ Variant A: Motor half coupling

ƒ$ Variant B: One-piece coupling

Both are described in the following. See Chapter 12.1 "Scope of delivery" to determine the coupling delivered and follow the respective instructions.

Variant A: Motor half coupling

1. Motor half coupling is factory installed. Refer to Figure 11.
2. Clean coupling and shaft, and lightly oil both.
3. Slip coupling on shaft with keyways aligned.

NOTE **Do not attempt to force the coupling.**

If the coupling will not seat freely:

- **remove the coupling**
- **verify that the shaft is free of dirt and foreign matter**
- **replace the coupling.**

4. Insert key (676-1), round end down, in the keyway.
5. Install socket head set screw (806-1) through its hole in the coupling (529) to engage its hole in the shaft.

   Use wrench provided to tighten set screw (806-1).
6. Identify the shaft adjusting button (130), alignment jig (265), screws (806-3) with washers (690-4), shaft button screw (806-2) and shims (262-6 and 262-7).
7. Remove string from shaft button screw (806-2) which holds shim in place.

   Verify that the shims (262-6 and 262-7) are attached to the screw (806-2).
8. Install alignment jig assembly in motor half coupling (265).
9. Install cap screw (806-2) and use wrench provided to tighten screw (806-2).
10. Remove the coupling lock screws (806-3) and washers (690-4).

    Set these pieces aside for later use (see Chapter 4.4.8 "Install pump bowl assembly", Page 30).
11. Remove alignment jig (265) and hold for storage in motor shipping cap (112-1).
12. Clean the motor flange face of any dirt or foreign matter.

    Verify that the balance line hole in the flange face is open and clear.
13. Cover the coupling (529) and shaft with a clean cloth.

The motor is now ready to receive the pump bowl assembly.

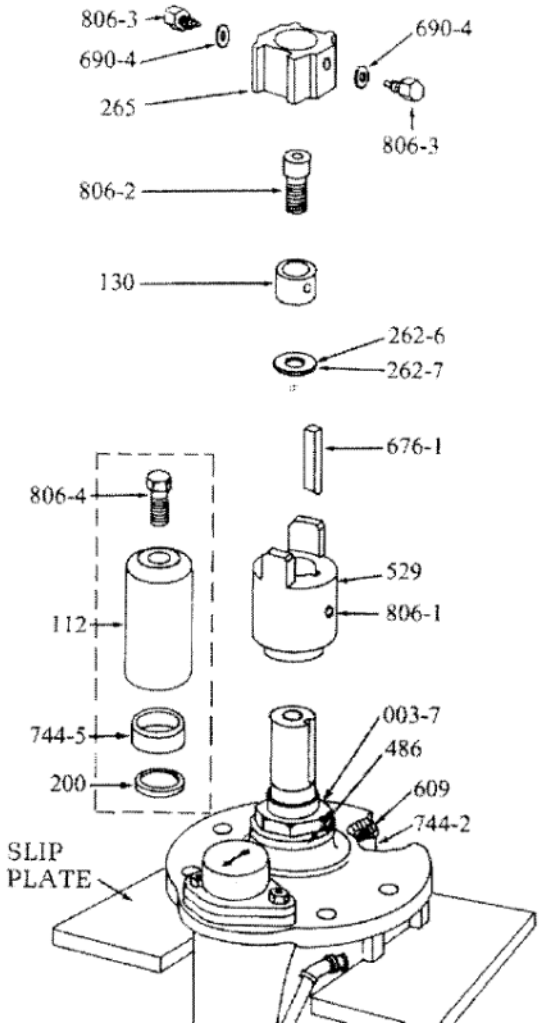

Figure 11 Motor half coupling components

Variant B: One-piece coupling

See Figure 12.

1. Clean the coupling (531) and shaft and lightly oil both.
2. Identify the thrust button (130), thrust button screw (806-2) and shaft adjusting shims (262-6 and 262-7) as required. These pieces are factory installed.
3. Insert key (676-1), round end down, in the keyway.
4. Slip coupling (531) on shaft with keyways aligned.

CAUTION Do not force the coupling.

If the coupling will not seat properly, again verify that shaft and coupling are clean.

5. Install the coupling pins (697) into the coupling holes and the thrust button.

   The thrust button may need to be rotated to align holes.

   Install the coupling lock screws (806-6), flat washers (004-1), and lock washers (690-6) to secure the pins in the coupling.
6. Tighten the thrust button socket head screw (806-2).
7. Rotate the motor shaft and coupling until the pin holes on the coupling are pointed 90 ° from the power terminal shipping cap.

   This aligns pin holes in coupling with adapter bracket to allow pump coupling pin (697-1) to be installed later. Also see Figure 12.
8. Clean the motor flange face of any dirt or foreign matter. Verify that the balance line hole is open and clear.
9. Cover the coupling (531) and shaft with a clean cloth.

The coupling is now ready to receive the pump bowl assembly.

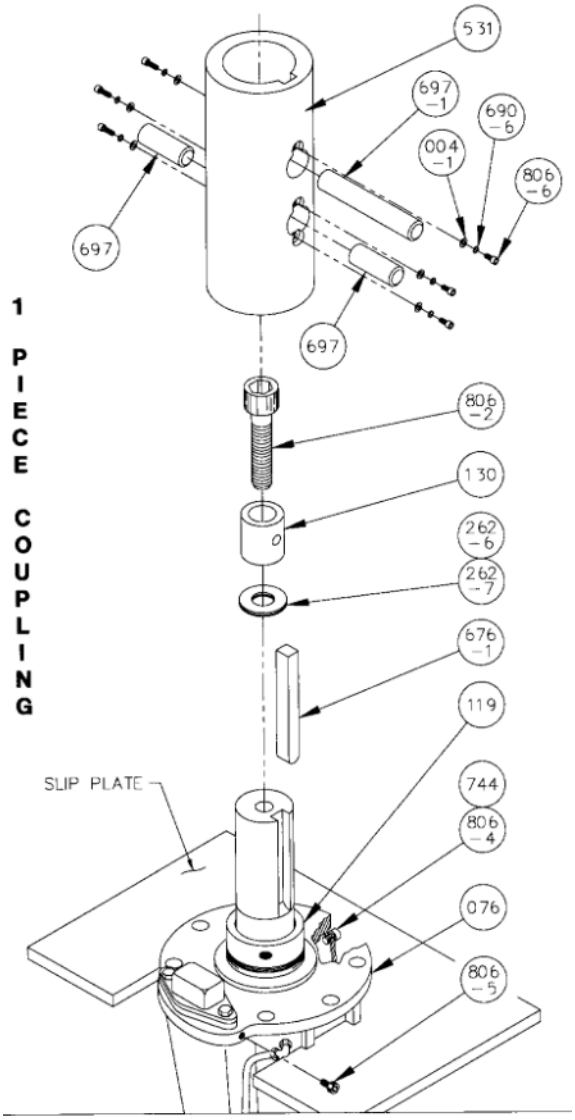

Figure 12 Components for one-piece coupling

4.4.8 Install pump bowl assembly

NOTE **Not all components or sub-assemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.**

These user instructions apply only to the components or sub-assemblies supplied by Flowserve in this delivery, see Chapter 12.1 "Scope of delivery".

Lift pump bowl assembly

Never step under floating load.

Watch for and avoid overhead obstructions including power lines.

NOTE **The following description refers to pumps without auxiliary carriers.**

Should the pump be delivered on an auxiliary carrier, refer to the pump manual for lifting instructions.

To transport the pump bowl assembly to the well site see Chapter 2.2.4 "Transport of the pump bowl assembly", Page 11.

1. Connect the pump to two lifting lines of a portable crane.

   The attachment points may vary according to pump type and local requirements.

2. Carefully lift the pump to a vertical position over the well head.

Install pump bowl assembly

The riser pipes are connected among each other by

- threads or
- flanges.

The motor hangs in the well on the U-plate.

1. Disassemble discharge housing or non-return valve from the pump bowl assembly.
2. Install the discharge housing or non-return valve in the short section of riser pipe.

Additional information for threaded riser pipes:

a. Clean the mating pipe threads of the pipe and the case or flange as shown in Figure 13.

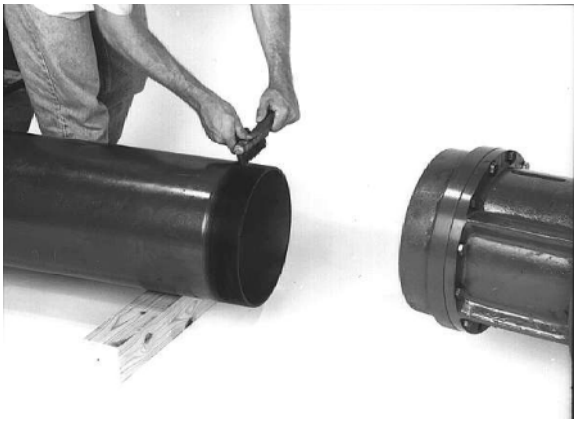

Figure 13 Cleaning riser pipe threads

b. Apply thread locking fluid, e. g. Loctite 242 or DELO 5249/5349 or equivalent, to the threads as shown in Figure 14.

Figure 14 Applying thread locking fluid

c. Install the pipe using chain tongs.

Figure 15 shows the proper method of applying chain tongs to the flange.

Thereby most of the force is exerted on the upper flange rather than the on the discharge housing or the non-return valve.

Apply torque approximating the values given in Table 5.

CAUTION The discharge section may require modification to provide protective clearance to the flat cable and splice which will be mounted later on the riser pipe just above the pump.

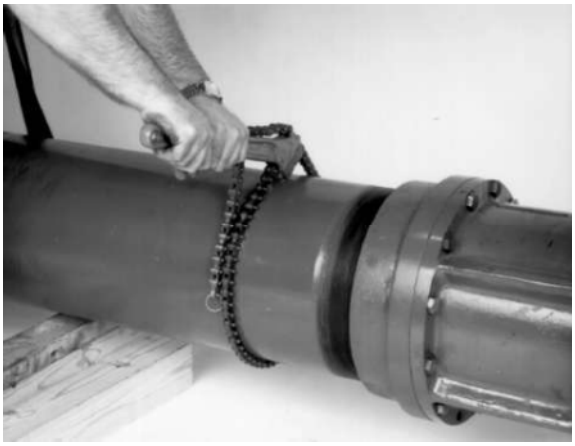

Figure 15 Proper method of applying chain tongs

Pipe Size	Torque [Nm]	Torque [ft-lbs]
2-1/2	620	500
3	950	700
4	1 220	900
5	1 425	1 050
6	1 625	1 200
8	2 170	1 600
10	2 710	2 000
12	4 070	3 000

Table 5 Torque for riser pipe assembly

3. Mount the first length of the riser pipe, which should not be longer than 0.5 m, onto the assembled pump bowl assembly.
4. Remove the cable clamps or cable guard from the pump bowl assembly.
5. Remove the cloth from the coupling.
6. Lift the pump bowl assembly above the motor.
7. Check the end float settings that are pre-adjusted by Flowserve.

4.4.9 Install impeller

NOTE **Not all components or sub-assemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.**

These user instructions apply only to the components or sub-assemblies supplied by Flowserve in this delivery, see Chapter 12.1 "Scope of delivery".

Flowserve manufactures two impeller variants for the Byron Jackson Double Mechanical Seal Motor:

- Variant A: Closed impeller
- Variant B: Open impeller

Both are described in the following. See Chapter 12.1 "Scope of delivery" to determine the coupling delivered and follow the respective instructions.

Variant A: Closed impeller

1. Refer to Figure 16.

   Scale from the face of the adapter bracket (808) to the end of the pump shaft (167) with the shaft down.
2. Remove adapter bracket (808) from bowl assembly.
3. Install adapter bracket (808) on motor top flange, using fasteners for motor shipping cap (112-1).
4. Scale from the face of the motor top case (076) to the face of the shaft adjusting button (130).
5. The distance recorded in step 1 should be 3.175 mm to 6.350 mm (1/8" to 1/4") less than that of step 4.

Figure 16 Verify end float

Variant B: Open impeller

1. Remove adapter bracket (808) from bowl assembly.
2. Install adapter bracket (808) on motor top flange, using fasteners from motor shipping cap (112-1).
3. Remove the pump half coupling (530) or one-piece coupling (531).
4. Provide four pieces of shim stock, each (50.8 mm x 50.8 mm x 0.508 mm (2" x 2" x 0.020") thick, and place each shim 90 degrees apart on the face of the adapter bracket.
5. Lower the pump bowl assembly into the adapter bracket (808) to rest on the shims.
6. Put a feeler gauge through the plug opening in the adapter bracket (808) and check the gap from shaft adjusting button (130) to pump shaft (167).
7. If gap, step 6, is less than 0.0381 mm (0.015") or more than 0.4572 mm (0.018"), the shims beneath the shaft button (130) must be changed.
8. Reinstall the pump half coupling (530) or one-piece coupling (531).

4.4.10 Vent motor

1. Remove the oil vent plugs (806-4) and (806-5) in the flange located at the power terminals and 90° or 180° from the power terminals.

   Add oil into the adapter bracket as shown in Figure 17. See Chapter 12.2 "Data sheet", Page 65, for oil quality.

NOTE **Do not add more than two full motor shipping caps' amount of oil during the venting process. The oil level in the motor will then rise and expel any air in the upper case cavity.**

Figure 17 Adding oil

2. Continue to add oil until bubble free oil flows from the vent located near the power terminals.

   Reinstall vent plug (806-4). Refer to Figure 18.

   Continue to add oil until bubble free oil flows from the vent located 90° or 180° from the power terminals.

   Reinstall vent plug (806-5) and tighten to 27 Nm (20 foot pounds). Refer to Figure 18.

Figure 18 Removing vent plug

Figure 19 Reinstalling vent plug

3. Remove oil vent plug next to power terminals (806-4) and again check for bubble free oil.

   Reinstall vent plug (806-4) and tighten to 27 Nm (20 foot pounds).

4. Place power terminal shipping cap (112-2), power terminal gasket (744-7), jig (265), hex socket wrenches (806-1, 806-2, 806-4, and 806-5), and power terminal gasket (744-6) into the motor shipping cap (112-1).

   Send to storage.

   The motor is now ready to receive the pump bowl assembly.

6. Verify that the pump half coupling (530) or one-piece coupling (531) is securely locked in place

   - by the coupling pin (697-1) and retainer ring (526) on pump half coupling or

- by the coupling pin (697-1) and the retainer screws (806-6), flat washers (004-1), and lock washers (690-5) on the one-piece coupling.

Also verify that the coupling bore and motor shaft are clean and free of dirt and foreign matter.

7. Refer to Figure 20.

   Lower the bowl assembly to engage

   - the jaws of the pump half coupling (530) and those of the motor half coupling (529) or
   - the one-piece coupling bore (531) with the motor shaft and key (676-1).

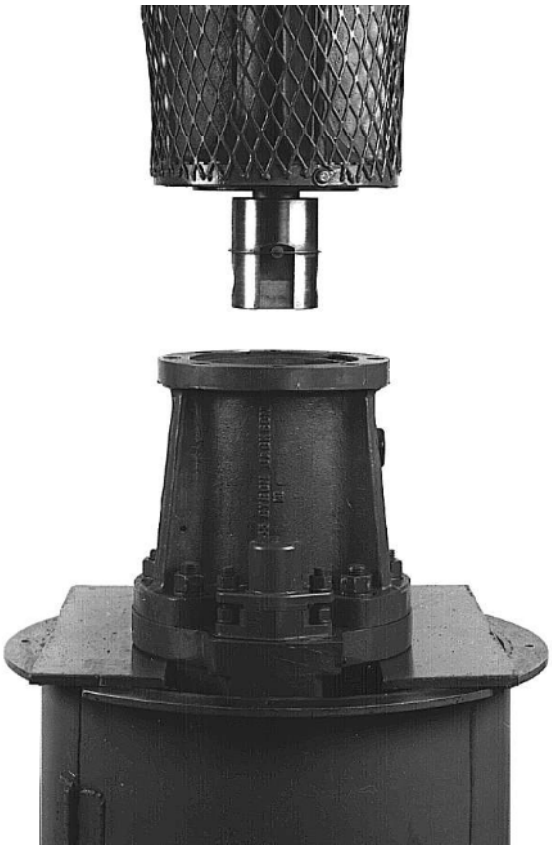

Figure 20 Aligning strainer and adapter

8. Rotate the bowl assembly to line up bolt holes of strainer with those of the adapter (808) and to line up bottom cable guard with power terminal shipping cap (112-2), then lower until flanges butt metal-to-metal.

   Install and tighten fasteners (cap screws or stud nuts with washers).

9. Remove the adapter bracket pipe plugs (794) to observe, through the pipe plug holes, the alignment of the holes for the half coupling lock screws (806-3).

   Install the half coupling lock screws (806-3) in the half-coupling, with their washers (690-4) and apply torque to the half coupling screws (806-3) according to Table 6.

Unit size [inches]	Torque [Nm]	Torque [Ft-lbs]
8	27	20
10	41	30
12	54	40
14	54	40
17	68	50
18	68	50
21	68	50

Table 6 Torque for half coupling screws

   After tightening, check that lock washers (806-3) are seated firmly and lock washers (690-4) are compressed.

   For one piece couplings, you will now install the coupling pin (697), coupling lock screws (806-6), lock washers (690-6), and flat washers (004-1) or the retaining rings (526) to retain the coupling pin in its proper position.

10. Reinstall the adapter bracket pipe plugs (609) and tighten firmly.

11. The strainer body has two holes, size 1/8" N.P.T. at 180°. Pour water into one of these holes to fill the adapter bracket (808) until water runs out the other hole. (A 90° street elbow is used for this purpose.)

The pumping unit is now ready for installation of the power cable.

4.4.11 Install power cable

NOTE **Not all components or sub-assemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.**

These user instructions apply only to the components or sub-assemblies supplied by Flowserve in this delivery, see Chapter 12.1 "Scope of delivery".

- Use a rope to hold the cable and the power cable installation wheel to support the power cable.
- Bring the power cable looping up off the power cable reel stand so that the power cable terminal box is suspended over the power terminal shipping cap.

CAUTION **Do not strain the power cable or bend it sharper than a diameter of 14 times the power cable outer diameter.**

Avoid strain on terminal box.

Do not use cable installation wheel to suspend cable above the top of pump bowl assembly until the flat cable guards are securely banded.

In the following, two variants of the power cable are described:

- Power cable for voltages of 2 300 V and less (metal clamp power terminal connector)
- Power cable for voltages of 4 000 V and greater (metal housing power terminal connector)

Power cable for voltages of 2 300 V and less (metal clamp power terminal connector)

1. Use the power cable installation wheel to unreel a sufficient length of power cable to pass the bowl assembly.

   Elevate the power cable to the approximate height of the pump bowl assembly and fasten the cable plug to the motor.

CAUTION Do not kink or stretch the power cable.

2. Remove the power terminal shipping cap nuts (003-3), washers (690-3) and power terminal shipping cap (112) at the motor.
3. Depending on configuration supplied:

   ƒ$ For flat faced (no rabbet fit) gland plate:

   Install flat gasket (744-10) over power terminals (019).

   See Figure 21.

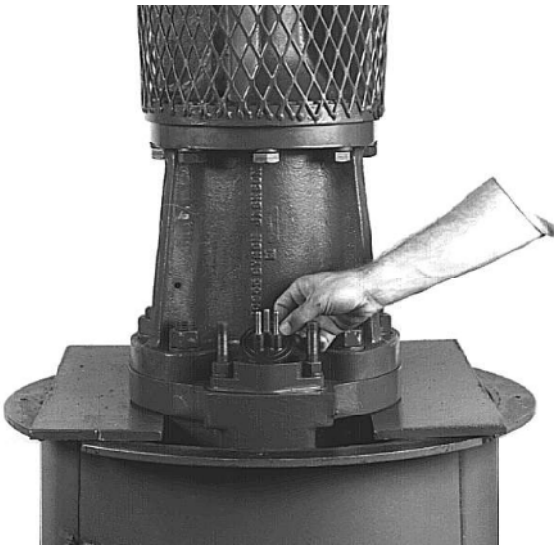

Figure 21 Installing power terminal gasket (flat-faced type shown)

   ƒ$ For gland plate with rabbet fit:

   First install gasket (744-11) over rabbet fit on gland plate (111).

   Then install gasket (744-10) over the motor terminals (019).

4. Remove the shipping cap (023) from the power cable plug (182).
5. Refer to Figure 22.

   Slide the metal terminal box clamp (180) down over the terminal box (182) as far as possible.

   Then check gap from bottom face of terminal box clamp (180) to bottom face of terminal box. This gap should be minimum 0.8 mm (1/32) and maximum 2.4 mm (3/32).

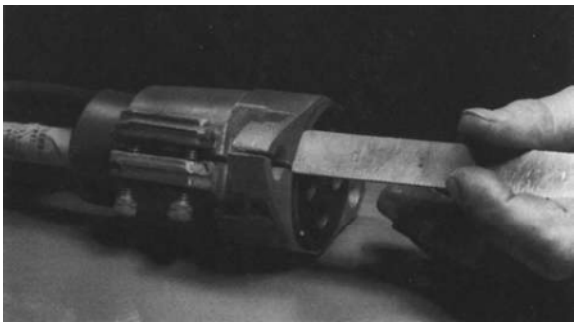

Figure 22 Checking gap, terminal box clamp to terminal box

6. See Figure 23.

   Slide the metal clamp (180) up the flat cable and off the cable plug (182), loosening the clamping screws (806), if necessary.

CAUTION Do not distort the clamp.

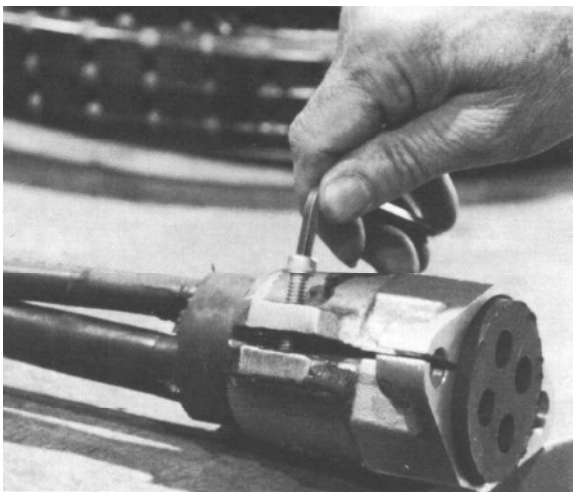

Figure 23 Preparing terminal box clamps

7. See Figure 24.

   Align plug connectors with the motor power terminals and push the cable plug (182) down on the motor power terminals (019) to mate with the gland plate (111) and gasket(s) (744-10, 744-11).

Figure 24 Terminal box installed

8. See Figure 25.

   Slide metal clamp (180) down over terminal box (182) and gland plate studs (002-1)

9. Install washers (690-3) and nuts (003-3). Tighten the nuts (003-3) alternatively and evenly to bring the clamp (180) firmly metal to metal against the gland plate (111).

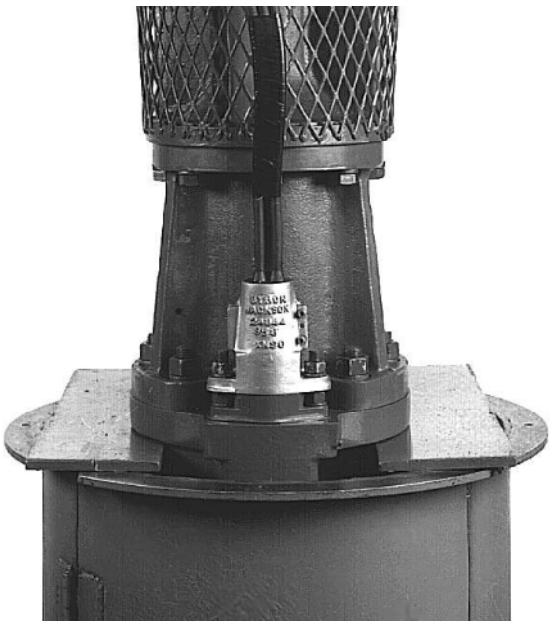

Figure 25 Power cable clamp installed

10. Back off the nuts (003-3) two or three turns each and tighten clamping screws (806).
11. Retighten the nuts (003-3) to achieve metal-to-metal fit of clamp (180) to gland plate (111).
12. Attach ground wire to rib of pump adapter using terminal, lock washer and cap screw.
13. Using surface end of the power cable, which should be accessible, megger the power cable and motor for ground and continuity.

    The megger reading should 10 MΩ or more.
14. When megger test is completed, install a plastic bag over the surface end of the power cable for protection from the weather.

Continue with "Fasten the power cable to the cable guard", Page 39.

NOTE **Key and keyway must be engaged prior to terminal engagement to prevent damage.**

The gland nut must be tightened by hand and repeated until seal is accomplished.

Failure to fully engage the plug and receptacle will result in electrical failure.

Power cable for voltages of 4 000 V and greater (metal housing power terminal connector)

Figure 26 Metal housing power terminal connector (4 000 V-cable)

1. Remove the power terminal shipping cap nuts (003-3), washers (690-3) and power terminal shipping cap (112) at the motor.
2. Remove the shipping cap (023) from the power cable connector (182).

Figure 27 O-ring for metal housing power terminal connector at motor gland plate (4 000 V-cable)

3. Refer to Figure 27.

   Place new O-Ring (747-10) into groove of the terminal gland plate (111) at the motor top case (074).
4. Align the power cable connector (182) with the motor power terminals (019) and push down them down to mate with the gland plate (111) and O-Ring (747-10).

   Slight side-to-side movement will aid this engagement.
3. Install the lock washers (690-3) and tighten nuts (003-3) at gland plate studs (002-1).
4. Tighten the nuts alternately and evenly to bring the power cable connector (182) firmly metal to metal against the gland plate (111) at the motor top case (074).
5. Attach ground wire to rib of pump adapter using terminal, lock washer and cap screw.
6. Using surface end of the power cable, which should be accessible, megger the power cable and motor for ground and continuity. The megger reading should 10 MΩ or more.
7. When megger test is completed, install a plastic bag over the surface end of the power cable for protection from the weather.

Continue with "Fasten the power cable to the cable guard", Page 39.

NOTE **Key and keyway must be engaged prior to terminal engagement to prevent damage.**

The gland nut must be tightened by hand and repeated until seal is accomplished.

Failure to fully engage the plug and receptacle will result in electrical failure.

4.4.12 Fasten the power cable to the cable guard

Figure 28 Outer guard and band in place - example

1. Inspect cable guards, particularly their inner surfaces, for sharp edges that could damage the cable jacket or insulation.
2. Support the cable alongside the pump bowl assembly with the cable installation wheel without stretching or straining the terminal box.

CAUTION The attachment of the power cable to the cable guard depends on the type of the pump bowl assembly.

3. Slightly lift the pumping unit.
4. Remove the U-plate.

Use to 2 persons to remove the U-plate.

Handle the U-plate carefully.

Danger of injury by dropping the U-plate onto parts of the body.

5. Install a clamp to hold the pumping unit.

The pumping unit is now ready for the attachment of riser pipe and lowering into the well.

4.4.13 Install riser pipe, fasten power cable to riser pipe

NOTE **Not all components or sub-assemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.**

These user instructions apply only to the components or sub-assemblies supplied by Flowserve in this delivery, see Chapter 12.1 "Scope of delivery".

CAUTION **Do not stretch the power cable and the splices.**

During the installation, observe the following precautions:

- Support the pumping unit weight with riser pipe elevator.
- Keep the riser pipe centered in the well casing.
- While lowering the riser pipe, hold the power cable flat against the pipe and keep it from dragging across the sharp well casing or flange.
- Avoid loss of power cable length.
- Prevent rotation of the riser pipe so that the power cable does not spiral wrap around it.
- If used or out of round riser pipe is utilized it is recommended to weld a steel strap across each coupling to prevent unthreading during start up or running.

Install the riser pipe(s)

1. Raise power cable installation wheel to 1.5 times the riser pipe length to facilitate power cable alignment to riser pipe and well casing.
2. Arrange the random lengths of riser pipe with their coupling ends facing one direction.

   At five feet in from each pipe end, draw a chalk mark to set the banding location.
3. Install the riser pipe.

   Ensure that the flow direction is upward.

   If the riser pipes are threaded:

   - Clean the mating pipe threads of the riser pipe as shown in Figure 13, Page 30.
   - Apply thread locking fluid, e. g. Loctite 242 or DELO 5249/5349 or equivalent, to the threads as shown in Figure 14, Page 30.
   - Install the pipe using chain tongs (see Figure 15, Page 31) and apply torque according to Table 5, Page 31.
6. When the motor first enters the water, use the surface end of the power cable to megger the power cable and motor for ground and continuity. The reading should be 10 MΩ or more.

If one or more vertical riser pipe check valves are to be used on an installation, each valve, which should have a bleed-back self draining feature, will take the place of a riser pipe coupling.

The recommended installation is as follows:

- One valve:

  Locate the valve approximately 23 m (75 feet) above the pump bowl assembly.
- Two valves:

  Locate the first valve 30 m (100 feet) above the pump bowl assembly.

  Locate the second valve at 3/5 of the distance between first valve and the surface support plate.

Fasten the power cable to the riser pipe

Use "BAND-IT" or equal stainless steel bands and buckles to fasten the cable guard to the riser pipe.

Pull each steel band tight enough to fasten the cable guard onto the riser pipe, but do not over tension it.

Instructions for use of "BAND-IT" materials and tools are shown in Figure 29, Page 41, to Figure 36, Page 42.

Use of BAND-IT steel bands

1. Cut off about 12" of band from the bulk roll.

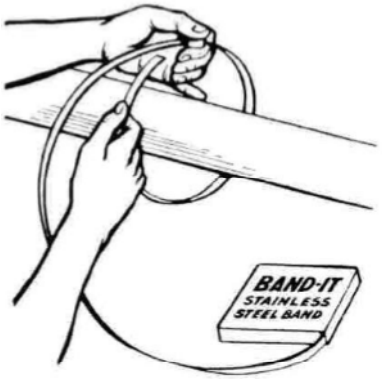

Figure 29 Use of "Band-It" steel band, step 1

2. Hook one end on the buckle and bring the other end around the object to be banded and through the buckle.

   For best results, apply the band twice around. Double banding develops almost 4 times the grip of single banding.

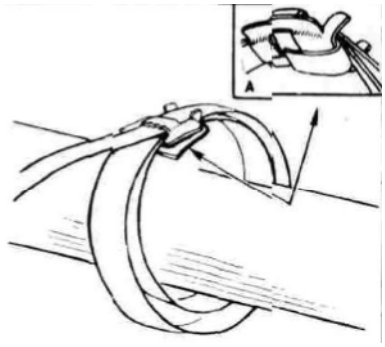

Figure 30 Use of "Band-It" steel band, step 2

3. Draw band tight.

   With the thumb on the band gripper lever, apply tension with the tool.

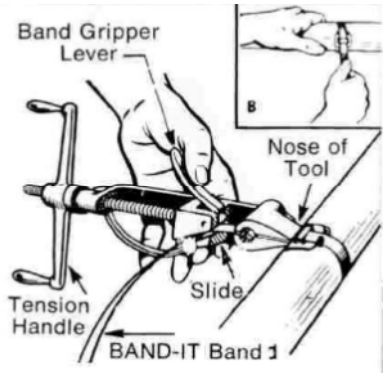

Figure 31 Use of "Band-It" steel band, step 3

4. Apply a proper amount of tension. The band gripper lever locks itself under tension.

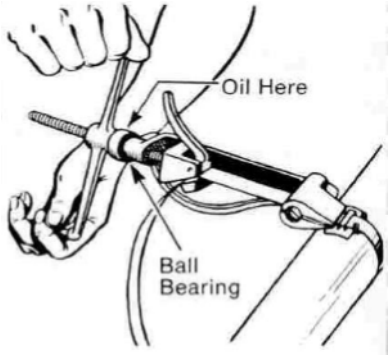

Figure 32 Use of "Band-It" steel band, step 4

5. Rotate the tool over the buckle, backing of with tension handle throughout the entire course of the bend.

   Failure to back off with tension handle throughout the entire course of bend may result in breaking of band. There is no loss of tension, as the band released is used up in the bend.

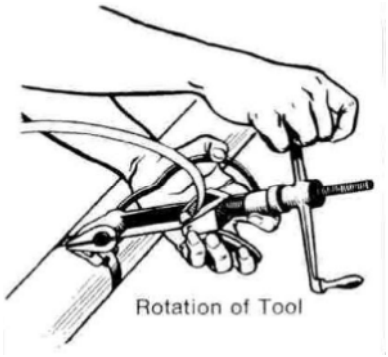

Figure 33 Use of "Band-It" steel band, step 5

6. Pull the cutter handle to cut the band.

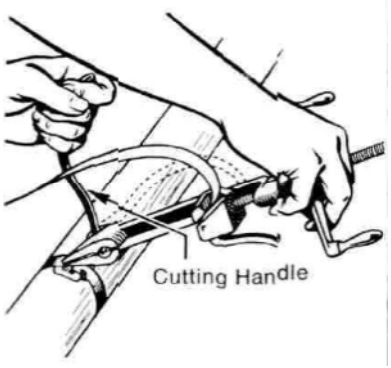

Figure 34 Use of "Band-It" steel band, step 6

7. Remove the tool holding the stub of the band down with your thumb.

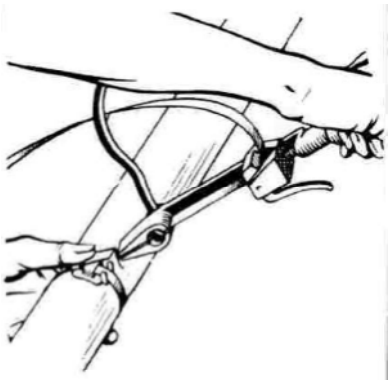

Figure 35 Use of "Band-It" steel band, step 7

8. Lock the stub by hammering down the buckle ears, thus completing the BAND-IT clamp.

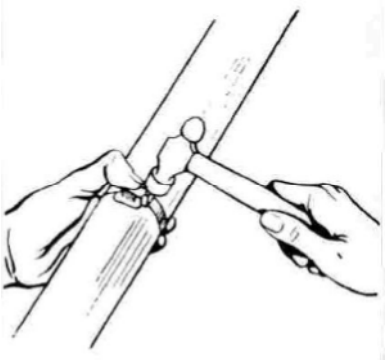

Figure 36 Use of "Band-It" steel band, step 8

4.4.14 Connect power cable to terminal box

NOTE **Not all components or sub-assemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.**

These user instructions apply only to the components or sub-assemblies supplied by Flowserve in this delivery, see Chapter 12.1 "Scope of delivery".

DANGER

Before completing the electrical connection, review Chapter 3.5 "Electrical requirements", Page 17.

The surface plate assembly is screwed in place and the pumping unit hangs well above the well base.

1. Measure and cut the cable to approximate length for surface make up.
2. Strip the power cable, if necessary.
3. Feed the cable through the packing gland (or glands) in wellhead and then into the terminal box.
4. Connect the terminal box leads to the power cable.

   Each lead is to be waterproof.
5. Place the two final supporting cable clamp assemblies 0.9 m to 1.2 m (3 feet to 4 feet) below the wellhead.
6. If the power cable is a 4-conductor cable and the grounding is in the scope of delivery: make the ground wire connection to wellhead with lug, lock washer and cap screw.
7. Lower the wellhead into its correct position and secure it in place.
8. At the terminal box, megger the power cable and motor for ground and continuity.

   The reading should be 10 MΩ or more.

The pumping unit is now ready for connection to the power supply.

4.4.15 Connect terminal box to main power supply

NOTE **Starting equipment for the pump bowl assembly is furnished by the customer.**

1. Ensure that the rating of the equipment is used conform to the National Electric Code requirements for high reactance squirrel cage motors.

   Make certain that the starter main contacts are in good condition and are working properly.

   Also see that the overload relays are for the correct full load current.

   To ensure that the starter is operated safely, verify that the panel housing is properly grounded to a ground rod and to the surface plate assembly.
2. Check the no-load voltage at the starter between all three phases. The voltage values must be equal and must be approximately the same as the voltage rating.
3. Strip back the outer sheath on the cable between 152 mm and 457 mm (6 " to 18") depending on cable size and panel terminal requirements.

   Strip by scoring the sheath, lengthwise with a knife or tool to the length needed, in several places around the outside.

   Do not cut all the way through and damage the individual conductor insulation.

   Grasp a scored segment of the sheath at the end and peel like a banana.

   Repeat this all the way around and cut off the stripped segments.
4. Strip a short segment of insulation off the end of each conductor for connection into the starter load terminals.
5. Remove a conduit knock-out in the bottom of the panel. Install the cable with its gasketed grip in this hole, and connect to the starter load terminals.
6. Ensure that the starter cannot be activated accidentally.
7. Perform insulation test as described in Chapter 6.8.1 "Insulation test", Page 53.

   Insulation resistance must be at least 10 MΩ.

8. Perform continuity test as described in Chapter 6.8.2 "Continuity testing, Page 53.
9. Connect the terminal box to the power source cable.

The pumping unit is now ready to be started.

4.5 Uninstallation

4.5.1 Safety instructions

DANGER

Before starting any installation work or removing any parts of the pumping unit, read Chapter 1.6 "Safety", Page 6.

Tighten all screws in accordance with Chapter 12.3 "Tightening torques".

DANGER

If the area was designated a hazardous location, refer to applicable safety procedures for safe handling of tools, equipment, and test instruments.

CAUTION **If the pumping unit is equipped with a non-return valve without load relieving holes, the pumping unit weight with ascending pipeline und the water column contained within it must be lifted during removal!**

If the non-return valve is provided with load relieving holes, the weight of the water column does not apply.

4.5.2 Uninstallation

1. Stop the pumping unit operation at the control panel.
2. Measure the power cable leads to check insulation resistance (leads-to-ground) and conductance (lead-to-lead) as directed in Chapter 6.8 "Electrical tests of the motor", Page 53.
3. Disconnect the cable at the starter panel. Megger the leads for ground and continuity. Reading should be 10 MΩ.
4. Remove the pumping unit in the reverse order of the installation procedure (see Chapter 4.4 "Installation", Page 23) and place all parts on the floor.

   Also consider Chapter 2.2 "Transport", Page 10.

   a. Disconnect terminal box from main power supply, see Page 43.

   b. Disconnect power cable form terminal box, see Page 43.

   c. Uninstall riser pipe and detach power cable from riser pipe, see Page 40.

      If the bands are double wrapped, cut them properly so that they can be saved for use as a single band for reinstallation.

   d. Uninstall power cable, see Page 35.

      Separate cable from motor and seal the cable with the original terminal box shipping cover (023).

   e. Uninstall pump bowl assembly, see Page 30.

   f. Uninstall coupling, see Page 27.

   g. Uninstall motor, see Page 26.

5. Check the riser pipes for need of replacement, particularly the sections between high and low well fluid levels.
6. Inspect any column check valves for wear and proper functioning.
7. Remove the coupling retainer rings, retainer screws, lock washers, and coupling pins. Separate the pump element from the motor between the adapter bracket (808) and the strainer body (564).
8. Megger the motor for ground and continuity. Reading should be 10 MΩ or more.
9. Seal the motor terminals with original power terminal gasket (744-7) and power terminal shipping cap (112-2).
10. If there is water in the motor, elevate motor over a sump or drum. Remove lower casing drain plug (806) from bottom of motor, then remove vent plugs (806-4 and 806-5) at top of motor to drain the water from the motor. Replace drain and vent plugs.

Continue with Chapter 2.3 "Storage and shipping", Page 12.

5 COMMISSIONING STARTUP, OPERATION AND SHUTDOWN

5.1 Safety instructions

NOTE **Before commissioning, operation or shutdown of the pumping unit, read Chapter 1.6 "Safety", Page 6.**

The pumping unit may only be operated

- ƒ$ by trained personnel,
- ƒ$ in a completely assembled condition, and
- ƒ$ completely filled and immersed.

5.2 Direction of rotation

The direction of rotation of motor and pump is given in Chapter 12.2 "Data sheet".

5.3 Starting the pump

5.3.1 First-time start-up of the pump

1. Measure insulation resistance (leads-to-ground) with power turned off and motor turned off to ascertain that not short circuits are present.

CAUTION **Do not attempt to start the pumping unit with an insulation resistance reading of less than 5 MΩ.**

2. Verify that balanced three-phase voltage is supplied by taking readings with the line voltmeter and using the voltmeter selector switch.

CAUTION **Never attempt to run the pumping unit with an unbalanced voltage between two leads.**

An imbalance between two leads can cause 6 - 10 times that amount of imbalance in an amperage and the resultant temperature increase means a decrease in motor life.

Poor voltage regulation of an engine driven generator, if the power is obtained from such a source, can be very detrimental.

3. Close the pump discharge valve.
4. Start the motor.

   The contractor closes and the pump motor starts.

CAUTION **Do not run the pump for more than 2 minutes with discharge valve closed.**

5. Immediately take current reading using line ammeter.

   If the current is in the range of amps at shut-off (see Chapter 12.2 "Data sheet"), rotation is correct.

   If current is about 80 % of shut-off amps, rotation is not correct. In this case,

   a. press STOP

   b. turn off all power

   c. move isolator handle to OFF

   d. reconnect motor leads for proper rotation.

   Mark the leads so that they can always be placed correctly any time they are removed.

6. After verifying proper rotation,

   ƒ$ stop the pumping unit.

   ƒ$ open the discharge valve

   ƒ$ start the pumping unit again.

7. Recheck the current, which should be the full load current as shown in Chapter 12.2 "Data sheet".

   Current could also be the same as full load amps with reversed rotation but head and flow would be greatly reduced.

CAUTION **If a circuit breaker trips, always wait at least 10 minutes before resetting.**

During first-time start-up, take notice of the following:

- ƒ$ When motor is started, it should attain full speed within 3 seconds.

  If after this period the line current is still high (over twice normal value), the pumping unit is not attaining the full speed.

CAUTION In the event the pumping unit does not attain the full speed, stop the pumping unit and do not attempt to restart it until the trouble is found and corrected.

During normal operation, the current must not exceed the motor data plate value.

ƒ$ Measure the line voltage between phases while the pumping unit is pumping.

The readings obtained should not be more than 10 % above or below the rated motor voltage.

ƒ$ In case of malfunction, stop the pumping unit and refer to Chapter 7 "Faults, causes and remedies", Page 56.

5.3.2 Normal start-up of the pump

CAUTION If maintenance has been performed, follow Chapter 5.3.1 "First-time start-up of the pump", Page 46.

1. Verify that the control panel door is closed.
2. Verify that balanced three-phase voltage is supplied by taking readings with the line voltmeter and using the voltmeter selector switch.

CAUTION Never attempt to run the pumping unit with an unbalanced voltage between two leads.

3. Start the pumping unit.

   The contractor completes the pump circuit, and the pump motor starts.
4. Verify that the pump motor comes up to speed within 3 seconds as indicated by normal readings of current, voltage, head and flow.

   If

   ƒ$ current exceeds the rated value of the amperage shown in Chapter 12.2 "Data sheet", or

   ƒ$ voltage varies + 10 % or - 10 % from the rated value shown in Chapter 12.2 "Data sheet", or

   ƒ$ head and flow are abnormal

   then stop the pumping unit and refer to Chapter 7 "Faults, causes and remedies", Page 56.

5.4 Running or operation

5.4.1 Performance and operating limits

Usually, a pumping unit has been selected and built to perform a maximum efficiency under defined conditions, see Chapter 3.3 "Performance and operating limits", Page 15.

Changes of these conditions, e. g. increase or decrease in head, will not cause an noticeable difference in the efficiency.

However, a large variation in head will not only show up as efficiency loss, but as a output, or thrust bearing overload.

Water level

ƒ$ A well should always be provided with a means for determining the static water level, and pumping level. A good air line, with depth gage, is generally the most simple and practical.

ƒ$ For monitoring the water level in the well, we recommend water level detectors or water level measuring units.

Sand

ƒ$ When a pumping unit is first started, a new well may produce considerable amounts of sand, despite the fact it had been sand pumped after drilling.

The discharge should be throttled back to where this is cut down to a minimum, then gradually opened up to full discharge as the sand disappears.

This operation may last from a matter of minutes to several days or longer.

If the sand flow shows no signs of stopping

ƒ$ rework the well to screen out the sand, or

ƒ$ install a pumping unit with a capacity smaller than that of the currently installed unit.

Continued sand pumping will result in increased pump wear which in turn will show up as increased efficiency loss. Too great a wear will run the pump beyond the repair stage and possibly have serious effects on the motor.

- Some wells will always produce a small amount of sand at start-up. Therefore, it may be necessary to bypass or trap out this first flow at each start-up, particularly if a closed piping system is used.
- When a pumping unit is known installed near to the bottom of a well, a close check should be kept to make sure that the well does not sand-up (fill in) around the motor.

  This is may take place without any noticeable effect in pumping or motor operation. However, the motor is dependent on adequate cooling from water, and any sand around it would eventually create overheating, resulting in at least shortened life, if not a burnout.

  If this problem cannot be cured by well work, contact Flowserve for devices that can be added to the pumping unit to prevent its sanding up.

Hydro-pneumatic pressure system

If the pumping unit is coupled into a hydro-pneumatic pressure system, the set-up must be designed so that the pumping unit

- does not get "water-logged" (loss of air through water absorption without replacement) and
- and does not receive too much air at each start-up.

5.4.2 Motor operation

- Always "meg" the motor before setting a tripped circuit breaker.
- Wait 10 minutes before restarting the motor.
- Breaking suction and/or inadequate power supply renders warranty void.
- A time delay must be installed when any type of automatic system is used in order to prevent starting of the motor while it is spinning backwards due to riser pipe drainback through the pump.

  A 3 minute time delay is usually adequate. This provides a safety measure in the event a failure in the automatic control system creates a rapid recycle series. It also provides a time period for the rotating element of pump and motor to stop, after reverse rotation due to vertical riser pipe drain- back.
- A pumping unit should not be run at closed valve for more than 2 minutes as virtually all the energy created is then dissipated as heat. This condition has been known to have practically "boiled" the water in the well and created an overheating problem for the motor.
- After the pumping unit has operated for a longer period of time, a minimal readjustment of the motor circuit breaker may be required due to changed operating conditions, e. g. sinking of the water level.

CAUTION In no case select a motor protection adjustment setting that is greater than the highest permissible value given in Chapter 12.2 "Data sheet".

If the pumping unit has shut-off hand the reason cannot be traced to a positive external source:

1. Switch off the motor.
2. Disconnect the motor from the main power supply.
3. Disconnect the power cable leads from the starter
4. Measure the insulation resistance of the power cable leads to the ground (the well casing).

CAUTION Never re-set or re-fuse and start a motor without first measuring the insulation resistance the unit.

5.4.3 Starting frequency

The amount of regularly-distributed starts per hour must be taken from Chapter 12.2 "Data sheet".

Higher starting frequencies are only permissible upon written agreement by Flowserve.

Amount of maximum permissible starts in sequence:

- Cold motor .....2 starts
- Warm motor .....1 starts
- Rest interval after each cycle .....10 minutes

It is suggested to protect the motor against non-permitted reconnection by a time relay.

5.5 Stopping and shutdown

To stop the pump, follow the user instructions of the control panel.

NOTE **An automatic 10-minute delay before restart is suggested as a feature in the control panel.**

6 MAINTENANCE

6.1 Safety instructions

Before maintenance or repair work

DANGER

Before commissioning, operation or shutdown of the pumping unit, read Chapter 1.6 "Safety", Page 6.

Before starting any maintenance or repair work or removing any parts of the pumping unit:

1. **Switch off the motor, see Chapter 5.5 "Stopping and shutdown", Page 49.**
2. **Completely separate the pumping unit from the power supply.**

During maintenance or repair work

During maintenance or repair work, avoid polluting water or soil with hazardous substances such as lubricants or cleaning agents. Collect these substances in suitable containers and dispose of the in accordance with the local regulations.

After maintenance or repair work

Immediately after finishing maintenance or repair work and before restarting the pumping unit, ensure that

- all tools and equipment required for maintenance or repair work have been removed from the pumping unit
- all screws and connections that were previously undone are retightened
- all safety devices are replaced and/or operate correctly
- the motor is filled.

6.2 Maintenance schedule

NOTE **Not all components or subassemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.**

These user instructions apply only to the components or subassemblies supplied by Flowserve in this delivery, see Chapter 12.1 "Scope of delivery".

Flowserve submersible pumps are custom designed to operate for extended periods with a minimum of regular maintenance, the frequency and scope of maintenance depending primarily on the conditions of service to which the pump is subject. Periodic dismantling for inspection is not necessary unless excessive wear is indicated or a pump malfunction is suspected.

To determine when major maintenance is required, periodic testing of the pumping unit (as described in Chapter 6.7 "Periodic testing", Page 52) is strongly recommended. This will establish a baseline of performance data indicative on pump condition that will permit scheduling of major maintenance tasks well ahead of the time they become necessary and will prove very beneficial to the prolonged lift and satisfactory operation of the pumping unit.

Interval	Part	Maintenance
Before each installation and after each uninstallation	All parts	Inspect all piping connections for evidence of leakage, loosening or other damage and repair if necessary.
	Pump bowl assembly	Inspect the integrity of the pump mounting fasteners which may loosen due to vibration, and tighten if necessary.
Every 2 - 3 months	Motor	Periodic testing, see Chapter 6.7, Page 52.
	Power cable, motor	Electrical tests of the motor, see Chapter 6.8, Page 53.
Every 2 to 3 months if pump stands idle for longer period of time	Pump bowl assembly	Pump test run, see Chapter 6.6, Page 51.

Table 7 Maintenance schedule

6.3 Working substances and auxiliary agents

Motor lubricants

The specific type of oil used in the motor is given in Chapter 12.2 "Data sheet". Do not use other oils.

The motor does not require periodic changing of oil. However, it may be necessary to fill up oil in larger intervals.

Pump bowl assembly lubricants

NOTE **Not all components or sub-assemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.**

These user instructions apply only to the components or sub-assemblies supplied by Flowserve in this delivery, see Chapter 12.1 "Scope of delivery".

The pump bowl assembly does not contain lubricants.

The bearings of the pump bowl assembly are self-lubricated by the liquid being pumped.

6.4 Motor maintenance

Motor maintenance can consist of anything from disassembly and inspection to complete rewinding and overhaul. In normal service, motor maintenance should be required infrequently.

To determine when motor maintenance is needed, periodic testing should be faithfully performed as described in Chapter 6.7 "Periodic testing ", Page 52. If periodic testing is performed satisfactorily, the need for motor maintenance can usually be anticipated and maintenance scheduled accordingly.

When periodic testing indicates a motor problem, remove the pump and inspect the motor while still vertical in the top of the well to check its electrical condition (see Chapter 6.8 "Electrical tests", Page 53). Also rotate the shaft manually to check for possible binding. Spare motors should be maintained in field stock to permit rapid re-installation when a pump is pulled.

No attempt should be made to repair a motor in the field. If a motor problem is suspected, contact a Flowserve service representative for further instructions. When repair of a motor is required, install a spare motor in its place and arrange to have the pumping unit returned to the factory.

6.5 Pump maintenance

NOTE **Not all components or sub-assemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.**

These user instructions apply only to the components or sub-assemblies supplied by Flowserve in this delivery, see Chapter 12.1 "Scope of delivery".

The pumping unit can be operated without maintenance measures, insofar as no irregularities in operation or pumping, caused by sand or a corrosive pumping medium, make premature removal necessary.

Fluctuating and/or rapidly increasing current consumption points to mechanical problems in the pump bowl assembly or motor.

Strong oscillation of the pressure and at the same time of the ammeter can be caused by irregular water inflow.

6.6 Pump test run

NOTE **Not all components or sub-assemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.**

These user instructions apply only to the components or sub-assemblies supplied by Flowserve in this delivery, see Chapter 12.1 "Scope of delivery".

If the pump bowl assembly should stand idle for a longer period of time, perform a 10-minute test run every 2 to 3 months, in order to recognize malfunctions.

CAUTION **The pumping unit must be completely submersed in pumping medium for this test run.**

6.7 Periodic testing of motor and pump

Motivation

As the pump wears, the internal sealing clearances increase, which results in increased recalculation flow (or leakage) from the impeller discharge back to its suction side.

At a fixed differential head, the total flow through each impeller in a worn pump is the same as in a new pump, but more of the flow is recirculated flow that the net flow out of the pump discharge is reduced.

To produce the same net flow output as a new pump, a worn pump must operate at a lower differential head so that the impellers can operate at a higher flow rate to make up for the higher recirulation flow. This reduced performance in a worn pump is the basis for the periodic testing procedure outlined below.

Scope

Periodic testing or mounting of critical pump bowl assembly and motor performance parameters such as head, flow, line voltage, driver current, starting time, etc., is recommended to establish a reliable performance record for use in evaluating and projecting the pumping unit's condition and in establishing the maintenance requirements for its particular application. Periodic testing is and important part of a well-planned maintenance program.

The scope and frequency of periodic testing is primarily a matter of customer decision based on the severity of pump operating conditions.

A "Periodic Test Record" is provided with each submersible pump to record the results of periodic tests.

Operating conditions during test

Periodic test measurements should be taken under one of the following conditions:

- Pumping unit operating at a predetermined test flow.

  The test flow used should be the same in each test and should be greater than 75 % of the design flow.

- Pumping unit operating at zero flow (discharge valve closed).

- Shut-off head reduced by 5 % - 10 %.

CAUTION To prevent possible overheating, do not run the pump more than 2 minutes against closed valve.

Evaluation

Periodic test data can be used in the following ways to plan preventative maintenance:

- Method 1

  Plot total differential head measurements at zero flow and, if practicable, at a fixed test flow.

  Extend (extrapolate) the curve to a future time when the differential head will be reduced to an unacceptable value. Plan to pull the pump before this future time.

- Method 2

  Sometimes, customer flow requirements will not permit throttling pump flow.

  If total differential head and flow can be measured during normal operation, this data can be used to plan preventative maintenance. To do so, plot the measured head and capacity point on the factory pump performance curve and record the test head as a percentage of the performance curve head at the test capacity. Plot this head versus time, extrapolate and use as in method 1.

- Method 3

  An alternate method would be to plot capacity (flow rate) as a percentage of performance curve capacity at test head. Plot this capacity data versus time, extrapolate and use as head data used in method 1. Note that in any case, absolute accuracy of test equipment is not too important, but repeatability is important to permit comparison of worn pump performance with pump performance when new.

Adaptation of maintenance intervals

If direct or projected periodic testing readings show reduced shut-off head, change maintenance intervals as follows.

- Shut-off head reduced by < 5 %

  No preventative maintenance is indicated.

- Shut-off head reduced by 5 % - 10 %

  Consider and project maintenance to take place at a time most convenient to the user providing the fall off in shut-off head would not exceed 15 % by such time.

ƒ$ Shut-off head reduced by 10 % - 15 %

Undertake maintenance before the next check period.

ƒ$ Shut-off head reduced by > 15 %

The pump requires immediate attention and should not be run further.

6.8 Electrical tests of the motor

DANGER

Do not conduct this test in an area that has been designated a hazardous location.

6.8.1 Insulation test

Before initial starting, as well as after longer storage or idle time, the insulation resistance of the drive must be measured.

DANGER

During and after the measurement, the connector ends of the motor line and/or the connection terminals partly carry dangerous voltage and may not be touched.

Before the measurement, ensure that there is no line voltage.

To measure the insulation, disconnect all leads of the power cable of the motor.

All leads must carefully be cleaned of all dirt. Heed the operating instructions of the insulation measuring device.

Insulation measurement is always performed with a measuring-circuit voltage of 1000 V. The measured value must be read after a minute of measurement duration.

DANGER

The motor windings or power cable, charged up to the measuring-circuit voltage, must be discharged after measurement by means of the insulation measuring device.

The limits for minimum insulation resistance and critical insulation resistance for measurements at 20 °C winding temperature are as follows:

ƒ$ Critical insulation value after longer operational time .....10 MΩ

CAUTION A relatively low insulation resistance does not definitely show that the pumping unit will break down due to insulation problems.

If however after measurements over a longer period of time, an extreme drop in the insulation resistance occurs within a short time, these must then be inspected.

If the insulation resistance falls below minimum value, the cause or the malfunctioning part (power cable, line connection or windings) must be determined and the insulation weakness removed.

6.8.2 Continuity testing

1. For continuity testing of the motor stator windings, use low resistance Ohm-Meter (4-pole Kelvin Bridge)
2. Perform continuity test with motor. The terminal resistance must first be measured in the three possible combinations (1-2, 1-3, 2-3). These three values must not vary by more than ± 2% from their average. The terminals must be grounded before the low resistance Ohm-Meter leads are connected. The temperature of the winding in °C must also be measured and recorded.

6.9 Spare parts

6.9.1 Recommended spares and consumable items

Flowserve generally provides spare parts listings as part of the original order specifications.

Flowserve recommends that the customer holds the following spares at the installation site.

General spares:

- One full spare pump, assembled, but not installed, and available to replace any unit, or one full spare pump installed in system with valve.

Spares for the pump bowl assembly:

- One full set of bowl assembly bearings
- One pump shaft key.
- Two full sets of case gaskets.

Spares for the motor:

- Case vent plug with gasket.
- Case shipping plugs.
- Shaft shipping cap nuts and lock washers.
- Driver shaft key.
- Coupling lock pin with retaining ring, if required (depends on pump type).
- Motor oil (Flowserve part no. and quantity see Chapter 12.2 "Data sheet").

6.9.2 Ordering spare parts

Ordering identical duplicate spare parts

When ordering identical duplicate replacement parts for this pumping unit, be certain to state

- pump serial number,
- size,
- type,
- service (or application)
- part name, and
- part reference number

as indicated on the applicable sectional drawing in Chapter 8 "Parts list and drawings".

Ordering spare parts for pumps with modified operating conditions

If the operating conditions have changed since pump was purchased, add full particulars of new operating conditions. This is especially important when selecting new impellers.

CAUTION **Should a change in operating conditions be considered, consult your nearest Flowserve representative or factory to determine if such a change is feasible with the existing pumping unit.**

Ordering oversized or undersized parts

If oversized or undersized parts are required add:

- Required dimensions (with sketch of part, if possible).
- Finishing by Flowserve or by customer ("leave rough")

NOTE **If the customer finishes parts the customer assumes the sole responsibility.**

Determine whether such a change is feasible.

Replacement of parts alternated during operation

Flowserve accepts no responsibility for incorrect replacement of original parts which have been altered in the field.

6.9.3 Storage of spare parts

Storage of spare metal parts

Shelf life:

- Indefinitely

Storage conditions:

- Adequately protected from moisture and physical damage.

Storage of rubber parts, e. g. spare O-rings

Shelf life:

- Maximum three years

Storage conditions:

- Stored in original heat sealed packaging
- Adequately protected from air, light, ozone, radiation, excessive temperature > 49 °C (> 120°F), contamination, and physical damage.

6.10 Tools for repair and maintenance

Refer to Chapter 4.2 "Equipment and personnel required", Page 19.

7 FAULTS, CAUSES AND REMEDIES

DANGER

Before repairing the pumping unit, read Chapter 1.6 "Safety", Page 6.

Before starting any maintenance or repair work or removing any parts of the pumping unit:

1. **Switch off the motor, see Chapter 5.5 "Stopping and shutdown", Page 49.**
2. **Completely separate the pumping unit from the power supply.**

FAULT SYMPTOM

Motor protection triggered											
⇓ Pump does not start											
	⇓ Flow inadequate										
		⇓ Pumping unit runs, but does not pump									
			⇓ Shut-off head current (amps) is higher than originally recorded but shut-off head is not diminished								
				⇓ Shut-off head is diminished but shut-off current (amps) is unchanged							
					⇓ Shut-off head is diminished and shut-off current (amps) is much higher						
						⇓ Duty capacity and head are low but running current (amps) and shut-off valves are normal					
							⇓ Pump starts bus trips circuit breaker				
								⇓ Pump does not start			
									⇓ **PROBABLE CAUSES**	**POSSIBLE REMEDIES**	
									A. SYSTEM TROUBLES		
●									Pump or motor sluggish	Check smooth running of pump and motor.	
			●						Heat to great because total system head does not correspond to pump characteristics.	Reduce head.	
			●						Unit not suspended in pumping medium due to inadequate installation depth.	Check well level and/or suspend unit deeper.	
									B. MECHANICAL TROUBLES		
	●								Pump blocked due to impurities in the pump.	Disassemble pump section and clean.	
		●							Reduction of area in the pressure pipe because isolator valves are not completely open.	Completely open isolator valves.	
		●							Reduction of area in the pressure pipe because pressure pipe is clogged.	Clean pressure pipe.	
		●							Reduction of area in the pressure pipe because of foreign body in the pipe.	Clean pipework.	
		●							Reduction of area in the pressure pipe because well filter stopped up.	Remove unit and regenerate well.	
		●							Pressure pipe leak due to defective pipework.	Check pipework.	
		●							Impellers worn out because of high sand content in the pumping medium.	Remove pump and repair. Check material selection. Analyze water.	
		●							Impellers worn out because of corrosive pumping medium	Remove pump and repair. Check material selection. Analyze water.	
		●							Impellers worn out because of cavitation.	Check operating conditions.	
			●						Pressure pipe not free because main slide valve is closed.	Check blockage and control units.	
			●						Motor runs but pump does not turn because coupling between pump and motor is defective.	Remove unit and repair.	
			●						Suction sieve stopped up because of foreign body in well	Remove unit and clean suction sieve..	
						●			Fracture in riser pipe	Replace respective riser pipe	
						●			Valve open on by-pass line etc.	Close respective valve	

FAULT SYMPTOM

Motor protection triggered										
⇓ Pump does not start										
	⇓ Flow inadequate									
		⇓ Pumping unit runs, but does not pump								
			⇓ Shut-off head current (amps) is higher than originally recorded but shut-off head is not diminished							
				⇓ Shut-off head is diminished but shut-off current (amps) is unchanged						
					⇓ Shut-off head is diminished and shut-off current (amps) is much higher					
						⇓ Duty capacity and head are low but running current (amps) and shut-off valves are normal				
							⇓ Pump starts bus trips circuit breaker			
								⇓ Pump does not start		
									⇓ **PROBABLE CAUSES**	**POSSIBLE REMEDIES**
							●			Blockage in discharge or intake	Disassemble and clean discharge and intake.
							●			Valve in system is not fully open	Fully open valve
										C. ELECTRICAL TROUBLES	
●										Motor circuit breaker adjusted too low.	Readjust motor circuit breaker according to rating plate or Chapter 12.2 "Data sheet".
●										Current consumption of motor too high due to under voltage or wrong frequency.	Check system voltage and frequency. Check if the information on the type plate corresponds with the system voltage and frequency.
●										Phase failure.	Check fuses. Examine power cables for damage.
	●									Voltage failure due to blown fuse(s).	Replace fuse(s).
	●									Defective power cable.	Replace power cable.
		●								Incorrect rotating direction.	Change rotating direction.
		●								Rotating speed too low because of under voltage or wrong frequency.	Check system voltage and frequency.
		●								Rotating speed too low because motor runs with one phase.	Check fuses.
		●								Rotating speed too low due to bearing damage.	Remove pumping unit and repair.
			●	●						Drop in line voltage	If amperage remains within 110 % of the rated value: No remedy necessary. If amerage does not remain within 110 % of the rate value: Check line voltage
								●		Insulation failure	Measure insulation resistance.
									●	Insulation failure	Measure insulation resistance. Check voltage.
									●	Pumping unit is stuck	Try momentarily reversing rotation by interchanging any two leads

8 PARTS LIST AND DRAWINGS

9 CERTIFICATION

Certificates determined from the Contract requirements are provided with these user instructions where applicable. Examples are certificates for CE marking, etc.

If required, copies of other certificates sent separately to the purchaser should be obtained from the purchaser for retention with these user instructions.

10 OTHER RELEVANT DOCUMENTATION AND MANUALS

10.1 Change notes

If any changes, agreed with Flowserve Pump Division, are made to the product after its supply, a record of the details should be maintained with these user instructions.

10.2 Abbreviations

ATEX	Equipment for Potentially Explosive Atmospheres
NPSH	Net positive suction head
OD	Outer diameter
rpm	revolutions per minute
VDE	German Association for electrical, electronic and information technologies ("Verband der Elektrotechnik, Elektronik und Informationstechnik e.V.")

11 GLOBAL CONTACT POINTS, EU CE MARKER AND SERVICE CONTACTS

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VERTICAL TURBINE PUMPS

INSTALLATION, OPERATION & MAINTENANCE INSTRUCTIONS

Product, Oil, Grease & Water Flush
Lubricated Construction Pumps

The Heart of Your Process

NOTICE

This Sulzer Pumps manual provides instructions for installing, operating, and maintaining our vertical turbine pumps. These instructions are written only for those who have a working knowledge of vertical pumps and a familiarity with both the terminology and proper field practices used in the vertical pump industry. Cautions and warnings are included, but they are not substitutes for the careful work of the experienced.

By furnishing this manual, Sulzer Pumps Houston Inc. does not accept liability for successful pump installation, operation, or maintenance; that liability belongs to those who actually install, operate, and maintain the pump.

Although we used the most current information available at the time this manual was published, all information contained herein is subject to change without notice. We made every effort to avoid errors, but we cannot guarantee that this manual is error-free.

We appreciate your interest in our product. If you have questions about the contents of this manual, please contact our field service department at our headquarters in Brookshire, Texas or one of our service centers nearest you.

Sales and Service Centers

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LIST OF ASSEMBLY AND ILLUSTRATIONS (DRAWINGS)

SECTION 1- INTRODUCTION

1-1 INTRODUCTION

1-2 The design, material, and workmanship incorporated in the construction of our pumps make them capable of giving long, trouble-free service. The life and satisfactory service of any mechanical unit, however, is enhanced and extended by correct application, proper installation, periodic inspection and careful maintenance. This instruction manual was prepared to assist operators in understanding the construction and the correct methods of installing, operating, and maintaining these pumps.

1-3 The following pages are instructions for installation, operation and maintenance of a Sulzer Vertical Turbine Pump. These instructions should be read carefully. After reading, any questions, technical advice or requests for assistance needed should be directed to:

SULZER PUMPS HOUSTON INC.
800 KOOMEY ROAD
BROOKSHIRE, TEXAS 77423
TELEPHONE (281)-934-6009
TOLL FREE 1-800-926-6688

WARNING
SULZER PUMPS HOUSTON INC. WILL NOT BE LIABLE FOR ANY DAMAGES OR DELAY CAUSED BY FAILURE TO COMPLY WITH THE PROVISIONS OF THIS INSTRUCTION MANUAL

1-4 RECEIVING AND CHECKING

1-5 The pump should be carefully supported prior to unloading from the carrier. Handle all components carefully. Inspection for damage of the shipping crate should be made prior to unpacking the pump. After unpacking, visually inspect the pump and check the following:
A. Contents of the pump assembly against shipping list.
B. All components for damage.
C. Shafting for straightness and damage should the crate be broken or show careless handling.

1-6 Any shortages or damages should be immediately called to the attention of the local freight agent of the carrier by which the shipment arrived and proper notation made on the bill. This shall prevent any controversy when a claim is made and facilitate prompt and satisfactory adjustment.

1-7 SAFETY PRECAUTIONS

1-8 **Personnel must be protected at all times from rotating shafts and couplings**. All screens and protective devices furnished with the pump, driver, and related equipment must be installed prior to pump startup and must remain in place during operation. If protective devices are not furnished, then the user must provide safety equipment conforming to regulations, codes, and statutes applicable to the operation site.

1-9 REQUIRED MATERIALS AND EQUIPMENT

1-10 The material and equipment necessary for installation of the pump will vary with the size of the pump and type of installation. The following list of lifting equipment and hand tools is offered only as a guide.

A. Lifting Equipment:
- Hoist (may be in the form of a portable crane, a permanent crane, tripod or other suitable and safe hoisting means)
- Wire, rope, blocks, and metal windlasses are recommended as lifting devices and must be fitted with sufficient flexible steel cable and a load hook

IMPORTANT: The installation rig should be rated to hold at least 1-1/2 times the weight of the complete pumping unit (i.e., the assembled pump and driver).

B. Bulk Material:
- Anti-galling lubricant (such as “MOLYKOTE” DOW-CORNING)
- Pipe joint compound
- Lubrication oil
- Turbine oil (see 14-18 Lubrication Chart) --one gallon for each 100 feet of tube and shaft assembly.
- Light grease
- Cleaning solvent, petroleum-base (kerosene, distillate)

C. Hand Tools:
- Installing elevators
- Installing clamps
- Chain tongs

- Cable slings
- 10-foot piece of 1/2-inch rope
- Pipe wrenches
- Tube tension wrench
- Clean rags
- Wire brush
- 12-inch ruler
- Two-inch wide paintbrushes

D. Optional Tools to Facilitate Pump Assembly and Disassembly:

- Dial indicator to assist in motor & pump alignment
- Lock collet hammer

SECTION 2-STORAGE

2-1 STORAGE

2-2 Sulzer Pumps carefully preserves and protects its products for shipment. However, the effective life of the preservatives applied at the factory can vary from 3 to 18 months depending on the severity of the environment in which the equipment is stored. This section provides procedures for preparation prior to storage and maintenance during storage of our vertical pumps. These procedures are necessary to protect the precision parts of the pump. Specific procedures for storing motors, gearheads, and engines, should be obtained from the equipment manufacturer. This section is intended to be of general assistance to the users of Sulzer Pumps. It shall not modify, amend and/or otherwise alter the scope of Sulzer Pumps warranty responsibilities to the purchaser in any way whatsoever.

2-3 STORAGE PREPARATION

2-4 Our Vertical Pumps require preparation for storage and regular maintenance during storage. The pump shall be considered in storage when it has been delivered to the job site and waiting installation.

2-5 It is suggested that a check of parts and material against the bill of material be made jointly with a Sulzer Pumps Houston Inc. representative and customer representative.

NO CLAIMS FOR SHORTAGES WILL BE HONORED BY SULZER PUMPS HOUSTON INC. AFTER THE MATERIAL HAS BEEN PLACED IN STORAGE.

2-6 RECOMMENDED STORAGE PROCEDURE--ONE MONTH OR LESS AFTER DELIVERY

2-7 Rust preventative applied to material for shipment is satisfactory unless the equipment is subject to extreme humidity or air borne corrosive gases. In this case, proper preservatives must be applied. (Consult your lubrication specialist)

2-8 RECOMMENDED STORAGE PROCEDURE—MORE THAN ONE MONTH AFTER DELIVERY

2-9 ***PROCEDURE FOR ASSEMBLED PUMPS***

- The storage area must be level and not subject to flooding.
- Blocks must support the pump at intervals to keep the weight off the flanges and suction bell.
- The suction and discharge openings are to be sealed.
- Small pumps may be stored as received, provided the skids were not damaged in transmit.
- All machined surfaces and exposed shafting must be coated with rust preventative. (Consult your lubrication specialist)
- The pump must be inspected periodically to insure that all preservatives are intact.
- Packing must be removed from the packing box for extended storage for possible pitting on the shaft or sleeve.

2-10 ***PROCEDURE FOR DISASSEMBLED PUMPS***

- Storage must not be subject to flooding. All small parts should be stored in boxes under cover.
- All openings are to be sealed.
- Heavy components must be placed on supports to keep them off the ground.
- Shafting must be removed from the boxes and coated with preservative, then reboxed with preservative paper.
- All machined surfaces must be coated with rust preventative. (Consult your lubrication specialist)
- Rubber parts i.e., “O” rings, gaskets and bearings must be stored in a closed container.
- Machined areas must be inspected periodically to assure that all preservatives are intact.

SECTION 3-GENERAL DESCRIPTION

3-1 GENERAL DESCRIPTION & INFORMATION

3-2 Sulzer Vertical Turbine Pumps are composed of four major sub-assemblies: **A) Bowl B) Column C) Head D) Driver** and are available in four bearing lubrication constructions. See page 4.

3-3 DRIVERS—FIGURE D

3-4 Where mechanical seals are required, the most common drivers supplied are solid shaft electric motors with adjustable spacer type couplings, which permit replacement of the mechanical seal without disturbing the driver. Solid shaft gears are also used, occasionally. Packing boxes or enclosed lineshafts usually require a hollow shaft driver, often used with a separate headshaft through the drive and connected to the pump by a threaded coupling. A rigid flanged or keyed type lineshaft coupling may also be provided, depending on the requirement.

3-5 DISCHARGE HEAD ASSEMBLY—FIGURE C

3-6 The discharge head is either a cast or a fabicated type head incorporating a water passage, driver pedestal, and base mounting flange. Various shaft seal arrangements are available, depending on the application: **E) Packing box- product lube F) Enclosing tube- waterflush G) Enclosing tube-grease lube H) Enclosing tube-oil lube--See page 4.** Ports are provided for connecting a discharge gage, stuffing box or mechanical seal bypass return. The discharge head is designed with large hand holes for easy mechanical seal or stuffing box adjustment. Adjustment of the rotating assembly is vital with the flanged or threaded coupling to assure proper clearances. See pages 8 & 9.

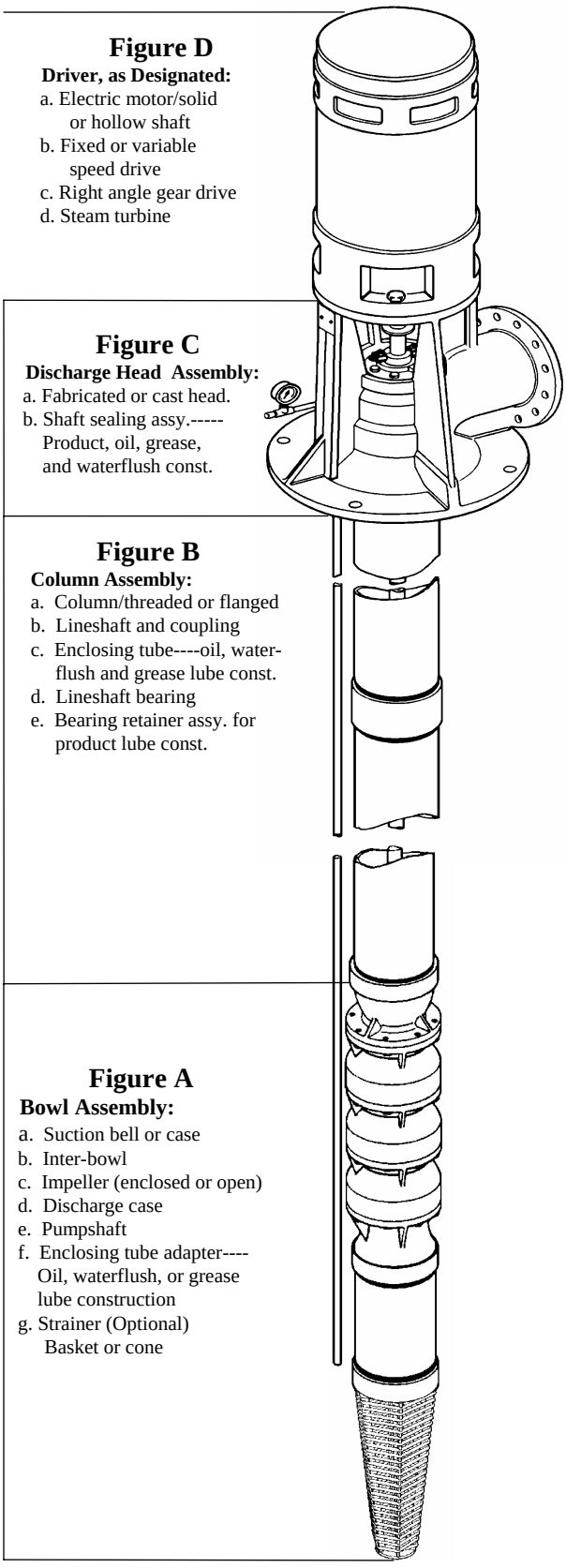


Figure D
Driver, as Designated:
a. Electric motor/solid or hollow shaft
b. Fixed or variable speed drive
c. Right angle gear drive
d. Steam turbine

Figure C
Discharge Head Assembly:
a. Fabricated or cast head.
b. Shaft sealing assy.----- Product, oil, grease, and waterflush const.

Figure B
Column Assembly:
a. Column/threaded or flanged
b. Lineshaft and coupling
c. Enclosing tube----oil, water-flush and grease lube const.
d. Lineshaft bearing
e. Bearing retainer assy. for product lube const.

Figure A
Bowl Assembly:
a. Suction bell or case
b. Inter-bowl
c. Impeller (enclosed or open)
d. Discharge case
e. Pumpshaft
f. Enclosing tube adapter---- Oil, waterflush, or grease lube construction
g. Strainer (Optional) Basket or cone

PUMP SHOWN: PRODUCT LUBRICATED DEEP WELL WITH CONE STRAINER

3-7 COLUMN ASSEMBLY-FIGURE B

3-8 The column connections will be threaded or flanged providing positive shaft and bearing alignment. Bearings are spaced to provide vibration free operation below the shaft first critical speed. Oil lubricated lineshaft bearings are enclosed by an enclosing tube. Rubber tube stabilizers keep the enclosing tube and shaft assembly aligned within the column pipe. Product lubricated lineshaft is supported within the column by use of bearing retainers with a snap-in type bearing. See pages 6 & 7.

3-9 BOWL ASSEMBLY—FIGURE A

3-10 The bowl connections are flanged or threaded for accurate alignment and ease of assembly and disassembly, depending on bowl size. The bowls may be vitriform enameled or plasite coated to achieve peak efficiency and reduce friction. The bowl assembly can be furnished with either a suction case or suction bell. Impellers may be either open or enclosed depending on design requirement. Impellers are locked onto the pumpshaft with tapered collets or thrust rings (optional) for positive locking. The pumpshaft maybe rifled drilled when waterflush construction is specified, depending on the number of stages. Grease lube construction can also be provided with external or internal grease lines for bearing lubrication. Dual bowl bearings are provided as standard to provide alignment and dampen vibration. See pages 5 & 10.

3-11 PUMP BEARING LUBRICATION CONSTRUCTIONS

A. Product Lubricated Construction---All pump bearings are lubricated with the fluid pumped. (See Figure E & page 6)

B. Waterflush Construction---Some or all pump bearings are lubricated with water from an external source. (See Figure F & page 7 and 10)

C. Grease Lubricated Construction---Some or all pump bearings are lubricated with grease from an external source. (See Figure G and page 7)

D. Oil Lubricated Construction---Head and lineshaft bearings are lubricated with oil supplied from an external source. Lubrication system may be either manual or automatic. (See Figure H & page 7)

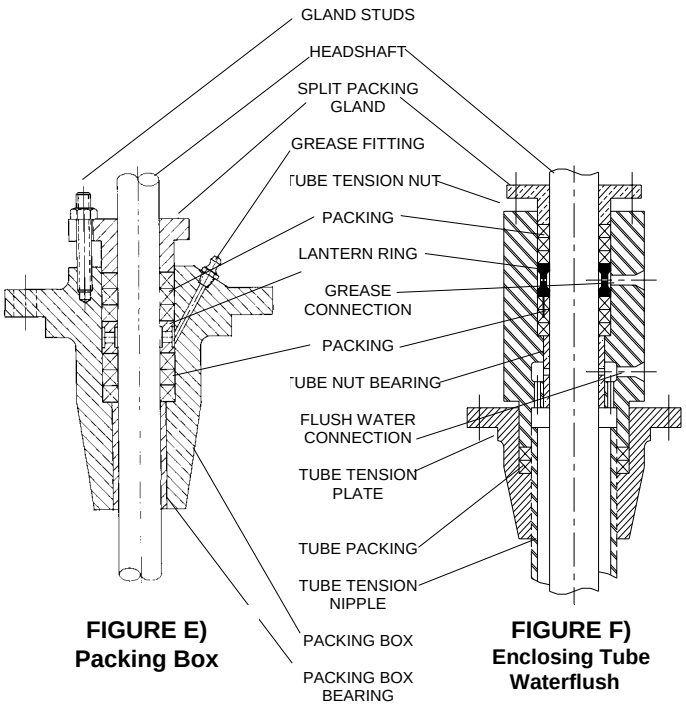


FIGURE E)
Packing Box

FIGURE F)
Enclosing Tube Waterflush

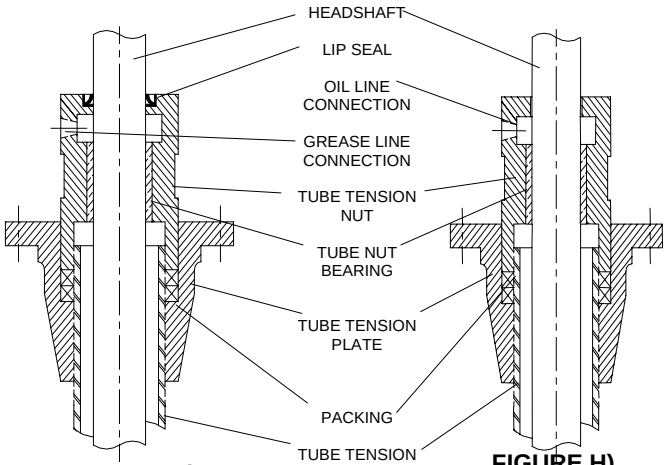


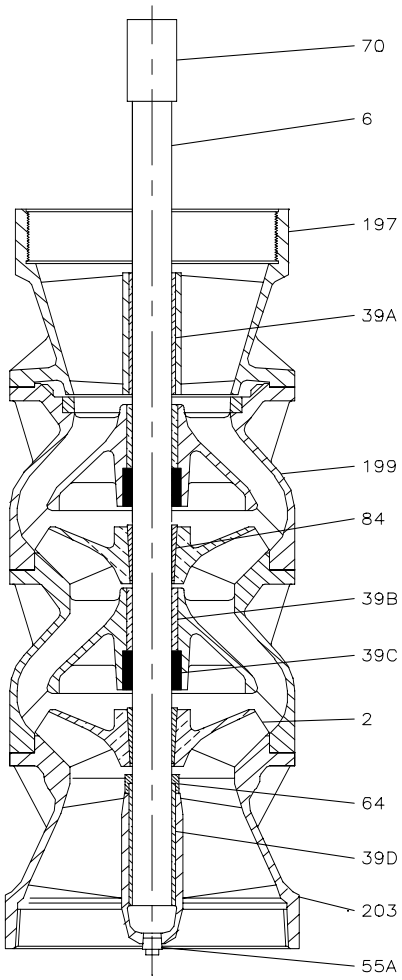
FIGURE G)
Enclosing Tube- Grease

FIGURE H)
Enclosing Tube- Oil

SHAFT SEALING ARRANGEMENTS

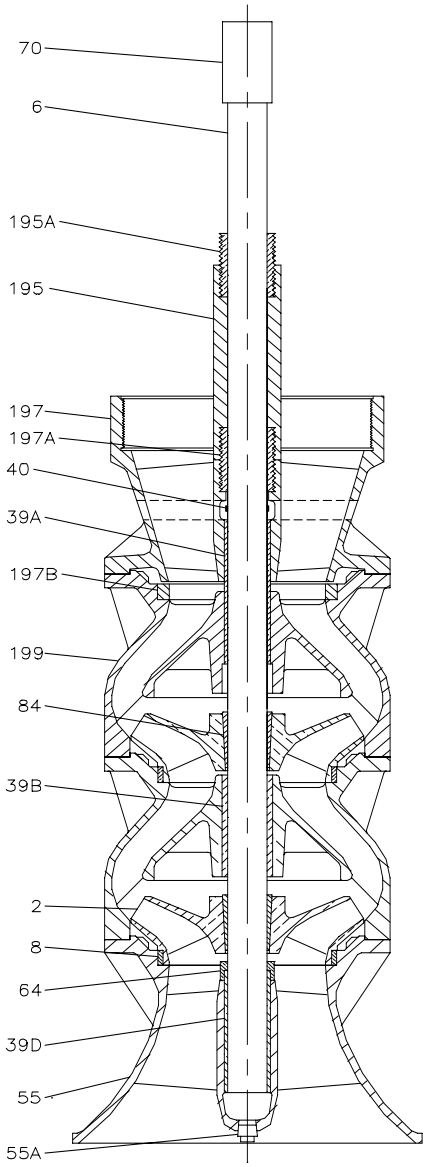
TURBINE BOWL ASSEMBLY

Product Lubricated
Lock Collet and Dual Bearings, Semi Open
Impellers and Suction Case (2 stages shown)



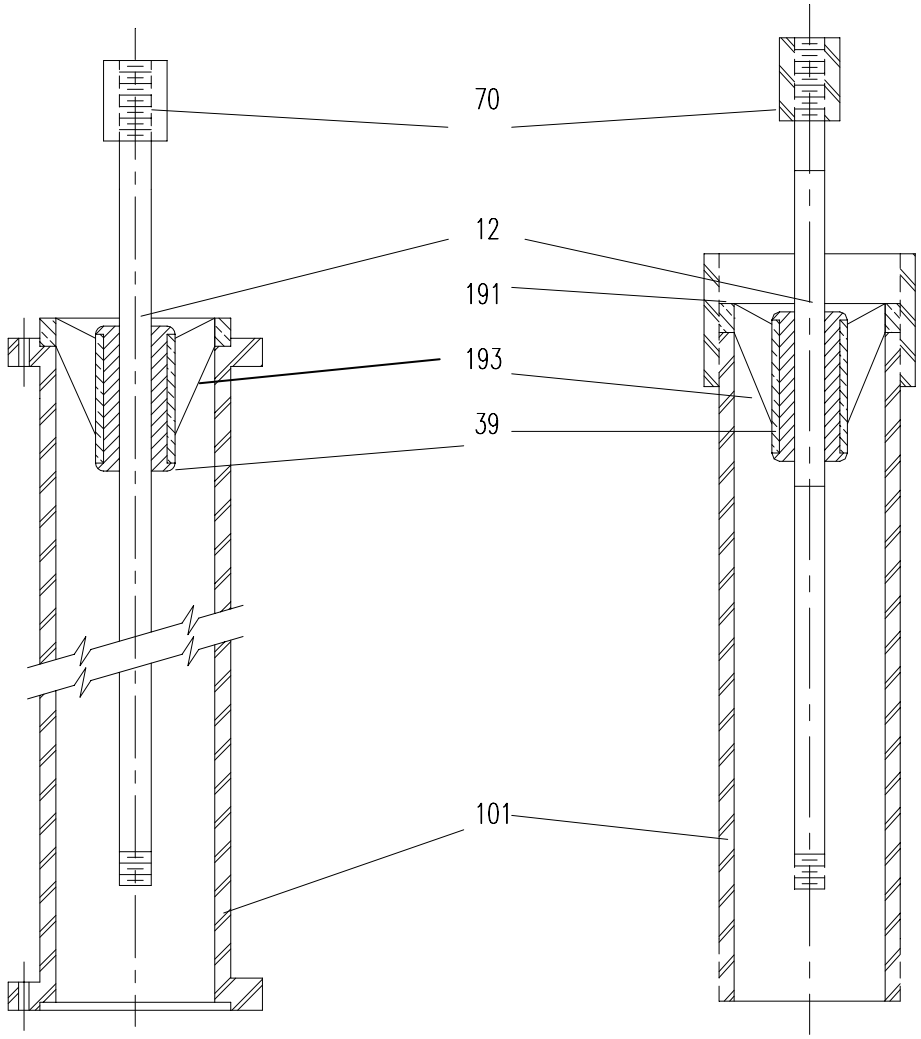
2	Impeller
6	Pumpshaft
8	Impeller Ring
39A	Discharge Case Bearing
39B	Interbowl Bearing (Top)
39C	Interbowl Bearing (Bottom)
39D	Suction Bell Or Case Bearing
55	Suction Bell
55A	Suction Bell Pipe Plug
64	Sand Collar

Oil Lubricated
Lock Collet and Single Bearings, Enclosed
Impellers and Suction Bell (2 stages shown)



70	Pumpshaft Coupling
84	Lock Collet
195	Tube Adapter
195A	Screw Discharge Case Bearing
197	Discharge Case
197A	Discharge Case Screw Bearing
197B	Flow Ring (When Required)
199	Intermediate Bowl
203	Suction Case
213	Bowl Ring (Not Shown)

PRODUCT LUBRICATED COLUMN ASSEMBLY



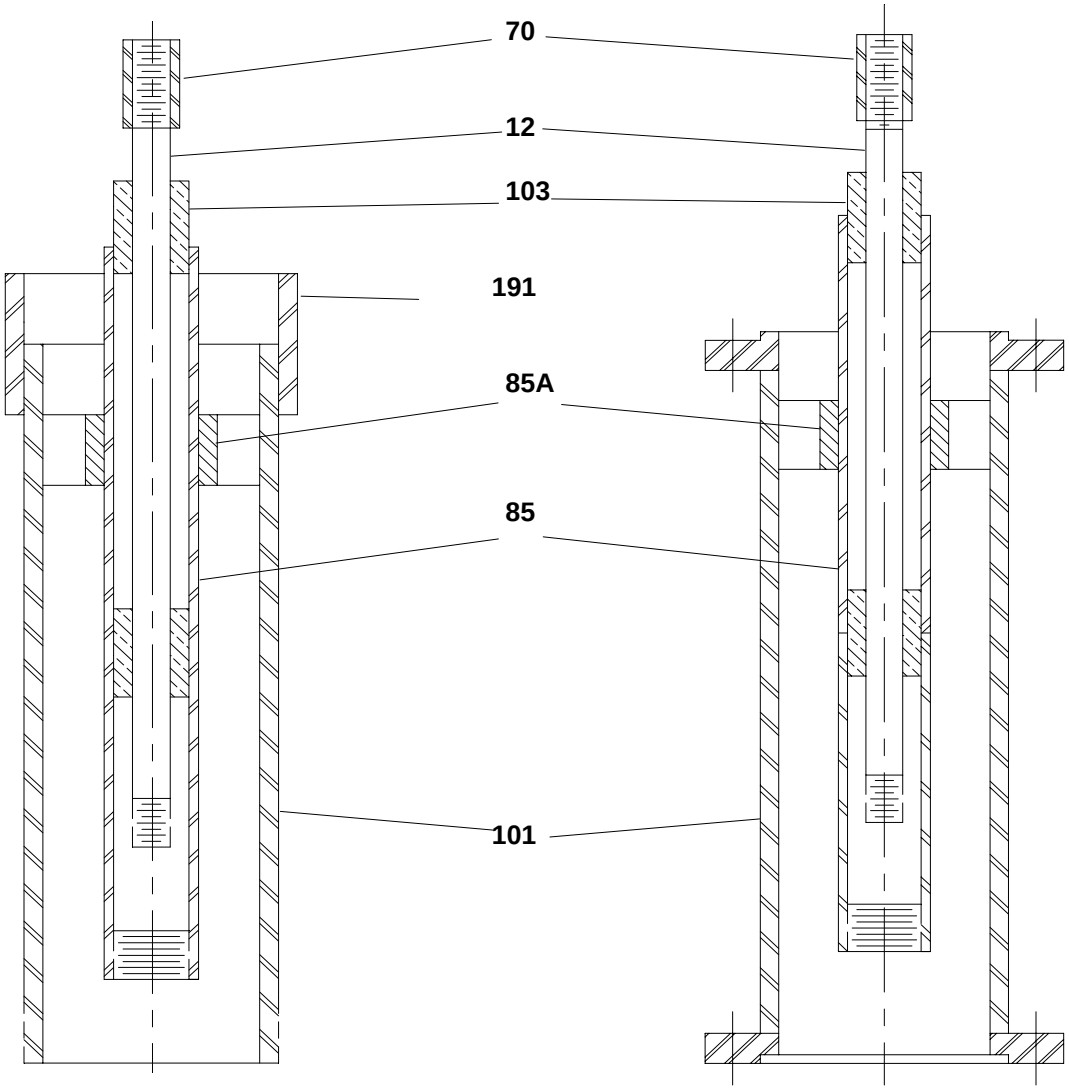
FLANGED COLUMN ASSEMBLY
PRODUCT-LUBRICATED

12 Lineshaft
39 Bearing Bushing
70 Shaft Coupling
101 Column Pipe
193 Open Lineshaft Bearing Retainer

THREADED COLUMN ASSEMBLY
PRODUCT-LUBRICATED

12 Lineshaft
39 Bearing Bushing
70 Shaft Coupling
101 Column Pipe
191 Column Pipe Coupling
193 Open Lineshaft Bearing Retainer

OIL LUBRICATED COLUMN ASSEMBLY
(ALSO REQUIRED FOR GREASE AND WATERFLUSH CONSTRUCTION)



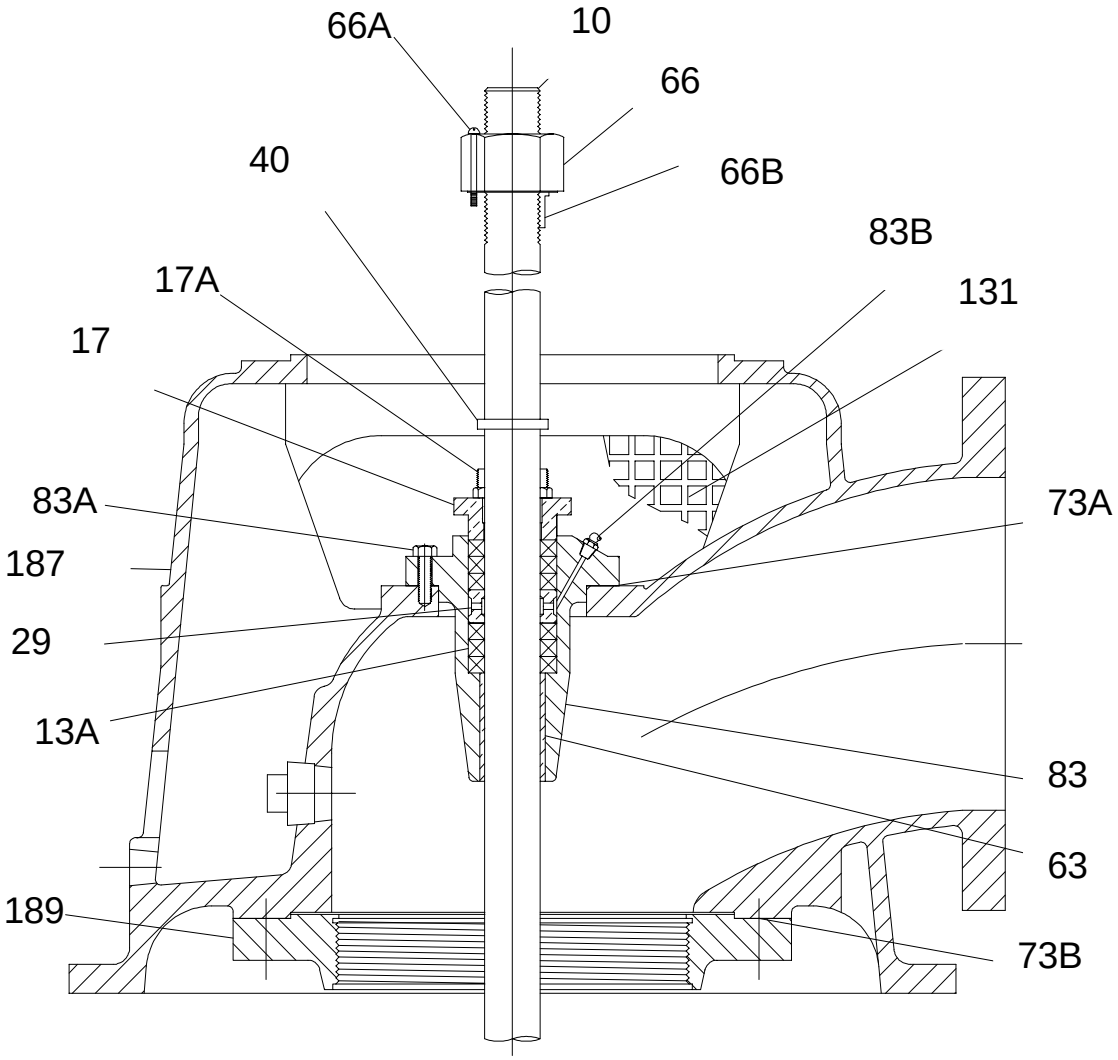
THREADED COLUMN ASSEMBLY
OIL LUBRICATED

12 Lineshaft
70 Shaft Coupling
85 Shaft Enclosing Tube
85a Enclosing Tube Stabilizer
101 Column Pipe
103 Enclosed Lineshaft Bearing
191 Column Pipe Coupling

FLANGED COLUMN ASSEMBLY
OIL LUBRICATED

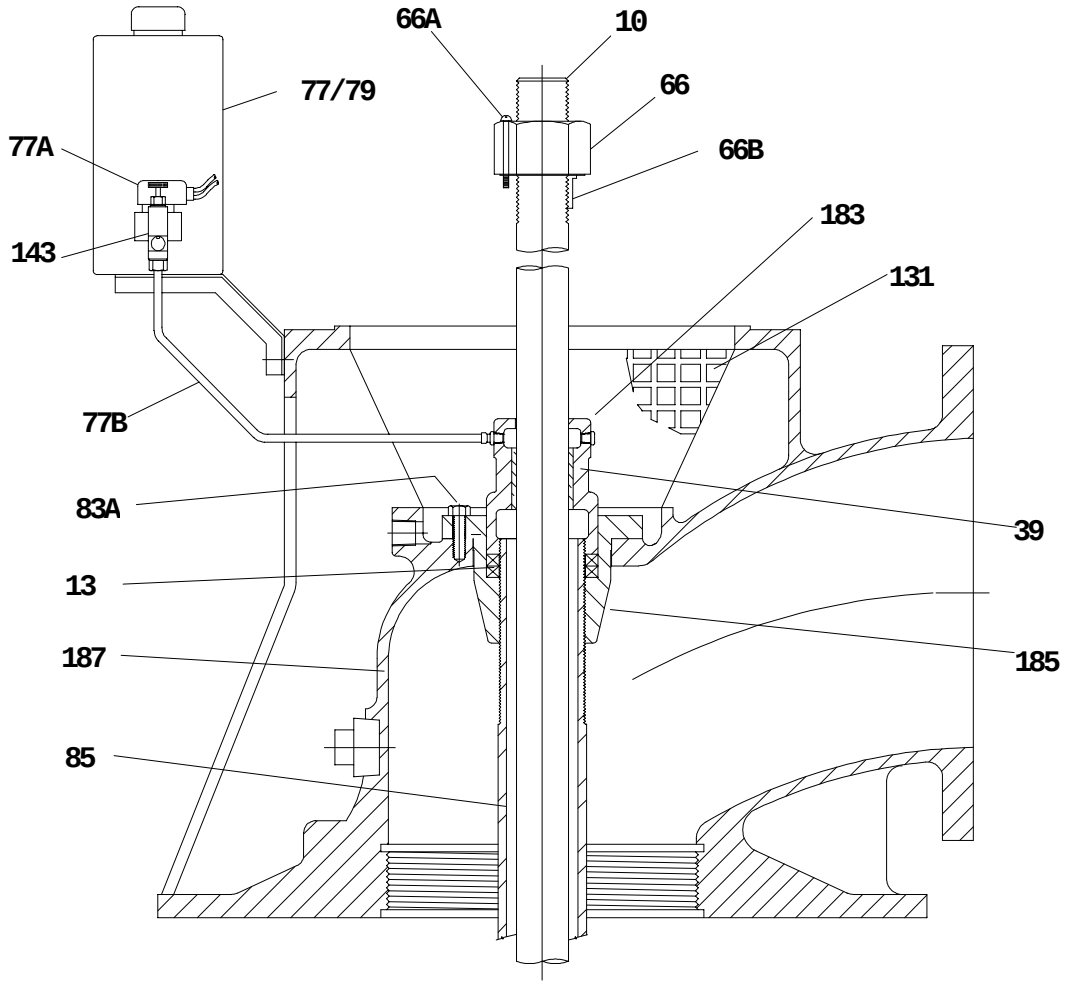
12 Lineshaft
70 Shaft Coupling
85 Shaft Enclosing Tube
85a Enclosing Tube Stabilizer
101 Column Pipe
103 Enclosed Lineshaft Bearing

PRODUCT-LUBRICATED DISCHARGE HEAD ASSEMBLY



10	Headshaft	66B	Gib Key
13A	Packing (Set Of Six Rings)	73A	Gasket
17	Gland	73B	Gasket
17A	Gland Studs (Set)	83	Packing Box
29	Lantern Ring	83A	Cap Screws (Set)
40	Deflector	83B	Grease Fitting
63	Stuffing Box Bushing	131	Guard, Coupling
66	Shaft Adjusting Nut	187	Surface Discharge Head
66A	Nut Locking Screws	189	Top Column Flange

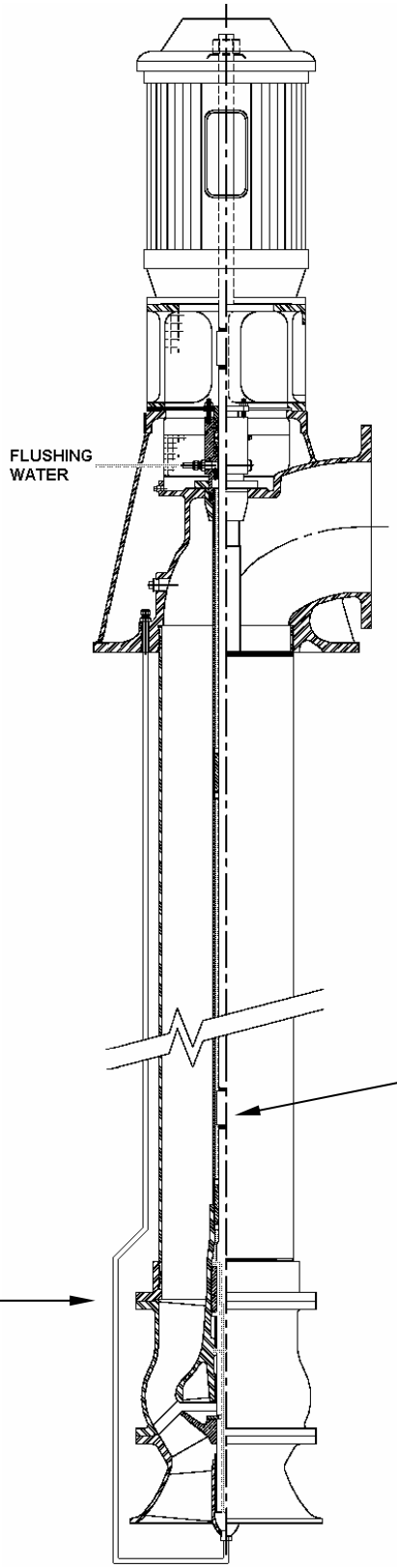
OIL-LUBRICATED DISCHARGE HEAD ASSEMBLY



10	Headshaft
13	Packing (Set Of Two Rings)
39	Bushing, Bearing
66	Shaft Adjusting Nut
66A	Nut Locking Screws
66B	Gib Key
77A	Solenoid Valve with Coil Or Manual Drip Valve
77B	Oil Line Fittings
77 & 79	Oil Reservoir with Bracket
83A	Cap Screws (Set)
85	Enclosing Shaft Tube
131	Guard Coupling
143	Sight Oil Gage
183	Tube Tension Nut
185	Tube Tension Plate
187	Surface Discharge Head

TYPICAL WATERFLUSH PUMP ASSEMBLY

NOTE:
Recommended flushing pressure is 5 to 10 PSI over discharge pressure of pump at all times

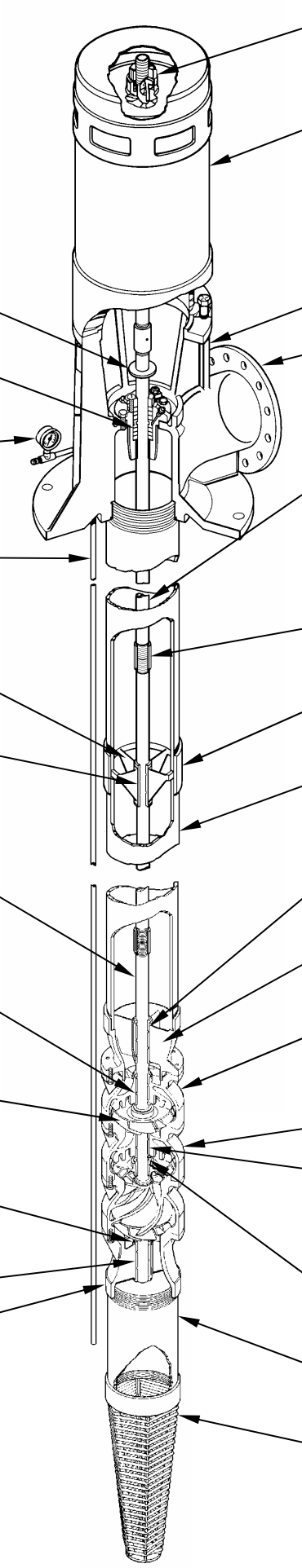


Slotted lineshaft bearings for clean water flush to pass through

Optional flush line to suction bell -- 316SS or copper pipe lubrication line to flush suction bell separately. Bottom of rifle drilled shaft plugged.

Optional - Rifle drilled pumpshaft allows water to enter shaft and travel down to flush additional stages

TYPICAL PRODUCT-LUBRICATED VERTICAL PUMP



TOP SHAFT ADJUSTING NUT - Easily accessible for adjusting impellers.

VERTICAL HOLLOW-SHAFT MOTOR - Manufactured especially for vertical pumps. (Discharge head can also be equipped with right angle gear drives and belt drives.)

DISCHARGE HEAD

AMERICAN STANDARD (ANSI 125#) FLANGE CONNECTION

WATER SLINGER - Protects motor from water spray.

PACKING GLAND - Split-ring type accessible at surface for easy adjustment or replacement of packing.

DRAW-DOWN GAUGE Measures fluid level. (Optional)

AIRLINE (Optional)

LINESHAFT - Ground and polished stainless steel; sized to carry necessary horse-power load; furnished in 10-foot or 20-foot lengths.

OPEN LINESHAFT BEARING RETAINER - Bronze; ensures shaft alignment

SNAP-IN RUBBER BEARING Spiral-grooved for better shaft-cleaning action.

LINESHAFT COUPLING Cold-finished steel.

COLUMN PIPE COUPLING Straight, eight-pitch threads.

COLUMN PIPE - Steel; straight, eight-pitch threads for butt joining connections.

IMPELLER SHAFT - Precision ground stainless steel.

TOP BOWL BEARING Combination bronze and rubber.

DISCHARGE CASE BEARING Bronze.

DISCHARGE CASE - Connects column pipe to bowl assembly.

TOP BOWL - Bowls are of close-grained cast iron vitriform enameled.

IMPELLERS - Either semi-open (shown) or closed; bronze or vitriform enamel-lined.

INTERMEDIATE BOWL

SUCTION CASE SAND COLLAR Keeps suction case bearing free of sand.

INTERMEDIATE BOWL BEARINGS - Bronze and rubber; for alignment and to dampen vibration.

SUCTION CASE BEARING - Bronze.

TAPER LOCK COLLET Holds impeller on shaft.

SUCTION CASE - Guides liquid to first impeller with minimum friction loss. (Suction bell also available.)

SUCTION PIPE (OPTIONAL) - High-grade steel.

SUCTION STRAINER (OPTIONAL) - Prevents large solids from entering pump.

SECTION 4- FOUNDATION

4-1 PREPARING THE FOUNDATION

4-2 A foundation is required for a Sulzer Vertical Turbine Pump. The foundation must be built to support the weight of the entire pump when the pump is full of water and should be rigid enough to withstand and prevent vibration.

4-3 Sulzer Pumps recommends that a concrete foundation be used whenever possible. This type of foundation provides the best support and minimizes vibration.

4-4 Steel I-beams or timbers may also be used as a foundation, but they must be strong enough to prevent spring action and braced to stop lateral movement.

4-5 INSTALLATION

4-6 ***Sub-base***

(1) Sulzer Pumps recommends that 2 to 3 inches of epoxy grout be required under the pump baseplate flanges to reach the desired compressive strength. Thinner pours do not generate enough exothermic reaction heat to fully cure the epoxy. **NOTE: Before leveling, the sub-base or baseplate should be high enough in grout thickness as noted above.**

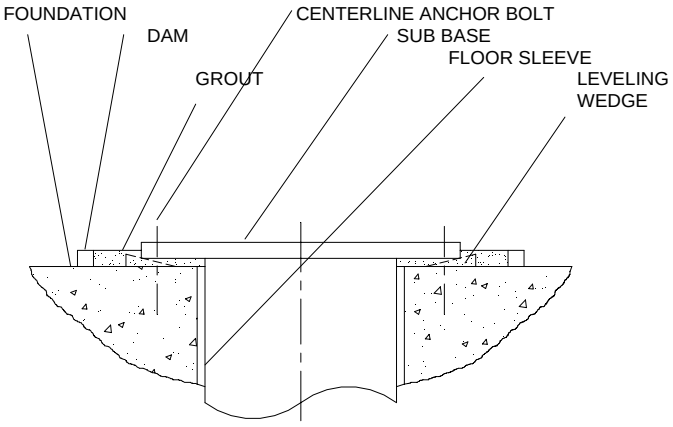


Figure 4.1
Sub-base Installation

(2) Leveling the sub-base may be done by one of the following methods:

a. Leveling wedges
b. Leveling nuts on the anchor bolts

Regardless of the method, a machinist level must be used for leveling. Level the sub-base in two directions at 90° on the machined surface.

NOTE: Preferred levelness is dead level but an acceptable tolerance is .002 inches per foot.

(3) Grout in the sub-base using a non-shrinking grout. Allow the grout to cure for approximately 48 hours before installing the pump.

NOTE: For deep well setting over 50 feet–See special instructions provided.

4-7 ***Barrel***

(1) Attach eyebolts to the mounting flange of the barrel.

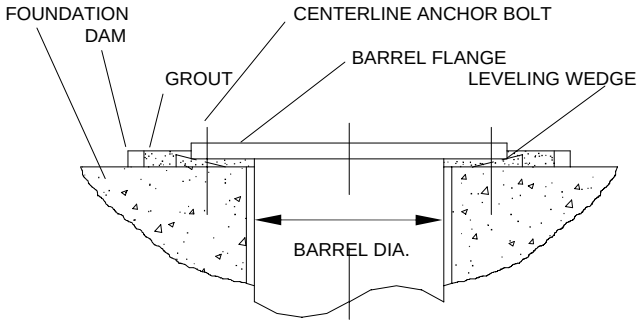


Figure 4.2 Barrel Installation

(2) Attach slings and raise the barrel to a vertical position over the foundation.

(3) Lower the barrel until the flange is resting on the foundation.

(4) Leveling of the barrel may be done by the following methods:

(a) Leveling wedges
(b) Leveling nuts on the anchor bolts

Whichever method is used, a machinist level must be used for leveling. Level the barrel flange in two directions at 90° on the machined surface.

NOTE: Preferred levelness is dead level but the acceptable tolerance is .002 inches per foot.

(5) Grout the barrel flange, using non-shrinking grout.

CAUTION:
WHEN CONNECTING EXTERIOR PIPING, CARE MUST BE TAKEN NOT TO DISTURB THE LEVELNESS OF THE BARREL FLANGE.

SECTION 5- PUMP INSTALLATION

5-1 NECESSARY STEPS PRIOR TO PUMP INSTALLATION

5-2 ***Well Examination***

Examine the well before installing the pump. The well should be straight and of sufficient diameter, depth, and capacity to receive the pump. The well must be developed, tested, and free of all foreign material in the liquid before the new pump is installed. Never use a new pump to develop and test a well; use a test pump for this purpose. ***Your new vertical pump is not warranted for pumping foreign material in the liquid (see Section 14-4 (7) CAUTION).***

5-3 ***Layout of Pump Parts for Inspection***

Uncrate and layout all parts on suitable timbers. Arrange the components in a manner that is convenient for the site and for the equipment to be used during the installation. Keep all parts away from the dirt. Be sure all the parts are clean and the threads are protected at all times. The headshaft and tube tension nipple should be left in the shipping crate until you are ready to install them.

CAUTION:

Never drop any crate or part to the ground. Always use skids. Great care should be taken in handling the shafting. Do not install a bent or sprung shaft.

(1) Compare the parts against the quantities listed on the bill of material.

(2) Prior to the installation of components received assembled, all nuts and bolts must be checked for tightness since they may have loosened during transportation.

(3) Cleanse the lineshaft of all grease, oil and foreign matter.

(4) The enclosing tube and lineshaft are ordinarily shipped assembled, if not, the shaft should be slipped into the tube carefully so no damage will occur to the shaft bearing which will serve as a coupling for the five foot lengths of tube.

(5) Slide each shaft and tube section or each shaft into a matching length of column pipe. If threaded column is provided, the top end is located where the coupling is. For flanged column, either end may serve as the top end.

(6) Clean all threads, shaft ends, couplings, and mating surfaces with a solvent and wire brush just before making connections.

(7) Pipe joint compound should be used on column threads. Non metallic antisieze compound should be used on the tube-connector threads and shaft threads.

5-4 INSTALLING A PARTIALLY ASSEMBLED PUMP

5-5 ***Installation***

Pumps 20 feet or less in length are usually shipped assembled, with the exception of the driver, packing, mechanical seal with tubing and coupling assembly, spacer or non-spacer type.

(1) See section 14-1, Pre-start procedure before commencing the installation.

(2) Check all nuts and bolts for tightness.

(3) Check the mounting flange of the pump and the matching flange on the foundation for burrs and nicks. These must be smoothed with a mill file.

(4) Attach a lifting device to the upper end of the assembled pump and raise it to a vertical position over the mounting foundation.

CAUTION:

When a strainer is attached to the suction end of the pump, use care not to damage the strainer when raising the assembly to the vertical position. Do not allow the suction end to drag or support the total weight of the assembled pump.

(5) Lower the unit until the mounting flange of the pump rests on the foundation.

CAUTION:

When the pump is fitted with external lines such as grease, by-pass, flush etc., extreme care must be used not to damage these lines while raising or lowering the assembly.

(6) When the headshaft is shipped separately, clean the threads and install the headshaft. Hand tighten only. **Note: The threads are left hand.**

(7) Install the shaft sealing assembly, when shipped separately, in accordance with section 9 & 10.

(8) Mount the drive and align the pump in accordance with section 11 & 12.

(9) Adjust the impellers in accordance with section 11.

CAUTION:

When connecting piping to the pump do not put a strain on the pump as this may cause misalignment.

SECTION 6-INSTALLING THE STRAINER ASSEMBLY (OPTIONAL)

6-1 BASKET & CONE STRAINERS

6-2 There is a number of methods for installing strainers, but the following steps are among the most common and practical.

6-3 ***Cone Strainer***

(1) Clean the threads on the cone strainer and the suction case of the bowl assembly.
(2) Apply pipe joint compound to the threads.
(3) Thread the cone strainer into the suction case and tighten with chain tongs.

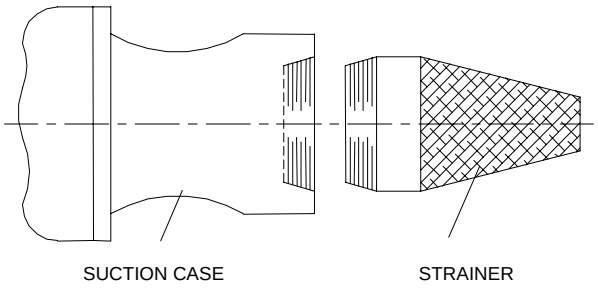
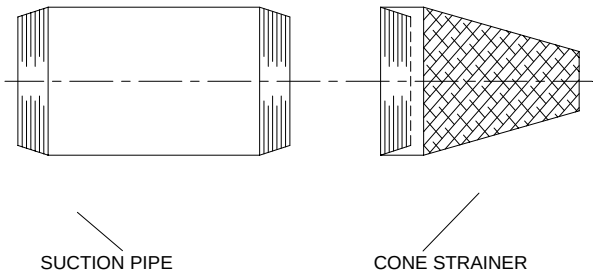


Figure 6.1 Cone Strainer Assembly

6-4 ***Cone Strainer with Suction Pipe***

(1) Repeat the above two steps.
(2) Attach the elevators and raise the suction pipe with the strainer to a vertical position over the foundation and lower until the elevators are resting on the foundation.
(3) Clean the threads on the suction pipe and the suction case of the bowl assembly.
(4) Apply pipe joint compound to the threads.
(5) Thread the suction pipe into the suction case.

NOTE: Suction pipe has tapered threads



6-5 ***Basket Strainer—Clip on Type***

(1) Place the basket strainer against the bottom of the suction bell.
(2) Place the clips, slotted end down, over the outside diameter of the suction bell.
(3) Insert the cap screws through the slots in the clips. Thread into the basket strainer and tighten.

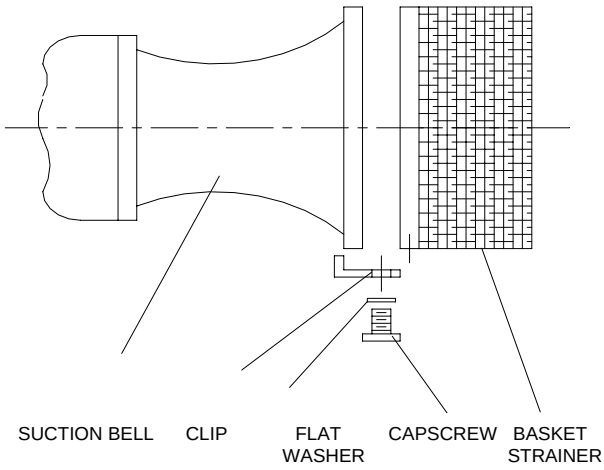


Figure 6.3 Basket Strainer/Clip on Type Assembly

6-6 ***Basket Strainer/Threaded Type***

This type of basket strainer is normally attached to the bowl assembly when shipped. In the event it is not attached, proceed as follows:

(1) Thread the nipple into the suction hub.
(2) Place the screen on the plate.
(3) Thread the nipple into the plate.
(4) Tighten, but do not distort the screen.

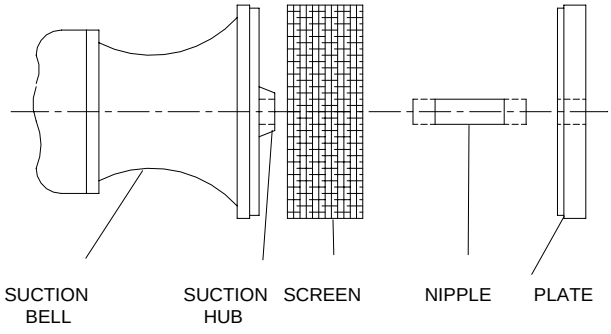


Figure 6.4 Basket Strainer/Threaded Type Assembly

SECTION 7-INSTALLING THE BOWL AND OPEN LINESHAFT ASSEMBLY

7-1 BOWL ASSEMBLY

7-2 Before installing, verify the pumpshaft projection, i.e., the distance from the column seat to the top of the pumpshaft when the impellers are seated against the suction case or bell. Note this dimension for future reference because it must be verified after each section of column is added to the pump.

7-3 THREADED OR FLANGED COLUMN ASSEMBLY

7-4 *Installation

(1) Attach the elevators to the top of the bottom column, just beneath the column coupling or column flange.

(2) With a rope, throw a timber hitch around the column approximately one foot above the bottom threads or flange and a double half hitch around the shaft.

(3) Raise the entire column section and shaft to a vertical position directly over the bowl assembly while tailing in the section rope.

NOTE: Care should be taken to prevent the shaft from slipping or binding as the assembly is raising.

(4) Lower the column assembly and couple the shafts. Butt the shaft ends tightly together using pipe wrenches, but ***do not distort***.

***(5)** Clean the column threads. Check for burrs and nicks that should be smoothed with a mill file.

(6)** Lower the **threaded column** and start the threads by hand. Use chain tongs and tighten until the columns butt. ***Do not distort. If **flanged column** is provided**,** lower the column to the registered fit and bolt the flange faces together. The bolts should be tighten uniformly, working to opposite sides of the flange. ***Do not distort.***

***(7)** Raise the entire assembly sufficiently to remove the lower elevators. Lower the entire unit until the upper elevators are resting on the foundation. When **fabricated retainers** are supplied, lower the entire unit until the upper column flange is above the foundation to allow placing of the installing clamps.

***(8)** Verify that the shaft is centered in the column. If the shaft is not centered, it may have been bent and must be removed.

(9) Install a lineshaft bearing retainer with a bearing between the column sections, inside the column coupling or flange.

***(10)** Measure the projection from the top of the shaft and compare this measurement with the pumpshaft projection. This measurement should be within 1/8 inch.

***(11)** Thread the coupling on the shaft.

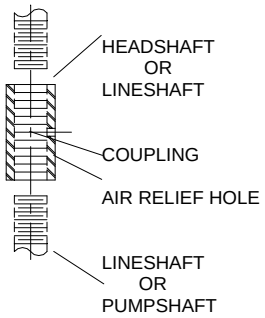


Figure 7.1 Threaded Coupling Assembly

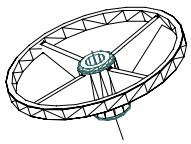


Figure 7.2 Bearing Retainer

Follow the same procedure for subsequent sections of shafting.

7-5 *Large Flanged Column with a Fabricated Retainer & Threaded Coupling.

When the pump is provided with a fabricated retainer and threaded coupling, proceed as follows:

NOTE: The top end of the column is where the bearing retainer is fabricated.

(1) Install a bearing in the bearing retainer.

(2) Temporarily place a coupling on the top end of the bottom shaft.

(3) With a rope, put a double half hitch on the shaft just below the coupling. Raise the shaft over the pumpshaft coupling.

(4) Butt the shaft ends tightly together using pipe wrenches, but ***do not distort***. Remove the rope and coupling.

(5) Attach either installing elevators to the column or eye bolts to the top flange of the bottom column.

***(6)** Raise the column and carefully lower it over the shaft.

***(7)** Check for burrs and nicks which must be smoothed with a mill file. Guide the shaft through the bearing.

CAUTION:
CARE MUST BE TAKEN NOT TO DAMAGE THE BEARING IN THE RETAINER WITH THE SHAFT THREADS.

***(8)** Repeat procedure 7-4, steps 6, 7, 10, & 11.

7-6 ***Large Flanged Column with a Fabricated Retainer & Thrust Stud Coupling***

When the pump is provided with a fabricated retainer and thrust stud coupling, proceed as follows:

NOTE: The top end of the column is where the bearing retainer is fabricated.

(1) Install a bearing in the bearing retainer.

(2) Temporarily place a lifting device on the top end of the bottom shaft.

(3) Raise the shaft over the pumpshaft.

(4) Connect the bottom shaft to the pumpshaft in accordance with the below instructions for a thrust stud coupling. See procedure 7-7.

(5) Repeat procedure 7-5, steps 6 through 8.

7-7 *Thrust Stud Coupling

NOTE: The coupling must be a sliding fit on the shafts and the keys must be a close fit in the keyways. The parts are match marked for easy assembly.

- Place one key in the keyway of a shaft and slide the coupling over the key and shaft until it is flush with the end of the shaft.
- Screw the thrust stud into the end of the shaft until it stops.

- Thread the other shaft onto the thrust stud until there is approximately 1/8-inch gap between the shaft ends.

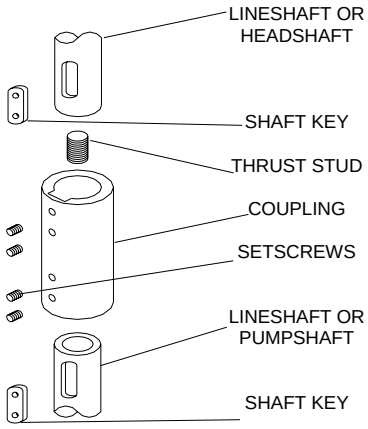


Figure 7.3 Thrust Stud Coupling Assembly

- Line up the keyway in the shaft with the keyway in the coupling.
- Place one key in the keyway of the other shaft.
- Slide the coupling over the key until all setscrew holes line up with the recessed holes in the key.
- Install the setscrews, using Loctite® #277, and tighten securely.

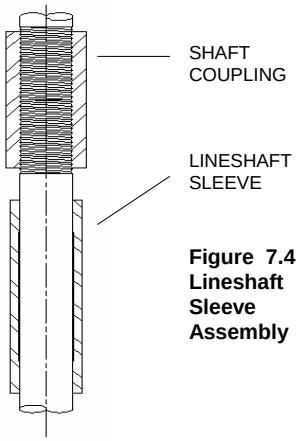


Figure 7.4 Lineshaft Sleeve Assembly

7-8 ***Lineshaft Sleeve (Optional)***

If the pump is supplied with a separate, replaceable lineshaft sleeve, proceed as follows:

- Slip the sleeve onto the lineshaft before threading on a coupling.
- Tighten the sleeve to the shaft with the setscrews after centering the sleeve under the lineshaft bearing.

CAUTION:

EXTREME CARE MUST BE EXERCISED NOT TO DAMAGE THE JOURNAL AREA OF THE SLEEVE THAT WILL BE IN CONTACT WITH THE BEARING.

7-9 ***Flanged Column with "O" Ring***

If the pump is supplied with "O" rings, use light grease and coat the "O" ring heavily. Place the "O" ring around the register of each flange connection.

7-10 ***Top Column—Threaded or Flanged***

(1) Thread the shaft coupling on the last section of lineshaft and hand tighten.

(2) Raise the top column while starting threads by hand and thread into the last coupling and tighten. If **flanged column** is provided, raise the top column and bolt in place.

(3) Thread the top column flange onto the top column and tighten. **NOTE: Some pumps are furnished with the top column flange fabricated to the top column.**

(4) Clean the face of the top flange and apply a light coat of grease to hold the gasket/"O" ring in place. Place the gasket/"O" ring on the flange face.

SECTION 8-INSTALLING THE BOWL AND ENCLOSED LINE SHAFT ASSEMBLY

8-1 BOWL ASSEMBLY

8-2 Before installing, verify the pumpshaft projections, i.e. the distances from the column seat to the top of the pumpshaft and from the tube seat to the top of the pumpshaft. Note these dimensions for future reference because they must be verified after each section of column is added to the pump.

8-3 ***Optional External Grease Line***

CAUTION: ALL GREASE LINES MUST BE PURGED OF AIR.

Connect the external grease/flush line(s) to the bowl assembly.

8-4 THREADED OR FLANGED COLUMN ASSEMBLY

8-5 ***Installation***

(1) Attach the elevators to the top of the bottom column, just beneath the column coupling or column flange.

(2) With a rope, throw a timber hitch around the column approximately one foot above the bottom threads or the bottom flange that matches the bowl flange; then throw a double half hitch around the tube and a double half hitch around the shaft.

(3) Raise the entire column, tube and shaft assembly to a vertical position directly over the bowl assembly while tailing in the assembly.

NOTE:

Care should be taken to prevent the tube and shaft from slipping or binding as they are raised.

(4) Lower the column assembly and couple the lineshaft to the pumpshaft. Butt the shaft ends tightly together using pipe wrenches, but ***do not distort***. **NOTE: The shaft threads are left hand.**

(5) Screw the enclosing tube on the tube adapter so it butts together tightly. Use pipe wrenches, but ***do not distort*****. NOTE: The tube threads are left-hand.**

(6) **Optional:** Fasten the grease line(s) to the enclosing tube during the tube installation.

(7) **Optional:** Install the grease line guard during the tube installation.

(8) Repeat procedure section 7-4, steps 5, 6, & 7.

(9) Verify that the shaft and tube are centered in the column. If the shaft and/or tube is not centered, they may have been bent and must be removed.

(10) Add approximately one pint of the proper oil to the enclosing tube. (See lubrication chart 14-18).

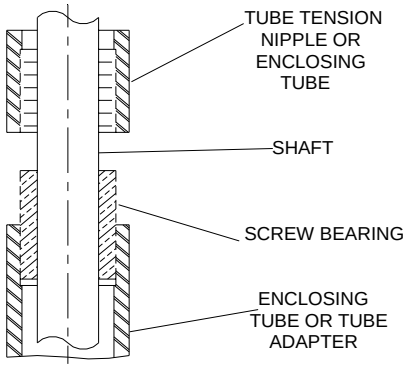


Figure 8.1 Enclosing Tube Assembly

(11) Measure the projection from the column seat to the top of the shaft and from the tube seat to the top of the shaft. Compare these note measurements with those recorded previously. The measurements should be within 1/8 inch.

(12) Install a lineshaft screw bearing and a lineshaft coupling.

Follow the same procedure for subsequent sections of column.

A. Pumps to be operated at 1800 RPM or below require tube stabilizers to be at 40-foot intervals, starting at 15 feet above the bowl assembly.

B. Pumps to be operated at 2900 RPM and above require tube stabilizers to be at 30 foot intervals, starting at 15 feet above the bowl assembly. In either case, the last stabilizer should be approximately 15 feet below the discharge head.

(13) **Optional:** Connect the internal grease line(s) to the bearing(s) during the bearing(s) installation.

(14) Wet the tube stabilizer with water **(DO NOT USE OIL)** and force it over the projecting end of the shaft enclosing tube. Locate the tube stabilizers two or three inches below the top of the column. It is not necessary to fasten the tube stabilizer in place.

(15) **Optional:** Fasten the external grease/flush line(s) during the column installation.

(16) **Optional:** Install the grease/flush line guard to the column during the column installation.

8-6 ***Thrust Stud Coupling***

If your pump is equipped with a thrust stud coupling, the following procedure should replace the method connecting the shafts, see procedure 7-7.

8-7 ***Top Column—Threaded or Flanged***

NOTE: Start all threads by hand.

(1) Thread a lineshaft screw bearing into the top section of the enclosing tube.

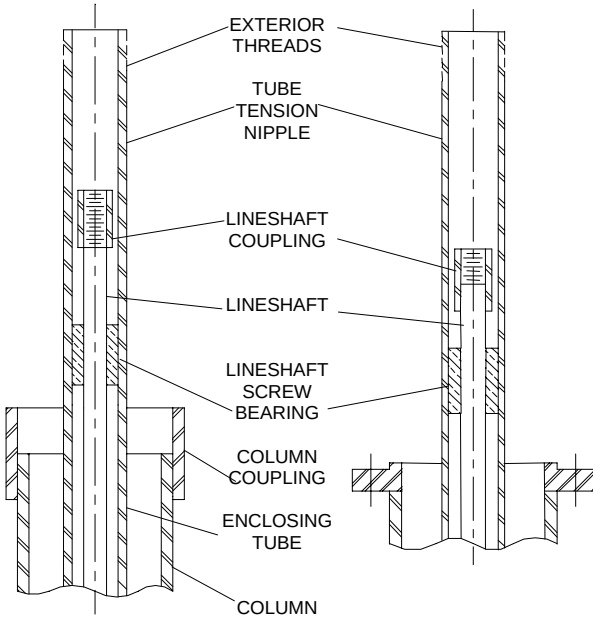


Figure 8.2 Threaded Top Column Assembly

Figure 8.3 Flanged Top Column Assembly

(2) Thread a shaft coupling on the top section of the lineshaft and hand tighten.
(3) Connect the tube tension nipple to the top lineshaft screw bearing and tighten with a pipe wrench.

(4) When **threaded column** is provided, raise the top column over the tube tension nipple, lower and thread into the last column coupling and tighten. Thread the top column flange onto the top column and tighten. Clean the face of the top column flange and apply a light coat of grease to hold the gasket in place.

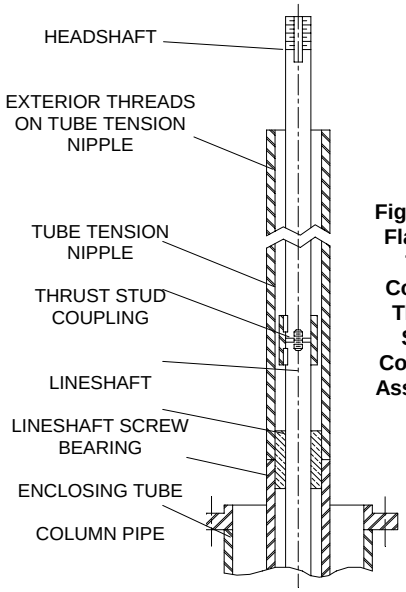


Figure 8.4 Flanged Top Column Thrust Stud Coupling Assembly

CAUTION:
CARE MUST BE TAKEN NOT TO DAMAGE THE THREADS ON THE TUBE TENSION NIPPLE.

(5) When **flanged column** is provided, raise the top column over the tube tension nipple then lower and bolt in place. Clean the face of the top flange and apply a light coat of grease to hold the gasket in place. Place the gasket on the flange face.

8-8 ***Flanged Top Column with a Thrust Stud Coupling***
(1) Thread a lineshaft screw bearing into the top section of the enclosing tube.
(2) Install a thrust stud coupling on the top section of the lineshaft and connect the headshaft.
(3) Connect the tube tension nipple to the top lineshaft screw bearing and tighten with a pipe wrench.
(4) Raise the top column over the tube tension nipple and headshaft, then lower and bolt in place.

CAUTION:
CARE MUST BE TAKEN NOT TO DAMAGE THE THREADS ON THE TUBE TENSION NIPPLE AND HEADSHAFT.

(5) Clean the face of the top flange and apply a light coat of grease to hold the gasket on the flange face.

8-9 SUB-BASE (OPTIONAL)

8-10 Confirm that the sub-base is grouted level and anchored before pump installation.

8-11 FOR BELOW BASE DISCHARGE--BASE PLATE ASSEMBLY, SEE SPECIAL INSTRUCTIONS PROVIDED.

SECTION 9-INSTALLING THE DISCHARGE HEAD ASSEMBLY (OPEN LINE SHAFT)

9-1 DISCHARGE HEADS

9-2 ***Type A or type L Cast Discharge Head***

(1) Raise the discharge head and clean the machined area that mates with the top column flange.
(2) Lower and bolt the head securely to the top column flange.
(3) Raise the assembly enough to remove the elevators.
(4) Remove the elevators and lower the unit until the discharge head rests on the foundation.
(5) Install the headshaft through the packing box register and hand tighten only.

9-3 ***Type AB Cast Discharge Head***

(1) Thread the top column into the discharge head and tighten with chain tongs.
(2) Raise the assembly, then lower and thread into the last column coupling. Tighten with chain tongs, but ***do not distort***.
(3) Raise the assembly enough to remove the lower elevators. Remove the elevators and lower the unit until the discharge head rests on the foundation.

Figure 9.3 By-Pass Packing Box Assembly

(4) Install the headshaft through the packing box register and hand tighten only.

9-4 ***Large Fabricated Discharge Head***

(1) Raise the discharge head over the headshaft.

CAUTION:
CARE MUST BE TAKEN NOT TO DAMAGE THE THREADS ON THE HEADSHAFT.

(2) Check for burrs and nicks on the top flange of the column including the register fit on the discharge head. The column flange and register fit must be smoothed with a mill file.
(3) Lower the discharge head to the register fit and bolt it to the top flange of the column. The bolts must be tightened uniformly, working to opposite sides of the flange. ***Do not distort.***
(4) While raising the entire unit, remove the installing clamps and lower until the discharge head rests on the foundation.
(5) Install the headshaft through the packing box register and hand tighten only.

9-5 ***Fabricated Barrel Discharge Head***

(1) Raise the head and check the flange faces for burrs and nicks that must be smoothed with a mill file.
(2) Lay the barrel flange on the elevators. Lower the head and connect it to the column.
(3) Raise the entire unit and remove the elevator. Place the gasket on the barrel flange.
(5) Lower the entire unit and bolt the head to the barrel.
(6) Install the headshaft through the packing box register and hand tighten only.

9-6 PACKING BOXES

9-7 *Six Ring Packing Box Assembly

***(1)** Lower the gasket and packing box over the headshaft and bolt the packing box to the discharge head.
***(2)** Tightly install three rings of packing into the packing box. Place the lantern ring in the packing box with the threaded holes up. Install the three remaining rings of packing.
***(3)** Thread the studs into the top of the packing box and place the split gland and clips over the studs. Thread the nuts onto the studs and finger tighten.
***(4)** Screw in and tighten the grease fitting.
***(5)** Slip the deflector down over the headshaft and position it just above the split gland. (See packing adjustment, Section 14-8).

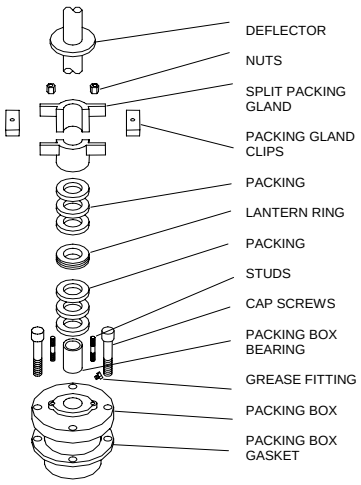


Figure 9.1 Six Ring Packing Box Assembly

9-8 *By-Pass Packing Box Assembly

***(1)** Lower the gasket and packing box over the headshaft and bolt the packing box to the head.
***(2)** Install the first lantern ring with the threaded holes up, followed by three rings of packing.
***(3)** Install the second lantern ring with the threaded holes up, followed by three more rings of packing.
***(4)** Screw the studs into the top of the packing box.
***(5)** Install the split gland, clips and nuts for the studs. Tighten the nuts finger tight.
***(6)** Connect the by-pass line to the hole leading to the first lantern ring and head with the fittings and tubing supplied.
***(7)** Screw in the grease fitting.
***(8)** Slip the deflector down over the headshaft to a position just above the split gland.

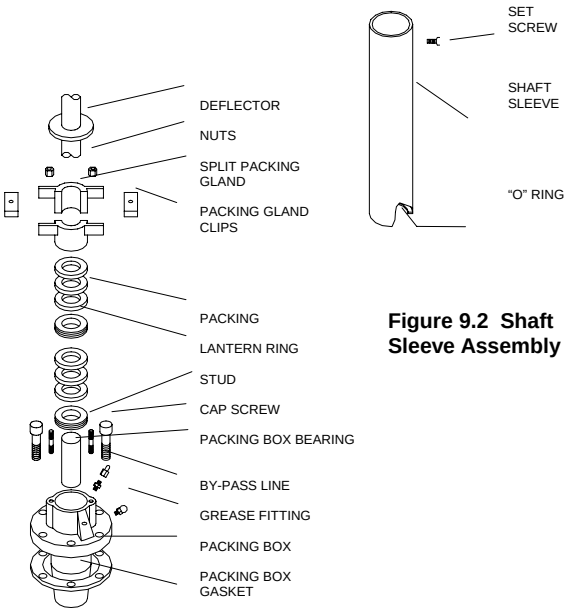


Figure 9.2 Shaft Sleeve Assembly

9-9 ***Packing Box Sleeve (Optional)***

- Coat the "O" ring lightly with grease and install inside the groove of the sleeve.
- Slip the sleeve down over the headshaft until the sleeve is deep into the packing box bearing. Hand tighten the setscrew to hold the sleeve in place. Proceed with procedure 9-7 or 9-8.

CAUTION: SHAFT THREADS MUST BE SMOOTH AND FREE FROM ALL BURRS AND NICKS SO THAT THE "O" RING WILL NOT BE DAMAGED WHEN THE SLEEVE IS INSTALLED.

9-10 MECHANICAL SEALS

CAUTION:
USE CARE NO TO DAMAGE THE SEAL/INSET
CAUTION:
USE CARE NOT TO DAMAGE OR DISTORT THE "O" RING/SHAFT PACKING.
NOTE: Coat all "O" rings with a light grease before installing.

(1) Place the gasket/"O" ring in the seal box.
(2) Lower the seal box over the headshaft and bolt to the discharge head.
(3) Check to ensure the "O" ring is in the groove of the seal sleeve. Install the complete seal assembly over the headshaft. Use care not to damage or distort the seal sleeve "O" ring. Bolt the seal gland to the seal box.
***(4)** Flush/by-pass lines are to be connected to the upper holes in the seal gland. Vent-drain/quench lines are to be connected to the lower holes in the seal gland when utilized.
***(5)** Install the drive and coupling in accordance with section 12.
***(6)** Adjust the impeller in accordance with section 11, procedure 11-5. **NOTE: When the impellers are re-adjusted, the seal must also be re-adjusted per the manufacturer's instructions.**
***(7)** Locate the mechanical seal collar in accordance with the seal instructions provided by the manufacturer on the mechanical seal drawing.
***(8)** Secure the seal drive collar to the headshaft with the setscrew provided.

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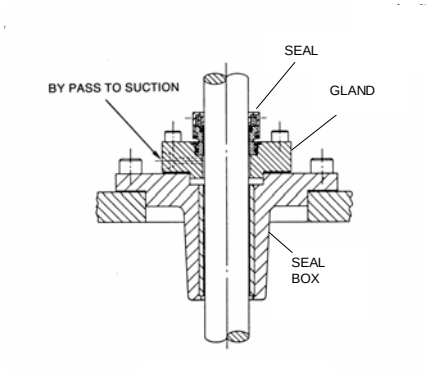


Figure 9.4 Outside Mechanical Seal Assembly

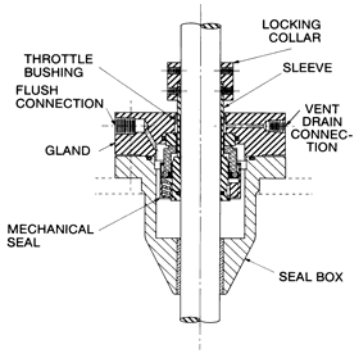


Figure 9.5 Inside (Cartridge) Mechanical Seal Assembly

SECTION 10-INSTALLING THE DISCHARGE HEAD ASSEMBLY (ENCLOSED LINE- SHAFT)

10-1 DISCHARGE HEADS

10-2 ***Type A or Type L Cast Discharge Head***

(1) Raise the discharge head over the tube tension nipple. Lower and bolt the head securely to the top column flange.

Caution: Be careful not to damage the tube tension nipple threads.

(2) Raise the assembly enough to remove the lower elevators.

(3) Remove the elevators and lower the unit until the discharge head rests on the foundation.

10-3 ***Type AB Cast Discharge Head***

(1) Thread the top column into the discharge head and tighten with chain tongs.

(2) Raise the assembly over the tube tension nipple.

(3) Lower the assembly and thread it into the last section of column. Tighten with chain tongs, but ***do not distort***.

Caution: Be careful not to damage the tube tension nipple threads.

(4) Raise the assembly enough to remove the lower elevators.

(5) Remove the elevators and lower the unit until the discharge head rests on the foundation.

10-4 ***Large Fabricated Discharge Head***

(1) Raise the discharge head over the tube tension nipple.

Caution: Be careful not to damage the tube tension nipple threads.

(2) Check for burrs and nicks on the top flange of the column including the register fit on the discharge head. The column flange and register fit must be smoothed with a mill file.

(3) Lower the discharge head to the register fit and then bolt to the top flange of the column. The bolts must be tightened uniformly, working to opposite sides of the flange. ***Do not distort***.

(4) Raise the entire unit while removing the installing clamps and lower until the discharge head rests on the foundation.

(5) Install the headshaft through the packing box register and hand tighten only.

10-5 TUBE TENSION NUTS

10-6 *Enclosing Tube- Oil

See page 4, Figure H for the drawing illustration assembly.

***(1)** Install the tube tension plate using a tube tension plate wrench to tighten the plate to the tube tension nipple. **NOTE: The tube tension nipple threads are left-hand.** Adjust the tube tension by stretching the tube about 1/8" for every 100 feet of tubing, or about 1-1/4 turns of the tube tension plate for every 100 feet of tubing after all slack is taken out of the tube.

NOTE: FOR DEEP SETTING PUMPS (OVER 700 FEET), SEE SPECIAL INSTRUCTIONS PROVIDED.

***(2)** Bolt the plate to the head.

***(3)** Install the headshaft through the tube tension nipple and hand-tighten. **NOTE: The headshaft threads are left-hand**.

***(4)** Install two rings of packing in the tube tension plate.

(5) Check to make sure the oil passage in the tube nut is clear. Install the tube tension nut and tighten.

10-7 ***Enclosing Tube- Grease***

See page 4, Figure G for the drawing illustration assembly.

(1) Repeat procedure 10-6, steps 1 through 4.

(2) Check to make sure the grease passage in the tube tension nut is clear.

(3) Install the tube tension nut and tighten.

(4) Install the lip seal in the tube tension nut with the lip down.

10-8 *Enclosing Tube – Water Flush

See page 4, Figure F for the drawing illustration.

(1) Repeat procedure 10-6, steps 1 through 4.

***(2)** Check to be sure the grease and water passages in the tube tension nut are clear. Install the tube tension nut and tighten.

***(3)** Install three rings of packing and place the lantern ring with the threaded holes up.

***(4)** Add the remaining three rings of packing and screw the studs into the top of the tube tension nut.

***(5)** Add the split gland, clips and nuts for the studs and tighten the nuts finger tight.

***(6)** Screw in the grease fitting and connect the water flush line to the fresh water supply.

10-9 ***Enclosing Tube with Shaft Sleeve- Water Flush***

(1) Repeat procedure 10-6, steps 1 through 4.
(2) Repeat procedure 10-8, step 2.
(3) Coat the "O" ring lightly with grease and install inside the groove of the sleeve.
(4) Slip the sleeve down over the headshaft until the sleeve is well into the tube tension nut bearing. Hand tighten the setscrew to hold the sleeve in place.

CAUTION: SHAFT THREADS MUST BE SMOOTH AND FREE FROM ALL BURRS AND NICKS SO THE "O" RING WILL NOT BE DAMAGED WHEN THE SLEEVE IS INSTALLED.

(5) Repeat procedure 10-8, steps 3 through 6.
(6) Loosen the setscrew in the sleeve and adjust the sleeve to a position approximately one inch above the packing gland. This step will have to be made after the impeller adjustment is completed. (See Section 11, procedure 11-5 for impeller adjustment.)

SECTION 11-INSTALLING THE DRIVER (VHS)

11-1 HOLLOW SHAFT DRIVES

Warning: ***Pumps will be damaged by the wrong direction of rotation. Drive should first run UNCOUPLED from pump to check direction of rotation. Rotation of the drive should be in accordance with the rotation indicated on the nameplate.***

11-2 *Electric Motor, Gear or Belt Drive

***(1)** Remove the drive cover and the top drive coupling. Try the drive coupling by slipping it over the headshaft. **Note: This must be a sliding fit**. If necessary, file, dress and polish, but do not force. Remove the coupling and try the gib key in the headshaft keyway and in the coupling keyway. This must be a sliding fit, but not loose.

***(2)** Raise the drive and check for burrs and nicks on the mounting register. This must be smoothed with a mill file.

(3) Lower the drive over the headshaft and bolt it to the discharge head.

(4) **CAUTION: CARE MUST BE TAKEN NOT TO DAMAGE THE THREADS ON THE HEADSHAFT OR BEND THE HEADSHAFT.**

11-3 *Pump Alignment*

(1) Check the shaft alignment just below the pump coupling half by means of a dial indicator. The total runout at this point should not exceed .003" for 3000 RPM or faster units, or .006" for slower speed units. Preferably, the runout should be as close to .000" as possible. Care must be used when rotating the shaft so the play in the lower drive bearing does not give a false reading..

11-4 *Driver Electrical Connection

Connect the drive terminals to the leads from the starter panel. Bump the drive to make sure the rotation is as indicated on nameplate when viewed from above. ***Drive should first run UNCOUPLED from pump to check direction of rotation.*** If the rotation is wrong, interchange any two leads on three phase drives. On single-phase drives, follow the manufacturer's instructions which accompany the driver. After changing the connections, recheck the rotation.

11-5 *Impeller Adjustment

***(1)** Slide the top drive coupling in place and insert the gib key. The top of the key should be slightly below the top of the drive coupling. Thread the adjusting nut on the headshaft.

***(2) INITIAL ADJUSTMENT:**

a. Rotate the adjusting nut until the rotation assembly turns without dragging. Continue to rotate the adjusting nut until the vertical clearance obtained is slightly higher than the one listed in the pump nameplate. Install the capscrews through the adjusting nut into the coupling.

b. Use an ammeter to check the preliminary setting. **IMPORTANT: Make sure that the impellers are not dragging and the motor is not overloaded.**

***(3) FINAL ADJUSTMENT:**

a. After the system is operational, the impellers can be reset to the recommended impeller lift as indicated on pump nameplate.

Note: The impellers must be adjusted so that they will turn without rubbing on the top or bottom while the pump is operating.

NOTE: REFER TO THE MANUFACTURER'S SPECIAL OPERATING INSTRUCTIONS PROVIDED FOR PUMP SETTINGS 50' OR DEEPER. MECHANICAL SEALS SHOULD BE ADJUSTED PER THE MANUFACTURER'S INSTRUCTIONS AFTER IMPELLER ADJUSTMENTS HAVE BEEN COMPLETED.

***(4)** Check the lubricant in the driver in accordance with the drive lubrication instructions.
***(5)** The unit is now ready for operation.

11-6 HOLLOW SHAFT DRIVES WITH A TWO PIECE HEADSHAFT AND THREADED COUPLING

11-7 ***Electric Motor, Gear or Belt Drive***

(1) Repeat procedure 11-2, steps 1 and 2.
(2) Thread a shaft coupling on the lower headshaft and hand tighten. **NOTE: Threads are left-hand.**
(3) Lower the drive and bolt it securely to the discharge head.

11-8 ***Driver Electrical Connection***
(1) Repeat procedure 11-4.

11-9 ***Pump Alignment***
(1) Install the upper headshaft through the drive hollow shaft. If the drive is supplied with a steady bushing or a guide/centering bearing, lubricate the upper headshaft with oil and use care when installing. Check the shaft alignment just below the pump coupling half by means of a dial indicator. The total runout at this point should not exceed .003" for 3000 RPM or faster units, or .006" for slower speed units. Preferably, the runout should be as close to .000" as possible. Care must be used when rotating the shaft so the play in the lower drive bearing does not give a false reading. **NOTE: The shaft threads are left-hand.**

11-10 ***Impeller Adjustment***
(1) Repeat all of procedure 11-5.

11-11 HOLLOW SHAFT DRIVES WITH A TWO PIECE HEADSHAFT AND RIGID FLANGED COUPLING

11-12 ***Electric Motor, Gear or Belt Drive Connection, Pump Alignment and Impeller Adjustment***
(1) Repeat procedure 11-2, steps 1 and 2.

***(2)** Make sure all mating surfaces are clean and free of any burrs or chips.

NOTE: KEYS SHOULD BE A SLIP FIT IN THE HEADSHAFT KEYWAY AND THE KEYS MUST BE LUBRICATED WITH AN ANTISIEZE COMPOUND FOR FUTURE REMOVAL. DRESS TO FIT.

***(3)** Slip a key and coupling half over the lower headshaft.
***(4)** Place a thrust ring in the thrust ring groove of the lower headshaft.
***(5)** Lower the drive and bolt it securely to the discharge head.
***(6)** Connect the electric driver as stated in procedure 11-4.
***(7)** Install the upper headshaft through the drive hollow shaft. If the drive is supplied with a steady bushing or a guide/centering bearing, lubricate the upper headshaft with oil and use care when installing.
***(8)** Slip a key and coupling over the upper headshaft.
***(9)** Place a thrust ring in the thrust ring groove of the upper headshaft and place the spacer on the pump coupling half.
***(10)** Line up the bolt holes on the coupling halves and the spacer. Orient keyway at 180°. Bolt securely together.
***(11)** Slide the top drive coupling in place and insert the gib key. The top of the key should be slightly below the top of the drive coupling. Thread the adjusting nut on the headshaft.
***(12)** Adjust the impellers in accordance with procedure 11-5.
***(13)** Check the shaft alignment just below the pump coupling half by means of a dial indicator. The total runout at this point should not exceed .003" for 3000 RPM or faster units, or .006" for slower speed units. Preferably, the runout should be as close to .000" as possible. Care must be used when rotating the shaft so the play in the lower drive bearing does not give a false reading. **NOTE: Removing the coupling bolts and rotating the drive coupling half relative to the spacer can result in a lower runout.**
***(14)** Check and lubricate the drive in accordance with the drive lubrication instructions.

***(15)** The unit is now ready for operation.

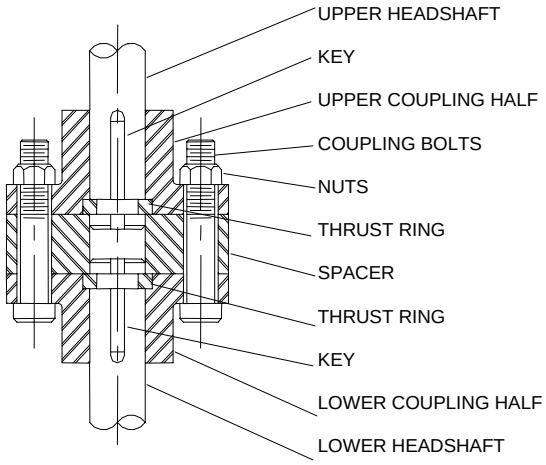


Figure 11.1 Rigid Flanged Coupling Assembly

SECTION 12-INSTALLING THE DRIVER (VSS)

12-1 SOLID SHAFT DRIVES WITH FLANGED COUPLINGS

Warning: ***Pumps will be damaged by the wrong direction of rotation. Drive should first run UNCOUPLED from pump to check direction of rotation. Rotation of the drive should be in accordance with the rotation indicated on the nameplate.***

12-2 *Adjustable Flanged Coupling with No Spacer/ Electric Motor, Gear or Belt Drive

The coupling halves are keyed to the driver shaft and the pump headshaft with square keys. The split thrust ring locks the driver coupling half to the drive shaft, transmitting vertical thrust in either direction.

***(1)** Make certain all mating surfaces are clean and free of any burrs or chips.

***(2)** Fit the driver coupling half and key on the driver shaft before the driver is mounted. Push the coupling half well above the thrust ring groove. This should be a sliding fit.

***(3)** Fit the thrust ring into the groove and slide the driver coupling half down over the thrust ring into position. The bottom of the coupling should extend 1/8" past the thrust ring.

***(4)** Insert the pump headshaft key and pin assembly into the pump coupling half keyway. Make sure the pin fits into the hole in the coupling and allows the key to seat properly in the keyway.

CAUTION:
THE KEY SHOULD NOT EXTEND ABOVE THE COUNTER BORE IN THE TOP END OF THE PUMP COUPLING HALF.

***(5)** Fit the pump coupling half and key assembly on the headshaft. The key should be a slip fit in the headshaft keyway.

***(6)** Thread the adjusting nut on the headshaft and screw down as far as possible. **NOTE: Adjusting nut threads are left-hand.**

***(7)** Clean the machined surfaces of the discharge head and the driver base. Hoist the driver into position and bolt down securely.

12-3 *Driver Electrical Connection

***(1)** Connect the drive terminals to the leads from the starter panel. Bump the drive to make sure the rotation is correct. If the rotation is wrong, interchange any two leads on three phase drives. On single-phase drives, follow the manufactur's instructions which accompany the driver. After changing the connections, recheck the rotation.

(2) IMPORTANT:** ***Pumps will be damaged by the wrong direction of rotation. Drive should first run UNCOUPLED from pump to check direction of rotation. Rotation of the drive should be in accordance with the rotation indicated on the pump nameplate.

Be sure that the endplay of the driver shaft clears the adjusting nut when checking rotation.

12-4 *Impeller Adjustment

***(1)** Refer to the nameplate adjustment dimension for the impeller in the pump.

***(2)** Screw the adjusting nut upward on the shaft to within the impeller adjustment dimension of the driver coupling and back off to the nearest bolt hole on the pump coupling half.

***(3)** Connect the coupling halves and tighten the coupling bolt securely.

12-5 *Pump Alignment

Check the pumpshaft alignment just below the pump coupling half by means of a dial indicator. The maximum total indicated runout at this point should not exceed .005" for 3000 RPM or faster units, or .008" for slower speed units. Preferably, the runout should be .003" and .006" respectively. Care must be used when rotating the shaft so the play in the lower driver bearing does not give a false reading. **NOTE: Removing the coupling bolts and rotating the driver coupling half relative to the adjusting nut can result in lower runout.**

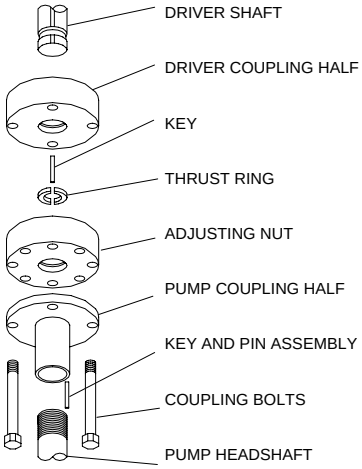


Figure 12.1 Adjustable Flanged Coupling Assembly

12-6 ***Adjustable Flanged Coupling with Short Spacer/Electric Motor, Gear or Belt Drive***

(1) Follow procedure 12-12, steps 1 and 2.
(2) Fit the thrust ring into the groove and slide the driver coupling half down over the thrust ring into position. The bottom of the coupling should be flush with the bottom of the thrust ring.
(3) Continue with procedure 12-2, steps 4 through 7.
(4) Repeat all of procedure 12-3.
(5) Repeat procedure 12-4, step 1.
(5) Place the spacer on the adjusting nut and proceed with procedure 12-4, steps 2 and 3, and all of procedure 12-5, pump alignment.

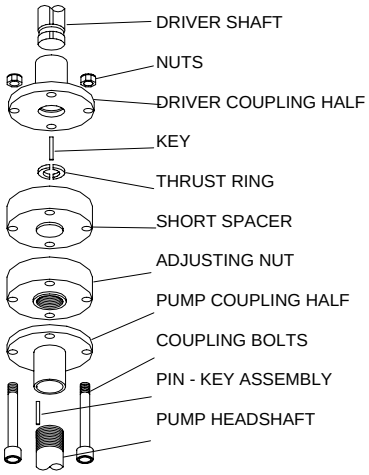


Figure 12.2 Adjustable Flanged Short Spacer Coupling Assembly

12-7 ***Adjustable Flanged Coupling with /Long Spacer/Electric Motor, Gear or Belt Drive***

(1) Follow procedure 12-2, steps 1 and 2.
(2) Fit the thrust ring into the groove and slide the driver coupling half down over the thrust ring into position. The bottom of the coupling should be flush with the bottom of the thrust ring.
(3) Continue with procedure 12-2, steps 4 through 7.
(4) Repeat all of procedure 12-3.
(5) Connect the spacer to the driver coupling half and tighten the bolts securely.
(6) Repeat 12-4, step 1, impeller adjustment.
(7) Screw the adjusting nut upward on the shaft to within the impeller adjustment dimension of the spacer flange and back off to the nearest bolt hole in the pump coupling half.
(8) Connect the pump coupling half to the long spacer and tighten the coupling bolts securely.
(9) Repeat pump alignment, procedure 12-5.

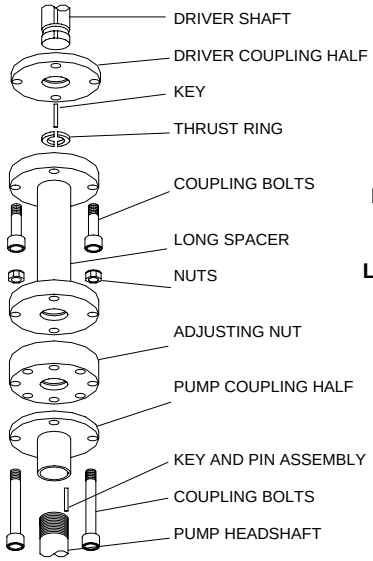


Figure 12.3 Adjustable Flanged Long Spacer Coupling Assembly

SECTION 13-INSTALLING ACCESSORIES

13-1 OILER ASSEMBLY FOR OIL LUBRICATED PUMPS, MANUAL OR SOLENOID

13-2
1. Bolt the oil reservoir and bracket to the discharge head.

2. Connect the oil reservoir to the tube tension nut with the fittings and tubing supplied
3. Install a pipe plug in the opposite end of the oil reservoir.
4. Verify that the solenoid valve is the correct voltage and connect it to the electrical power.
If you use a manually operated oiler instead of a solenoid-operated oiler, follow the same connection

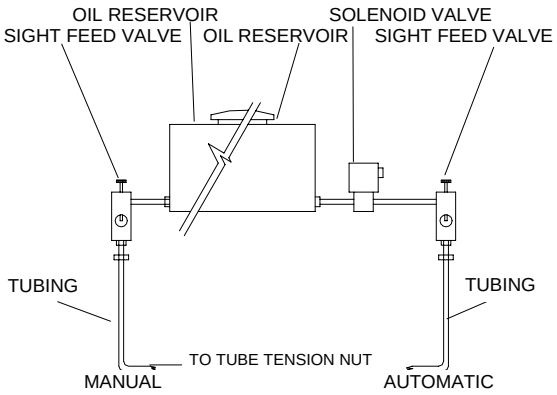


Figure 13.1 Oiler Reservoir Installation Assembly

procedure, but omit step 4. Fill the reservoir with turbine oil of the proper viscosity (See procedure 14-18 for a list of acceptable lubricants).

13-3 AIRLINE AND GAUGE (OPTIONAL)

13-4
To set the airline gauge properly you must know the length of the airline. The bottom end of the airline should be located just above the discharge case of the bowl assembly.
One of three types of airline is normally supplied:

- PVC tubing (one continuous length)
- Copper tubing (50 foot lengths)
- Galvanized pipe (20 foot) random lengths.

Locate the bottom end of the airline just above the discharge case of the bowl assembly. Copper and galvanized airline should be fastened to the column as the column is being installed. PVC tubing is normally installed after installation of the pump. After the airline is in place, install a tubing connector or coupling on the top end of the airline. Thread a short nipple into the connector or coupling and insert it through the bottom of the discharge head. Place a washer over the short nipple and thread on a coupling. Thread another short nipple with a 90-degree elbow into the coupling and then thread a long nipple of pipe into the elbow. Thread the tee onto the nipple and attach the airline gauge to the tee. Thread the Schrader valve into the tee. Adjust the gauge according to the manufacturer's instructions.

NOTE:
USE CARE WHEN INSTALLING COPPER TUBING SO THE TUBING WILL NOT PINCH. THE EXACT LENGTH OF THE AIRLINE USED MUST BE KNOWN TO PROPERLY SET THE GAUGE.

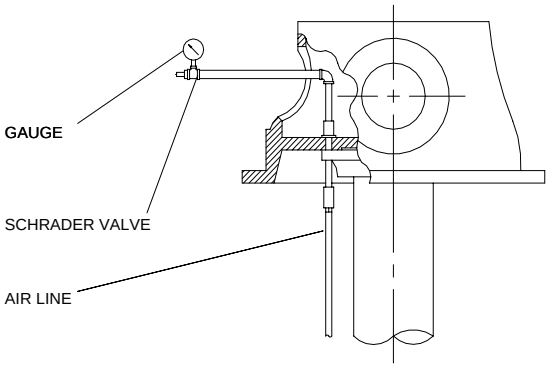
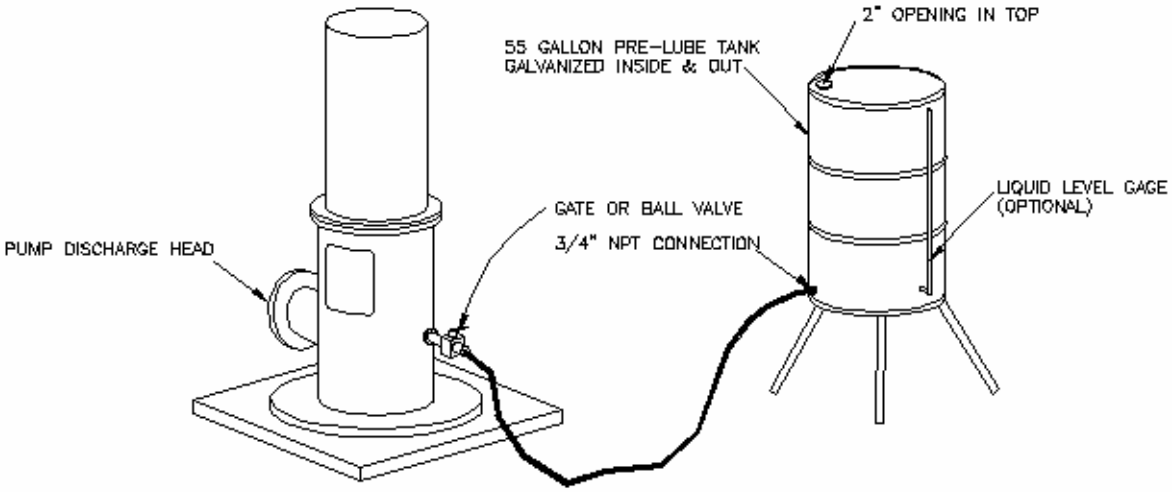


Figure 13.2 Airline and Gauge Installation Assembly

13-5 PRE-LUBE TANK AND FITTING (OPTIONAL)

13-6
Figure 13.3 drawing illustrates a typical installation for a pre-lube tank on a product lubricated pump. Sulzer Pumps recommends using a pre-lube system on product lubricated pumps having a setting, greater than, or equal to 50 feet. At a 50-foot setting, it takes a few moments for the pumped liquid to begin lubricating all of the lineshaft bearings. Using a pre-lube system can help prolong the life of the pump by not allowing the lineshaft bearings to run dry during start-up periods. Before starting the pump driver, pre-lubricate the lineshaft bearings by opening the gate or ball valve. The pre-lubrication valve should remain open for approximately one minute for each 100 feet of column length. After the pump is running, the pre-lube tank will begin to refill. After the tank is full, the gate or ball valve should be closed. There are many ways to automate the pre-lube system using electric valves and timers, however the one illustrated in this manual is a simple and inexpensive method.

TYPICAL PRE-LUBE TANK INSTALLATION



SECTION- 14 PUMP START-UP AND OPERATION

*14-1-PRE-START PROCEDURE

Consult the applicable manufacturer's instructions for detailed information for the prime mover (engine or steam turbine) coupling, drive-shaft, electric driver, gear-head or mechanical seal. When applicable to the pump and prior to start-up, check the following:

- Mechanical seal is properly lubricated and all piping to the seal connected.
- All cooling, heating and flushing lines are operating and regulated.
- Alignment with a dial indicator to indicate the headshaft at the oilnut or packing box. Refer to chart for acceptable run-out tolerances.

Shaft with packing ----------.003"-0.006" (see instruction 12-4) Shaft with a seal----------.002" (see instruction 12-4)

- Wiring of the driver.
- Driver rotation when viewed from above. Must be as shown on pump nameplate
- All connections to driver and starting device with the wiring diagram.
- Voltage, phase, and frequency on the motor nameplate with the line circuit.
- Impeller adjustment.
- Rotate the shaft manually to ensure impellers are not binding.
- Driver bearings for proper lubrication and oil level in housing.
- Auxiliary seal components are properly vented.
- Discharge piping and pressure gages for proper operation.
- Oil reservoir is full of the proper oil.

14-2 PRIMING

The first stage must always be completely submerged. The pump must not run dry as the rotating parts within the pump may gall and seize to the stationary parts. The liquid being pumped must lubricate the parts.

14-3 PUMP START-UP/PRODUCT LUBRICATED

14-4 *VHS or VSS Drive

***(1)** For settings greater than fifty feet, open the pre-lube valve and allow fluid to run for one minute per each 100 feet of setting to pre-lubricate the lineshaft bearings.

***(2)** Momentarily bump-start the driver to tighten all the lineshaft couplings then immediately stop the pump. This step is necessary only on the initial start-up after pump installation.

***(3)** Re-check the impeller adjustment making sure the rotating element turns freely by hand. If impeller adjustment is required, see Section 11 or Section 12 as applicable to the pump.

***(4)** For settings greater than fifty feet, repeat step (1) as above.

***(5)** Set the discharge valve to a nearly closed position before starting the pump on a new installation.

***(6)** Start the pump and then open the valve slowly after the liquid begins to flow.

*(7) CAUTION:

THIS NEW PUMP IS NOT WARRANTED FOR PUMPING FOREIGN MATERIAL IN THE LIQUID. All foreign material should have been removed from the sump, well system, etc. before the pump was installed to avoid possible pump damage. In the event foreign material is encountered, the following instructions will minimize the damage:

- ***Do not immediately stop the pump.*** If you stop it while foreign material is still present in the flow, additional foreign material suspended in the liquid may settle in the pump bowls and cause the rotating element to seize.
- Stop the unit after the fluid has cleared.
- Determine the extent of the damage incurred in pumping the foreign material. It may be necessary to pull the unit to check the problem.

14-5 IMPORTANT OPERATING GUIDELINES

14-6 *Operating Guidelines for Vertical Turbine Pumps

Following these helpful guidelines will assure longer life for your vertical pump.

(1)** If the pump loses its prime or breaks suction, immediately shut it down! ***DO NOT RUN IT DRY! The impellers and bearing have small clearances and may bind and cause serious trouble. **NOTE:** ***Product lubricated rubber lineshaft bearings require continuous lubrication.***

***(2)** It is better to operate the pump without suction lift. Ideal operating conditions call for at least ten feet of submergence for the top bowl—although this may vary, depending on the installation. For example, a small-capacity pump in a large diameter well will require less submergence than a large-capacity pump in a small-diameter well.

(3)** If the pump capacity is too great for the supply, it is better to throttle the pump than to let it break suction. Only vertical turbine and mixed flow pumps may be throttled, however, the throttling should be limited to 50 percent of design flow. ***NOTE: Throttling may affect impeller adjustment and driver load.

(4)** When the pump is stopped, the flow of liquid backing down through the column will cause the pump to rotate backward without a foot valve or a non-reverse ratchet. ***Caution: Never start the pump again while this backward rotation is occurring! If you do, you will place a severe strain on the shafting and it may break. Always allow the pump to stop completely before restarting it.

***(5)** The discharge head should never be the sole support for the discharge pipe. Use concrete or steel structures as the primary support.

***(6)** If the pump is operating in a closed system, an air-relief valve should be installed on the discharge pipe between the discharge head and the check valve. Air must be admitted to the column when the pump is stopped and vented when the pump is started.

14-7 LUBRICATION DURING OPERATION/PRODUCT LUBRICATED PUMPS

14-8 ***Stuffing Box***

When the pump is in operation, there should be some leakage at the stuffing box packing. For cooling and lubrication, allow approximately 60 drops of liquid to escape each minute. **Upon initial start-up**, use a hand grease gun filled with a light waterproof grease and apply two full strokes of grease to the packing at the grease fitting**. NOTE: Do not over grease**, **since this may distort the split gland. Packing lubrication is not required after initial start-up.**

14-9 ***Mechanical Seal***

If the seal leaks slightly at start-up, allow a reasonable amount of time for the seal to adjust itself. Liquids with good lubricating qualities normally take longer to wear in the seal than liquid with lesser qualities. When a seal starts out with a slight leak and gets progressively less with running, it indicates leakage across the seal faces and continued running will usually eliminate this. Where leakage occurs immediately and remains constant, unaffected by running, it usually indicates a secondary seal damage (shaft packing), or the seal faces are warped out of flat. See **Section 19 Troubleshooting**, for possible causes and remedies.

14-10 *Suction Bearing

The suction bearing for your new vertical pump was packed with grease at the factory and will not require further attention until the pump is removed from service. Before re-installing the pump, repack the suction bearing with any of the following greases:

14-11 *Suction Bearing Lubrication Chart

- Lyondell . . . . . Litholine H EP # 2
- Exxon . . . . . Lidox EP # 2
- Sun Oil. . . . . Sun Prestige EP # 2
- Mobil . . . . . Mobilux EP # 2
- Phillips . . . . . Philube EP # 2
- Shell . . . . . Alvania EP # 2
- Chevron . . . . . Duralith EP # 2
- Citgo. . . . . Premium Lithium EP #2

USDA H-1 Lubricants:

- Chevron .....Chevron FM Greases EP NLGI 2
- Shell.... Shell Cassida Grease EPS 2

NOTE: When pumping grease dissolving fluid or operating the pump at high temperatures, grease is not used in the suction bearing. For these types of applications, do not pack the suction with grease when re-installing the pump.

14-12 PUMP START-UP/OIL LUBRICATED PUMPS

14-13 ***VHS Drive***

(1) Verify that the oil reservoir is full of the proper oil. See the lubrication chart in section 14-18.

(2) Adjust the sight feed valve to one drop per second.

(3) Momentarily bump-start the driver to tighten all the lineshaft couplings, then immediately stop the pump. This step is necessary only on the initial start-up after pump installation.

(4) Re-check the impeller adjustment making sure the rotating element turns freely by hand. If impeller adjustment is required, see section 11 as applicable to the pump.

(5) Set the discharge valve to a nearly closed position before starting the pump on a new installation.

(6) Start the pump and then open the valve slowly after the liquid begins to flow.

(7) Review procedure 14-4, step 7—**Caution.** After the fluid pumped has cleared, adjust the sight feed valve to one drop of oil per minute for each 40 feet of column (but never under 5 drops per minute) for the first week of operation.

NOTE:
MANUAL AND AUTOMATIC LUBRICATORS USE THE SAME ADJUSTMENTS. THE MANUAL LUBRICATOR MUST BE SHUT OFF WHEN THE PUMP IS IDLE.

14-14 ADDITIONAL IMPORTANT OPERATING GUIDELINES

14-15 ***Oil Lubricated Pumps***

(1) Review all of section 14-6—Operating Guidelines.

(2) Keep the oil supply container covered. Do not permit the container to collect dirt.

(3) Check the oil reservoir at least once every eight hours to assure an adequate supply of lubricant.

14-16 LUBRICATION DURING OPERATION/OIL LUBRICATED PUMPS

14-17 ***Lineshaft Lubricant***

Using the lubricants listed below will help ensure proper operation and long pump life. Use turbine oil only. Do not use automotive or diesel engine lubricating oils. The oils listed below are recommended for lubricating lineshaft bearings:

14-18 ***Lineshaft Lubrication Chart-Hydrocarbon Oils***

- Lyondell . . . . . Duro 32
- Exxon . . . . . Terresstic
- Gulf . . . . . Gulfcrest # 32
- Mobil . . . . . DTE # 797
- Phillips . . . . . Magnus 150
- Shell . . . . . Turbo # 32
- Chevron . . . . . GST # 32
- Sun . . . . . Sunvis # 916
- Texaco . . . . . Regal 32 (R&O)
- Citgo . . . . . PaceMaker 32

NSF Approved Food Grade Oils

- Citgo . . . . . Ideal GF #32
- Chevron . . . . . FM #32
- Texaco . . . . . Cynus #32
- Huskey 15A14

14-19 ***Suction Bearing Lubricant***
(1) Review all of procedure 14-10 & 14-11.

14-20 PUMP START-UP & LUBRICATION DURING OPERATION/GREASE LUBRICATED

14-21 ***VHS Drive***
CAUTION: THE GREASE LINES MUST HAVE BEEN PURGED OF AIR BEFORE PROCEEDING.
(1) Fill the grease reservoir and fill all the grease lines. For proper grease selection see the lubrication chart in section 14-23.
(2) A heavy duty, high-pressure grease gun is recommended for manual operation. When using an automatic grease system see the manufacturer's instructions for operation.
(3) Repeat procedure 14-4, steps 2 through 6. Pump Start-Up
(4) Review procedure 14-4, step 7—**Caution. NOTE: The bearings must be lubricated every eight hours of operation.**
(5) Review all of procedure 14-6. Operating Guidelines.
14-22 ***Lineshaft Lubricant***
The greases listed below are recommended for automatic lubricator applications and for grease packing the shaft enclosing tube for grease lubricated lineshaft bearings.
14-23 ***Grease Lubrication Chart***

Company	Normal Temp.	Low Temp.
Lyondell	Litholine H EP #1	Litholine H EP #00
Exxon	Lidox EP #1	Lidok EP #0
Citgo	Premium Lithium EP #1	Premium Lithium EP #0
Mobil	Mobilux EP #1	Mobilux EP #0
Phillips	Philube EP #1	----------
Shell	Alvania EP #1	Alvania EP R/0
Sun	Sun Prestige EP #1	Sun Prestige EP #0
Texaco	Novatex #1	Low Temp. EP
Chevron	Duralith EP #1	Duralith EP #0

14-24 ***Suction Bearing Lubricant***
(1) Review all of procedure 14-10 & 14-11.

14-25 PUMP START-UP & LUBRICATION DURING OPERATION/WATERFLUSH LUBRICATED

14-26 ***VHS Drive***
(1) Tighten the packing gland nuts finger tight.
(2) Flush the pump bearings with 1-5 GPM of water at a pressure of 15 PSI greater than the discharge pressure of the pump**. NOTE: Establish the flow rate BEFORE the pump is started.**
(3) Control the packing gland leakage after start-up by tightening or loosening the gland nuts. Always allow enough leakage to keep the tube tension nut cool.
NOTE: When the pump is in operation, there should be some leakage at the stuffing box packing. For cooling and lubrication, allow approximately 60 drops of liquid to escape each minute. **Upon initial start-up**, use a hand grease gun filled with a light waterproof grease and apply two full strokes of grease to the packing at the grease fitting**.**
(4) Repeat procedure 14-4, steps 2 through 6. Pump Start-Up.
(5) Review procedure 14-4, step 7—**Caution.**
(6) Review procedure 14-6. Operating Guidelines.

14-27 ***Suction Bearing Lubricant***
(1) Review procedure 14-10 & 14-11.

14-28 RECOMMENDED SPARE PARTS

14-29 ***Recommended Spare Parts for Product, Oil, Grease and Waterflush Construction.***

(1) Procedure for ordering spare parts:
- List the serial number of the pump
- List the part number (from the bill of material)
- List the quantity
- List the complete part description (from the bill of material)

(2) List of parts subject to the most wear:
- Bowl assembly/lineshaft bearings
- Shaft sealing assembly bearing
- Seal rings/wear rings/liners
- Packing
- Complete mechanical seal (less gland and sleeve)

(3) List of parts to be stocked if down time is critical:
- Gaskets and "o" rings
- Rotating parts
- Seal rings/wear rings/liners
- Driver bearings and mechanical seal sleeve

SECTION 15-MAINTE-NANCE INSTRUCTIONS BOWL ASSEMBLY, LOCK COLLET CON-STRUCTION

READ THE FOLLOWING INSTRUCTIONS THOROUGHLY BEFORE DISASSEMBLING OR REASSEMBLING A BOWL ASSEMBLY.

15-1 VERTICAL TURBINE PUMP BOWL ASSEMBLY, PRODUCT LUBRICATED, ENCLOSED IMPELLER(S)

15-2 *Assembly Procedure

***(1)** Layout the bowl assembly parts and check them against the bill of material.

***(2)** Check the impeller diameter against the trim shown on the bill of material.

***(3)** Install the bearings in the bowls. Where dual bearings are required (check the bill of material), press the bronze bearings into place then install the rubber bearings using 3M Scotch-Grip 1711 Rubber Adhesive (or an equivalent product) to hold them in place. Do not get adhesive into any bearing bore. Install the suction bearing in the suction (on some pumps, the suction bearing will project above the suction bearing hub).

NOTE: The discharge case and the top intermediate bowl must be screwed or bolted together (depending on the type of construction being used), and the combination bearing must be pressed in the intermediate bowl flush with the top of the rubber bearing pocket.

(4) Position the bottom impeller at the pin line etched on the pumpshaft.

***(5)** Clamp the pumpshaft in a vice with a soft metal cover on the jaws. Slip an impeller and taper lock collet over the end of the pumpshaft and lock it into position using a lock collet hammer (available from Sulzer Pumps Houston Inc.). When the lock collet is in the proper position, it will project about 1/8 inch above the impeller hub.

(6) Use a straightedge to verify that the bottom of the impeller wear ring is aligned with the pin line on the pumpshaft. If adjustment is required, remove the impeller by using the opposite end of the lock collet hammer. If a sand collar is provided (see bill of material), install it on the shaft beneath the impeller.

(7) Insert the pumpshaft into the suction bearing and position it so the impeller seats in the bowl wear ring seat.

***(8)** Support the pumpshaft with collapsible supports at several points to hold it horizontal.

***(9)** Remove the pipe plug from the bottom of the suction piece.

(10) Thread the stop into the bottom of the shaft and tighten it firmly to seat the impeller in the bowl. Keep this stop tight while assembling the bowl. ***NOTE: After the bowl assembly is completed, the stop must be removed. (See step 16 below).***

***(11)** Slip an intermediate bowl over the end of the shaft and bolt or thread the bowl in position (depending on whether flanged or threaded bowls are required).

(12) Place the next impeller and lock collet on the pumpshaft and use the lock collet hammer to lock them in position in the bowl ring seat.

SEE THE ILLUSTRATIONS ON PAGES 35 & 36 FOR ASSEMBLY AND DISASSEMBLY OF A LOCK COLLET IMPELLER(S)

***(13)** Compare the endplay with the specification on the bill of material. Do this by unthreading the pumpshaft stop and measuring the lateral travel of the shaft; this travel is the endplay. Relock the shaft and proceed to install the bowls and impellers for the remaining number of stages.

***(14)** After the final impeller is positioned, install the top inter-bowl and the discharge case. Bolt or thread the assembly in position (depending on whether threaded or flanged construction is provided). Recheck the endplay.

***(15)** With the impellers in their lowest position, verify that the pumpshaft projection matches what's specified on the bill of material. The projection is the distance from the end of the shaft to the column seat when the shaft is in its lowest position. *NOTE: The column seat for threaded column is the point at which the column bottoms. The column seat for flanged column is the face of the flange.*

***(16)** Remove the stop from the bottom of the shaft.

***(17)** Pack the suction hub with waterproof grease (see procedure 14-10 & 14-11) through the bottom. Install the pipe plug. The shaft should be at its lowest position when you are packing this bearing.
DO NOT OVER GREASE! ***Excess grease will prevent the impeller from seating properly. NOTE: When pumping a grease-dissolving fluid or operating the pump at high temperatures, omit this step and do not use grease.***
***(18)** Make sure the rotating element turns freely by hand. Upon completion of all steps, the bowl assembly is ready to install.

15-3 ***Disassembly Procedure***
To disassemble the bowl assembly, simply reverse the assembly procedure as described in section 15-2. Be sure to raise the shaft to its highest position before attempting to drive off the impeller(s). Use the recessed end of the lock collet hammer to remove the impeller (s).

15-4 VERTICAL TURBINE PUMP BOWL ASSEMBLY, PRODUCT LUBRICATED, SEMI-OPEN IMPELLER(S)

15-5** ***Assembly Procedure
(1) Repeat procedure 15-2, steps 1 through 3.
(2) Insert the pumpshaft into the suction bearing and position it so the pin line etched on the pumpshaft is even with the top of the suction bearing.
(3) Repeat procedure 15-2, steps 8 and 9.
(4) Thread the stop into the bottom of the shaft and tighten it to hold the pin line in position. Keep this stop tight while assembling the bowl. ***NOTE: After the bowl assembly is completed, the stop must be removed.***
(5) Repeat procedure 15-2, step 5.
(6) Verify that the top of the bearing is aligned with the pin line etched on the pumpshaft. If adjustment is required, remove the impeller by using the opposite end of the lock collet hammer. If a sand collar is provided (see bill of material), install it on the shaft beneath the impeller.
(7) Repeat procedure 15-2, step 11.
(8) Place the next impeller and lock collet on the pumpshaft and use the lock collet hammer to lock them in position against the bowl seat.
(9) Repeat procedure 15-2, steps 13 through 18.

15-6 ***Disassembly Procedure***
To disassemble the bowl assembly, simply reverse the assembly procedure as described in section 15-5.

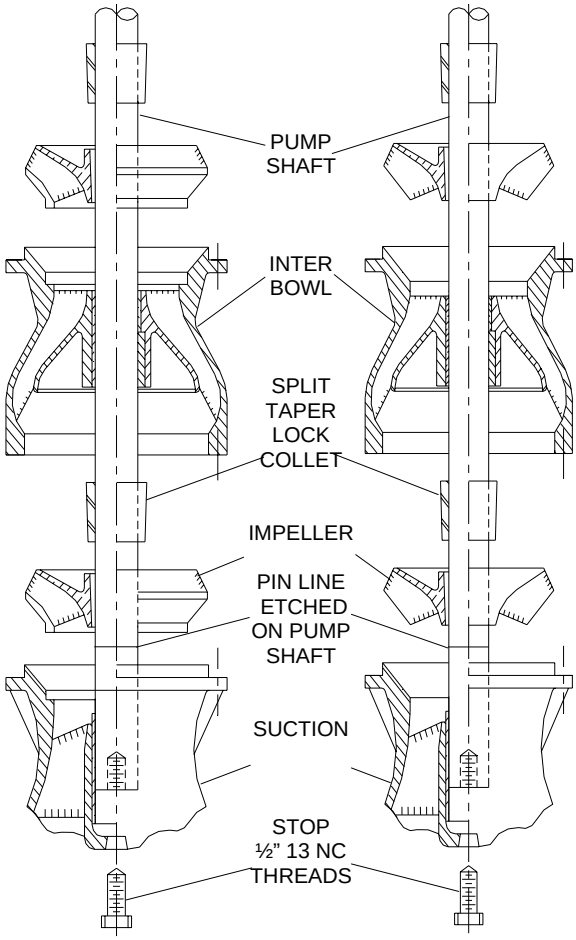


Figure 15.1 Product Lubricated Bowl Assembly Installation/Enclosed Impeller/Lock Collet Construction

Figure 15.2 Product Lubricated Bowl Assembly Installation/Semi-Open Impeller/Lock Collet Construction

Be sure to raise the shaft to its highest position before attempting to drive off the impeller(s). Use the recessed end of the lock collet hammer to remove the impeller(s).

SECTION 15-7 VERTICAL TURBINE PUMP BOWL ASSEMBLY, OIL LUBRICATED, ENCLOSED IMPELLER(S)

15-8** ***Assembly Procedure
***(1)** Layout the bowl assembly parts and check them against the bill of material.
***(2)** Check the impeller diameter against the trim shown on the bill of material.

***(3)** Install the bearings in the bowls. Where dual bearings are required (check the bill of material), press the bronze bearings into place then install the rubber bearings using 3M Scotch-Grip 1711 Adhesive (or an equivalent product) to hold them in place. Do not get adhesive into any bearing bore. Install the suction bearing in the suction (on some pumps, the suction bearing will project above the suction bearing hub).

NOTE: The discharge case and the top intermediate bowl must be screwed or bolted together (depending on the type of construction being used), and the combination bearing must be pressed in the intermediate bowl flush with the top of the rubber bearing pocket. ***NOTE: Check the by-pass ports to verify that the combination bearing does not seal them shut. If these ports are closed, the tube and shaft will not be properly lubricated and early pump failure will result. CAUTION: Never install a rubber bearing in the top inter-bowl!***

(4) Position the bottom impeller at the pin line etched on the pumpshaft.

***(5)** Clamp the pumpshaft in a vice with a soft metal cover on the jaws. Slip an impeller and taper lock collet over the end of the pumpshaft and lock it into position using a lock collet hammer (available from Sulzer Pumps Houston Inc.). When the lock collet is in the proper position, it will project about 1/8 inch above the impeller hub.

(6) Use a straightedge to verify that the bottom of the impeller wear ring is aligned with the pin line on the pumpshaft. If adjustment is required, remove the impeller by using the opposite end of the lock collet hammer. If a sand collar is provided (see parts list/), install it on the shaft beneath the impeller.

(7) Insert the pumpshaft into the suction bearing and position it so the impeller seats in the bowl wear ring seat.

***(8)** Support the pumpshaft with collapsible supports at several points to hold it horizontal.

***(9)** Remove the pipe plug from the bottom of the suction piece.

(10) Thread the stop into the bottom of the shaft and tighten it firmly to seat the impeller in the bowl. Keep this stop tight while assembling the bowl. ***NOTE: After the bowl assembly is completed, the stop must be removed (see step 21)***.

***(11)** Slip an intermediate bowl over the end of the shaft and bolt or thread the bowl in position (depending on whether flanged or threaded bowls are required).

(12) Place the next impeller and lock collet on the pumpshaft and use the lock collet hammer to lock them in position in the bowl ring seat.

***(13)** Compare the endplay with the specification on the bill of material. Do this by unthreading the pumpshaft stop and measuring the lateral travel of the shaft; this travel is the endplay. Relock the shaft and proceed to install the bowls and impellers for the remaining stages.

***(14)** After the final impeller is positioned, install the top inter-bowl and the discharge case. Bolt or thread the assembly in position (depending on whether threaded or flanged construction is provided).

***(15)** Install the O-ring slinger on the shaft in line with the bypass ports located in the discharge case. Recheck the endplay.

***(16)** Verify that the pumpshaft projection matches what's specified on the bill of material. The projection is the distance from the end of the shaft to the column seat when the shaft is in its lowest position. *NOTE: The column seat for threaded column is the point at which the column bottoms. The column seat for flanged column is the face of the flange.*

***(17)** Thread the discharge case screw bearing into the discharge case.

***(18)** Thread the tube adapter on the discharge case screw bearing and tighten.

***(19)** Thread the tube adapter screw bearing into the tube adapter.

***(20)** With the impellers in their lowest position, check the projection of the shaft above the tube seat.

***(21)** Remove the stop from the bottom of the shaft.

(22)** Pack the suction hub with waterproof grease (see procedure 14-10 & 14-11) through the bottom. Install the pipe plug. The shaft should be at its lowest position when you are packing this bearing,. **DO NOT OVER GREASE!** ***Excess grease will prevent the impeller from seating properly. NOTE: When pumping a grease-dissolving fluid or operating the pump at high temperatures, omit this step and do not use grease.

***(23)** Make sure the rotating element turns freely by hand. Upon completion of all steps, the bowl assembly is ready to install.

15-9 ***Disassembly Procedure***

To disassemble the bowl assembly, simply reverse the assembly procedure as described in section 15-8. Be sure to raise the shaft to its highest position before attempting to drive off the impeller(s). Use the recessed end of the lock collet hammer to remove the impeller(s).

15-10 VERTICAL TURBINE PUMP BOWL ASSEMBLY, OIL LUBRICATED, SEMI-OPEN IMPELLER(S)

15-11 *Assembly Procedure

(1) Repeat procedure 15-8, steps 1 through 3.
(2) Insert the pumpshaft into the suction bearing and position it so the pin line etched on the pumpshaft is even with the top of the suction bearing.
(3) Repeat Procedures 15-8, steps 8 & 9.
(4) Thread the stop into the bottom of the shaft and tighten it to hold the pin line in position. Keep this stop tight while assembling the bowl. ***NOTE: After the bowl assembly is completed, the stop must be removed.***
(5) Repeat procedure 15-8, step 5.
(6) Verify that the top of the bearing is aligned with the pin line etched on the pumpshaft. If adjustment is required, remove the impeller by using the opposite end of the lock collet hammer. If a sand collar is provided (see parts list), install it on the shaft beneath the impeller.
(7) Repeat procedure 15-8, step 11.
(8) Place the next impeller and lock collet on the pumpshaft and use the lock collet hammer to lock them in position against the bowl seat.
(9) Repeat procedure 15-8, steps 13 through 23.

15-12 ***Disassembly Procedure***

To disassemble the bowl assembly, simply reverse the assembly procedure as described in section 15-11. Be sure to raise the shaft to its highest position before attempting to drive off the impeller(s). Use the recessed end of the lock collet hammer to remove the impeller(s).

15-13 VERTICAL TURBINE PUMP BOWL ASSEMBLY, GREASE LUBRICATED, ENCLOSED OR SEMI-OPEN IMPELLER(S)

15-14 The assembly and disassembly for grease and oil lubricated bowl assemblies are identical.
(1) **NOTE:** The grease connections in the suction bell and bowls must line up when they are bolted together.

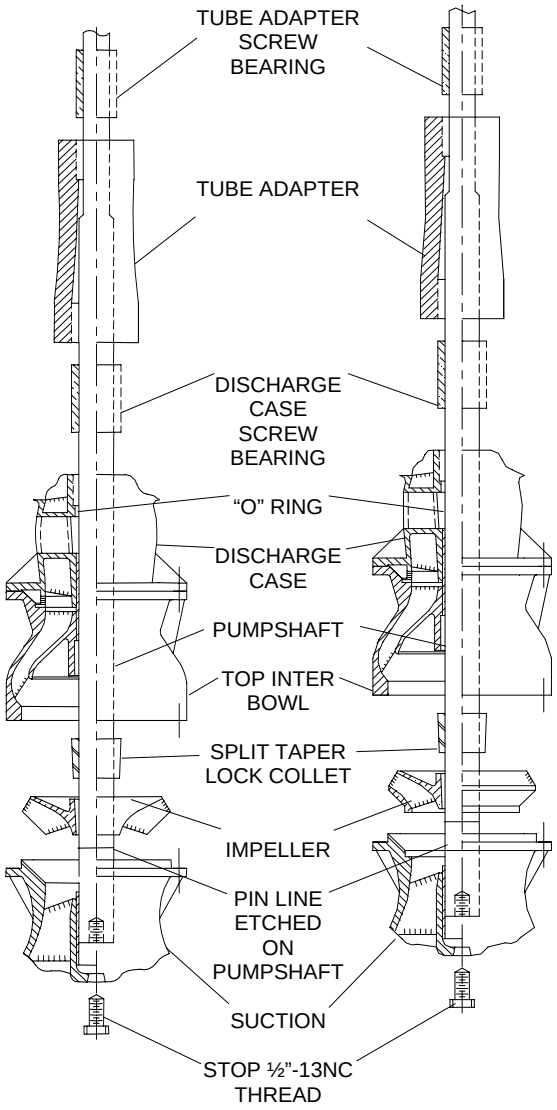


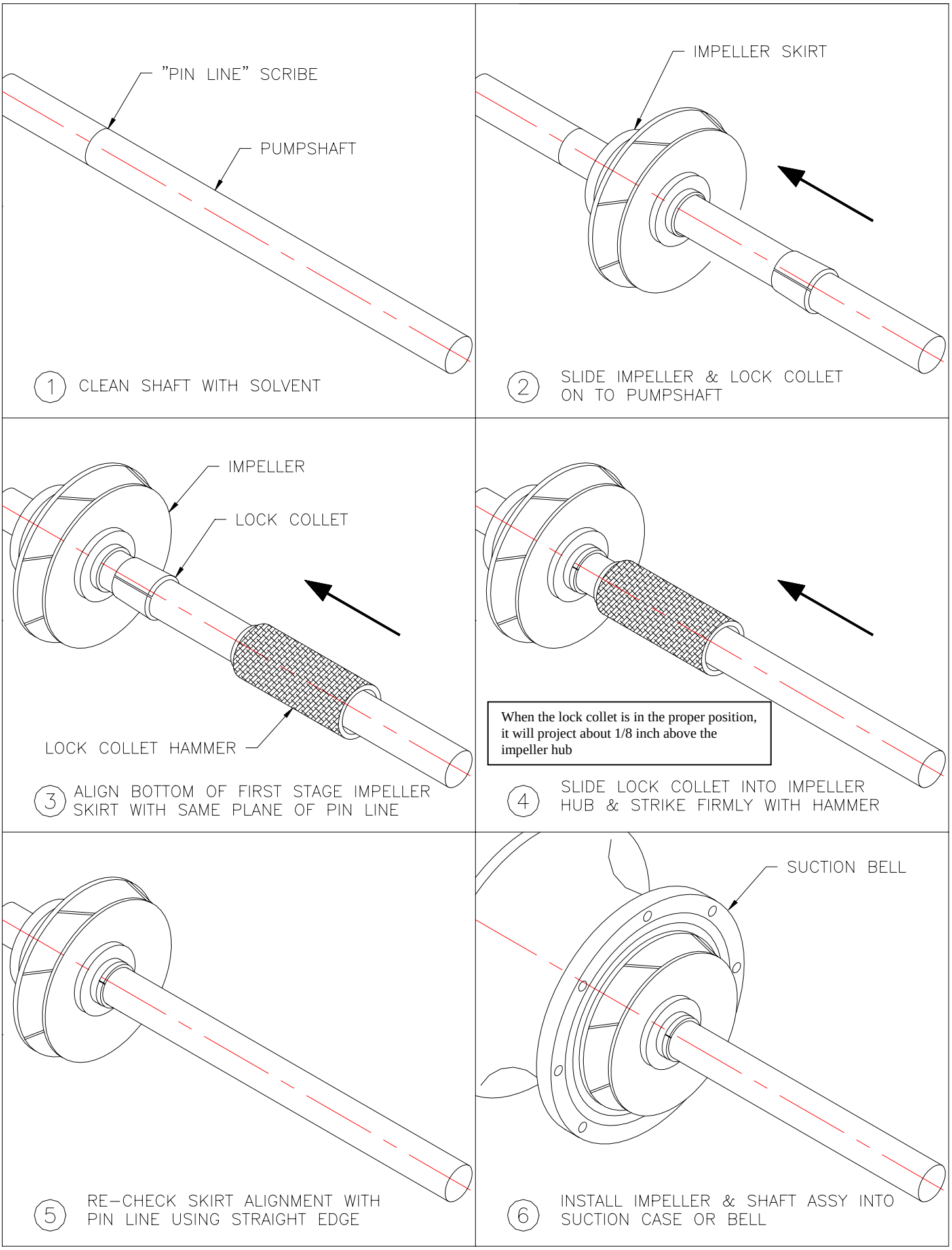
Figure 15.3 Oil Lubricated Bowl Assembly Installation/Semi-Open Impeller/Lock Collet Construction

Figure 15.4 Oil Lubricated Bowl Assembly Installation/Enclosed Impeller/Lock Collet Construction

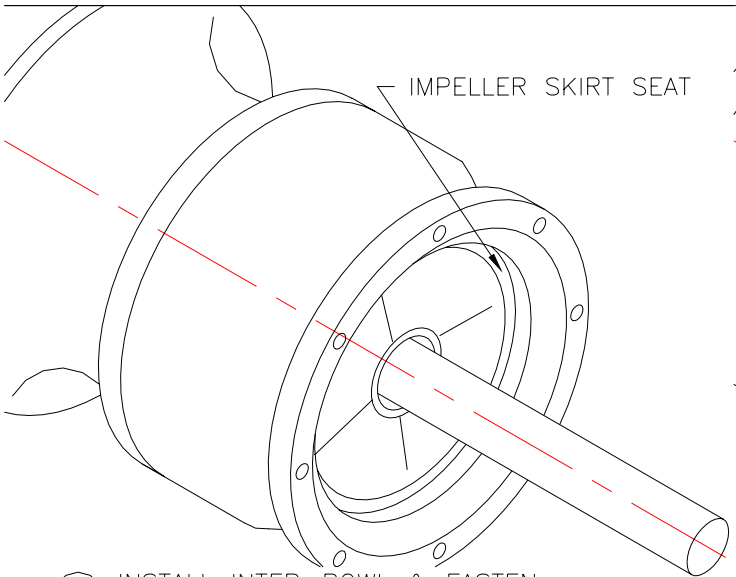
15-15 VERTICAL TURBINE PUMP BOWL ASSEMBLY, WATER-FLUSH LUBRICATED, ENCLOSED OR SEMI-OPEN IMPELLER(S)

CONSULT SULZER PUMPS HOUSTON INC. FIELD SERVICE OR ONE OF OUR SERVICE CENTERS FOR MAINTENANCE INSTRUCTIONS ON A WATERFLUSH BOWL ASSEMBLY.

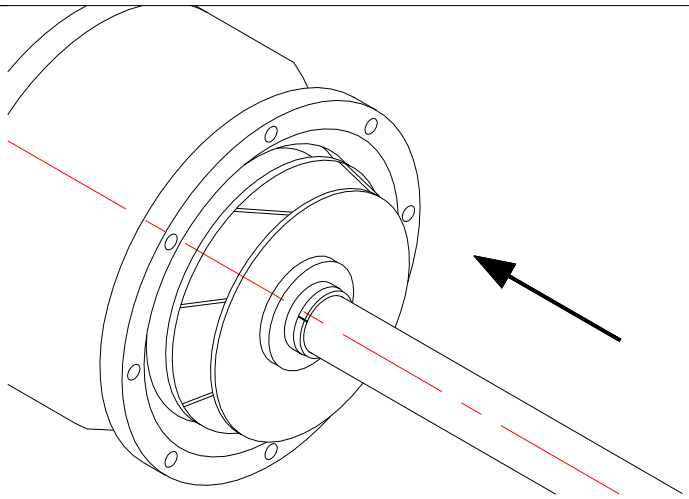
TYPICAL LOCK COLLET ASSEMBLY AND DISASSEMBLY ILLUSTRATION



TYPICAL LOCK COLLET ASSEMBLY AND DISASSEMBLY ILLUSTRATION



7 INSTALL INTER–BOWL & FASTEN SECURELY TO SUCTION BELL



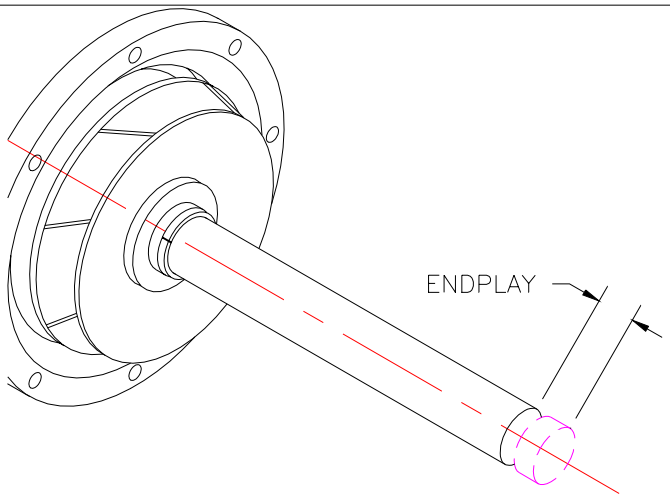
8 WITH PUMPSHAFT & IMPELLER IN BOTTOM POSITION INSTALL SECOND IMPELLER & LOCK COLLET. MEASURE AXIAL ENDPLAY OF SHAFT

IF AXIAL ENDPLAY MEETS THE REQUIREMENTS LISTED ON THE PUMP BUILT SHEET, CONTINUE ADDING STAGES. MEASURE ENDPLAY AFTER ADDING EACH STAGE.

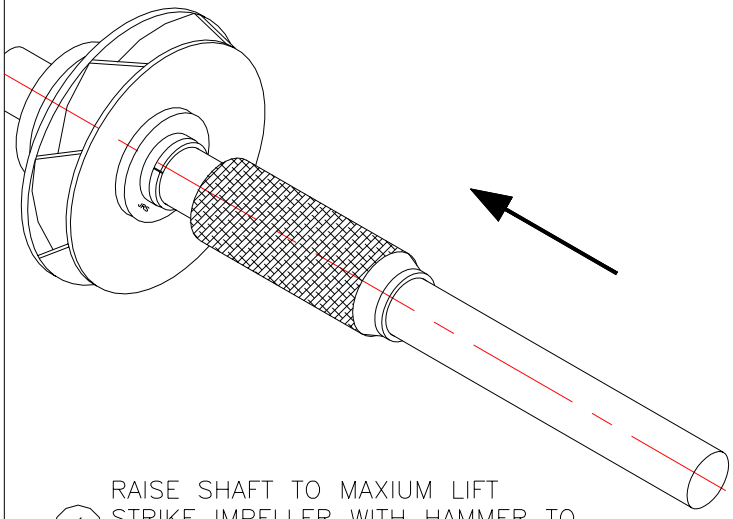
IF AXIAL ENDPLAY IS LESS THAN THE REQUIREMENTS LISTED ON THE PUMP BUILD SHEET – DISASSEMBLE & CHECK FOR OBSTRUCTIONS

ENDPLAY IS THE TOTAL DISTANCE THE SHAFT AND IMPELLER ASSEMBLY CAN TRAVEL FROM THE IMPELLER SKIRT SEAT UNTIL THE SHAFT STOPS FROM AN OBSTRUCTION IN THE BOWL ASSEMBLY

9



10 PUMPSHAFT AXIAL ENDPLAY



1 RAISE SHAFT TO MAXIUM LIFT STRIKE IMPELLER WITH HAMMER TO LOOSEN LOCK COLLET

REMOVING IMPELLER FROM SHAFT

SECTION 16- MAINTE-NANCE INSTRUCTIONS BOWL ASSEMBLY, KEYED CONSTRUCTION

16-1 Before you commence work on your pump, it will be necessary for you to determine where the thrust ring is located. A thrust ring maybe installed either at the top or bottom of the impeller. If the thrust ring is located on the bottom of the impeller, you should start working from the suction end of the bowl assembly. However, if the thrust ring is located on the top of the impeller, you should commence from the discharge end of the bowl assembly.

16-2 VERTICAL TURBINE PUMP BOWL ASSEMBLY, PRODUCT LUBRICATED, ENCLOSED OR SEMI-OPEN IMPELLER(S)

16-3 *Assembly Procedure

(1) Lay out the bowl assembly parts and check them against the bill of material.
(2) Check the impeller diameter against the trim diameter shown on the bill of material.
(3) If the bearings have not been installed in the bowls and suction, install them now (on some pumps, the suction bearing will project above the suction bearing hub).
(4) Determine from which end of the bowl assembly to commence work by checking the location of the thrust ring as follows:

A. If the thrust ring is located on the bottom of the impeller, start from the suction end of the bowl assembly.
B. If the thrust ring is located on the top of the impeller, start from the discharge end of the bowl assembly.

(5) To attach an impeller to the pumpshaft, first place a key in the keyway of the pumpshaft and slide the impeller over the key. The key must have a sliding fit in the keyway of the pumpshaft and impeller.
(6) Place the thrust ring in the thrust ring groove of the pumpshaft.
(7) Slip the thrust ring retainer over the pumpshaft and thrust ring, then bolt it to the impeller.
(8) Slide the pumpshaft into the suction or discharge bowl (depending on the location of the thrust ring and the end of the bowl assembly from which the work commenced).
(9) Support the pumpshaft with collapsible supports at several points to hold it horizontal.
(10) Slip an intermediate bowl over the end of the pumpshaft and bolt the bowl in position.
(11) Assemble the next key, impeller, thrust ring and thrust ring retainer on the pumpshaft and bolt the thrust ring retainer to the impeller.
(12) After assembling each stage, compare the endplay with the specification on the bill of material. Do this by measuring the lateral travel of the pumpshaft; this travel is the endplay.

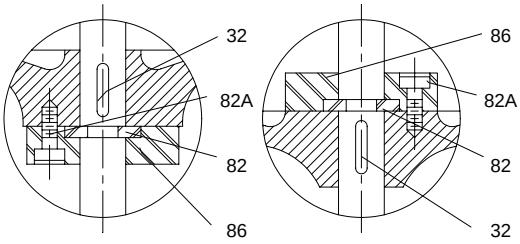


Figure 16.1 Thrust Ring Assembly Mounted at Bottom

Figure 16.2 Thrust Ring Assembly Mounted at Top

32 Impeller Key
82 Thrust Ring Retainer
82A Bolting
86 Thrust Ring

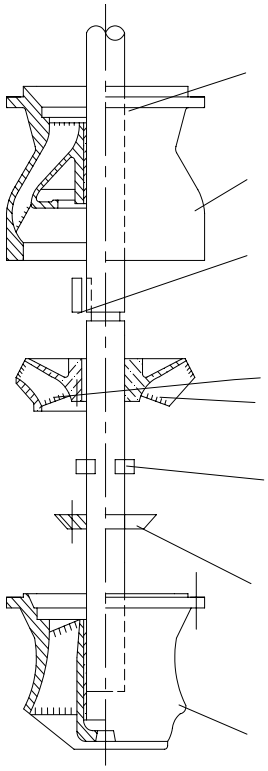


Figure 16.3 Product Lubricated Bowl Assembly Installation Semi-Open & Enclosed Impeller/Keyed Construction

***Repeat Procedure**

(13) Assemble the bowls and impellers for the remaining stages.
(14) Verify that the pump shaft projection matches what's specified on the bill of material. The projection is the distance from the end of the shaft to the column seat when the shaft is in its lowest position. *NOTE: The column seat for threaded column is the point at which the column bottoms. The column seat for flanged column is the face of the flange.*
(15) Pack the suction hub with waterproof grease (see procedure 14-10 & 14-11) from the bottom. Install the pipe plug. The shaft should be at its lowest position when you are packing this bearing. **DO NOT OVER-GREASE!** ***Excess grease will prevent the impeller from seating properly. NOTE: When pumping a grease-dissolving fluid or operating the pump at high temperatures, omit this step and do not use grease.***
(16) Make sure the rotating element turns freely by hand. Upon completion of all steps, the bowl assembly is ready to install.

16-4 ***Disassembly Procedure***
To disassemble the bowl assembly, simply reverse the assembly procedure as described in section 16-3.

16-5 VERTICAL TURBINE PUMP BOWL ASSEMBLY, OIL LUBRICATED, ENCLOSED OR SEMI-OPEN IMPELLER(S)

16-6 *Assembly Procedure
(1) Layout the bowl assembly parts and check them against the bill of material.
(2) Check the impeller diameter against the trim diameter shown on the bill of material.
(3) If the bearings have not been installed in the bowls and suction, install them now (on some pumps, the suction bearing will project above the suction bearing hub).
NOTE: Check the bypass ports to verify that the combination bearing does not seal them shut. If these ports are closed, the tube and shaft will not be lubricated properly and early pump failure will result.
(4) Determine from which end of the bowl assembly to commence work by checking the location of the thrust ring as follows:

A. If the thrust ring is located on the top of the impeller, start from the suction end of the bowl assembly.
B. If the thrust ring is located on the bottom of the impeller, start from the discharge end of the bowl assembly.

(5) To attach an impeller to the pumpshaft, first place a key in the keyway of the pumpshaft and slide the impeller over the key. The key must have a sliding fit in the keyway of the pumpshaft and impeller.
(6) Place the thrust ring in the thrust ring groove of the pumpshaft.
(7) Slip the thrust ring retainer over the pumpshaft and thrust ring, then bolt it to the impeller.
(8) Slide the pumpshaft into the suction or discharge bowl (depending on the location of the thrust ring and the end of the bowl assembly from which the work commenced).

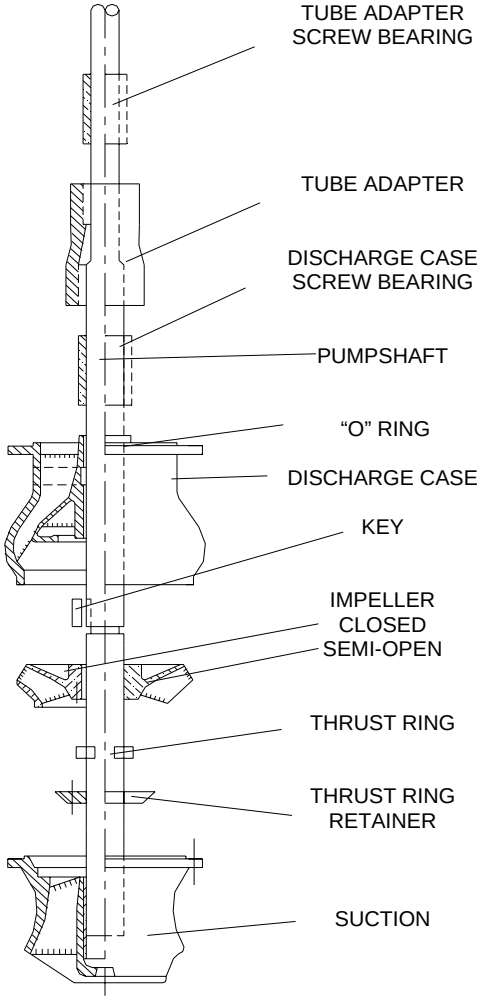


Figure 16.4 Oil Lubricated Bowl Assembly Installation Semi-Open Enclosed Impeller/Keyed Construction

(9) Support the pumpshaft with collapsible supports at several points to hold it horizontal.
(10) Slip an intermediate bowl over the end of the pumpshaft and bolt the bowl in position.
(11) Assemble the next key, impeller, thrust ring and thrust ring retainer on the pumpshaft and bolt the thrust ring retainer to the impeller.
(12) After assembling each stage, compare the endplay with the specification on the bill of material. Do this by measuring the lateral travel of the pumpshaft; this travel is the endplay.
(13) Assemble the bowls and impellers for the remaining stages.
(14) Install the O-ring slinger on the shaft in line with the bypass ports located in the discharge bowl. Check the endplay again.
(15) Verify that the pumpshaft projection matches what's specified on the bill of material. The projection is the distance from the end of the shaft to the column seat when the shaft is in its lowest position. *NOTE: The column seat for threaded column is the point at which the column bottoms. The column seat for flanged column is the face of the flange.*
(16) Thread the discharge bowl screw bearing into the discharge bowl.
(17) Thread the tube adapter on the discharge bowl screw bearing and tighten.
(18) Thread the tube adapter screw bearing into the tubeng adapter.
(19) With the impellers in their lowest position, check the projection of the shaft above the tube seat.
(20) Pack the suction hub with waterproof grease (see procedure 14-10 & 14-11) from the bottom. Install the pipe plug. The shaft should be at its lowest position when you are packing this bearing. **DO NOT OVER GREASE!** ***Excess grease will prevent the impeller from seating properly. NOTE: When pumping grease dissolving fluid or operating the pump at high temperatures, omit this step and do not use grease.***
(21) Make sure the rotating element turns freely by hand. Upon completion of all steps, the bowl assembly is now ready to install.

16-7 ***Disassembly Procedure***
To disassemble the bowl assembly, simply reverse the assembly procedure as described in section 16-6.

SECTION-17 MAINTE-NANCE INSTRUCTIONS

BOWL ASSEMBLY, ASSEMBLY & DIS-ASSEMBLY "SPECIALS"

17-1 ***"O" Ring Gasket(s)***
The "O" rings are installed on top of the interbowl flange as follows:

- Lightly coat an "O" ring with grease and place it over the register of the bowl.
- Use care installing the next bowl over the register fit so the "O'" ring will not be damaged.

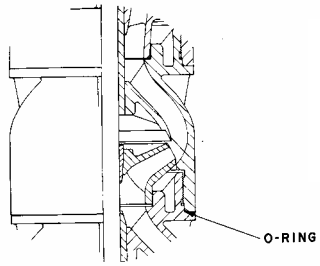


Figure 17.1 "O"Ring Construction Bowl Assembly

17-2 ***Thrust Balanced Construction***
The impellers of your bowl assembly are of thrust balanced construction. They are fastened to the pumpshaft same as the *standard impellers. The thrust balanced impeller is easily recognized by the seal ring on the top.
***NOTE STANDARD CONSTRUCTION:** Bowl models 6 through 18" are lock colleted. Bowl models 20" and up are keyed construction.

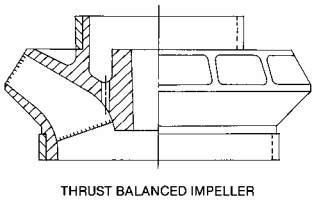


Figure 17.2 Thrust Balanced Impeller Assembly

17-3 ***Thrust Balanced Construction with "O" Ring(s)***
The "O" rings are installed on the top flange of each inter bowl as follows:

- Lightly coat an "O" ring with grease and place it in the groove.
- Use care installing the next bowl over the register fit so the "O'" ring will not be damaged.

17-4 ***Thrust Balanced Construction with Bowl Wear Ring(s)***

The bowl assembly is equipped with wear rings installed in the bowls. These wear rings are replaceable.

NOTE:

When the original wear rings are secured by setscrews, the setscrews must be replaced when the wear rings are replaced.

17-5 ***Keyed Impeller(s) with Lock Collet(s)***

Before installing the impellers and lock collets, place a key in the keyway in the pumpshaft. Proceed with the assembly in accordance with the bowl assembly instructions included in this manual. **NOTE:** Keys must be a sliding fit in the keyway of the pumpshaft and impellers.

17-6 ***Keyed Impeller(s) with Retaining Ring(s)***

The following instructions replace the standard lock collet method of installing the impellers to the pumpshaft.

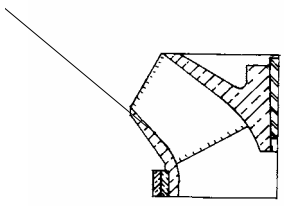
NOTE: A stop is not required for this type of construction.

- Install a retaining ring in the bottom ring groove in the pumpshaft.
- Place a key in the bottom keyway in the pumpshaft. **NOTE:** Keys must be a sliding fit in the pumpshaft and impellers.
- Slide the impeller over the pumpshaft and key.
- Place a retaining ring in the groove on top of the impeller.
- Repeat the above steps for the remaining impellers.

17-7 ***Bowl Wear Ring(s)***

Your bowl assembly is equipped with wear rings installed in the bowls. These wear rings are replaceable. **NOTE:** When the original wear rings are secured by setscrews, the setscrews must be replaced when the wear rings are replaced.

Figure 17.3 Bowl Wear Ring Assembly



SECTION-18 PREVENTIVE MAINTENANCE INSTRUCTIONS

18-1 Preventive Maintenance Table

INSTRUCTIONS	TIME INTERVAL (OPERATING HOURS)
Clean dirt, oil and grease from driver and discharge head	As required
Clean driver ventilation passage to prevent over-heating	As required
Change lubricant gear drive.	Refer to manufacturer's instructions
Tighten all loose bolts, and check for excessive vibration.	As required
Check for some excessive leakage through stuffing box while pump is in operation.	As required
Lubricate motor bearings	Refer to manufacturer's instructions

SULZER PUMPS HOUSTON INC.

SERVICE REPORT

START-UP CHECK LIST

1. ____ PUMP SERIAL NO._____TYPE_____STAGES_____
2. ____ MOTOR: U.S._____G.E._____WEST._____A.C._____OTHER_____
3. ____ MOTOR SERIAL NO._____HP_____
4. ____ GEAR DRIVE_____SERIAL NO._____MANUF._____
5. ____ DIESEL SERIAL NO._____MANUF._____
6. ____ HOLD DOWN BOLTS (MOTOR, BASEPLATE, DISCHARGE FLANGE)
7. ____ REMOVE HEADSHAFT OR MOTOR CLUTCH (HOLLOW SHAFT MOTOR)
8. ____ DISASSEMBLE DRIVE COUPLING (SOLID SHAFT MOTOR)
9. ____ N.R.R. YES_____NO_____
10. ____ MOTOR VIBRATION UNCOUPLED: X1_____X2_____X3_____Y1_____Y2_____Y3_____Z_____**
11. ____ MOTOR TEMPERATURE_____AMPS_____(UNCOUPLED)
12. ____ COUPLE PUMP TO DRIVER
13. ____ IMPELLER ADJUSTMENT "
14. ____ SEAL ADJUSTMENT_____" MANUF._____TYPE_____
15. ____ WATERFLUSH: FRESH_____OTHER_____MAN._____AUTO._____BOTH_____
16. ____ PACKING BOX GLAND
17. ____ SHAFT RUNOUT AT PACKING BOX_____"
18. ____ OIL LUBE PUMP: AUTO_____MAN._____BOTH_____TYPE OF OIL_____
19. ____ DRIVER OIL: TYPE_____ GREASE LUBE_____

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20. ____ SUCTION VALVES: OPEN_____CLOSED_____(BARREL PUMPS)
21. ____ DISCHARGE VALVES: OPEN_____CLOSED_____PARC_____
22. ____ SUMP CLEAN_____DIRTY_____FILLED_____
23. ____ UNIT STARTED_____AM: PM: STOPPED_____AM: PM:
24. ____ AMPS_____TEMP_____(COUPLED)
25. ____ DISCHARGE PRESSURE_____P.S.I.
26. ____ VIBRATION W/PUMP AND DRIVER: X1_____X2_____X3_____Y1_____Y2_____Y3_____Z_____**
27. ____ RPM'S_____
28. ____ PACKING BOX LEAKAGE YES_____NO_____

**X1, X2, X3, 180° FROM DISCHARGE: Y1, Y2, Y3, 90° FROM DISCHARGE: Z IS AXIAL

**SEE PAGE 42 FOR RECOMMENDED VIBRATION SENSOR LOCATIONS ON THE MOTOR AND PUMP

GENERAL DESCRIPTION OF WORK PERFORMED AND NOTES_____

_____

_____

_____

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_____

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_____

SULZER PUMPS HOUSTON INC.
SERVICE REPRESENTATIVE_____ **DATE**_____

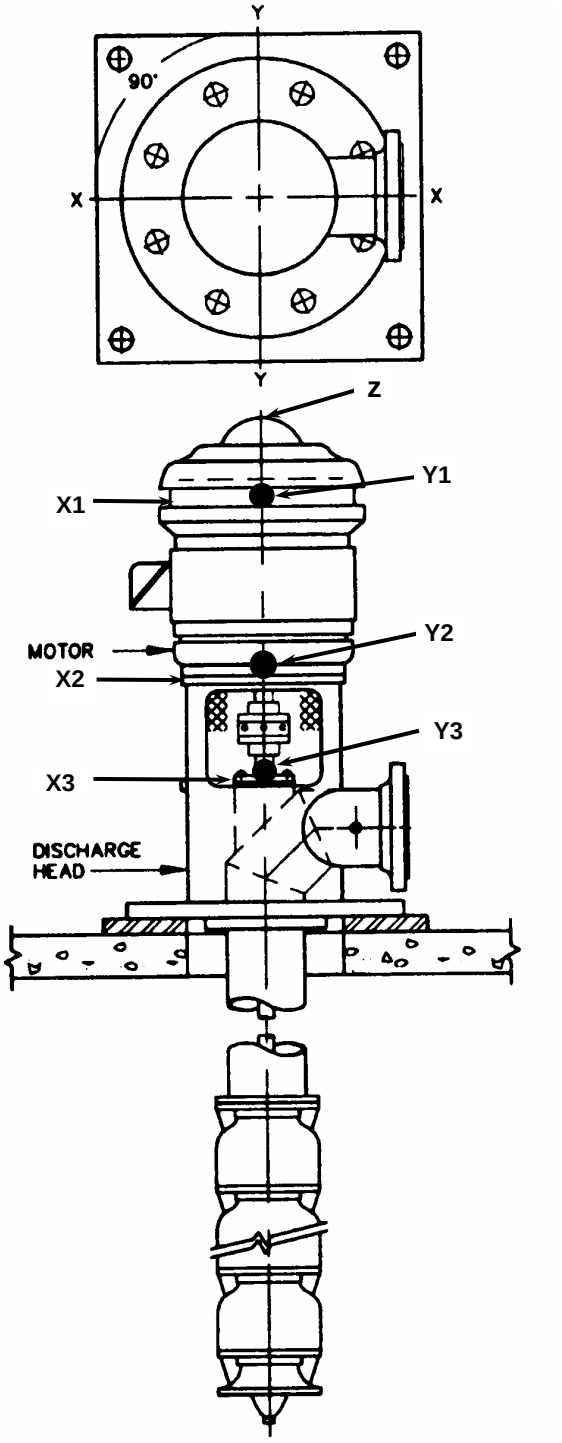
CUSTOMER _____**DATE**_____

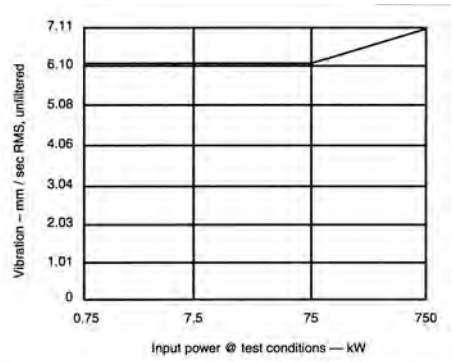
SULZER PUMPS HOUSTON INC.

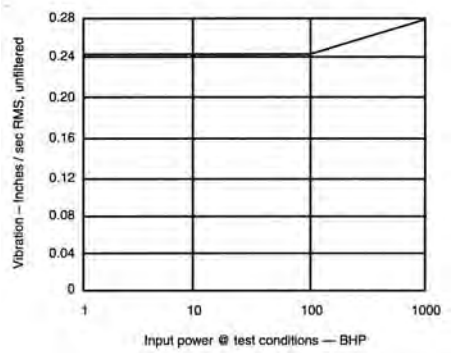
SERVICE REPORT

START-UP CHECK LIST

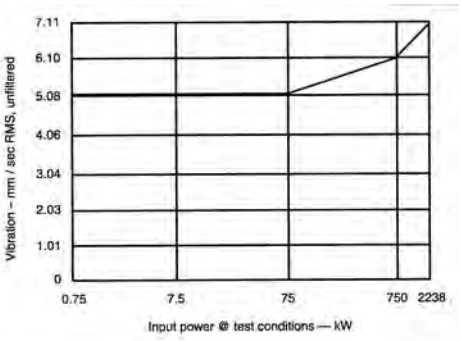
HYDRAULIC INSTITUTE STANDARDS
ACCEPTABLE FIELD VIBRATION LIMIT CHARTS

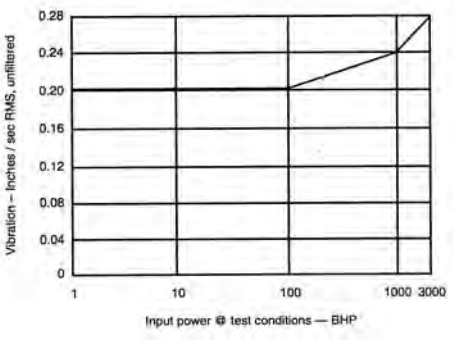






Vertical turbine, mixed flow and propeller type (Fig. 9.6.4.13 – HI Pump Vibration – 2000)





Vertical turbine, short set pumps, assembled for shipment by the manufacturer (Fig 9.6.4.14- HI Pump Vibration – 2000)

SECTION 19 -TROUBLESHOOTING

19-1

TROUBLE INDICATOR	POSSIBLE CAUSES AND RECOMMENDED REMEDIES
1. Insufficient Pressure	A. Speed too slow—Check to assure the turbine receives full steam pressure. Check if driver is directly across the line and receiving full voltage. Check the pump rev/min is consistent with manufacturer's recommendations. B. Improper impeller adjustment—Use an ammeter to check the accuracy of the impeller adjustment. Follow the manufacturers recommended clearance. C. Loose impeller (rarely occurs)—Refit impeller. Change material with the same expansion factor. Overcome by adding keyway to collet mounting. D. Plugged impeller—Pull the pump. Inspect impeller and bowl passages. E. Wear rings worn—Inspect and replace. F. Entrained air in pump—Clean screen and trash racks. Check return line size and location in sump or tank. Increase suction bell diameter so the pumps required submergence is less than the actual submergence available. G. Leaking column joints or bowl castings—Pull pump and inspect. H. Wrong rotation—Rotation must be as indicated by arrow on pump nameplate. Check engagement of motor coupling.
2. Insufficient Capacity	A. Speed too slow—See 1A. B. Improper impeller adjustment—See step 1B. C. Impeller loose (rarely occurs)—See step 1C. D. Impeller or bowl partially plugged—Pull pump and inspect for obstruction. E. Leaking joints—See 1G. F. Strainer partially clogged—See 3D. G. Suction valve throttled—Check and open valve. H. Low Water Level (Deep well)—Increase column length and add a stage or different bowl assembly. I. Wrong rotation—See step 1H.
3. No Liquid Delivered	A. Pump suction broken (water level below bell inlet)—Check for adequate submergence. B. Suction valve closed—Open valve. C. Impeller plugged—Pull pump and inspect for obstruction. D. Strainer clogged—Backflush. Install finer mesh strainer or larger strainer. Pull pump and remove obstruction. E. Wrong rotation—See step 1H. F. Shaft broken—Pull pump and replace shaft. G. Impeller loose—See step 1C.
4. Using Too Much Power	A. Speed to high—Check voltage on motor. B. Improper impeller adjustment—See step 1B. C. Improper impeller trim—Pull pump and inspect. Modify existing impeller to provide actual system requirements. D. Pump out of alignment or shaft bent—Check alignment of pump and driver, also foundations. E. Lubricating oil too heavy—Check quantity and quality of lubricants. Refer to manufacturers recommendations. F. Pumping sand, silt, or foreign material—Test liquid for viscosity and specific gravity.
5. Vibration	A. Motor imbalance—electrical—Carefully observe and analyze the operating history of the pump. Determine cause utilizing vibration frequency analyzer and/or pump disassembly. Consult motor and pump manufacturer. B. Motor bearings not properly seated—See step 5A. C. Motor drive coupling out of balance—See step 5A. D. Misalignment of pump, castings, discharge head, column or bowls—See step 5A. E. Discharge head misaligned by improper mounting or pipe strain—See 5A. F. Bent shafting—See step 5A. Check, straighten or replace. G. Worn pump bearings—See step 5A. Check and replace.

TROUBLE INDICATOR	POSSIBLE CAUSES AND RECOMMENDED REMEDIES
5. Vibration	H. Clogged impeller or foreign material in pump—Backflush. Pull, check for damage and replace. I. Improper impeller adjustment—See step 1B. J. Vortex problems in sump—Increase pump submergence. Apply sump modification such as; install vertical splitter; install suction umbrella; relocate pump in sump, lower the inlet velocity in sump. K. Resonance—System frequency at or near pump speed—Loosen anchor bolts. Change pipe loading.
6. Abnormal Noise	A. Motor noise—Check for bearing failure. Install RTD'S in bearing housing. Monitor bearing oil level. B. Broken column bearing retainers—Check and replace. C. Broken shaft or shaft enclosing tube—Check and replace. D. Impellers dragging on bowl case—Re-adjustment impellers per manufacturers recommendations. E. Cavitation due to low submergence or operation beyond maximum capacity rating—Insufficient NPSH available. Evaluate system head conditions and reduce pump capacity, if possible. Change pump impeller to lower NPSH design. Replace bowl assembly with a different model capable of operating with the system NPSH available. F. Foreign material in pump—Backflush or pull and inspect.
7. Seal Leaks Steadily	A. Faces not flat—Check for incorrect installation dimensions. B. Blistered carbon graphite seal faces—Check for gland plate distortion due to over-torquing of gland bolts. Improve cooling flush line, if overheated. Check gland gasket for proper compression. Clean out any foreign particles between seal faces and re-lap faces. Check for cracks and chips at seal faces during installation. Replace primary and mating rings, if damaged. C. Secondary seals nicked or scratched during installation—Replace secondary seals. D. Worn out or damaged O-rings—Check for proper seal selection with seal manufacturer. E. Compression set of secondary seal (hard and brittle)—Check for proper lead-in on chamfers, burrs, etc. F. Chemical attack (soft and sticky)—Review with seal manufacturer for alternate materials selection. G. Spring failures—Replace parts. H. Erosion damage of hardware and/ or corrosion of drive mechanism—Review with seal manufacturer for alternate materials selection.
8. Seal Squeals during Operation.	A. Inadequate amount of liquid to lubricate seal faces—Flush line maybe required. Enlarge flush line and/or orifices in gland plate.
9. Carbon Dust Accumu-lating on Out-side of Gland Ring.	A. See step 8A. B. Liquid film evaporating between seal faces—Check for proper seal design with seal manufacturer if pressure in stuffing box is excessively high.
10. Seal Leaks Intermittently	A. See causes listed under "Seal leaks steadily."—See step 7 A through H. Check for squareness of stuffing box to shaft. Align shaft, impeller and bearing to prevent shaft vibration and/or distortion of gland plate and/or mating ring.
11. Short Seal Life	A. Abrasive particles in fluid—Prevent abrasives from accumulating at seal faces. Flush line maybe required. Use abrasive separator or filter. B. Seal running too hot—Increase cooling of seal faces (for example, by increasing flush line flow). Check for obstructed flow in cooling lines. C. Equipment mechanical misaligned—Align properly. Check for rubbing of seal on shaft.

NOTES

NOTES

SULZER PUMPS HOUSTON INC.
STANDARD TERMS AND CONDITIONS OF SALE

SECTION 1: THE CONTRACT The Contract shall be comprised of the following terms, together with such terms and conditions as are set forth in Seller's written proposal or quotation (the "Quotation"), including any documents, drawings or specifications incorporated therein by reference, and any additional or different terms proposed in Buyer's purchase order (the "Purchase Order") that are accepted by Seller in writing, which together shall constitute the entire agreement between the parties, provided, however, that preprinted terms on Buyer's purchase order or invoice shall not apply and Seller gives notice of objection to such terms. An offer by Seller in its Quotation that does not stipulate an acceptance date is not binding. This Contract shall be deemed to have been entered into upon written acknowledgment of the Purchase Order by an officer or authorized representative of Seller, which may not be modified, supplemented, or waived except in a writing executed by an authorized representative of the party to be bound.

SECTION 2: PRICE The price quoted in the Quotation shall be the Purchase Price unless otherwise agreed in the Purchase Order. The Purchase Price for equipment shall include packing for shipment. Field Services shall be provided at Seller's standard rates. All other costs, including packing for storage, freight, insurance, taxes, customs duties and import/export fees, or any other item not specified in the Contract, shall be paid by Buyer unless separately stated in the Quotation and included in the price quoted. Any sales, use, or other taxes and duties imposed on the transaction or the equipment supplied shall be paid or reimbursed by Buyer.

SECTION 3: PAYMENT TERMS Payment shall be due within 30 days of the date of Seller's invoice in U.S. funds unless otherwise agreed. If Buyer does not observe the agreed dates of payment, Buyer shall pay interest to Seller on overdue amounts at a rate that is the higher of: 9% per annum or a rate 5% in excess of the rate borne from time to time by new issues of six-month United States Treasury bills. Seller shall be entitled to issue its invoice for the Purchase Price for equipment upon the earlier of shipment, or notice to Buyer that Seller is ready to ship, and for services, upon completion. If the Purchase Price exceeds $250,000 USD, Buyer shall pay the Purchase Price in progress payments as follows: 15% upon delivery of general arrangement drawings, 35% after notice to Buyer of delivery to Seller of major castings, 20% after notice that machining is complete, and 30% upon notice that Seller is ready to ship.

SECTION 4: ACCEPTANCE AND INSPECTION All equipment shall be finally inspected and accepted by Buyer within 14 days after delivery or such other period of time as is agreed in the Purchase Order. Buyer shall make all claims (including claims for shortages), excepting only those provided for under the warranty clause contained herein, in writing within such 14 day period or they are waived. Services shall be accepted upon completion. Buyer shall not revoke its acceptance. Buyer may reject the equipment only for defects that substantially impair its value, and Buyer's remedy for lesser defects shall be in accordance with Section 10, Warranty. If tests are made by Buyer to demonstrate the ability of the equipment to operate under the contract conditions and to fulfill the warranties in Section 10, Buyer is to make all preparations and incur all expenses incidental to such tests. Seller will have the right of representation at such tests at its expense, and the right to technically direct the operation of the equipment during such tests, including requiring a preliminary run for adjustments.

SECTION 5: TITLE AND RISK OF LOSS Full risk of loss (including transportation delays and losses) shall pass to Buyer upon delivery, regardless of whether title has passed to Buyer, transport is arranged or supervised by Seller, or start-up is carried out under the direction or supervision of Seller. Delivery shall be ex works, INCOTERMS 2000. Loss or destruction of the equipment or injury or damage to the equipment that occurs while the risk of such loss or damage is borne by Buyer does not relieve Buyer of its obligation to pay Seller for the equipment.

SECTION 6: PATENT OR TRADEMARK INFORMATION If the equipment sold hereunder is to be prepared or manufactured according to Buyer's specifications, Buyer shall indemnify Seller and hold it harmless from any claims or liability for patent or trademark infringement on account of the sale of such goods.

SECTION 7: CHANGES Buyer may request, in writing, changes in the design, drawings, specifications, shipping instructions, and shipment schedules of the equipment. As promptly as practicable after receipt of such request, Seller will advise Buyer what amendments to the Contract, if any, may be necessitated by such requested changes, including but not limited to amendment of the Purchase Price, specifications, shipment schedule, or date of delivery. Any changes agreed upon by the parties shall be evidenced by a Change Order signed by both parties.

SECTION 8: CANCELLATION OR TERMINATION Buyer shall have the right to cancel the Contract upon 15 days' prior written notice to Seller, and Seller shall stop its performance upon the receipt of such notice except as otherwise agreed with Buyer. If Buyer cancels the Contract, it shall pay: (a) the agreed unit price for equipment or components completed and delivered, (b) additional material and labor costs incurred, and for engineering services supplied by Seller with respect to the canceled items, which shall be charged to Buyer at Seller's rates in effect at the time of cancellation, but which shall not exceed the contract price for such items, and (c) such other costs and expenses, including cancellation charges under subcontracts, as Seller may incur in connection with such cancellation or termination.

SECTION 9: DELIVERY AND DELAYS Seller shall use its best efforts to meet quoted delivery dates, which are estimated based on conditions known at the time of quotation. Seller shall not be liable for any nonperformance, loss, damage, or delay due to war, riots, fire, flood, strikes or other labor difficulty, governmental actions, acts of God, acts of the Buyer or its customer, delays in transportation, inability to obtain necessary labor or materials from usual sources, or other causes beyond the reasonable control of Seller. In the event of delay in performance due to any such cause, the date of delivery or time for completion will be extended to reflect the length of time lost by reason of such delay. Seller shall not be liable for any loss or damage to Buyer resulting from any delay in delivery.

SECTION 10: WARRANTY Seller warrants that the equipment or services supplied will be free from defects in material, and workmanship for a period of 12 months from the date of initial operation of the equipment, or 18 months from the date of shipment, whichever shall first occur. In the case of spare or replacement parts manufactured by Seller, the warranty period shall be for a period of six months from shipment. Repairs shall be warranted for 12 months or, if the repair is performed under this warranty, for the remainder of the original warranty period, whichever is less. Buyer shall report any claimed defect in writing to Seller immediately upon discovery and in any event, within the warranty period. Seller shall, at its sole option, repair the equipment or furnish replacement equipment or parts thereof, at the original delivery point. Seller shall not be liable for costs of removal, reinstallation, or gaining access. If Buyer or others repair, replace, or adjust equipment or parts without Seller's prior written approval, Seller is relieved of any further obligation to Buyer under this section with respect to such equipment or parts. The repair or replacement of the equipment or spare or replacement parts by Seller under this section shall constitute Seller's sole obligation and Buyer's sole and exclusive remedy for all claims of defects. SELLER MAKES NO OTHER WARRANTY OR REPRESENTATION OF ANY KIND WITH RESPECT TO THE EQUIPMENT OR SERVICES OTHER THAN AS SPECIFIED IN THIS SECTION 10. ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE HEREBY DISCLAIMED. For purposes of this Section, the equipment warranted shall not include equipment, parts, and work not manufactured or performed by Seller. With respect to such equipment, parts, or work, Seller's only obligation shall be to assign to Buyer any warranty provided to Seller by the manufacturer or supplier providing such equipment, parts or work. No equipment furnished by Seller shall be deemed to be defective by reason of normal wear and tear, failure to resist erosive or corrosive action of any fluid or gas, Buyer's failure to properly store, install, operate or maintain the equipment in accordance with good industry practices or specific recommendations of Seller, or Buyer's failure to provide complete and accurate information to Seller concerning the operational application of the equipment.

SECTION 11: TECHNICAL DOCUMENTS Technical documents furnished by Seller to Buyer, such as drawings, descriptions, designs and the like, shall be deemed provided to Buyer on a confidential basis, shall remain Seller's exclusive property, shall not be provided in any way to third parties, and shall only be used by Buyer for purposes of installation, operation and maintenance. Technical documents submitted in connection with a Quotation that does not result in a Purchase Order shall be returned to Seller upon request.

SECTION 12: LIMITATION OF LIABILITY Seller shall in no event be liable for any consequential, incidental, indirect, special or punitive damages arising out of the Contract, or out of any breach of any of its obligations hereunder, or out of any defect in, or failure of, or malfunction of the equipment, including but not limited to, claims based upon loss of use, lost profits or revenue, interest, lost goodwill, work stoppage, impairment of other equipment, environmental damage, nuclear incident, loss by reason of shutdown or nonoperation, increased expenses of operation, cost of purchase of replacement power or claims of Buyer or customers of Buyer for service interruption whether or not such loss or damage is based on contract, tort (including negligence and strict liability) or otherwise. Seller's maximum liability under this Contract shall not exceed the Purchase Order amount of the equipment or portion thereof upon which such liability is based. All such liability shall terminate expiration of the warranty period, if not sooner terminated.

SECTION 13: THIS COMPANY IS AN EQUAL OPPORTUNITY EMPLOYER This agreement incorporates by reference applicable provisions and requirements of Executive Order 11246 and FAR Section 52.222-26 (covering race, color, religion, sex and national origin); the Vietnam Era Veterans Readjustment Assistance Act of 1974 and FAR Section 52.222-35 (covering special disabled and Vietnam era veterans); and the Rehabilitation Act of 1973 and FAR Section 52.222-36 (covering handicapped individuals). By acceptance of this agreement Buyer certifies that it does not and will not maintain any facilities in a segregated manner, or permit its employees to perform their services at any location under its control where segregated facilities are maintained, and further that appropriate physical facilities are maintained for both sexes. Buyer agrees that it will obtain a similar certificate prior to award of any nonexempt lower-tier subcontracts.

SECTION 14: LAW AND ARBITRATION The Contract shall be governed by the law of the State of Texas. Any disputes arising out of this Contract shall be resolved by informal mediation in any manner that the parties may agree within 45 days of written request for mediation by one party to the other. Any dispute that cannot be resolved through mediation shall be resolved by binding arbitration conducted in English in Houston, Texas under the Commercial Rules of the American Arbitration Association except as otherwise provided in this Section. The arbitration shall be conducted by three arbitrators chosen in accordance with said Rules. The arbitrators are not entitled to award damages in excess of compensatory damages. Judgment upon the award may be entered in any court having jurisdiction.

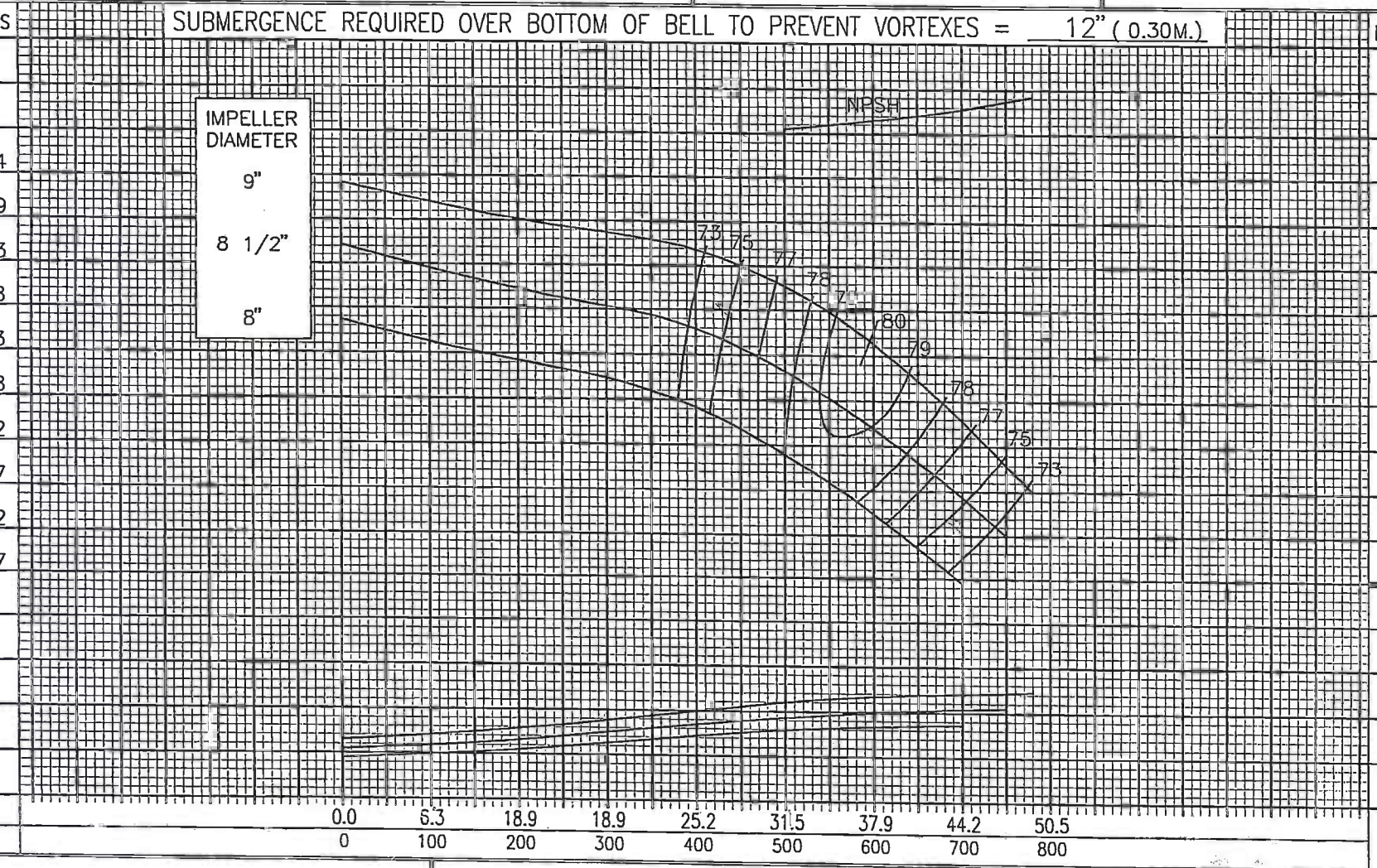
BOWL PERFORMANCE CURVE PER STAGE

IMPELLER PART NO.: 3234
IMPELLER PATTERN NO.: 3212

THRUST CONSTANT: 9
WR^2 0.914 LB. FT^2/STAGE

PUMP SHAFT DIAMETER: 1 11/16 IN. (0.04 M.)

SUBMERGENCE REQUIRED OVER BOTTOM OF BELL TO PREVENT VORTEXES = 12" (0.30M.)



FEET	METERS
80	24.4
75	22.9
70	21.3
65	19.8
60	18.3
55	16.8
50	15.2
45	13.7
40	12.2
35	10.7
30	9.1

TOTAL BOWL HEAD

LPS	0.0	6.3	18.9	18.9	25.2	31.5	37.9	44.2	50.5
GPM	0	100	200	300	400	500	600	700	800

METERS	FEET
6.1	20
3.0	10
0.0	0

N.P.S.H. REQUIRED AT SUCTION IMPELLER

KW	BHP
11.2	15
7.5	10
1.7	5
0.0	0

HORSEPOWER

PERFORMANCE BASED ON MULTISTAGE TESTS PUMPING CLEAR COLD WATER, SPECIFIC GRAVITY OF 1.00

FOR 1 STAGE MULTIPLY HEAD & EFF. BY 0.95

FOR 2 STAGES MULTIPLY HD. & EFF. BY 0.98

REVISION NO.	DATE	DRAWN BY	CHECKED BY
1	12/8/94	DLH	EER

Johnston Pump Company
Brookshire, Texas 77423
ESTABLISHED 1909

12 AC TYPE

IMPELLER – BRONZE

1770 R P M

BOWL – CAST IRON
VIT. COATING

LPS = LITERS PER SECOND
GPM = U.S. GALLONS PER MINUTE

CURVE SHEET NO.	REV.
EC–0557	1

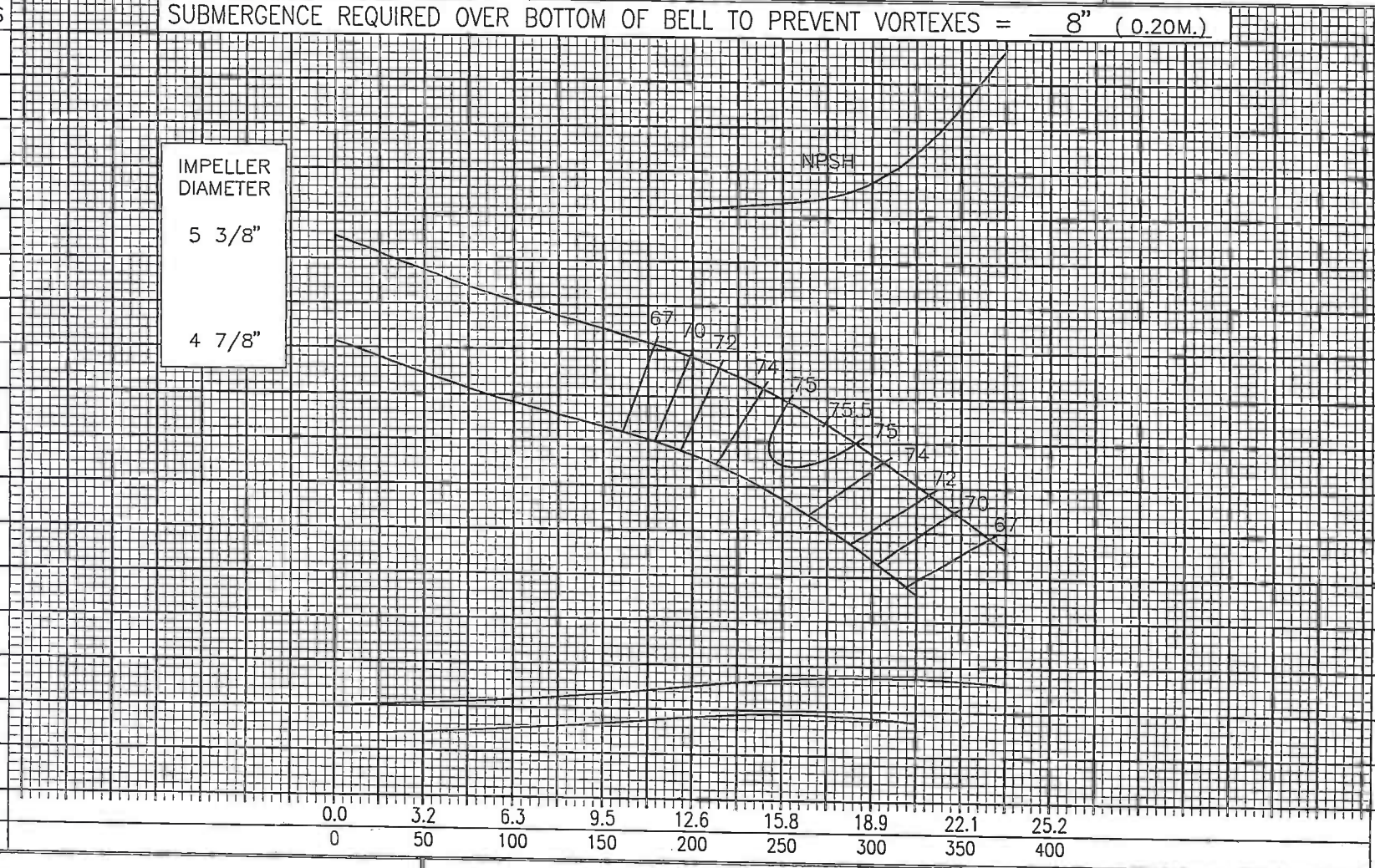
BOWL PERFORMANCE CURVE PER STAGE

IMPELLER PART NO.: 17733
IMPELLER PATTERN NO.: 6609

THRUST CONSTANT: 3.5
WR^2 .068 LB. FT^2/STAGE

PUMP SHAFT DIAMETER: 1 3/16 IN. (.03 M.)

SUBMERGENCE REQUIRED OVER BOTTOM OF BELL TO PREVENT VORTEXES = 8" (0.20M.)



TOTAL BOWL HEAD

FEET	METERS
120	36.6
110	33.5
100	30.5
90	27.4
80	24.4
70	21.3
60	18.3
50	15.2
40	12.2
30	9.1

N.P.S.H. REQUIRED AT SUCTION IMPELLER

METERS	FEET.
15.2	50
12.2	40
9.1	30
6.1	20

HORSEPOWER

KW	BHP
5.6	7.5
3.7	5
1.9	2.5

LPS	0.0	3.2	6.3	9.5	12.6	15.8	18.9	22.1	25.2	
GPM	0	50	100	150	200	250	300	350	400	

PERFORMANCE BASED ON MULTISTAGE TESTS PUMPING CLEAR COLD WATER, SPECIFIC GRAVITY OF 1.00

FOR 1 STAGE MULTIPLY HEAD & EFF. BY 0.95

FOR 2 STAGES MULTIPLY HD. & EFF. BY 0.98

REVISION NO.	DATE	DRAWN BY	CHECKED BY
1	12/8/94	DLH	EER

Johnston Pump Company
Brookshire, Texas 77423
ESTABLISHED 1909

7 BC TYPE
IMPELLER – BRONZE

3500 R P M
BOWL – CAST IRON
VIT. COATING

LPS = LITERS PER SECOND
GPM = U.S. GALLONS PER MINUTE

CURVE SHEET NO.	REV.
EC-0586	1

APPENDIX C Oil Recovery Well Operating Manual

WRB REFINING LP – WOOD RIVER REFINERY

OIL RECOVERY WELLS

OPERATING PROCEDURES & EQUIPMENT INFORMATION

INDEX

NORTH PROPERTY OIL RECOVERY WELLS
VARIABLE SPEED DRIVE
OPERATING PROCEDURE

Start-up

1) Turn the main 480 volt disconnect switch to the ON position and verify that the display for the drive, timer, counter, and ammeter indicate power available.
2) Press the reset buttons on the trip counter and timer.
3) Leave the speed adjustment potentiometer as set.
4) Move the two position selector switch to the ON position which will start the motor.
5) After approximately 15 seconds, the drive will reach the speed as selected by the speed potentiometer. The speed may be adjusted from 2,754 to 4,600 RPM but should not be adjusted unless the undercurrent protection is tested to confirm that the drive will shut down due to loss of suction.

Operating Mode

During normal operation, the following items should be observed on the front of the drive panel:

1) The undercurrent trip indicating light should not be lit. The ammeter will indicate the input current to the drive. This value should not exceed 3 ampere for input current at any speed.
2) The undercurrent trip indicator will show the number of undercurrent trips (the number of times the pump experienced loss of suction). This will normally be 0. When the motor operating current drops below the undercurrent setpoint for approximately 15 seconds, the undercurrent relay will shut off the drive and increment the trip counter to 1. After 5 minutes, the drive will be restarted. If the drive trips a second time on undercurrent, it will increment the trip counter by 1 and restart after 5 minutes. When the counter reaches 3, the drive will not restart automatically and the amber light will be lit to indicate undercurrent trip.
3) To restart the drive after undercurrent trip has occurred for the third time, press the reset button on the trip counter and record the run timer data before resetting its value to 0.
4) The drive will indicate a two digit alarm code if the drive has shut down for some reason. If the display shows OL, the overload reset button may be pressed one time before restarting the drive. For any other display, contact the area electrician and enter a Work Request with information to identify what alarms were displayed.

Troubleshooting

If the drive fails to start, verify that the disconnect switch is in the ON position, no alarms appear on the display panel of the drive, and the trip counter is reset to 0. If an OL is displayed, then the RESET pushbutton may be pressed one time and the drive restarted.

Oil Recovery Optimization Strategy

Goal: Maintain continuous hydrocarbon recovery well operation.

1. Maximizing well on stream time increases the potential for hydrocarbon recovery.
2. Maintain recovery pump suction at hydrocarbon/water interface.
3. Maximize hydrocarbon collection.
    a. Collect skimmer pump discharge sample and allow hydrocarbon layer to separate from water.
    b. Estimate the amount of hydrocarbon present in the collected sample. (i.e. 10% oil, 50% oil)
    c. Record pump discharge flow rate
    d. Determine hydrocarbon recovery rate by multiplying the amount of hydrocarbon (determined in step b) by the pump flow rate (determined in step c).
    e. Try increasing motor speed. (Wait a few minutes to allow well system to stabilize). Caution: Increasing pump speed may cause pump to lose suction. Do not exceed the well recharge rate
    f. Repeat steps 3a - 3d. If the hydrocarbon flow rate increased then repeat step 3g. If the hydrocarbon flow rate decreased then go to step 3e.
    g. Try decreasing motor speed
    h. Repeat steps 3a – 3d. If the hydrocarbon flow rate increased then repeat step 3g. If the hydrocarbon flow rate decreased then go to step 3e.

Notes:

1) Some of the oil recovery wells with variable frequency drives may still have pressure switches mounted on the discharge piping. These pressure switches are not in service. The undercurrent protection included in the variable frequency drive replaces the pressure switches.

2) Do not raise discharge piping above well casing more than ten feet to prevent breaking the PVC pipe.

3) Refer to the following drawings for locations of the water/recovery wells:

   E-400J7-0 Plot plan of North Property showing well locations.

   E-36137-10 Plot plan of complex showing well locations.

North Property Oil Recovery Well Troubleshooting Guide

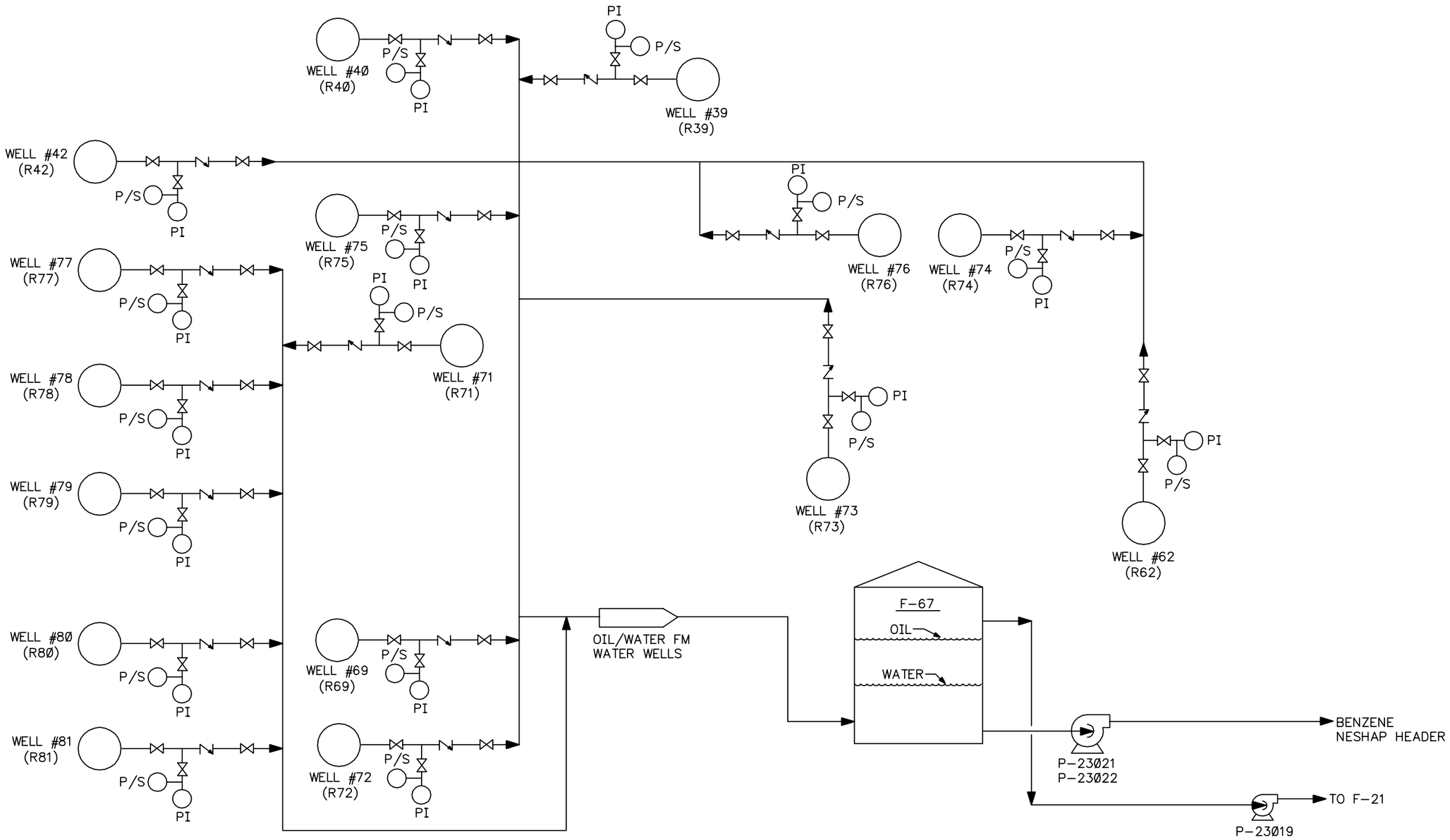
Fault	Possible Causes	Check Points	Corrective actions
I. Pump docs not operate.	a) Under current monitor tripped motor more than three times.	a) Check reset counter for number of motor restarts.	a) Lower pump suction. Reset counter.
	b) Motor tripped on overload amps.	b) Check overload indicator on drive	b) Reset overload protection after attempting one restart.
	c) No power to control panel.	c) Cheek control panel lights.	c) Check disconnect switch position.
	d) No power to well site.	d) Check water well operation.	d) Contact electrician.
2. Pump operates but produces no flow	a) Pump suction located too high.	a) Check sample line for flow.	a) Lower pump suction. Install additional discharge piping if necessary.
	b) Stuck check valve.	b) Check pressure gauge. Check sample line for flow. Check pump curve.	b) Shutdown well and open check valve body. Remove pump from well for inspection.
	c) Insufficient discharge pressure to enter system.	c) Check pressure gauge. Check flow meter. Check variable speed rpm.	c) Increase variable speed. (May need to lower pump suction.)
	d) Pump vapor locked.	d) Check sample line for liquid flow.	d) Block discharge from system. Connect hose to sample tap and route hose into bucket. Open sample tap and allow pump to operate for several minutes.
	e) Pump strainer plugged.	e) Check pressure gauge. Check pump curve.	e) Pull pump and clean strainer.
	f) Pump speed too slow	f)Verify drive speed setting	f) Adjust speed to 4,000 - 4,100 rpm and attempt to restart pump
3. Pump operating at lower capacity than expected.	a) Pump rotating backwards	a) Electrical leads may be reversed.	a) Contact electrician and reverse wire leads.
	b) Pump strainer plugged.	b) Check pressure gauge and flowmeter. Check pump curves	b) Gradually block in well discharge and record pressure. Compare to pump curve.
	c) Pump vanes plugged.	c) See item "B" listed above	c) See item "B" listed above
4. Pump cycles on/off too frequently	a) Pump suction too high.	a) Check pressure gauge.	a) Lower pump suction.
	b) Pump flow rate greater than recharge rate.	b) Check well operating level	b) Reduce motor variable speed and test undercurrent shut-off.
5. Pump does not shut off.	a) Undercurrent protection not functioning properly	a) *N/A*	a) Contact area electrician
	b) Motor speed set incorrectly	b) Verify drive speed setting	b) Adjust drive speed to 4,000 to 4,100 rpm and attempt restart.
6. No reading/display on flowmeter	a) No flow.	a) Check display button.	a) Increase variable speed.
	b) Dead batteries.	b) Check display button.	b) Replace batteries.
	c) Undercurrent protection not functioning properly	c) Contact area electrician.	c) Contact area electrician.

SUMMARY OF OIL RECOVERY WELLS

Water Well #	Recovery Well #	Straight Pipe or Flanged Top	Fixed/Variable Speed Drive	Well Location and Notes
Well 39	R-39	6" -150# Flange	Fixed	East of 7th and R St.
Well 40	R-40	6" Straight Pipe	Fixed	North of 7th and R St.
Well 42	R-75	6" -150# Flange	Fixed	West of 7th and R St by large filters. Water well and oil recovery wells have different numbers.
Well 64	R-64	6" -150# Flange	Variable	East of 7th and O St.
Well 67	R-67	6" Straight Pipe	Variable	South of 7th and R St. Install well casing extension pipe.
Well 69	R-69	6" Straight Pipe	Fixed	North of Well 72. There are cables around the well casing for inst. support
Well 71	R-71	6" Straight Pipe	Fixed	Along 1st St, Just South of OMC
Well 72	R-72	6" Straight Pipe	Fixed	North of 7th and L St. Metal tabs with holes welded to well casing O.D. Cables around well casing for inst. support
Well 73	R-73	6" Straight Pipe	Variable	South of 8th and R St.
Well 75	R-65	6" Straight Pipe	Fixed	North Of Well 69. Water well and oil recovery wells have different numbers.
Well 76	R-76	6" -150# Flange	Variable	Intersection of 8th and R St. Grundfos variable speed drive.
Well 77	R-77	6" -150# Flange	Variable	Northeast of 1st and M St.
Well 78	R-78	6" Straight Pipe	Variable	East of 1st and M St.
Well 79	R-79	6" Straight Pipe	Fixed	Near 2nd Street at N.P. Install well casing extension pipe.
Well 80	R-80	6" Straight Pipe	Fixed	South of Well 79
Well 81	R-81	6" Straight Pipe	Fixed	Located south of K St at N. Prop Bridge Install well casing extension pipe.

NORTH PROPERTY OIL RECOVERY WELLS
MECHANICAL MATERIAL LIST

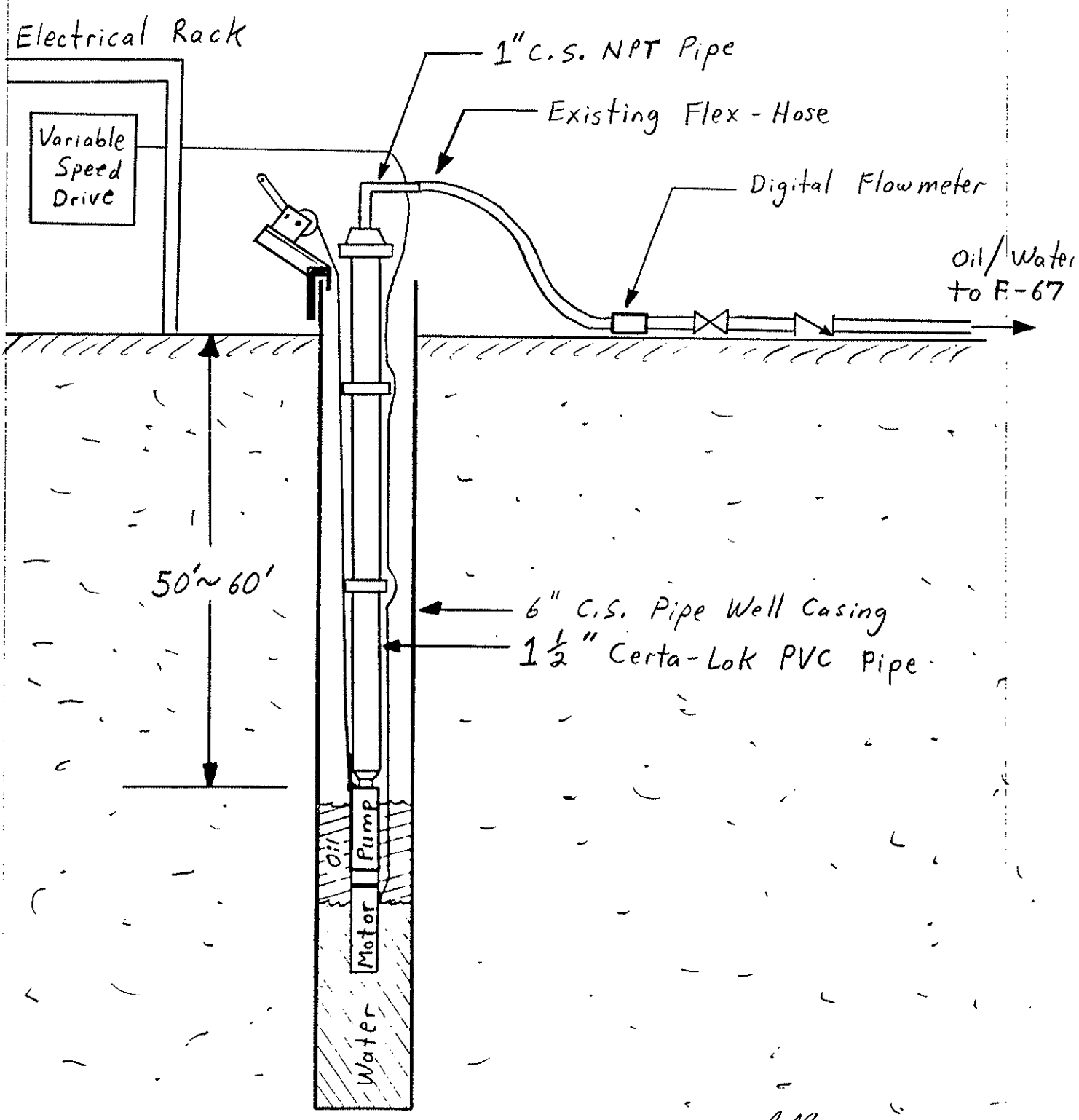
ITEM #	DESCRIPTION
1	Pump/Motor: Grundfos submersible Recti-Flo Pump model 5E8 Grundfos 2 HP, 460 V, 3 phase, pollution recovery motor
2	100' of TFZL motor lead 12/3 with ground.
3	10' sections of 1-1/2" CertainTeed Certa-Lok PVC Drop Pipe
4	1-1/2" Certa-Lok Coupling to fabricate 5' pipe lengths from 10' lengths.
5	1-1/2" Certa-Lok pipe to 1-1/2" NPT C.S. pipe adapter.
6	1-1/4"x 5' PVC sch 80 threaded pipe.
7	1-1/4" x 10' PVC sch 80 threaded pipe.
8	1-1/4" PVC threaded pipe coupling.
9	1-1/4" x 1" stainless steel pipe reducer.
10	3/8" torque control screw (set screw), 304 SS, for coupling drain plug,
11	Manual Winch
12	316 Stainless Steel Clip for "Clip N' Thimble" for 3/16" Steel Cable
13	316 Stainless Steel Thimble for "Clip N' Thimble" for 3/16" Steel Cable
14	Light Two Bolt Pipe Clamp, 1" Pipe, Stainless Steel. Figure 50
15	3/16" 7x19 Construction, 316 Stainless Steel Cable in 100' pre-cut lengths
16	Fabricated winch support to attach to top of recovery well 6" casing.
17	Fabricated two 5' PVC Certa-Lok pipe sections from one 10' section.
18	GPI Digital Flowmeter (A-107-GMS-025-NAI), 1" NPT Connections, S.S. with Total and Continuous Flow Readings.



SHELL OIL PRODUCTS US AT THE WRB REFINING LLC WOOD RIVER REFINERY ROXANA, ILLINOIS		PROJECT NO. 21562593
URS		
DRN. BY: djd April 2011 DSGN. BY: djd CHKD. BY: hwb	General – Simplified Flow Diagram North Property Oil Recovery Wells	FIG. NO. 2

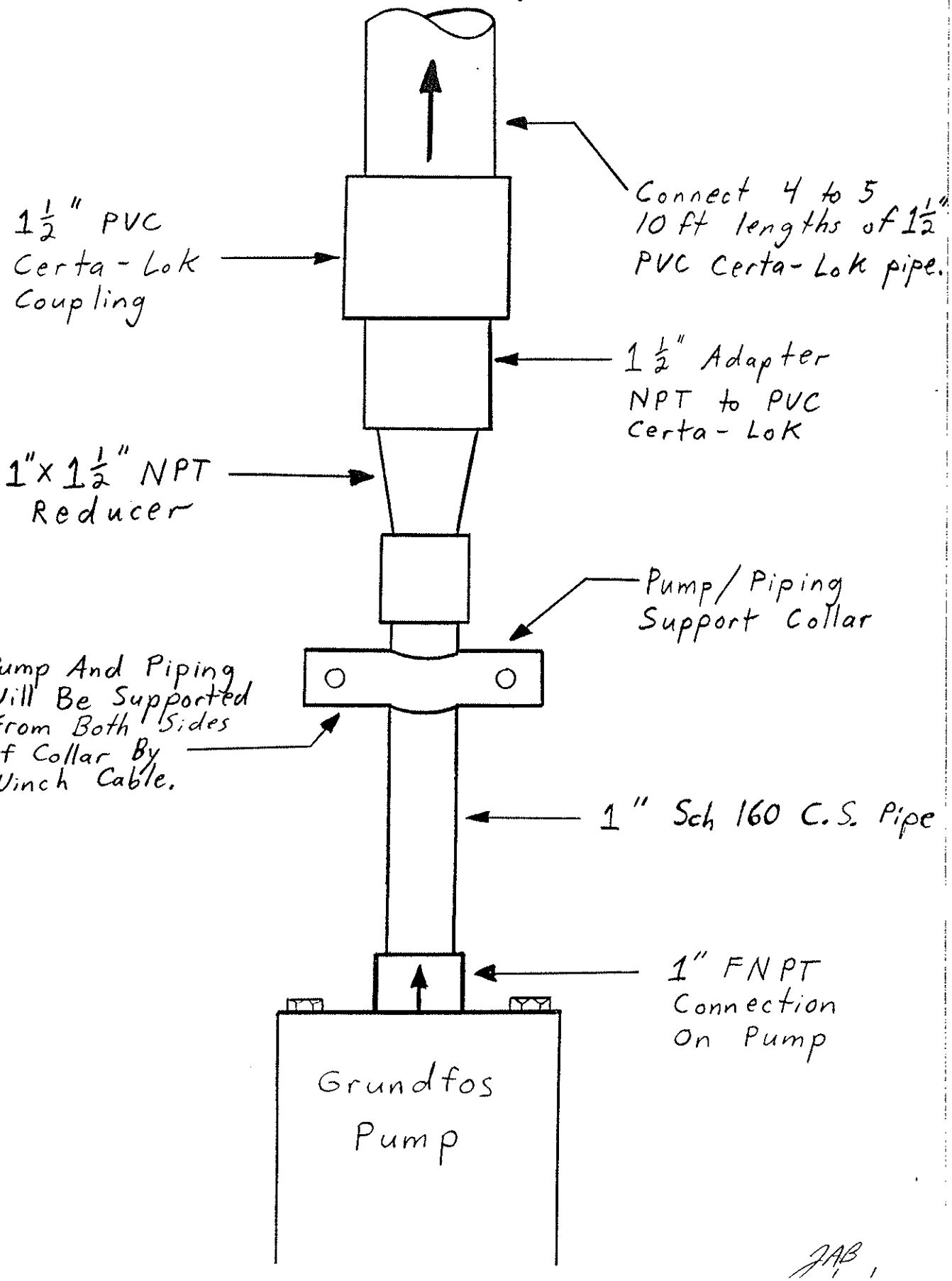
Proposed Equipment Arrangement

New North Property Recovery Wells



J.1B.

Detail of Pump/Piping Attachment



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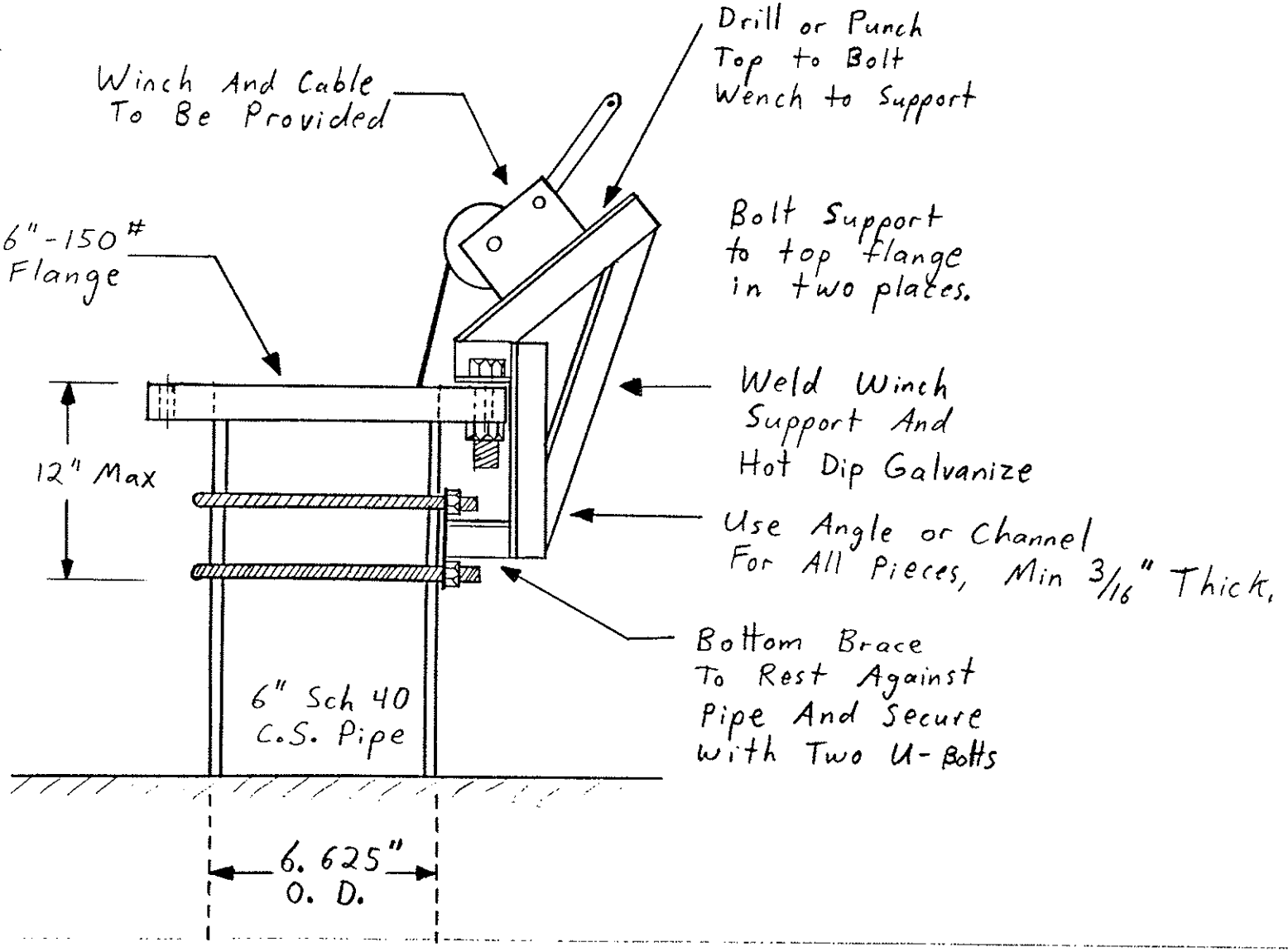
Winch Support For Skimmer Well Casing With Flange



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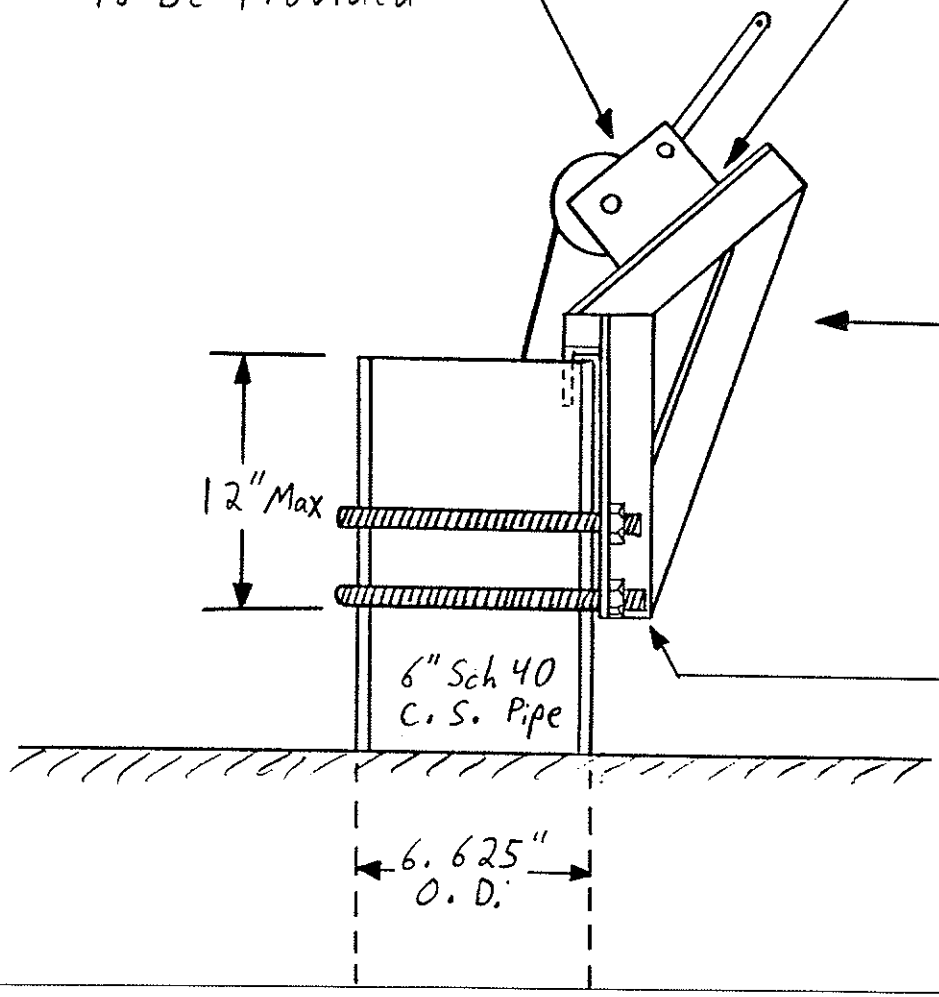
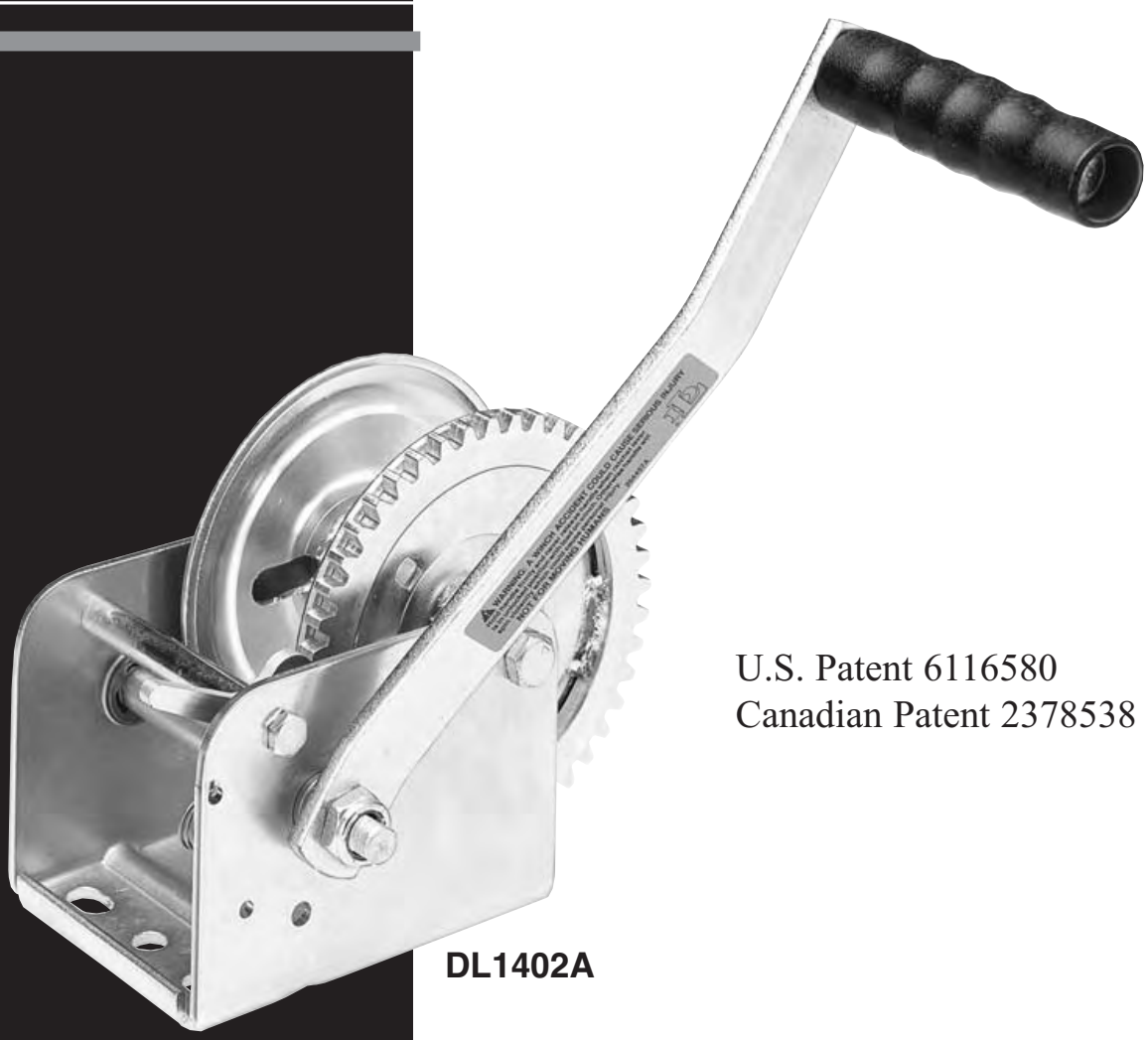
Winch Support For Skimmer Well Casing Without Flange



JAB 7/26/95

DL1402A, DL1602A, DL1802A, DL2102A

PULLING WINCHES



DL1402A

U.S. Patent 6116580
Canadian Patent 2378538

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MADE IN USA

ISO 9001: 2008 REGISTERED Q.M.S.

Dwg. No. 206304M 2/09

⚠ WARNING READ INSTRUCTIONS CAREFULLY BEFORE ATTEMPTING TO INSTALL, OPERATE OR SERVICE THIS WINCH. FAILURE TO COMPLY WITH INSTRUCTIONS COULD RESULT IN SERIOUS OR FATAL INJURY. RETAIN THESE INSTRUCTIONS FOR FUTURE REFERENCE.

⚠ IMPORTANT SAFETY INFORMATION

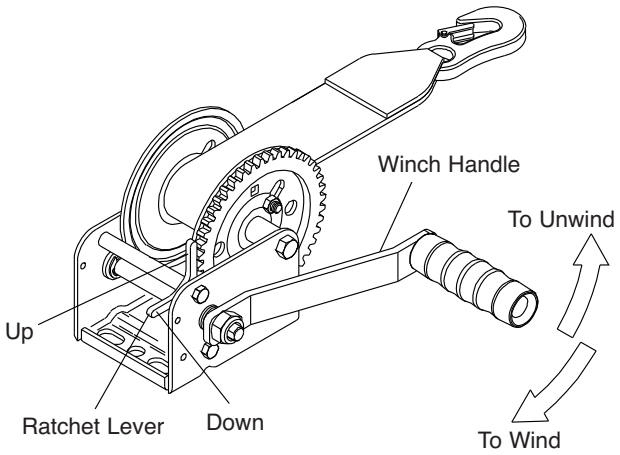
- This winch is built for multi-purpose hauling and pulling operations. It is not recommended for lifting applications. For lifting, use a self-locking winch. DL winches are not to be used as hoists for lifting, supporting or transporting people, or for loads over areas where people could be present.
- Respect this winch. High forces are created when using a winch, creating potential safety hazards. It should be operated and maintained in accordance with instructions. Never allow children or anyone who is not familiar with the operation of the winch to use it.
- Maintain a firm grip on the winch handle at all times, and never release the handle when ratchet lever is in unlocked position with a load on the winch. Otherwise, handle will spin violently, which could cause personal injury.
- Check for proper ratchet operation on each use of the winch. Do not use if damaged. Seek immediate repairs.
- Never use the winch handle as a convenient handle for pulling or maneuvering the entire trailer or other equipment. Never pull on the winch handle against a locked ratchet.
- Never exceed rated capacity. Excess load may cause premature failure and could result in serious personal injury. This winch is rated with three layers of line on the hub. Using more layers of line or a large hub increases the load on the winch.
- Never apply load on winch with cable or rope fully extended. Keep at least three full turns of cable or rope on the reel.
- Secure load properly. When winching operation is complete, do not depend on winch to support load.
- Operate with hand power only. This winch should not be operated with a motor of any kind. If the winch cannot be cranked easily with one hand, it is probably over-loaded.

WINCH MOUNTING AND CABLE ATTACHMENT – For maximum strength and safety, (and compliance with SAE Standard J1853) this winch should be mounted with three ⅜" or M10 bolts, washers, and lock washers. (See parts drawing).

Select a winch line with breaking strength at least 1-1/2 times the winch rating and a hook 1-1/2 times stronger than the line. If steel cable is selected, the optional reel with large hub may extend cable life. (The above combination meets SAE Standard J1853 for boat trailer winches).

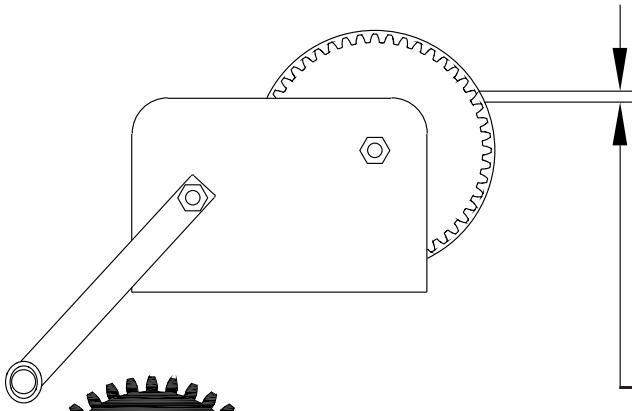
Attach cable or rope by either method described in sketch. If nylon strap is used, it should have a loop sewn in one end and be attached using a ⅜" x 3" (DL1402A & DL1602A) or ⅜" x 3¼" (DL1802A & DL2102A) long bolt and locknut. Use a locknut, not a nut and lockwasher. Insert bolt through slots in both reel sideplates so that nut is on gear side. Tighten only until snug with bolt in bottom of slot next to reel hub.

OPERATING INSTRUCTIONS – HANDLE AND NUT MUST BE TIGHTENED AGAINST DRIVE SHAFT BEFORE OPERATING WINCH. Wind line on winch reel by turning winch handle in clockwise direction with ratchet lever in up position. The ratchet should produce a loud, sharp clicking noise. Make sure that ratchet lever is in up position and holding load before winch handle is released. To unwind or reel out line, securely grip winch handle and apply force in clockwise direction so that ratchet lever can easily be moved to down position. Carefully turn handle in counterclockwise direction. Do not lose control. The winch can be converted to wind line on to the underside of the reel. To do this, carefully examine ratchet assembly and remove it from winch. Do not lose small parts. Turn the lever over and reassemble. Do not over tighten bolt. Check operation to insure the ratchet lever rotates fully without binding.



WINCH MAINTENANCE – This winch has been fully lubricated at the factory; but, for continued smooth performance and increased life, occasional greasing of gears and reel shaft and an occasional drop of oil on drive shaft bearings are recommended. Keep winch in good working order. Damaged or severely-worn parts create unnecessary dangers and could result in personal injury or property damage.

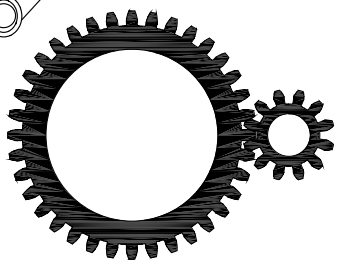
NOT FOR THE MOVEMENT OF HUMAN BEINGS



DL1402A – 1400 lbs/635 kg
DL1602A – 1600 lbs/726 kg
DL1802A – 1800 lbs/817 kg
DL2102A – 2100 lbs/953 kg

CABLE

DL1402A – ¼" x 40 ft (6 mm x 14.2 m)
DL1602A – ¼" x 58 ft (6 mm x 20 m)
DL1802A – 9/32" x 58 ft (7 mm x 17.9 m)
DL2102A – 9/32" x 58 ft (7 mm x 17.9 m)



DL1402A – 4.4:1
DL1602A – 5.4:1
DL1802A – 5.4:1
DL2102A – 5.4:1

CE

ENGLISH – EC DECLARATION OF CONFORMITY – Dutton-Lainson Company, Hastings, NE 68902-0729 U.S.A. manufactures and declares that this winch is in conformity with the essential health and safety requirements specified in The Supply of Machinery (Safety) Regulations 1992 and the provisions of The Machinery Directive (89/392/EEC). This declaration does not apply to other machinery using this winch.

DANSK – EØF OVERENSSTEMMELSESERKLÆRING – Dutton-Lainson Company, Hastings, NE 68902-0729 USA, fremstiller og erklærer, at dette skraldespil er i overensstemmelse med de væsentlige sundheds- og sikkerhedsregler som er specificeret i The Supply of Machinery, Sikkerhedsregulativer af 1992, og Maskineldirektiv (89/392/EØF). Denne erklæring gælder ikke andet maskineri, der benytter skraldespillet.

SUOMI – EY:N VAATIMUSTENMUKAISUUSVAKUUTUS – Dutton-Lainson Company, osoite Hastings, NE 68902-0729, USA, vakuuttaa tämän vintturin valmistajana, että vintturi noudattaa vuoden 1992 koneidentoimitussäännösten (Supply of Machinery [Safety] Regulations) olennaisia työterveys- ja turvallisuusvaatimuksia sekä konedirektiivin (89/392/ETY) määräyksiä. Tämä vakuutus ei koske muita laitteita, joissa vintturia käytetään.

NEDERLANDS – EG VERKLARING VAN OVEREENSTEMMING – Dutton-Lainson Company, Hastings, NE 68902-0729 VS, fabrikant, verklaart dat deze lier voldoet aan de fundamentele gezondheids- en veiligheidseisen zoals vastgelegd in de Machinerichtlijn (89/392/EEG) en de nationale wetgeving ter uitvoering van deze richtlijn. Deze verklaring is niet van toepassing op andere machines die gebruik maken van deze lier.

FRANÇAIS – DÉCLARATION DE CONFORMITÉ CE – Dutton-Lainson Company, Hastings, NE 68902-0729 U.S.A. construit ce treuil et déclare qu'il est conforme aux exigences de sécurité et de sûreté essentielles spécifiées dans «The Supply of Machinery (Safety) Regulations 1992» (règlements de sécurité relatifs à la fourniture de machinerie) et dans «The Machinery Directive» (directive relative à la machinerie) (89/392/CEE). Cette déclaration ne s'applique pas aux autres machines utilisant ce treuil.

DEUTSCH – EU-KONFORMITÄTSERKLÄRUNG – Dutton-Lainson Company, Hastings, NE 68902-0729 USA, der Hersteller der Winde, erklärt, daß das Produkt mit den grundlegenden Gesundheits- und Sicherheitsanforderungen übereinstimmt, die in den Bestimmungen zum Inverkehrbringen von Maschinen (Sicherheit) 1992 und den Bestimmungen der Maschinenrichtlinie (89/392/EWG) spezifiziert sind. Diese Erklärung gilt nicht für andere Maschinen, die diese Winde verwenden.

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PORTUGUÊS – DECLARAÇÃO DE CONFORMIDADE COM A CE – A empresa Dutton-Lainson Company, Hastings, NE 68902-0729, nos E.U.A., fabrica este guincho e declara que este está em conformidade com os requisitos essenciais de saúde e segurança, tal como especificados nos Regulamentos (de Segurança) para o Fornecimento de Máquinas de 1992 e como previsto na Directiva relativa a Máquinas (89/392/CEE). Esta declaração não se aplica a outras máquinas que utilizem este guincho.

ESPAÑOL – DECLARACION DE HOMOLOGACION PARA CE – Dutton-Lainson Company, de Hastings, NE 68902-0729, EE.UU., fabrica y declara que este cabrestante satisface los requisitos esenciales de salubridad y seguridad especificados en el Reglamento (de Seguridad) para Suministro de Maquinarias de 1992 y en las disposiciones de la Directriz de Maquinarias (89/392/EEC). Esta declaración no incluye los demás equipos que utilicen este cabrestante.

SVENSKA – FÖRSÄKRAN OM ÖVERENSSTÄMMELSE – Dutton-Lainson Company, Hastings, Nebraska 68902-0729 U.S.A. tillverkar och försäkrar att denna vinsch överensstämmer med de väsentliga hälso- och säkerhetskrav som specificerats i Maskinerifförordningar (säkerhet) 1992 och bestämmelserna i Maskineridirektiv (89/392/EEC). Denna försäkran gäller inte andra maskiner som använder denna vinsch.

ΕΛΛΗΝΙΚΑ – ΔΗΛΩΣΗ ΣΥΜΜΟΡΦΩΣΗΣ ΕΟΚ

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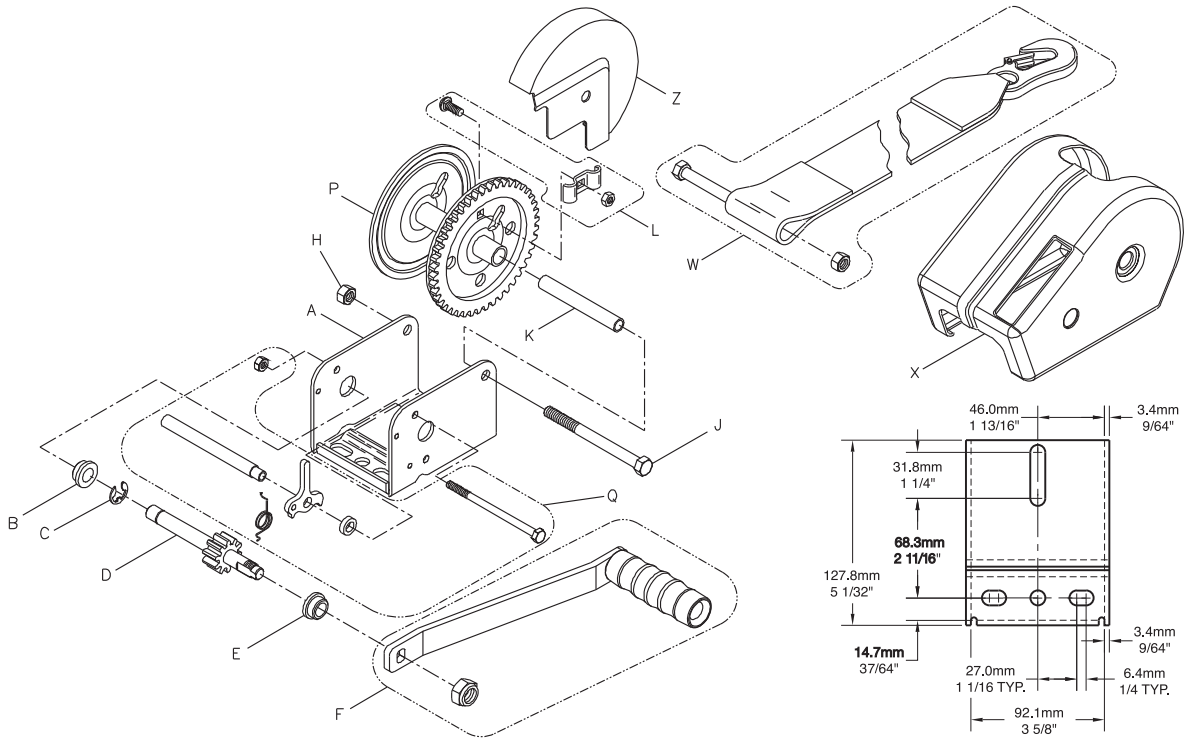
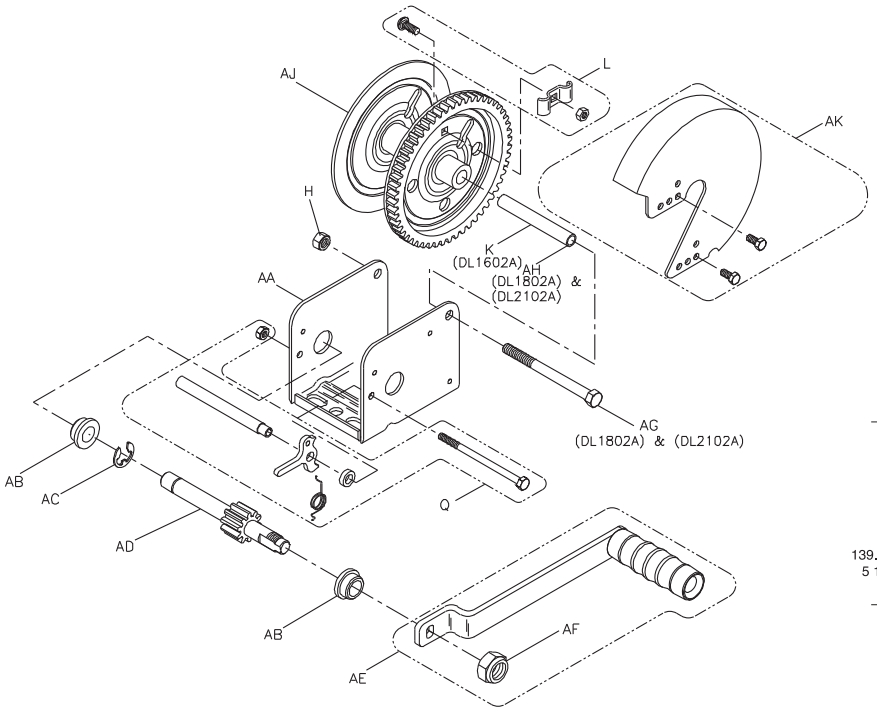
Ron Haase

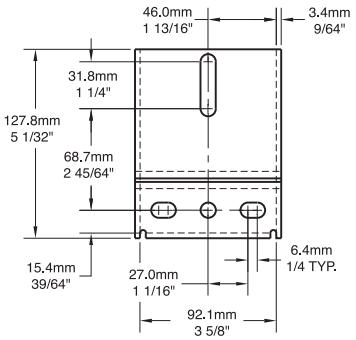
DL1402A



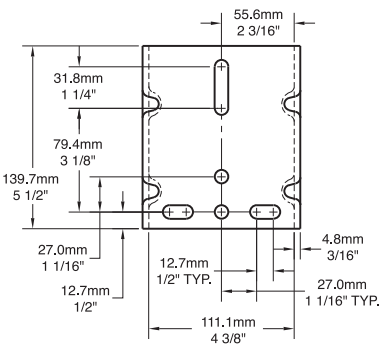
DL1402A

DL1602A, DL1802A & DL2102A





DL1602A



DL1802A & DL2102A

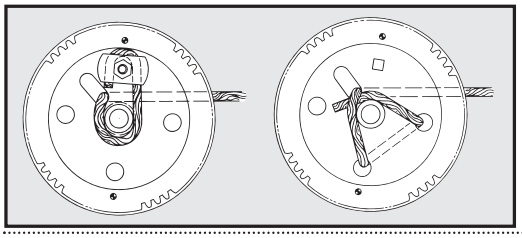
Ref	Description	Part No.
A	Base - DL1402A	404870*
B	Bushing	204006
C	E-Ring	205012
D	Drive Shaft	304722
E	Bushing	204007
F	Handle (6") w/Nut	5703657
F	Handle (7") w/Nut	5703046
F	Handle (9-1/2") w/Nut	5703251
H	Locknut	204803
J	Reel Shaft - DL1402A & DL1602A	203161
K	Spacer - DL1402A & DL1602A	204807
L	Rope Clamp Kit	5243506
P	Reel	304723*
P	Reel (1-7/8" Hub)	306062*
Q	Ratchet Kit - DL1402A and DL1602A	5704556
Q	Ratchet Kit - DL1802A and DL2102A	5704754
W	Strap, Opt. - 20'	5242607
X	Hand Winch Cover Kit, Opt.	5241203
Z	Gear Cover - DL1402A-PL, Opt.	5240197
Z	Gear Cover - DL1402A-BZ, Opt.	5240213

Ref	Description	Part No.
AA	Base - DL1602A	404874*
AA	Base - DL1802A	404884*
AA	Base - DL2102A	406022*
AB	Bushing	204009
AC	E-Ring	205116
AD	Drive Shaft - DL1602A	304725
AD	Drive Shaft - DL1802A & DL2102A	304731
AE	Handle (8") w/Nut	5146980
AE	Handle (9-1/2") w/Nut	5703236
AE	Handle (11")	306017
AF	Nut	204809
AG	Reel Shaft - DL1802A & DL2102A	205127
AH	Spacer - DL1802A & DL2102A	204808
AJ	Reel - DL1602A	304724*
AJ	Reel (2-1/2" Hub) - DL1602A	304769*
AJ	Reel (2-1/2" Wide) - DL1802A & DL2102A	304730*
AJ	Reel (2" Wide) - DL1802A & DL2102A	304779*
AJ	Reel (2-1/2" Hub) - DL1802A & DL2102A	304755*
AK	Gear Cover - DL1602A-PL, Opt.	5240221
AK	Gear Cover - DL1602A-BZ, Opt.	5240122
AK	Gear Cover - DL1802A/2102A-PL, Opt.	5240403
AK	Gear Cover - DL1802A/2102A-BZ, Opt.	5240387

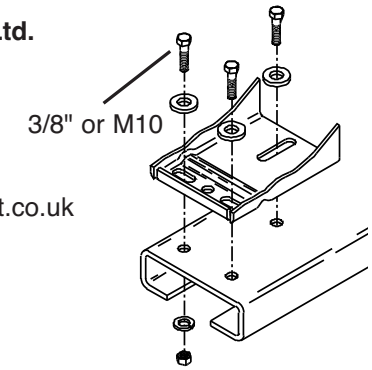
*Specify Color When Ordering

To order replacement parts:

Dutton-Lainson Company
www.dlco.com
Tel: 800-569-6577
Fax: 402-460-4612
e-mail: DLsales@dutton-lainson.com



In Europe Contact
Aqua Marine International Ltd.
8 Flanders Park
Hedge End, Southampton
Hants, England SO30 2FZ
Tel: 44 (0) 1489-776050
Fax: 44 (0) 1489-776055
e-mail: sales@aqua-marineint.co.uk



ENGLISH-To obtain a copy of the warranty in English, send a self-addressed envelope to: Dutton-Lainson Company; P.O. Box 729; Hastings NE 68902-0729; U.S.A.

DANSK-Man kan få garantibeviset på dansk ved at sende en svarkuvert til: Dutton-Lainson Company, P.O. Box 729, Hastings NE 68902-0729, USA.

SUOMI-Takuutodistuksesta saa suomenkielisen kopion lähettämällä riittävällä postimaksulla ja vastaanottajan osoitteella varustetun kirjekuoren osoitteeseen Dutton-Lainson Company, P.O. Box 729, Hastings NE 68902-0729, USA.

NEDERLANDS-Voor een exemplaar van de garantie in het Nederlands dient u een aan u zelf geadresseerde enveloppe te zenden naar: Dutton-Lainson Company; P.O. Box 729; Hastings NE 68902-0729; U.S.A.

FRANÇAIS-Pour obtenir une copie de la garantie en français, envoyer une enveloppe à votre nom et adresse à : Dutton-Lainson Company; P.O. Box 729; Hastings NE 68902-0729; U.S.A.

DEUTSCH-Wenn Sie eine deutsche Kopie der Garantibestimmungen erhalten möchten, senden Sie bitte einen adressierten Rückumschlag an: Dutton-Lainson Company; P.O.Box 729; Hastings NE 68902-0729; USA

ITALIANO-Per ricevere una copia della garanzia in italiano, inviare una busta riportante il proprio indirizzo a: Dutton-Lainson Company, P.O. Box 729, Hastings NE 68902-0729 USA.

NORSK-En kopi av denne garantien på norsk fås ved å sende en konvolutt med eget navn og adresse, til Dutton-Lainson Company, P.O. Box 729, Hastings NE 68902-0729, USA

PORTUGUÊS-Para obter uma cópia da garantia em português, envie um envelope com a sua morada para: Dutton-Lainson; P. O. Box 729; Hastings NE 68902-0729; E.U.A.

ESPAÑOL-Para obtener una copia de la garantía en español, envíe un sobre con su dirección impresa a: Dutton-Lainson Company, P.O. Box 729; Hastings NE 68902-0729 EE.UU.

SVENSKA-För att erhålla ett exemplar av garantin på svenska skicka ett adresserat kuvert till: Dutton-Lainson Company, P.O. Box 729, Hastings NE 68902-0729 U.S.A.

ΕΛΛΗΝΙΚΑ-Για να λάβετε ένα αντίγραφο της εγγύησης στα Ελληνικά, στείλτε ένα φάκελο εσωκλείοντας τα ταχυδρομικά τέλη αποστολής στην εξής διεύθυνση: Dutton-Lainson Company, P.O. Box 729, Hastings NE 68902-0729 U.S.A.

CertainTeed

CERTA-LOK™ DROP PIPE

PVC Well Products

CertainTeed

Quality made certain. Satisfaction guaranteed.

LOCK INTO THE ADVANTAGES OF CERTA-LOK™ PVC DROP PIPE

Certa-Lok™ Non-Threaded, Corrosion-Resistant PVC Drop Pipe

Certa-Lok™ PVC (Polyvinyl Chloride) Drop Pipe offers an instant, ready-to-use joint utilizing CertainTeed's unique, field-proven coupling/spline locking design, which allows submersible pumps to be set or pulled quickly and with confidence.

Certa-Lok PVC Drop Pipe is designed and manufactured to meet or exceed ASTM Specification D1785 requirements (SCH 80). Available in sizes 2" – 8", Certa-Lok PVC Drop Pipe is perfect for a wide range of deep and shallow-well applications, including:

- Domestic wells
- Irrigation wells
- Municipal wells
- Recharge wells
- Test pumps
- Offshore oil platform water supply systems

Certa-Lok PVC Drop Pipe offers you distinct advantages that will boost your bottom line.

Cost effective – Certa-Lok PVC Drop Pipe combines a competitive initial cost with a long life, making it the preferred product for submersible pump installations requiring 2" – 8" drop pipe.

Reliable – The Certa-Lok joint has been successfully used for over 30 years in various water supply applications.

Thread-free – With its groove and spline design, the Certa-Lok joint eliminates the need to constantly rotate the drop pipe for assembly and disassembly.

Easy to handle – 6" Certa-Lok PVC Drop Pipe weighs approx. 112 lbs. per 20' length compared to approx. 400 lbs. for 6" SCH 40 steel.

Easy to set and pull – The Certa-Lok joint is fast and easy to assemble and disassemble by hand. Just insert the pipe into the gasketed coupling, insert the locking spline and tighten the torque control screws. To disassemble, reverse these steps. For complete assembly instructions, see next page and back cover.

Weather resistant – Heat, cold, moisture, humidity and wind do not affect Certa-Lok PVC Drop Pipe joint assembly or disassembly.

Adaptable – Certa-Lok PVC Drop Pipe easily adapts to solvent weld discharge fittings such as Tees, Ells, Flanges, etc. Certa-Lok threaded adapters (PVC or stainless steel) allow easy connection to pumps, check valves and threaded discharge fittings.

Clean – Say goodbye to grease, thread lubricant and pipe dope that can contaminate water supplies.

Lower friction loss – Certa-Lok PVC Drop Pipe provides a flow coefficient of 150, vs. 100 for non-corroded metal drop pipe.

Chemical resistant – Certa-Lok PVC Drop Pipe can handle most corrosive fluids, subject to temperature service factors.

NSF listed, customer preferred – PVC compounds used in the manufacturing of Certa-Lok Drop Pipe are NSF61 listed after being tested for taste, color and toxicity. Many customers prefer to drink potable water pumped through PVC rather than water pumped through metal pipe.

Won't rust or corrode – The inherent properties of PVC prevent it from rusting and corroding like metal drop pipe.

Faster test pumping – Test pump installers can save considerable time and money by using quick, easy-to-assemble and disassemble Certa-Lok joints.

Readily available – Certa-Lok PVC Drop Pipe is available worldwide through your local CertainTeed Certa-Lok distributor.

RAPID JOINT ASSEMBLY

Certa-Lok PVC Drop Pipe is fast and easy to set and pull. You can assemble or disassemble the Certa-Lok joint in seconds – by hand, without any special tools. Since there are no threads, time spent rotating threaded pipe is completely eliminated. Follow these simple steps for rapid joint assembly:

1. **Clean**
   Clean the joining surfaces and make sure gaskets are clean and evenly seated in the gasket grooves.

2. **Lubricate**
   If lubrication is needed to ease joint assembly, soapy water or CertainTeed-approved PVC pipe lubricant can be applied to the joining surfaces prior to assembly. Apply only to the exposed gasket surface and to the tapered end of the drop pipe.

   CAUTION: To maintain joint integrity, do not apply lubricant to the spline or to the spline grooves.

3. **Assemble**
   Insert the drop pipe into the coupling until it seats against the coupling stop. This automatically aligns the locking grooves for receiving the spline. The spline is then inserted through the entry hole until it is fully seated. This securely locks the joint, while the gasket is designed to provide a reliable, watertight seal. The spline may then be cut so that only a short length protrudes from the coupling to facilitate future disassembly.
   In circumstances where there is a need to prevent sand infiltration into the joint (which can make coupling disassembly more difficult), wrap the coupling edges with waterproof tape and seal the spline entry holes with putty or similar material.

4. **Tighten torque control screws**
   Using an allen wrench, tighten the torque control screws into the coupling until each just touches the pipe. Then tighten each screw one-half to one full turn or until snug.

   CAUTION: Do not over-tighten. Over-tightening may result in leakage and/or coupling failure.

ENGINEERING SPECIFICATION

▼ *Offshore oil platform*

1.0 SCOPE

This specification covers Polyvinyl Chloride (PVC) Drop Pipe for submersible pumps, which utilizes a spline-lock mechanical joining system. Pipe is produced in nominal sizes 2" – 8".

2.0 REFERENCE DOCUMENTS

ASTM International:
ASTM D1784 – Standard Specification for Rigid PVC Compounds and Chlorinated PVC Compounds.

ASTM D1785 – Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

ASTM D2837 – Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.

NSF International:
NSF14 – Plastic Piping System Components and Related Materials

NSF61 – Drinking Water System Components – Health Effects

3.0 REQUIREMENTS

3.1 Materials: Pipe and couplings shall be made from unplasticized PVC compounds having a minimum cell classification of 12454, as defined in ASTM D1784. The compound shall qualify for a Hydrostatic Design Basis (HDB) of 4000 psi for water at 73.4° F, in accordance with the requirements of ASTM D2837. White pipe shall be supplied, unless otherwise agreed upon at time of purchase.

3.2 Approvals: Products intended for contact with potable water shall be evaluated, tested, and certified for conformance with NSF61, or the health effects portion of NSF14, by an acceptable certifying organization, when required by the regulatory authority having jurisdiction.

3.3 Physical Requirements: Standard pipe laying length is 20'. 10' long joints may also be supplied, if available. Nominal drop pipe diameter should be selected by the Design Engineer based on required flow rate, total dynamic head, pump weight, and setting depth/pumping level, utilizing manufacturer-supplied guidelines on allowable tensile loading, pressure, and torque limitations.

3.4 Performance: All pipe supplied to this specification shall meet the performance requirements of ASTM D1785 for SCH80 pipe.

3.5 Joints: Pipe shall be joined using a spline lock joint. High-strength, acid-resistant, flexible thermoplastic splines shall be inserted into mating precision-machined grooves to provide full 360° restraint with evenly distributed loading. No external pipe-to-pipe restraining devices which clamp onto or otherwise damage the pipe surface as a result of point-loading shall be permitted. The joining system shall incorporate elastomeric sealing gaskets which are designed to provide a watertight seal. Note that this specification does not cover pipe with threaded joints.

3.6 Adapters: Drop pipe shall be joined to pumps, check valves, pitless adapters, or other components using a PVC or Stainless Steel Drop Pipe Adapter provided by the same manufacturer as provides the drop pipe, and which utilizes the same spline lock joint as used on the drop pipe.

3.7 Marking: Drop pipe shall be legibly and permanently marked in ink with the following information:

- Manufacturer and Trade Name
- Nominal Size & SCH Rating
- Manufacturing Date Code
- (NSF-61)

3.8 Workmanship: Pipe and couplings shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions, blisters and dents, interior roughness, and other injurious defects that may affect wall integrity. The pipe and couplings shall be as uniform as commercially practicable in color, opacity, density, and other physical characteristics.

4.0 INSTALLATION

Installation of drop pipe shall be in strict accordance with manufacturer's procedures and recommendations. Prior to installation, drop pipe shall be visually inspected to ensure there is no dirt or foreign matter in the pipe, and any such material which is found shall be removed before installation.

5.0 SUGGESTED SOURCE OF SUPPLY

Certa-Lok PVC Drop Pipe
as supplied by:
CertainTeed Corporation
P.O. Box 860
Valley Forge, PA 19482
866-CT4-PIPE

◄ *Irrigation supply well*

QUICK SELECTION GUIDE

This guide provides a quick reference for evaluating proposed installations based on a set of generally conservative operational conditions. For a given surface discharge pressure, setting depth must be limited to the maximum values indicated.

This table should be used only for a preliminary assessment. Use the Design Worksheet which can be found at www.certainteed.com to obtain final calculations, or to engineer any installations which do not fit the table data or which exceed the setting depths shown.

	MAXIMUM DISCHARGE PRESSURE AT WELL HEAD, PSI										
	0	25	50	75	100	125	150	175	200		
SIZE	MAXIMUM PUMP SETTING DEPTH (FEET)									MAXIMUM FLOWRATE (GPM)*	MAXIMUM HP CAPACITY**
2"	422	380	338	296	253	211	169	127	84	80	20
3"	556	510	464	418	372	326	280	234	188	200	30
4"	489	441	394	347	299	252	205	157	110	350	50
5"	468	420	373	326	279	231	184	137	89	550	75
6"	493	445	397	349	300	252	204	156	108	800	100
8"	477	428	379	330	281	232	183	130	73	1400	125

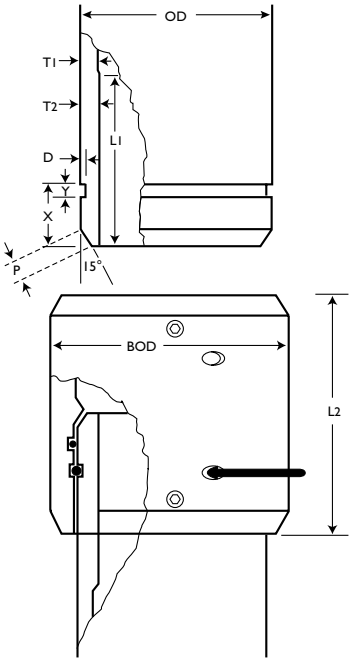
* Based on a maximum flow velocity of 10 fps to control transient surge pressures; lower velocities are preferred.
** "Soft-start" controls are recommended to minimize imposed torque, especially on the higher HP motors (50 HP and above).

SUPPORTING DATA

	SIZE	2"	3"	4"	5"	6"	8"
@ 73.4° or less	Maximum Hanging weight allowed at the top joint, lbs	1,307	3,209	4,506	6,612	9,617	15,214
	Maximum Pressure with threaded PVC Adapter, psi	250	230	200	175	170	150
	Maximum Pressure with threaded Stainless Steel Adapter, psi	375	309	288	274	280	232

DROP PIPE PRESSURE TABLES												
	2"		3"		4"		5"		6"		8"	
Flow GPM	Velocity fps	Friction Loss PSI/100 Ft	Velocity fps	Friction Loss PSI/100 Ft	Velocity fps	Friction Loss PSI/100 Ft	Velocity fps	Friction Loss PSI/100 Ft	Velocity fps	Friction Loss PSI/100 Ft	Velocity fps	Friction Loss PSI/100 Ft
10												
20	2.17	0.44										
30	3.26	0.93	1.46	0.13								
40	4.35	1.58	1.94	0.22								
50	5.43	2.38	2.43	0.34	1.40	0.09						
60	6.52	3.34	2.91	0.47	1.67	0.12						
70	7.61	4.45	3.40	0.63	1.95	0.16						
80	8.69	5.69	3.89	0.80	2.23	0.21	1.41	0.07				
90			4.37	1.00	2.51	0.26	1.59	0.08	1.11	0.04		
100			4.86	1.21	2.79	0.32	1.76	0.10	1.23	0.04		
150			7.29	2.57	4.19	0.67	2.65	0.22	1.85	0.09	1.05	0.02
200			9.71	4.38	5.58	1.14	3.53	0.37	2.46	0.16	1.41	0.04
250					6.98	1.72	4.41	0.56	3.08	0.23	1.76	0.06
300					8.37	2.41	5.29	0.79	3.69	0.33	2.11	0.08
350					9.77	3.21	6.17	1.05	4.31	0.44	2.46	0.11
400							7.06	1.35	4.92	0.56	2.81	0.14
450							7.94	1.67	5.54	0.70	3.16	0.18
500							8.82	2.03	6.15	0.85	3.51	0.22
550							9.70	2.43	6.77	1.01	3.86	0.26
600									7.38	1.19	4.22	0.30
700									8.62	1.58	4.92	0.40
800									9.85	2.02	5.62	0.52
900											6.32	0.64
1000											7.03	0.78
1100											7.73	0.93
1200											8.43	1.10
1300											9.13	1.27
1400											9.84	1.46

The Certa-Lok system utilizes precision-machined, self-aligning grooves in the pipe and coupling that allow a high-strength flexible spline to be inserted, resulting in a fully circumferential restrained joint that locks the pipe and coupling together. Flexible elastomeric gaskets (O-rings) in the coupling are designed to provide a reliable watertight pressure seal. Stainless steel torque control screws are used to prevent joint rotation.



Certa-Lok Drop Pipe										Certa-Lok Coupling		Certa-Lok Drop Pipe and Coupling		
		WALL*		L1	D								Approx. Weight	Part No.
Size	O.D.	T1	T2	Min.	Min.	Max.	X	Y	P	BOD	L2	Laying Length	Lbs./Ft. (with coupling)	Pipe & Coupling
2"	2.375	.218	.262	3.00	.100	.120	1.250	.313	1/4	3.200	4.50	20' 10'	1.002 1.049	661211 661112
3"	3.500	.300	.360	3.00	.100	.120	1.313	.375	1/4	4.380	4.50	20' 10'	1.991 2.079	662218 662119
4"	4.500	.337	.404	3.50	.125	.145	1.313	.375	1/4	5.470	5.00	20' 10'	2.909 3.039	663215 663116
5"	5.563	.375	.450	4.00	.125	.145	1.313	.375	1/4	6.625	5.50	20'	4.045	664212
6"	6.625	.432	.518	4.00	.125	.145	1.313	.375	1/4	7.840	6.00	20'	5.629	665219
8"	8.625	.500	.600	6.00	.135	.155	3.163	.500	21/32	10.190	10.00	20'	8.776	666216

* Minimum wall thickness

Notes

All dimensions are in inches and are subject to manufacturing tolerances.

Gaskets are Teflon® coated. Special lubricant may be used, but is generally not required.

CertainTeed also supplies 20' lengths of fully thickened Drop Pipe Nipple stock, which can be field cut (square cuts are essential) and grooved (a power tool is available) to place the pump at the required setting depth. 5' prefabricated joints are also available.

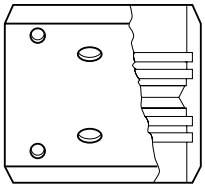
20' is standard length. Consult your distributor or CertainTeed for availability of 10' lengths prior to placing an order.

Packaging and Weights

Size	Laying Length	Feet per Fast-Pak	Fast-Paks per T/L	Feet per T/L	Lbs. per T/L
2"	20'	700	64	44800	44890
	10'	350	122	42700	44792
3"	20'	920	24	22080	43961
	10'	460	46	21160	43992
4"	20'	580	26	15080	43868
	10'	290	50	14500	44066
5"	20'	460	24	11040	44657
6"	20'	400	20	8000	45032
8"	20'	280	16	4480	39316

CERTA-LOK DROP PIPE COUPLING

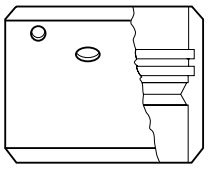
INCLUDES: GASKETS, SPLINES AND SCREWS



SIZE	PART NO.
2"	707209
3"	707216
4"	707223
5"	707230
6"	707247
8"	707254

CERTA-LOK DROP PIPE ADAPTER COUPLING

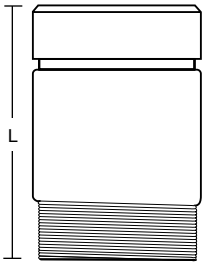
FEMALE BY SOLVENT WELD SOCKET
INCLUDES: GASKET, SPLINE AND SCREWS



SIZE	PART NO.
2"	708114
3"	708121
4"	708138
5"	708145
6"	708152
8"	708169

CERTA-LOK PVC DROP PIPE ADAPTER

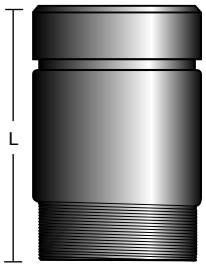
CERTA-LOK MALE BY MALE THREAD NPT



SIZE	PART NO.	L
2"	707513	6.00
3"	707520	6.25
4"	707537	7.00
5"	707544	7.25
6"	707551	7.50

CERTA-LOK 304 STAINLESS STEEL DROP PIPE ADAPTER

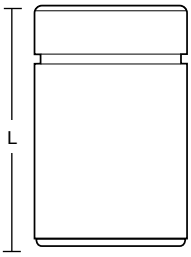
CERTA-LOK MALE BY MALE THREAD NPT



SIZE	PART NO.	L
2"	708015	6.00
3"	708022	6.00
4"	708039	6.00
5"	708046	6.00
6"	708053	6.00
8"	708060	9.00

CERTA-LOK PVC DROP PIPE NIPPLE

CERTA-LOK MALE BY PLAIN END



SIZE	PART NO.	L
2"	707414	6.00
3"	707421	6.25
4"	707438	7.00
5"	707445	7.25
6"	707452	7.50
8"	707469	8.00

CERTA-LOK DROP PIPE TORQUE CONTROL SCREWS

STAINLESS STEEL

SIZES	COUPLING SIZES	PART NO.
$^{3}/_{8}$" x $^{3}/_{8}$" L	2" – 3"	549519
$^{3}/_{8}$" x $^{1}/_{2}$" L	4" – 8"	549526

SPLINE

SIZE	PART NUMBER	SIZE (IN.)	LENGTH (IN.)
2"	865701	3/16 RND.	10.5
3"	865718	1/4 RND.	16
4"	865725	1/4 RND.	18
5"	865732	1/4 RND.	22
6"	865749	1/4 RND.	24
8	865756	5/16 SQ.	32

O-RING (GASKET)

SIZE	PART NUMBER
2"	861215
3"	861222
4"	861239
5"	861246
6"	861253
8"	862717

Certa-Lok Drop Pipe Application And Installation Guidelines

Certa-Lok Drop Pipe for submersible pumps is engineered and manufactured to provide long and reliable service in most well applications. For best results, the following guidelines must be observed when installing Certa-Lok Drop Pipe.

The CertainTeed Design Worksheet (www.certainteed.com) must be consulted to determine the appropriate size pipe for the proposed application. Select size carefully to accommodate the maximum anticipated flow rate, and always account for worst-case transient conditions (e.g., surge pressures, increased pressure at start-up, etc.). The discharge pressure used must account for the effect of any upstream piping, including changes of elevation. Maximum flow velocity of 10 fps is recommended to control transient surge pressures; lower velocities are preferred.

Handle pipe and couplings with normal care at all times, being particularly careful not to strike the pipe with any objects, especially in colder weather. When unloading the truck, lower pipe slowly to the ground.

Important: Do not use PVC Drop Pipe if there is the potential for pump-generated heat, which can occur if the system is allowed to operate continuously under zero flow/pump shut-off head conditions. Heat can greatly reduce the strength of thermoplastic materials. A safety cable or rope must be used on all installations due to this potential problem.

All Certa-Lok Drop Pipe application guidelines are given with the assumption that a check-valve is used at or within 20 feet of the pump and at higher elevations, as required, to control water hammer.

If surge pressures are not totally predictable due to potential variations in system operation, a properly sized pressure relief valve must be installed at the well-head. Use the Design Worksheet to verify that maximum system pressures, which develop when the relief valve actuates, do not exceed published pressure ratings.

Note: As CertainTeed cannot predict the degree of pump motion that may be experienced in a particular application due to factors such as mechanical unbalance, a centralizer or torque arrestor located directly above the pump should be considered, especially on deeper wells, to prevent the Drop Pipe from whipping and vibrating. Use and spacing of additional centralizers above the pump should be determined based on the particular installation conditions.

The Certa-Lok system incorporates coupling set-screws, which are tightened to provide resistance against torque imposed on the system by the pump motor during start-up. Set-screws should be tightened after the joint has been assembled and slack removed; manually filling the Drop Pipe with water before starting the pump will increase hanging weight, helping to remove slack from the joint and air from the system. Tighten with an allen wrench until set-screws are just touching the pipe; then torque each screw one-half to one full turn or until snug.

Caution: Excessive tightening of the set-screws will cause high local stresses, and may result in a joint that leaks under pressure. If a stainless steel adapter is used, a small indentation, or countersink, is recommended to provide a recess for the set-screws. This can be accomplished with a conventional power drill, after using the Certa-Lok coupling to mark the set-screw hole locations.

"Soft-start" controls are recommended to minimize imposed torque, especially on the higher HP motors (50 HP and above).

buildingresponsibly™

Building Responsibly with PVC Pipe

- PVC resin starts with two simple building blocks: chlorine (57%) from common salt, a plentiful inexhaustible raw material, and ethylene (43%) from natural gas. Most of the natural gas utilized to manufacture ethylene is domestically produced, which reduces consumption of imported oil products.
- PVC Pipe manufacturing is an extremely efficient process. The ability to immediately return scrap and off-specification materials (regrind) directly into the manufacturing process results in virtually no manufacturing waste.
- PVC Pipes are completely recyclable and consume less energy to produce than alternative pipes.
- Smooth and corrosion resistant PVC lowers flow losses and reduces energy costs for pumping water.
- Durability and long-life: The number of recorded failures in PVC pipes is low compared to other materials (AWWA Research Foundation, 2005)—valuable water resources are conserved.
- Considering equipment utilization and reduced traffic disruption, trenchless construction methods using restrained-joint PVC pipes result in significantly lower carbon outputs compared to conventional open-cut methods.
- PVC is often used to pump reclaimed, treated wastewater for applications such as irrigation of parks—conserves highly treated, expensive drinking water.

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EXTERIOR: ROOFING • SIDING • WINDOWS • FENCE • RAILING • TRIM • DECKING • FOUNDATIONS • PIPE
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P.O. Box 860
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www.certainteed.com

CertainTeed

40-37-4012

GRUNDFOS **REDI-FLO**
VARIABLE PERFORMANCE PUMPING SYSTEMS

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GRUNDFOS

GRUNDFOS **REDI-FLO**
VARIABLE FREQUENCY DRIVE

The Redi-Flo Variable Frequency Drive (VFD) has been uniquely designed to operate and protect the Redi-Flo2® Variable Performance Groundwater Sampling Pump and the Redi-Flo4® Variable Performance Sampling / Remediation Pumps. Due to the sophisticated electronics within the Redi-Flo VFD, the operator can easily change between the Redi-Flo2® Pump or the Redi-Flo4® Variable Performance Pumps by pressing a button. With the pressing of another button, the operator can precisely control the discharge flow rate from the pump from a maximum of 50 gallons per minute to a minimum of 100 milliliters per minute, to depths to 524 feet of head.

Unlike most variable frequency drives, the Redi-Flo VFD is compatible with either 120V or 230V single-phase, AC input power. The operator can simply change the power cord to accommodate the different voltages.

The Redi-Flo VFD can also be purchased without the carring case for use in dedicated applications.

THE UNIQUE FEATURES OF THE REDI-FLO VFD:

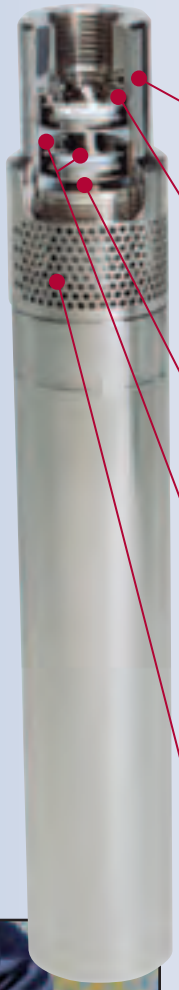
- **Precise Flow Control** — The push button control pad provides greater control over the pump's discharge flow rate for better accuracy and precision during sampling.
- **Wide Performance Range** — Instead of operating according to one performance curve, the Redi-Flo VFD allows for coverage of a range of performances and can function at any point of operation within that range.
- **Motor Protection** — The Redi-Flo VFD will protect the Redi-Flo Variable Performance Pumps from adverse motor conditions such as, over-and-under-voltage, over-current, and groundfault.
- **Dual Input Power Capability** — Either 120V or 230V, single-phase AC input power is accommodated simply by changing the power cord.
- **Dual Functionality** — The Redi-Flo VFD can be easily switched to operate either the Redi-Flo2® pump or the Redi-Flo4® Variable Performance Pumps.
- **Enclosure** — The Redi-Flo VFD NEMA 4 enclosure is designed for outdoor duty and is resistant to damage as a result of incidental exposure to rain or splashing water.

GRUNDFOS **REDI-FLO2® AND REDI-FLO 4™ VARIABLE PERFORMANCE PUMPS**

The Redi-Flo2® Variable Performance Pump combines state-of-the-art technology into a light, compact and yet powerful submersible pump for precise, accurate and reproducible groundwater sampling. Designed for long-term reliability in dedicated monitoring wells, the Redi-Flo2® provides optimal sample quality with either traditional purging prior to sampling, or low draw-down passive sampling when operated with the new Redi-Flo VFD.

The Redi-Flo4® Variable Performance Pumps are submersibles constructed of virgin Teflon® and stainless steel to handle the rigors of contaminated groundwater monitoring and continuous operation in remediation applications. The Redi-Flo4® Variable Performance Pumps are designed to operate in 4 inch and larger wells to depths of 524 feet. The Redi-Flo4® pumps have a built-in check valve to prevent back-flow in the well after the pump is shut down. A user-friendly cable guard aids in the ease of variable length motor lead installation.

Studies have shown the Redi-Flo2® Variable Performance Pump is the ideal sampling device for representative groundwater samples.



Discharge/Pump Housing*
corrosion-resistant with Female NPT discharge pipe connection

Integral Check Valve (Redi-Flo4® only)
offers reliable, jam-free back flow prevention

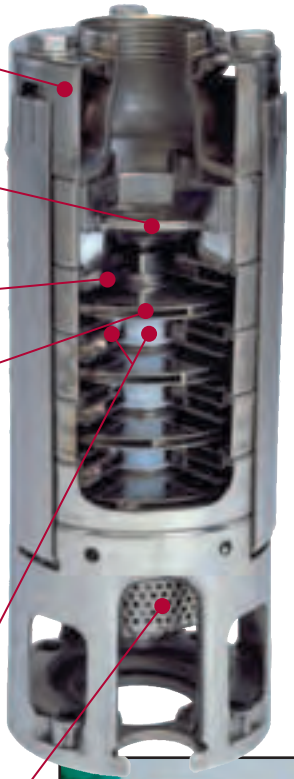
Guide Vane*
increases pump efficiency by providing optimal fluid movement

Impeller*
long-wearing, corrosion-resistant with a high strength-to-mass ratio; a fabricated design allows for optimum hydraulic performance

Spacer Ring and Wear Ring (Redi-Flo2® only)
placed at each impeller, eliminating vibration and maintains pump efficiency

Seal Ring and Intermediate Bearing (Redi-Flo4® only)
placed at each stage to support the shaft and maintain pump efficiency; constructed of 100% virgin Teflon®

Inlet Screen*
non-corrosive inlet screen prevents the impellers from clogging



The Redi-Flo4® provides up to 45 gallons per minute for purging and remediation.

Smooth, continuous, uninterrupted discharge flow rate is possible with the Redi-Flo2®.

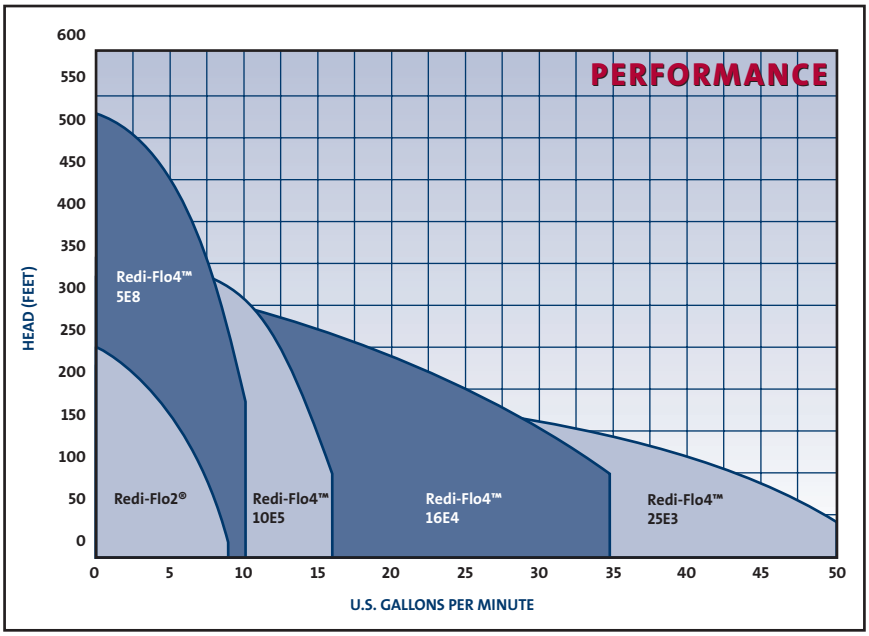
*On these features, the material of construction for the Redi-Flo2® is 316 stainless steel, and the Redi-Flo4® is 304 stainless steel.

GRUNDFOS

GRUNDFOS **ENVIRONMENTAL PRODUCTS**

MODELS	WELL SIZE	DISCHARGE SIZE*	FLOW RANGE GPM	HEADS TO: (FT.)
REDI-FLO2® VARIABLE PERFORMANCE PUMP				
MP1	2”	1/2”	100 ml/min - 9	250
REDI-FLO4® VARIABLE PERFORMANCE PUMPS				
5E8	4”	1”	100 ml/min - 10	524
10E5	4”	1-1/4”	100 ml/min - 15	356
16E4	4”	1-1/4”	100 ml/min - 35	302
25E3	4”	1-1/2”	100 ml/min - 50	234

*Female NPT



Contact:

VFD unit:

c UL LISTED

L-SI-SL-001 | 5/08
PRINTED IN USA

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Parque Industrial Stiva Aeropuerto
C.P. 66600 Apodaca, N.L. Mexico
Phone: 011-52-81-8144 4000
Telefax: 011-52-81-8144 4010

www.grundfos.com

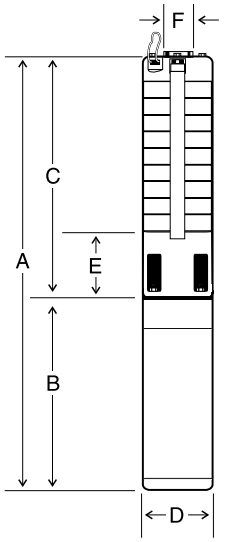
GRUNDFOS

Submittal Data

JOB or CUSTOMER:	
ENGINEER:	
CONTRACTOR:	
SUBMITTED BY:	DATE:
APPROVED BY:	DATE:
ORDER NO:	DATE:
SPECIFICATION REF:	

QUANTITY	TAG NO.	MODEL NO.	GPM	FEET	VOLT	PHASE	COMMENTS
					230	3	
					230	3	
					230	3	
					230	3	

Dimensions



Technical Data

FLOW RANGE:
5E8: 0 - 10 U.S. GPM
10E5: 0 - 15 U.S. GPM
16E4: 0 - 35 U.S. GPM
25E3: 0 - 50 U.S. GPM

MOTORS: Grundfos MS402E Environmental Submersible Motor
2.0 HP/ 230V/ 3PH
Maximum Operating Motor Temperature: 104°F (40°C)
Maximum Operating Pressure: 220 PSI
Maximum Number of Starts Per Hour: 100
Motor Fluid: Deionized water with 30% propylene glycol

DISCHARGE SIZE:
5E8: 1" NPT
10E5: 1 1/4" NPT
16E4: 1 1/4" NPT
25E3: 1 1/2" NPT

MATERIALS OF CONSTRUCTION: See reverse side.
INSTALLATION: Unit to be installed vertically for submerged operation.
MAXIMUM SETTING DEPTH: Not to exceed 600 ft.
MAXIMUM SUBMERGENCE: 500 ft.

Electrical Data, Dimensions, and Weights

Model	Motors				DIMENSIONS IN INCHES						Net Weight (Lbs.)*	Ship. Weight (Lbs.)*
	HP	SF	PH	Volts	Overall Length A	Motor Length B	Pump End Length C	Max. Dia. D	Inlet E	Disch. Pipe Size (NPT) F		
5E8	2	1.25	3	230	26 3/16	13 7/16	12 3/4	3 31/32	3 1/4	1	37	39
10E5	2	1.25	3	230	23 3/4	13 7/16	10 5/16	3 31/32	3 1/4	1 1/4	35	37
16E4	2	1.25	3	230	22 7/8	13 7/16	9 7/16	3 31/32	3 1/4	1 1/4	34	36
25E3	2	1.25	3	230	22	13 7/16	8 9/16	3 31/32	3 1/4	1 1/2	34	36

* Does not include motor leads.

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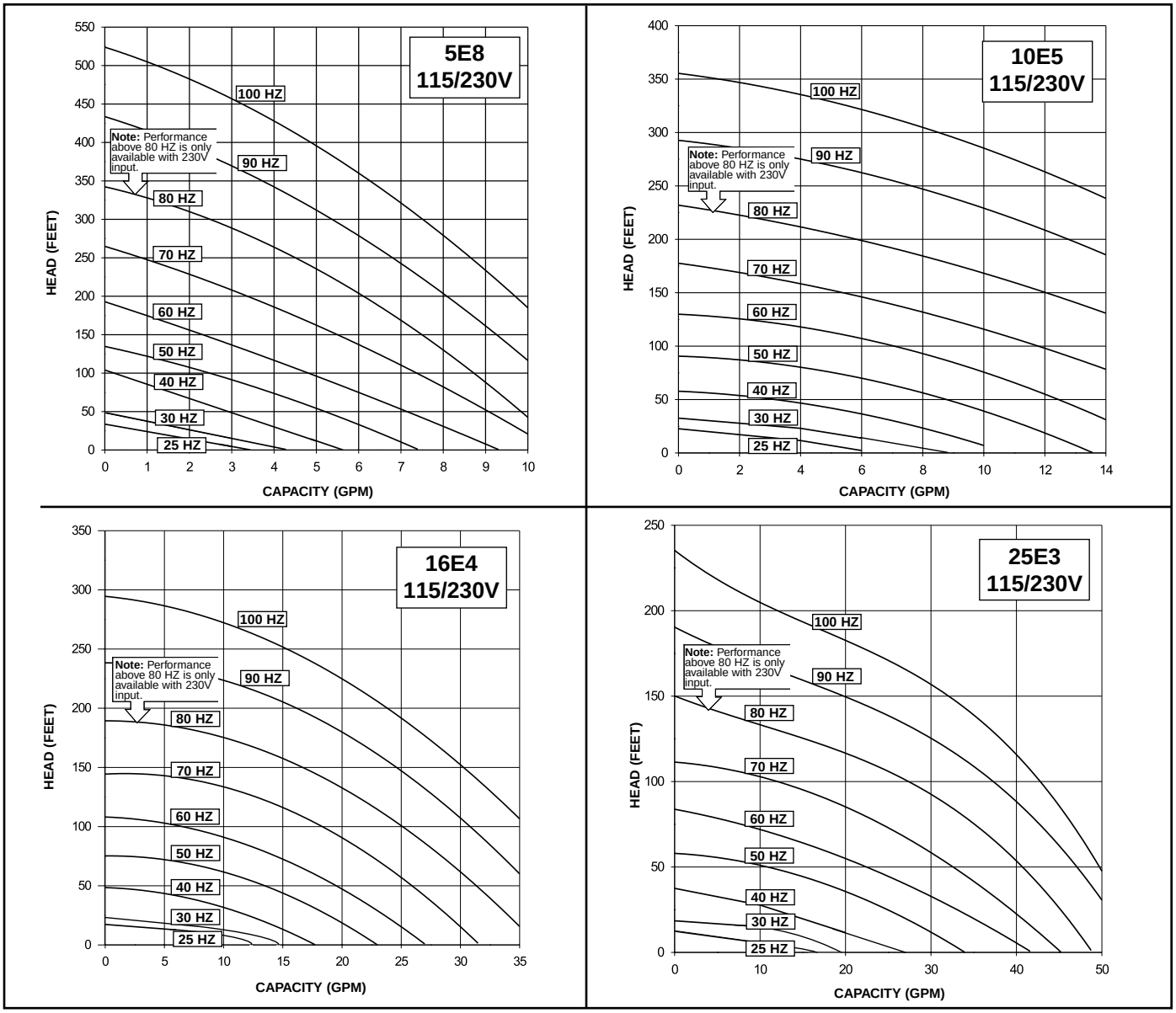
Being responsible is our foundation
Thinking ahead makes it possible
Innovation is the essence

Performance Curves

Redi-Flo4™ Variable Performance Pumps



Materials of Construction

REDI-FLO4 PUMP END

Description	Material
Check Valve Housing, Check Valve, Diffuser Chamber, Impeller, Suction Interconnector, Inlet Screen, Pump Shaft, Straps, Cable Guard, Priming Inducer	304 SS
Check Valve Seat	304 SS & Teflon®
Impeller Seal Ring	Teflon®
Coupling	329/420/431 SS
Intermediate Bearings	Teflon®

GRUNDFOS ENVIRONMENTAL MOTOR

Description	Material
NEMA Flange, Studs & Fasteners, Stator Housing, Fill Plug Screw	304 SS
Nuts	316 SS
Sand Slinger	FPM
Motor Shaft	431 SS
Diaphragm	FPM
Fill Plug Washer	Teflon®

GRUNDFOS ENVIRONMENTAL MOTOR LEADS

Description	Material
Connector Sleeve	304 SS
Connector Potting	Scotch Cast #4® Epoxy w/FPM Cap
Connector Plug	FPM
Lead Insulation	Tefzel (Teflon® Blend)

NOTES: Specifications are subject to change without notice.
Teflon® is a registered trademark of DuPont.
Scotch Cast #4® is a registered trademark of 3M company.

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GRUNDFOS®

ELECTRONIC DIGITAL METER

03 Series Owner's Manual

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GREAT PLAINS INDUSTRIES, INC.
"A Great Plains Ventures Subsidiary"
www.gpi.net
1-800-835-0113

07/08

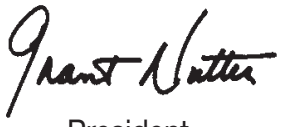
Rev. B 920685-09

To the owner…

Congratulations on receiving your GPI Electronic Digital Meter. We are pleased to provide you with a meter designed to give you maximum reliability and efficiency.

Our business is the design manufacture, and marketing of liquid handling, agricultural, and recreational products. We succeed because we provide customers with innovative, reliable, safe, timely, and competitively-priced products. We pride ourselves in conducting our business with integrity and professionalism.

We are proud to provide you with a quality product and the support you need to obtain years of safe, dependable service.



President
Great Plains Industries, Inc.

TABLE OF CONTENTS

GENERAL INFORMATION

This manual will assist you in operating and maintaining your 03 Series meter. Differences in models are detailed in the Specifications Section of this manual. Please take a few moments to read through this manual before installing or operating your meter. If you need assistance, contact the dealer from whom you purchased your meter.

If You Measure in Litres

This manual commonly refers to "gallons." Your meter is factory calibrated in gallons and litres, consider all references to "gallons" apply equally to "litres."

This symbol is used throughout the manual to call your attention to safety messages.

⚠ WARNING **Warnings** alert you to the potential for personal injury.

⚠ CAUTION **Cautions** call your attention to practices or procedures which may damage your meter.

Notes give you information that can improve efficiency of operations.

It is your responsibility to make sure that all operators have access to adequate instructions about safe operating and maintenance procedures.

Safety Instructions

For your safety, review the major warnings and cautions below before operating your meter.

1. This meter is approved to handle only fluids which are compatible with the meter's housing material.
2. When metering flammable liquids, observe precautions against fire or explosion.

3. When handling hazardous liquids, always follow the liquid manufacturer's safety precautions.
4. Always dispose of used cleaning solvents in a safe manner according to the solvent manufacturer's instructions.
5. During meter removal, liquid may spill. Follow the liquid manufacturer's safety precautions to clean up minor spills.
6. Do not blow compressed air through the meter.
7. Do not submerge the meter.
8. Do not allow liquids to dry inside the meter.
9. Do not use a wrench to install plastic meters. Hand tighten only.
10. For best results, always verify calibration before use.

INTRODUCTION

Your Electronic Digital Meter is designed for measuring liquids. The meter translates pulse data from the turbine into calibrated flow units shown on the meter's readout. Field replaceable batteries provide power.

All meters are tested and factory calibrated before shipping.

This manual refers to three families of meters: Low Flow, One Inch, and Two Inch. To further identify your particular model, refer to the Specifications Section at the end of this manual.

BEFORE INSTALLATION

Upon receipt, examine your meter for visible damage. Remove protective plugs and caps for a thorough inspection. If any items are damaged or missing, contact your distributor.

Make sure the meter model meets your specific needs. Refer to the Specification Section and confirm the following:

1. Your flowrate is within the limits of your model.
2. Your liquid is compatible with your meter's material.
3. Your system's pressure does not exceed the meter's maximum pressure rating.

Quick Start

If your installation is relatively simple and you have installed our Electronic Digital Meter (EDM) meters before, you may use this section to quickly install and operate your meter. This section is especially helpful to those measuring thin viscosity fluids dispensed through a hose and nozzle.

If you complete this section and encounter difficulties, please refer to other sections, as necessary.

NOTE: To accommodate different installations, the faceplate can be rotated 180°. To do this, remove the four corner screws from the face of the meter and lift the computer assembly from the turbine. Rotate the computer assembly 180°. Place on the turbine ensuring the seal is fully seated. Secure the four screws.

Connections

1. To protect against leakage, make sure all threads are sealed with two or three turns of thread tape or a sealing compound compatible with the liquid being metered. (Figure 1)

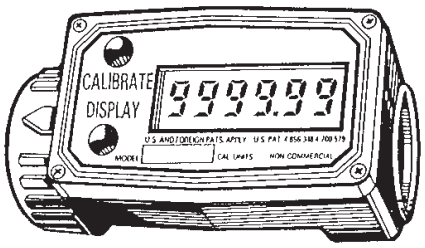
Figure 1

⚠ CAUTION

Make sure the thread tape or sealing compound does not interfere with flow.

2. Make sure the arrow on the outlet is pointing in the direction of the flow. (Figure 2)

Figure 2



3. Tighten the meter onto the fittings. Use a wrench only on metal meters. Hand tighten plastic meters.

⚠ CAUTION

Using a wrench on plastic meters could damage the meter.

Verify Meter Accuracy

Before using, you should check the meter's accuracy and verify calibration.

1. Make sure there is no air in the system by starting the flow until it runs steadily. Then, stop the flow using a valve or nozzle.
2. If desired, hold down DISPLAY for 3 seconds to zero the meter's Batch Total. When zeros appear, release the button.
3. Meter an exact known volume into an accurate container. For best results, meter with one continuous full stream.
4. Check the readout. If the amount metered is accurate, field calibration is not necessary. If not, refer to the Calibration Section for further instructions.

Using the Meter

The meter turns on automatically when fluid flow starts and, to conserve power, turns off automatically shortly after flow stops.

The meter can also be turned on manually by pressing and releasing the DISPLAY button.

To determine the exact volume measured with each use, use the Batch Total function. You can zero the Batch Total before measuring and monitor volume as it flows through the meter, just like the gas pump at the service station as you fill up your tank.

To zero the Batch Total, make sure the meter is on. Hold down the DISPLAY button for 3 seconds until zeros appear. Release the button, start the flow, and watch the volume on the readout.

NOTE: If LOCKED appears on the readout, the Cumulative Total is displayed. It cannot be manually zeroed. To select the Batch Total, press and release DISPLAY until LOCKED does not appear on the bottom line.

If the numbers in the readout are dim or fading, the batteries need replacement. Refer to the Maintenance Section for more details.

INSTALLATION

Review the Before Installation and Quick Start Sections. Also consider the following recommendations, especially if you are installing your meter in a piping system. These suggestions will help maximize performance of your meter.

The meter can be mounted either vertically or horizontally. It should be field calibrated in the same orientation in which it is mounted.

Avoid installing the meter in electrically "noisy" environments. If installed within 6 inches (15.2cm) of large motors, relays,

vehicle ignition systems, or transformers, the meter's accuracy can be adversely affected.

To avoid pulsation or swirl, use the following recommendations.

For Low Flow or One Inch Meters, install with

- 20 inches (51cm) of straight pipe upstream and
- 5 inches (13cm) of straight pipe downstream.

For Two Inch Meters, install with

- 40 inches (102cm) of straight pipe upstream and
- 10 inches (26cm) of straight pipe downstream.

Flow straightening vanes installed upstream from the meter can reduce the upstream pipe length.

Flow control valves upstream from the meter and within the straight pipe distances given earlier can adversely effect meter accuracy. This is especially true when measuring liquids with low vapor pressures such as fuels, oils and solvents.

If cavitation effects meter accuracy, a flow control valve on the downstream side of the meter can provide a back pressure of 5 to 50 PSI (0.3 to 3.4 bar) to minimize the problem.

Foreign material in liquid can clog the meter's rotor. If the problem affects meter accuracy or material coats the rotor, install screens to filter the incoming flow.

- For Low Flow Meters use a 25 micron or .005 inch screen, 55 mesh.
- For One Inch or Two Inch Meters use a 500 micron or .018 inch screen, 28 mesh.

For maximum accuracy, the velocity profile of the flow entering the meter must be uniform throughout the cross section of the pipe.

OPERATIONS

All meter operations are reflected in the readout on the face of the meter. The readout contains three lines of information. They are generally defined as follows:

- The top line identifies the calibration curve,
- The middle line reflects flow information, and
- The bottom line shows information from the totalizer.

The words or "flags" that display on the top and bottom line further identify specific information.

Turn On

The meter is on when any display is present. It turns on automatically when liquid flows through the meter. It can be turned on manually by pressing and releasing the DISPLAY button.

Turn Off

The meter turns off automatically shortly after flow stops. When the meter is off, the readout is blank.

Batch and Cumulative Totals

Total flags are displayed on the bottom line. There are two types of totals: Batch Total and Cumulative Total.

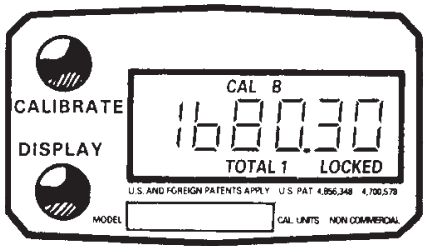
A Batch Total indicates totalization flow during a single use. It is the total liquid metered since the last manual clearing of this total. For example, the Batch Total indicates when you have metered 20 gallons of diesel into your truck's tank (like the pump at the gas station).

Batch Total is labeled with TOTAL followed by a number. On most models this is TOTAL 2.

The Cumulative Total is the total of all liquid measured since the meter's power supply was connected. At your first use, the Cumulative Total is not zero because of calibration at the factory.

The Cumulative Total is labeled TOTAL 1 and **always** flagged with the word LOCKED indicating that this total is locked and cannot be manually zeroed. (Figure 3)

Figure 3



Select Totals

To change between totals, press and release DISPLAY.

NOTE: Generally, readout displays change when buttons are **released**.

Clear Batch Total

Make sure a Batch Total is displayed. To clear, press and hold DISPLAY for 3 seconds or until the readout changes to zeros.

Clear Cumulative Total

Cumulative Totals are zeroed only when batteries are removed or go dead or when the Cumulative Total reaches the maximum value of 999,999.

Calibration Curves

Calibration Curve information is shown on the top line of the readout. There are two types of calibration curves: Field Calibration and Factory Calibration.

A Field Calibration Curve is set by the user. It can be changed or modified at any time using procedures given in the Calibration Section.

If a Field Calibration has not been completed, the meter uses the Factory Calibration.

A Factory Calibration Curve is "preset" by the manufacturer and stored permanently in the meter's computer. Factory Calibration curves display PRESET on the top line.

Select Calibration Curves

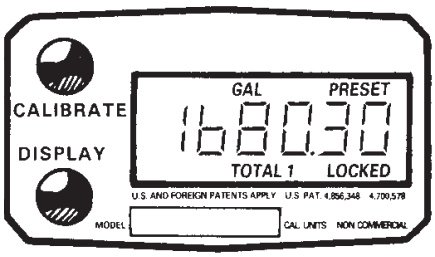
To change between a Field Calibration curve and a Factory Calibration curve, hold CALIBRATE down while pressing and releasing DISPLAY. When the desired calibration curve appears, release both buttons.

NOTE: In this case, the CALIBRATE button acts like a "Shift" key on a typewriter, shifting the operations of the DISPLAY button to change the top line of the readout.

Field Calibration is labeled with CAL followed by a letter. On most models this is CAL B.

All units are configured with a "factory" calibration curve. Both gallons and litres are available ("GAL" or "LTR" will be displayed). Use the CALIBRATE and DISPLAY buttons to switch between gallons and litres. This curve is NOT user adjustable: the word "PRESET" is displayed to show this (Figure 4). The factory calibration is stored permanently in the computer's memory.

Figure 4



The "field" calibration curve(s) may be set by the user, and can be changed or modified at any time using the calibration procedure described in the Calibration section.

Selecting a Different Calibration Setting

You can switch between GAL or LTR modes at will without "corrupting" totalizer contents. For example, the computer can totalize 10.00 gallons. If the user switches to LTR mode, the display will immediately change to "37.85" (the same amount in units of litres).

To select a different calibration setting, first press and hold the CALIBRATE button. Continue to hold it while also briefly pressing and releasing the DISPLAY button (you may then also release the CALIBRATE button). The flag indicators in the upper area of the display will change to show the newly selected calibration setting. Calibration settings change in this order: GAL, LTR, CAL B, GAL (etc.). While fluid is flowing only the GAL and LTR selections may be made, however, when NO fluid flow is occurring, any setting may be selected.

Propeller

Any time liquid flows through the meter, a small propeller displays.

Normal Precautions

Check the following items frequently to insure proper operation and measurement.

1. Make sure there are no leaks in the connections. To seal leaks, remove and inspect the meter and replace the thread tape or sealant. Refer to the Troubleshooting Section.
2. A dim or fading readout indicates loss of power. To restore power, replace the batteries and check for corrosion on the battery terminals. Refer to the Maintenance Section.
3. Verify meter accuracy before use. To do this, measure a known quantity of liquid into a calibration container and compare the volume measured against the readout. If necessary, field calibrate the meter. Refer to the Calibration Section.
4. To ensure accurate measurement, remove all air from the system before use. To purge the system of air:
   a. Open the discharge valve or nozzle and allow fluid to completely fill the system. Make sure the stream is full and steady and no air is present.
   b. Close the discharge valve or nozzle. Leave the system on.
   c. Start normal operations. If necessary, zero the Batch Total.

⚠ WARNING

If handling hazardous liquids, always follow the liquid manufacturer's safety precautions. Wear protective clothing such as goggles, gloves, and respirators as instructed.

⚠ WARNING

When metering flammable liquids, observe precautions against fire or explosion. Do not meter in the presence of any source of ignition including running or hot engines, lighted cigarettes, or gas or electric heaters.

CALIBRATION

The two types of calibration are Field Calibration and Factory Calibration. These are defined in the Operation Section. This section deals with the Field Calibration specifics and procedures. It also gives more specific information about Factory Calibration.

Field Calibration is necessary when Factory Calibration accuracy is not acceptable.

Factory Calibration is completed with a thin viscosity liquid. If you are dispensing liquid which has a different uniform viscosity, a Field Calibration can improve meter accuracy. If your liquid is very thick, multiple points at different flowrates can improve accuracy.

Calibration Container

The desired calibration container should be uniformly dependable and constructed with a graduated neck. The container's volume indicator should be clearly and precisely marked. It is helpful if the container's material allows a window through which the level of liquid can be viewed.

Two Inch Meter Field Calibration

Due to high flowrate, the Field Calibration of 2" meters should be considered carefully. It is strongly recommended that Field Calibration of these meters be completed with a combination of volume and weight. Only fine resolution scales should be used.

Before Starting Field Calibration

For successful Field Calibration, please review the following before beginning.

For most accurate results, dispense at full flow. Quickly start and stop at full flow as many times as necessary to reach the desired volume. Do not "choke" or "trickle" the flow to reach that volume.

Use an accurate calibration container.

Meet the meter's minimum requirements for flowrate.

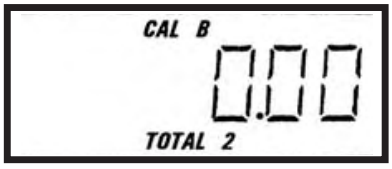
- Low Flow minimum calibration flowrate is 0.3 GPM (1.5 LPM).
- One Inch minimum calibration flowrate is 3 GPM (12 LPM).
- Two Inch minimum calibration flowrate is 30 GPM (114 LPM).

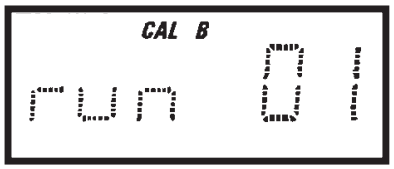
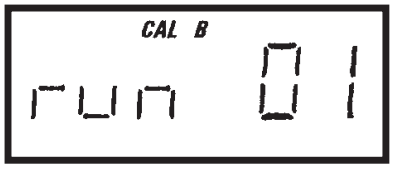
Use the correct button sequence during the calibration procedure.

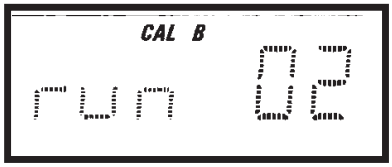
Install your meter on your system according to the installation instructions given earlier in this manual.

Immediately prior to calibration, purge the system of air by turning on the system and dispensing until the flow stream is full and steady. Stop the flow, but leave the system running.

Dispense-Display Field Calibration Procedures

Your Actions	Notes
1. Hold down CALIBRATE while pressing and releasing DISPLAY until the Field Calibration curve appears ("CAL B" message will be displayed). Release both buttons. 	Remember that Field Calibration curves are not preset.
2. To calibrate, press and hold the CALIBRATE button. While continuing to hold CALIBRATE, also press and hold the DISPLAY button. Hold both buttons for about 3 seconds until you see a "dd CAL" message.  Once the "dd CAL" message appears, release both buttons. You are now in field calibration mode.	This step puts the unit in dispense-display field calibration mode ("dd CAL").

Your Actions	Notes
3. Once the buttons have been released from Step 2, the display will show the blinking message “run 01.” 	The computer is waiting for you to make a decision to either exit from field calibration mode or to begin a dispense run. If you want to exit the calibration now, go to Step 10.
4. If you want to continue with the calibration, but have not dispensed any fluid yet, make your final preparations to your pumping system, but don’t start pumping yet.	
5. Start your pumping system so that fluid flows through the meter. The display will stop blinking and show the “run 01” message. Dispense into a container that allows you to judge the amount of fluid pumped. When you have pumped the desired amount (for example, 10 gallons), stop the fluid flow quickly. 	When the computer displays a non-blinking “run 01” message, it is sensing fluid flow. For accurate results, dispense at a flowrate which best simulates your actual operating conditions. Avoid “dribbling” more fluid or repeatedly starting and stopping the flow - these actions will result in less accurate calibrations.
6. Once the flow has stopped, briefly press and release both buttons. At this point the computer display will change to “0000.00” with the left-hand digit blinking. 	When the display shows “0000.00” the computer has stopped “watching” for fluid flow and is now waiting for you to enter some numbers.
7. Enter the volume (amount) of fluid that you dispensed (for example, if your 10-gallon container is full, enter “10.00” for gallons or “37.85” for litres). To enter numbers use the CALIBRATE button to change the value of the digit that is blinking and use the DISPLAY button to shift the “blink” to the next digit. 	

Your Actions	Notes
8. Once the correct number has been entered, briefly press and release both buttons. The display will change to a blinking “run 02” message. 	You have installed the new cal-curve point. You are ready to end calibration (Step 10) or enter another new calibration point (Step 9).
9. To enter another calibration point, go back and repeat Steps 3 through 8. Or, to end calibration now, proceed with Step 10.	It is possible to set up to 15 cal-curve points, and the “run ##” message will increment each time you repeat the calibration process (run 01, run 02, run 03, etc., up to run 15).
10. To end calibration, press and hold both buttons for 3 seconds until you see “CAL End” message. 	After you release the buttons, the computer will resume normal operations. If Run 01 was showing and you have not dispensed any fluid, the old cal curve is till intact. However, if you have dispensed any fluid the new curve will be active.

Factory Calibration

Factory Calibration curves are set at the factory for measuring liquids in gallons and litres and always display PRESET on the readout. This calibration is permanently stored in the meter's computer and provides calibration information for the meter unless Field Calibration is completed.

MAINTENANCE

During daily use, these meters are virtually maintenance-free.

When not in use, rinse and clean and keep free of liquids to protect internal components. If liquids have dried and caked on the rotor, refer to the Cleaning instructions.

Beware of a dim or fading readout. This condition indicates potential battery failure. Refer to the Battery instructions.

Batteries

Your meter is equipped with field replaceable lithium batteries that provide power for approximately 9,000 hours. Replacement batteries can be ordered from the factory.

If the meter's readout should become dim or blank, it is an indication that the batteries should be replaced.

When batteries are disconnected or fail, the Batch and Cumulative Totals return to zero.

Factory and Field Calibrations are **NOT** lost when batteries are replaced or power is lost. They are saved in the meter's computer and are available after new batteries are installed. You do not need to repeat Field Calibration.

Check the batteries and terminals at least every year to ensure proper operation. It is strongly recommended that terminals be cleaned annually.

NOTE: Batteries can be replaced without removing meter from the hose or pipe.

To replace batteries or clean terminals:

1. Remove the corner screws from the face of the meter and lift the computer assembly from the turbine.
2. Remove the batteries. (Figure 5)

Figure 5

3. If necessary, clean any corrosion from the battery terminals.
4. Place the batteries in position, with the positive posts in the correct position. (Figure 6)

Figure 6

When the batteries are installed correctly, the computer powers on automatically. Check the readout to make sure normal meter functions have resumed before assembling again.

5. Place the computer assembly on the turbine. Make sure the seal is fully seated to avoid moisture damage. Secure with the four screws.

To Remove

⚠ WARNING

During meter removal, liquid may spill. Follow the liquid manufacturer's safety precautions for clean up of minor spills.

1. Ensure all liquid is drained from the meter. This could include draining the hose, meter, nozzle or pipe.
2. Wear protective clothing as necessary, loosen both ends of the meter. Use a wrench only on the meter's flat metal surfaces.

⚠ CAUTION

Using a wrench on plastic meters could damage the meter.

3. If the meter is not immediately installed again, cap the hose end or pipe to prevent spills.

To Clean

During use, the meter should be kept full of liquid to ensure that drying does not occur inside the meter. If drying or caking should occur, the rotor will stick or drag, affecting accuracy. In this circumstance, cleaning is required.

To determine if the rotor is stuck or dragging, gently blow air through the meter and listen for the quiet whir of the rotor.

⚠ CAUTION

Never blow compressed air through the meter. It could damage the rotor.

To clean a stuck or dragging rotor, follow the procedures below.

1. Remove the meter from the hose or pipe following the directions above.
2. Apply a penetrating lubricant such as WD-40® or a recommended cleaning solvent on the turbine's rotor, shaft and bearings. Allow it to soak for 10 to 15 minutes.

⚠ CAUTION

Do not submerge the meter.

3. Carefully remove residue from the rotor using a soft brush or small probe such as a screwdriver. Be careful not to damage the rotor and support.
4. When the rotor turns freely, install it again following the Installation instructions provided in this manual.

To Store

After thoroughly cleaning the meter, store it in a dry location.

⚠ WARNING

Follow the liquid manufacturer's instructions for the disposal of contaminated cleaning solvents.

TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
A. METER IS NOT ACCURATE	1. Field Calibration not performed properly	Field calibrate again or select Factory Calibration.
	2. Factory Calibration not suitable for liquid being measured	Perform a Field Calibration according to Calibration Section.
	3. Meter operated below minimum flowrate	Increase flowrate. See Specifications Section.
	4. Meter partially clogged with dried liquid	Remove meter. Clean carefully with WD-40® or similar penetrating lubricant. Make sure rotor spins freely.
	5. Turbine bearings partially clogged with dried liquid	Remove meter. Lubricate bearings with WD-40® or similar penetrating lubricant through small holes in turbine supports. Make sure rotor spins freely.
	6. Teflon® tape or other material wrapped around rotor	Remove meter. Clear material from rotor. Make sure rotor spins freely.
	7. Installed too close to fittings	Install correctly. See Installation Section.
	8. Installed too close to motors or electrically "noisy" environment	Install correctly. See Installation Section.
B. READOUT FADED OR BLANK	1. Batteries weak, dead or not connected	Remove computer and replace batteries. Install computer again, making sure that the seal seats evenly around the computer and turbine housing.
	2. Computer defective	Contact the factory.
C. NORMAL FLOW RATE BUT METER DOES NOT COUNT (Meter comes on when DISPLAY button pushed.)	1. Field Calibration not performed correctly	Field calibrate again or select Factory Calibration.
	2. Rotor stuck or damaged	Remove meter. Lubricate turbine bearings with WD-40® or similar penetrating lubricant through small holes in turbine supports. Make sure rotor spins freely. If rotor cannot be loosened, contact the factory.

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
C. (continued)	3. Teflon® tape or other material wrapped around rotor	Remove meter. Clear material from rotor. Make sure rotor spins freely.
	4. Computer defective	Contact the factory.
D. REDUCED FLOWRATE & METER DOES NOT COUNT (Meter comes on when DISPLAY button pushed.)	1. Meter clogged with dried liquids	Remove meter. Clean carefully with WD-40® or similar penetrating lubricant. Make sure rotor spins freely.
E. CANNOT GET METER INTO FIELD CALIBRATION	1. Factory Calibration (PRESET) curve active	Hold down CALIBRATE and push and release DISPLAY until PRESET flag goes off. Proceed with calibration according to the Calibration Section.
	2. Computer circuit board defective	Replace computer. Contact the factory.
F. METER CONNECTIONS LEAK	1. Meter installed without thread sealant	Remove meter. Wrap male connections with 3 to 4 wraps of thread tape or compatible sealing compound. Install again.
	2. Connecting threads damaged	Remove meter and inspect threads. Replace damaged connections. If meter threads are damaged, contact the factory.
	3. Meter housing	Inspect housing for cracks. If cracks present, contact the factory.

SPECIFICATIONS

The following specifications apply to all models and materials.

Power Source:
Two lithium batteries provide approximately 9,000 hours of use (1 year)

Operating Temperature:
+14° to +140° F (-10° to +60° C)
(For temperatures up to 250°F, contact factory)

Storage Temperature:
-40° to +158° F (-40° to +70° C)

Accuracy:
Low Flow Models:
Factory Calibration: N/A*
Field Calibration: ±1.5% of reading
(Low Flow meters must be field calibrated)

1-inch and 2-inch Models:
Factory Calibration: ±1.5% of reading
Field Calibration: ±1.0% of reading

Filter Screens:
Low Flow Models:
Use a 25 micron or .005 inch screen, 55 mesh.

1-inch and 2-inch Models:
Use a 500 micron or .018 inch screen, 28 mesh.

Wetted Materials:
Rotor & Supports: Nylon
Signal Generators: Ferrite
Shaft: Tungsten Carbide
Journal Bearings: Ceramic
Retaining Rings: Stainless Steel
Housing: Nylon or Aluminum

Turbine Housing/
Rotor Support Materials:
Nylon Housing / Nylon
Aluminum Housing / Nylon

The following specifications are dependent upon housing materials.

Pressure Rating:
Aluminum: 300 PSIG (20.7 bar)
Nylon: 150 PSIG (10.3 bar)

Recommended Chemicals:
Aluminum Models:
Are recommended for use with petroleum products, and should not be used with water. Please verify chemical compatibility with all wetted parts.

Nylon Models:
Are recommended for use with water or non-aggressive chemicals.

** Accuracy can vary up to ±5% depending on installation and fluid type. Field calibration is recommended*

Specifications

	Low Flow Model	1 Inch Model	2 Inch Model
Units	Gallons & Litres	Gallons & Litres	Gallons & Litres
Flow Range	0.3-3 GPM 1-10 LPM	3-50 GPM 10-190 LPM	30-300 GPM 100-1,000 LPM
Threads	NPT	NPT	NPT
Inlet and Outlet	1 inch	1 inch	2 inch
Internal Diameter	1/4 inch	1 inch	2 inch
Design Type	Paddlewheel	Turbine	Turbine
Minimum Readout Total	.01	.01	0.1
Maximum Readout Total	999,999	999,999	999,999
Pressure Drop at Max. Flowrate	2 PSIG @ 3 GPM .14 bar @ 10 LPM	5 PSIG @ 50 GPM .35 bar @ 190 LPM	7 PSIG @ 300 GPM .48 bar @ 1,000 LPM
Dimension - Length - Height - Width	4 in. (10.2cm) 2.5 in. (6.4cm) 2 in. (5.1cm)	4 in. (10.2cm) 2.5 in. (6.4cm) 2 in. (5.1cm)	6 in. (15.2cm) 4.25 in. (10.8cm) 3 in. (7.6cm)

PARTS

Replacement Kits & Accessories

Replacement Kits are available for turbine assemblies and computer assemblies. Individual components within these assemblies, such as rotors, signal generators, and buttons are not available. The factory will determine the exact Turbine Assembly or Computer Assembly you need based on your model and serial number.

Other replacement kits and accessories can be ordered with the part numbers below.

Part No.	Description
113520-1	Battery Replacement Kit
901002-52	Seal
116000-1	Large (5 gallon) Calibration Container
116004-5	Small (5 quart) Calibration Container (Note: Calibration containers are for use with water based fluids. Do not use with fuel products.)

SERVICE

For warranty consideration, parts, or other servicing information, please contact your local distributor. If you need further assistance, call the GPI Customer Service Department in Wichita, Kansas, during normal business hours.

1-800-835-0113

To obtain prompt, efficient service, always be prepared with the following information:

1. The model number of your meter.
2. The serial number of your meter.
3. Specific information about part numbers and descriptions.

For warranty work always be prepared with your original sales slip or other evidence of purchase date.

Returning Parts

Please contact the factory before returning any parts. It may be possible to diagnose the trouble and identify needed parts in a telephone call or letter. GPI can also inform you of any special handling requirements you will need to follow covering the transportation and handling of equipment which has been used to transfer hazardous or flammable liquids.

⚠ CAUTION

Do not return meters without specific authority from the GPI Customer Service Department. Due to strict regulations governing transportation, handling, and disposal of hazardous or flammable liquids, GPI will not accept meters for rework unless they are completely free of liquid residue.

⚠ CAUTION

Meters not flushed before shipment can be refused and returned to the sender.

Declaration of Conformity

Manufacturer's Name:	Great Plains Industries, Inc.
Manufacturer's Address:	5252 East 36th Street North Wichita, KS USA 67220-3205

Declares, that the product:

Product Name:	Electronic Digital Meter
Model Numbers:	03***** A1********** A2********** G2*********

Model numbers include all combinations of an alpha-numeric series as illustrated above.

Conform to the following Standards:

EMC:	EN 50081-1 (Reference EN 55022) EN 50082-1
Energy - Limited Apparatus:	EN 50021
I.P. Code:	BS EN 60529

Supplementary Information:

"The products comply with the requirements of the EMC Directive 89/336/EEC and the ATEX Directive 94/9/EC (ANNEX VIII)."

I, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s) and Standard(s).

Signature:	
Full Name:	Mr. Grant Nutter
Position:	President Great Plains Industries, Inc.
Place:	Wichita, KS USA May 2003

The following patent may apply, check your meter.

Patent Number
U.S. Patent 5,046,370.

Limited Warranty Policy

Great Plains Industries, Inc. 5252 E. 36th Street North, Wichita, KS USA 67220-3205, hereby provides a limited warranty against defects in material and workmanship on all products manufactured by Great Plains Industries, Inc. This product includes a 1 year warranty. Manufacturer's sole obligation under the foregoing warranties will be limited to either, at Manufacturer's option, replacing or repairing defective Goods (subject to limitations hereinafter provided) or refunding the purchase price for such Goods theretofore paid by the Buyer, and Buyer's exclusive remedy for breach of any such warranties will be enforcement of such obligations of Manufacturer. The warranty shall extend to the purchaser of this product and to any person to whom such product is transferred during the warranty period.

The warranty period shall begin on the date of manufacture or on the date of purchase with an original sales receipt. This warranty shall not apply if:

A. the product has been altered or modified outside the warrantor's duly appointed representative;
B. the product has been subjected to neglect, misuse, abuse or damage or has been installed or operated other than in accordance with the manufacturer's operating instructions.

To make a claim against this warranty, contact the GPI Customer Service Department at 316-686-7361 or 1-800-835-0113. Or by mail at:

Great Plains Industries, Inc.
5252 E. 36th St. North
Wichita, KS, USA 67220-3205

The company shall, notify the customer to either send the product, transportation prepaid, to the company at its office in Wichita, Kansas, or to a duly authorized service center. The company shall perform all obligations imposed on it by the terms of this warranty within 60 days of receipt of the defective product.

GREAT PLAINS INDUSTRIES, INC., EXCLUDES LIABILITY UNDER THIS WARRANTY FOR DIRECT, INDIRECT, INCIDENTAL AND CONSEQUENTIAL DAMAGES INCURRED IN THE USE OR LOSS OF USE OF THE PRODUCT WARRANTED HEREUNDER.

The company herewith expressly disclaims any warranty of merchantability or fitness for any particular purpose other than for which it was designed.

This warranty gives you specific rights and you may also have other rights which vary from U.S. state to U.S. state.

Note: In compliance with MAGNUSON MOSS CONSUMER WARRANTY ACT – Part 702 (governs the resale availability of the warranty terms).

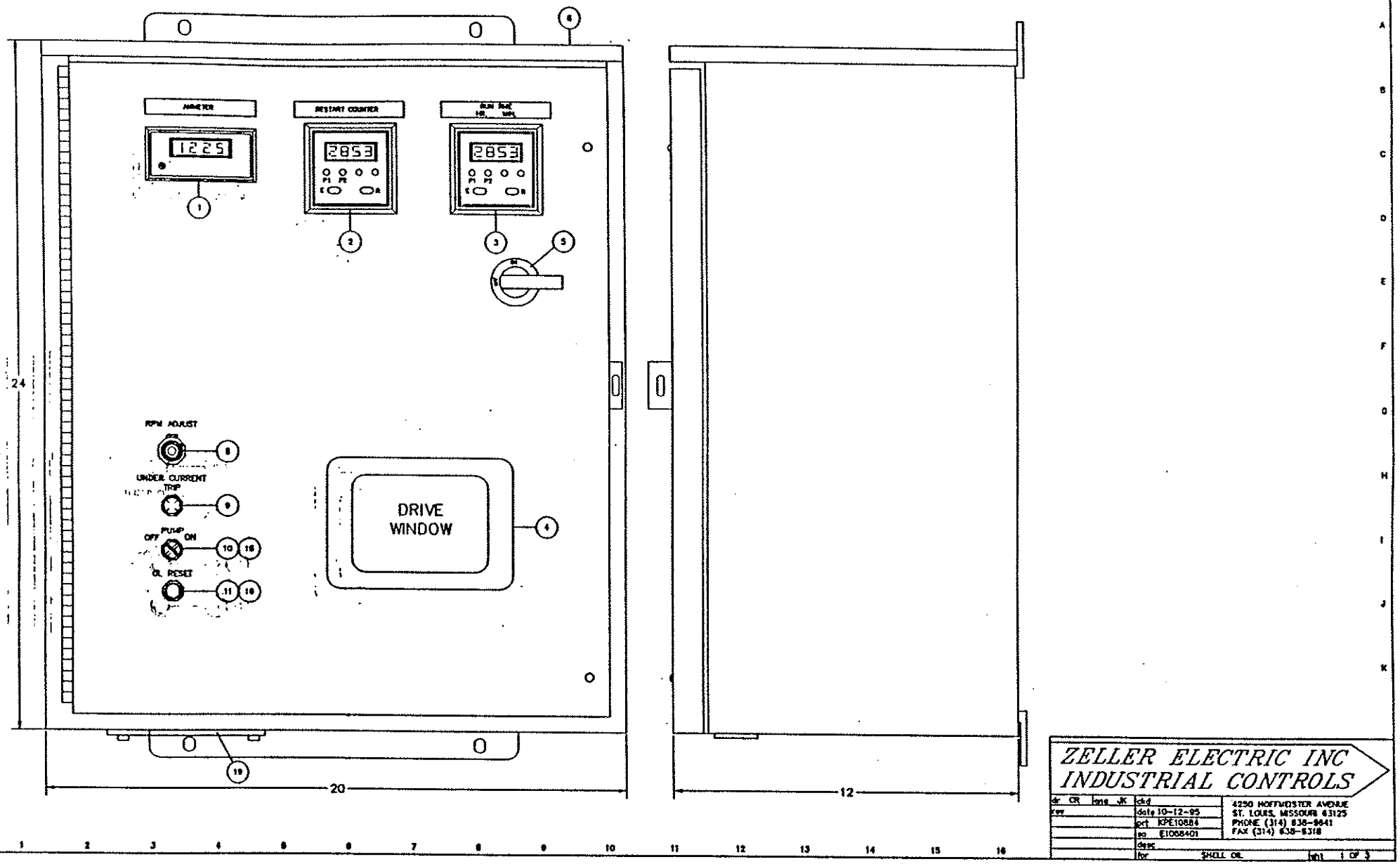
FM APPROVED CE CLASSIFIED C UL

ATEX NEMA 4 (IP44)

5252 East 36th Street North
Wichita, KS USA 67220-3205
TEL: 316-686-7361
FAX: 316-686-6746

GREAT PLAINS INDUSTRIES, INC.
"A Great Plains Ventures Subsidiary"
www.gpi.net
1-800-835-0113

07/08 Printed in U.S.A. Rev. B 920685-09



ZELLER ELECTRIC INC
INDUSTRIAL CONTROLS

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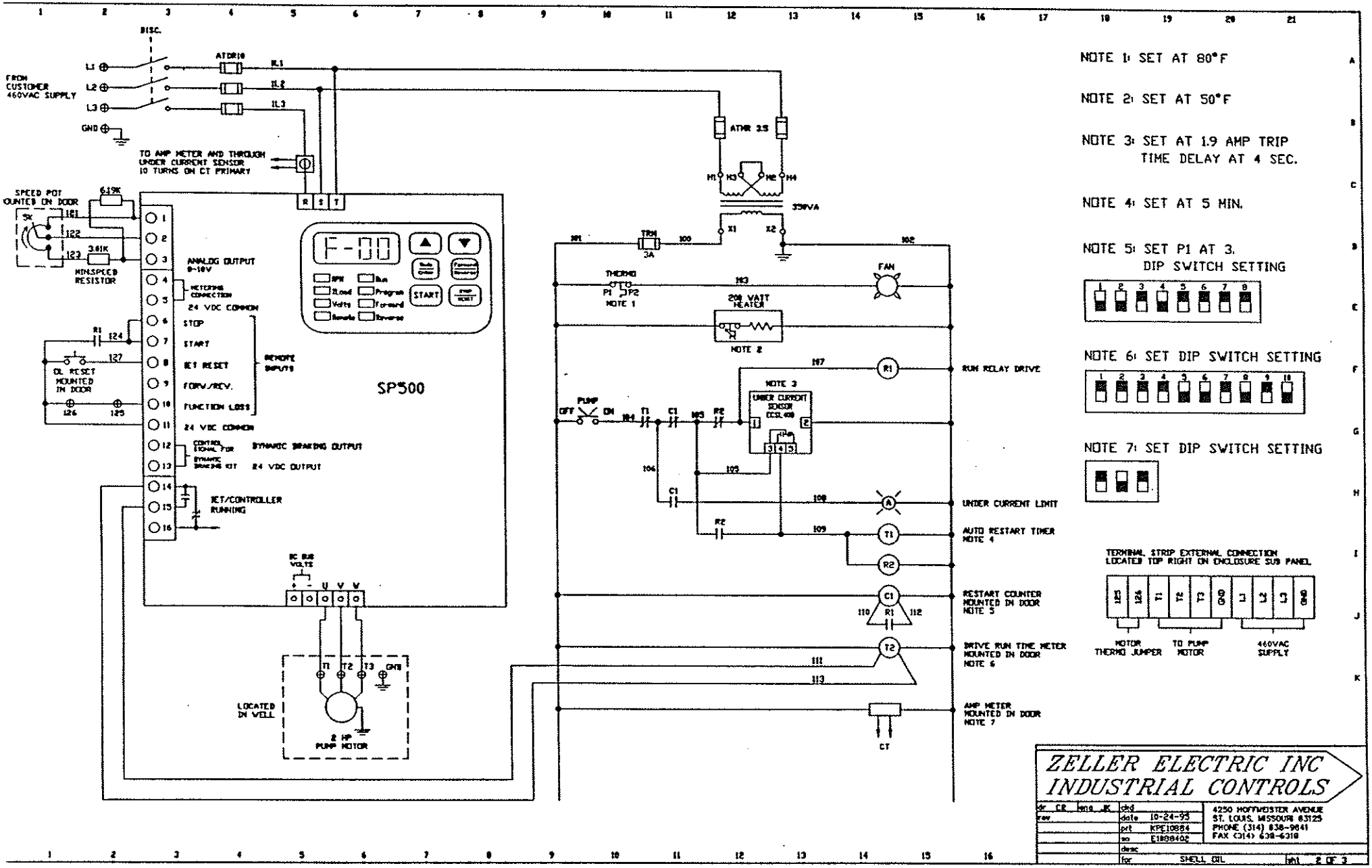
		eq E1068401	
		desc	
		for SHELL OIL	sht 1 OF 3

4250 HOFFMEISTER AVENUE
ST. LOUIS, MISSOURI 63125
PHONE (314) 638-8641
FAX (314) 638-8318



ZELLER ELECTRIC INC
INDUSTRIAL CONTROLS

4250 HOFFMEISTER AVENUE
ST. LOUIS, MISSOURI 63125
PHONE (314) 638-9641
FAX (314) 638-6318

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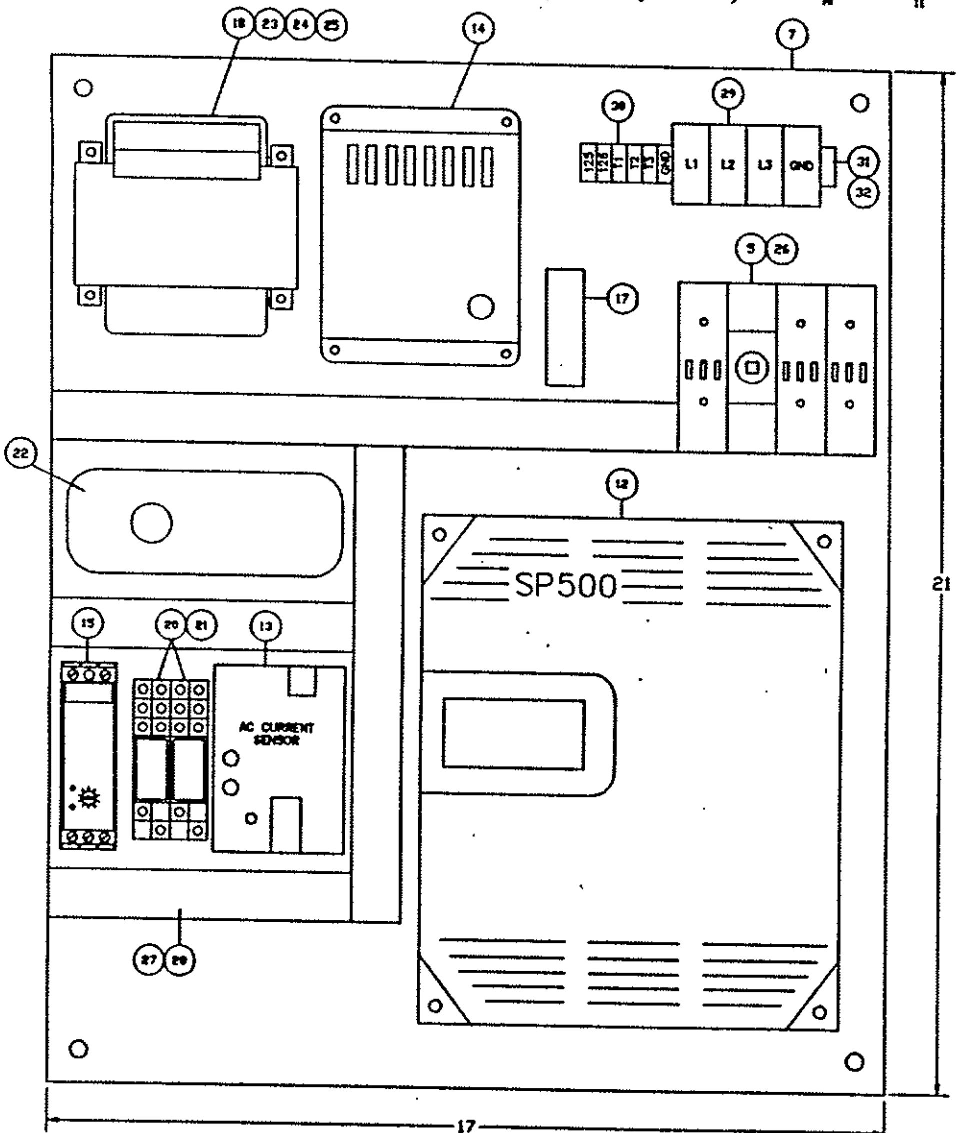
date	10-24-95
prt	KPE10884
so	E1808402
desc	
for	SHELL OIL

sht 2 OF 3



ITEM	QTY.	DESCRIPTION	PART NUMBER
1	1	AMP METER	APLIT 405 RED LION
2	1	RESTART COUNTER	LIDC 1E00 RED LION
3	1	RUN TIME	LIDT 1E00 RED LION
4	1	DRIVE WINDOW	E-PWK53NFSS ELECTROMATE
5	1	DISCONNECT	OESA-CF30CC6P ABB
6	1	NEMA 3R ENCLOSURE	E24R2012 HCRAL ELECTROMATE
7	1	PANEL	E24P20 ELECTROMATE
8	1	SPEED POT	800H-UR24 AB
9	1	UNDER CURRENT LIMIT LIGHT	3SB03-LTI SIEMENS
10	1	PUMP OFF-ON SELECTOR	3SB03-2MKB SIEMENS
11	1	OL RESET PUSH BUTTON	3SB03-PFE SIEMENS
12	1	PUMP VFD (SP500)	ISU 41003 RELIANCE
13	1	UNDER CURRENT RELAY	ECSL40B SSAC
14	1	200 WATT HEATER	D-AH200/A HOFFMAN
15	1	AUTO RESTART TIMER	7PU4020-5AJ20 SIEMENS
16	2	N/O CONTACT	3SB1400-0B SIEMENS
17	1	CURRENT TRANSFORMER	3CT35 MIDWEST
18	1	CONTROL TRANSFORMER	MTD350A SIEMENS
19	1	EXHAUST FAN	A-PA4AXFN HOFFMAN
20	2	DRIVE RUN RELAY	G2R-2-S-120 OMRON
21	2	DRIVE RUN RELAY SOCKET	P2RF-08 OMRON
22	1	FAN THERMOSTAT	2E869 GRANGER
23	2	PRIMARY FUSE	ATMR 3 1/2 GOULD
24	1	SECONDARY FUSE	TRM 3 GOULD
25	1	PRIMARY FUSE HOLDER	KCCFPX 2R SIEMENS
26	3	MAIN FUSE	ATDR 10 GOULD
27	1	WIRE DUCT	71020 GOULD
28	1	DUCT COVER	79010 GOULD
29	4	LARGE TERMINALS	CE2 AB
30	6	SMALL TERMINALS	EA1 EMH
31	2	END BARRIER	EC2 EMH
32	1	MOUNTING TRACK	ET1 EMH

ZELLER ELECTRIC INC
INDUSTRIAL CONTROLS

dr CR	eng JK	chd	4250 HOFFMEISTER AVENUE ST. LOUIS, MISSOURI 63125 PHONE (314) 638-8641 FAX (314) 638-6318
rev		date 24-10-95	
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		desc	
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