APPENDIX B

Mixing System Shop Drawings

ENGINEERING SUBMITTAL

CITY OF WINNIPEG - NORTH END WPCC

RFP. NO. 187-2012
DIGESTER
1 ROTAMIX SYSTEM

2 EA VAUGHAN MODEL HE12W18CSB-210 BELT-DRIVE CHOPPER PUMP WITH 125 HP, 1750 RPM MOTORS (ONE PUMP AND MOTOR IS STANDBY), PLUS
FOUR FLOOR MOUNT UP-AIMED DUAL NOZZLE ASSEMBLIES AND FOUR SINGLE FLOOR-MOUNT NOZZLE ASSEMBLIES AND ONE WALL-MOUNT FOAM BUSTER/SCUM NOZZLE ASSEMBLY

DATE: August 22, 2012

PREPARED BY GLENN R. DORSCH; PE
VAUGHAN CO. ENGINEERING DEPARTMENT

VAUGHAN COMPANY, INC.
364 MONTE-ELMA ROAD
MONTESANO, WA 98563
(360) 249-4042
(360) 249-6155 FAX

TABLE OF CONTENTS -- ENGINEERING SUBMITTAL
CITY OF WINNIPEG, NORTH END WPCC

IMPORTANT NOTE ON NOZZLE AIMING & SYSTEM VENTING
VAUGHAN ROTAMIX SYSTEM

1. Each individual nozzle of each of the Rotamix nozzle assemblies must be individually aimed by a Vaughan Co. representative after nozzle installation and before the digester or mixing tank is closed up and filled. If nozzle aiming is not performed before closing and filling of the tank, the Rotamix mixing system will not work properly.

   Please provide advance warning to Vaughan Co. or to your local Vaughan Co. representative regarding when you will be ready for this aiming operation.

   Please note Vaughan drawing # 115707, which shows a plan view of the digesters detailing placement of the nozzle assemblies and angle of nozzle adjustment. Since Vaughan Co. has system responsibility for the Rotamix system, Vaughan Co. must have the freedom to specify nozzle location and nozzle aim angles based on our experience and on our computer models. Please use Vaughan's drawing #115707 for this critical location information. Incorrect location of these nozzle assemblies could have significant negative impact on the performance of the mixing system and will affect Vaughan Co.'s ability to provide a system guarantee.

   A venting system for the pump may be required to be sure that trapped air or gas can be vented from the pump (while not operating) to allow it to work correctly. We have included the Rotamix Installation Instructions in this submittal to address venting issues. The venting system is to be provided by others. Note that top discharge pumps tend to be self-venting and unless there is a check valve located immediately off the pump discharge, a venting system may not be required.

   Yours truly,

   Glenn R. Dorsch

   Glenn Dorsch; Vaughan Co. VP/Chief Engineer

ROTAMIX SLUDGE DIGESTION TANK MIXING SYSTEMS
LIST OF EQUIPMENT TO BE SUPPLIED
-CITY OF WINNIPEG, NORTH END WPCC-

Vaughan Co. Inc. is pleased to offer our Rotamix Mixing System to mix one (1) 33.5 M Diameter x 8.2 M HWL Cylindrical Anaerobic Digester tank, consisting of:

(8) VAUGHAN TANK MIXING ASSEMBLIES, Rotamix assemblies can accommodate a total recirculation flow of **8,150 GPM @ 41 FT. TDH** for (4) single and (4) double floor mounted nozzle assemblies (total of 12 nozzles) per tank. Assemblies are glass lined with hardness of Rockwell 73C. Nozzle is cast ductile iron with 1.0 inch nominal wall thickness. Zinc anodes protect against galvanic corrosion. Exterior is SSPC-SP5 sandblasted and finished with 3M™ Scotchkote™ 134 Fusion Bonded Epoxy Coating.

(1) ROTAMIX FOAMBUSTER / SCUM ASSEMBLY, combined wall mounted unit containing foam suppression and scum mixing components, receiving a portion of the total flow noted above. The foambuster assembly creates an evenly dispersed spray pattern of droplets and is mounted 6-12 inches above high liquid level in the tank (4 feet of overhead ceiling is needed). The scum nozzle mounts approximately 1 ft. or more below the surface. Same material features as above.

(2) VAUGHAN HORIZONTAL MIXING CHOPPER PUMPS, Model HE12W18CSB-210. **(1) PUMP IS STANDBY**

CONSISTING OF:

CASING AND BACK PULL-OUT PLATE, cast ductile iron.

IMPELLER, UPPER CUTTER AND EXTERNAL CUTTER, cast alloy steel, heat-treated to a minimum 60 Rockwell C Hardness. Impeller dynamically balanced. Impeller-to-cutter bar clearance is externally adjustable. **IMPELLER BALANCE (CERTIFICATE) required.**

CUTTER BAR INSERT, Alloy Steel, heat-treated to minimum 60 Rockwell C Hardness.

SHAFT, 4140 heat-treated alloy steel, with oil lubricated ball bearing housing complete with sight glass.

MECHANICAL SEAL, cartridge style seal with silicon carbide faces. Seal manufactured by Vaughan. Seal water flush is not required and cannot be used.

ELASTOMERS,BUNA N.

FLANGES, 12" discharge & 18" inlet, 150 LB ANSI rated.

SIDE MOUNT BELT DRIVES, include adjustable motor mount, safety guard, belts and sheaves for *720 pump RPM*.

BASES, fabricated from 1018 steel with *lipped base*.

DRIVES, 125 HP, 1750 RPM, 575/3/60, Division 2, Class 1, Group A, B, C & D, 1.15 SF, TEFC, premium efficient, Baldor/Reliance electric motor. ROUTINE MOTOR TESTS.

FACTORY TESTING, includes pump performance and noise test; routine motor test.

FINISH, SSPC-SP6 commercial sandblast and single coat of Tnemec Zinc-filled Primer and finish coat of Tnemec 27WB Epoxy, (Except Motor-motor will be manufacturers standard). Coat pumps internal machine surfaces with a corrosion protective compound.

STARTUP AND TRAINING SERVICES, supplied by the local Vaughan Representative.

CUSTOM NAMEPLATES: Additional information: Efficiency, Brake power, bearing make and model.

1	LOT	**SPARE PARTS,** per section 46 41 00 - 2.8.		
	6	EA	Mechanical Seals	V801-310
	4	EA	Thrust Bearings	V801-729
	2	EA	Radial Bearings	V801-783
	6	EA	O-ring, Brg Hsg/Thr Brg	V850-375
	6	EA	O-ring, Brg Hsg/Brg Cap	V850-161
	6	EA	O-ring, Bk Plate/Wrplt	V850-460
	6	EA	O-ring, Bk Plate/Casing	V850-469
	6	EA	O-ring, Suction Manifold/Casing	V850-391
	6	EA	O-ring, Impeller/Shaft	V850-138
	6	EA	O-ring, Ext Cutter/Impeller	V850-138
	6	EA	O-ring, Endcap Sleeve	V850-035
	6	EA	O-ring, Bkplate/Upper cutter	V850-379
	6	EA	O-ring, Stuffing Box/Upper Cutter	V850-361
	6	EA	O-ring, Wear Plt/Case	V801-857

FIELD TESTING, Solids Profile and Temperature Profile Testing included.

NOTES:

The items contained in the List of Equipment are the only items being supplied by Vaughan Co., Inc., the mixing system manufacturer. Other specific items which may be required by the specification, including, but not limited to the items listed below, must be furnished by others.

HARD PIPING AND ALL SUPPORTS FROM THE VAUGHAN CHOPPER PUMP DISCHARGE TO THE INLET ELBOW OF THE NOZZLE ASSEMBLIES.
GAUGES, SWITCHES, VALVES AND OTHER SPECIALTIES NOT SPECIFICALLY CALLED OUT HEREIN.
SEAL WATER SYSTEMS.
CONTROL PANELS.
SPECIAL COATINGS OTHER THAN THOSE QUOTED.
FACTORY HYDRO, VIBRATION, AND FACTORY MOTOR TESTS.
EQUIPMENT, LABOR, MATERIAL AND PERSONNEL REQUIRED PERFORMING FIELD TESTING OF SYSTEMS.
SPECIAL MOTOR SPECIFICATIONS INCLUDING EXPLOSION PROOF, INTERNAL SPACE HEATERS, ETC.
INTRINSICALLY SAFE FEATURES.
SPARE PARTS AND ADDITIONAL LUBRICANTS, EXCEPT AS NOTED.
COMPUTATIONAL FLUID DYNAMIC (CFD) ANALYSIS.
VAUGHAN RECOMMENDS THE USE OF A FOAMBUSTER FOAM SUPPRESSION ASSEMBLY AND VARIABLE FREQUENCY DRIVES IN ORDER TO OFFER OPERATION FLEXIBILITY IN ADDRESSING THE POSSIBILITY OF A CHANGE IN FEED STOCK OR INTRODUCTION OF FILAMENTOUS BACTERIA.

PERFORMANCE AFFIDAVIT
CITY OF WATERLOO

Addressed to: City of Waterloo; CITY OF WINNIPEG, NORTH END WPCC

Reference – Tender T2011-007 – CITY OF WINNIPEG, NORTH END WPCC

Text: Vaughan Company has examined the contract documents and has verified that we comply with the referenced specifications and applicable standards with the exceptions are clarifications listed below. The system will provide a minimum of 90% active mixing within thirty minutes or less from startup in anaerobic digesters. The proposed pumps meet or exceed the performance requirements and design specifications set forth in RFP. NO. 187-2012 of the contract documents.

01 91 13;

1.4.2.2 – Peak vibration per Hydraulic Institute is standard for the Vaughan chopper pumps.

1.5.6.2 – Hydraulic Institute testing will be performed at the factory prior to shipment. Field gauge readings can then be used to determine performance.

26 05 00:

2.4.1 – Vaughan will provide motors meeting Division 2, Class 1, Group A, B ,C & D.

46 05 00:

2.4.1 – Vaughan cannot guaranty noise levels on belt driven pumps. Vaughan will dry run each pump and conduct a noise test before shipment.

2.5 – Vaughan will provide our standard stainless steel belt guards.

46 41 00:

1.3.1.9: Vaughan pumps are chopper pumps not solids handling pumps, and therefore, do not pass solids spheres. All materials are chopped.

1.3.1.15: Vaughan Co., is not providing anchorage or seismic calculations.

1.3.1.16: Motor overhaul manual is not available. Motor I,O&M manual will be provided with complete equipment I,O&M manuals.

1.3.1.21: Vaughan will provide our standard paint scheme for use in the intended application.

2.6.6 – The inlet pipe to the scum / foam buster nozzle assembly is by the contractor. The material of construction for this nozzle assembly is the same as the floor mounted units, except the foam buster has a deflector constructed of stainless steel.

3.4 & 3.5: Field testing is the responsibility of the Contractor. Vaughan Authorized Representative will be on site for start-up.

Drawings:

187-2012_Drawing_A-4 RP – a note shows a soft start to control the pump motors. Vaughan does not recommend the chopper pumps be operated with a soft start. It is suggested that this system with a foam buster nozzle be operated with a constant torque, AC variable frequency drive controller, so power can be reduced during a foaming occurrence.

Glenn R. Dorsch

Glenn R. Dorsch, PE
VP/Chief Engineer

Ferdy M. Kloetzer
Notary

FERDY M. KLOETZER
NOTARY PUBLIC
STATE OF WASHINGTON
My Commission Expires Dec. 06, 2012

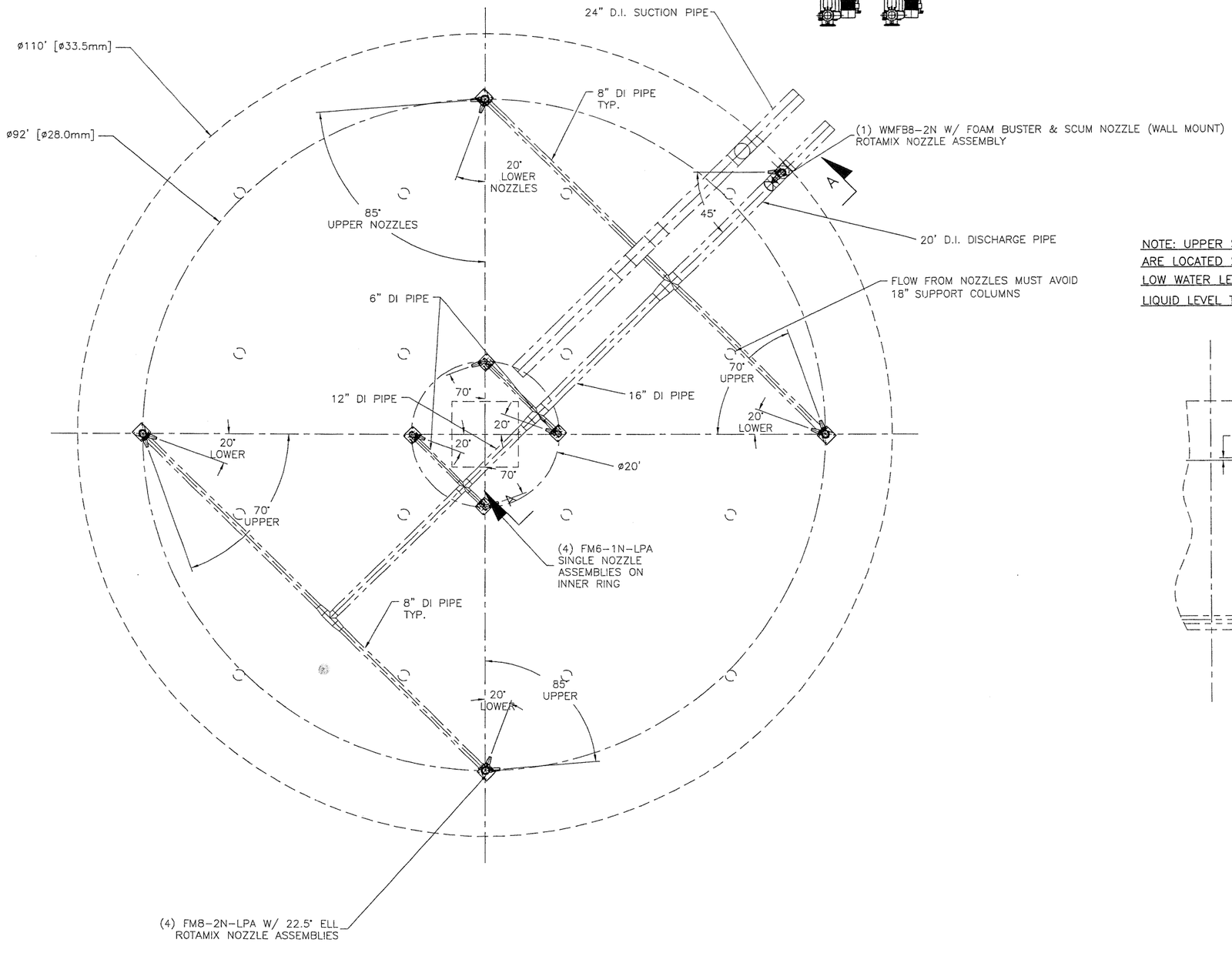
RECOMMENDED SPARE PARTS

Vaughan Co. does not recommend that the customer stock any parts as Vaughan Co. has 24 hour turn around on most parts.

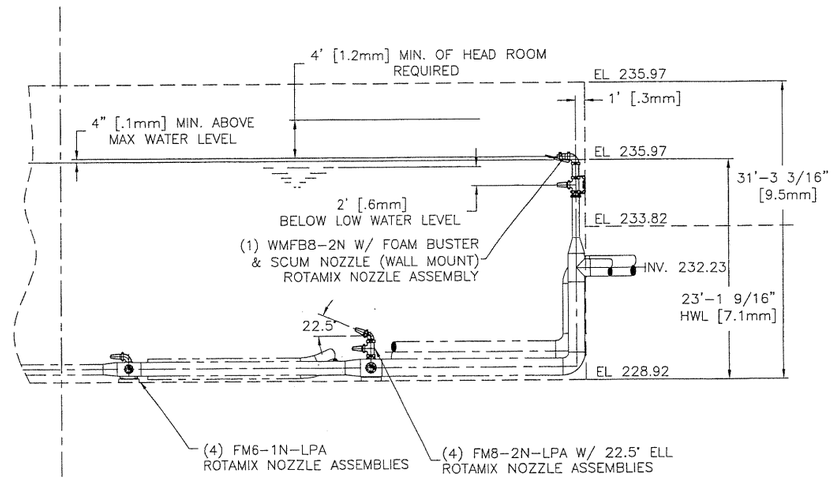
PAINT CERTIFICATION

Vaughan Co. certifies that the factory –applied coating system is identical to the requirements specified per 2.7.

MODEL: HE12W18CSB-210
MOTOR: 125 HP, 1750 RPM
PERFORMANCE REQUIRED: 8,150 GPM



NOTE: UPPER SCUM NOZZLE MUST BE LOCATED SO THAT THEY ARE LOCATED 2 FEET BELOW LIQUID LEVEL AT LOW WATER LEVEL. NOZZLES MUST NOT DISCHARGE ABOVE LIQUID LEVEL TO AVOID POOR MIXING OR FOAMING.



SECTION A-A

NOTE:

1. NOZZLE ANGLES TO BE POSITIONED IN FIELD BY VAUGHAN ENGINEER.
2. VAUGHAN CO. TO SUPPLY PUMP(S) AND NOZZLE ASSEMBLIES. ALL PIPING TO BE SUPPLIED & INSTALLED BY OTHERS. PIPING LAYOUT & FITTINGS FOR ILLUSTRATION PURPOSES ONLY.

Vaughan
VAUGHAN CO., INC.
364 MONTE-ELMA ROAD
MONTESANO, WA 98563
PHONE: (360) 249-4042
FAX: (360) 249-6155

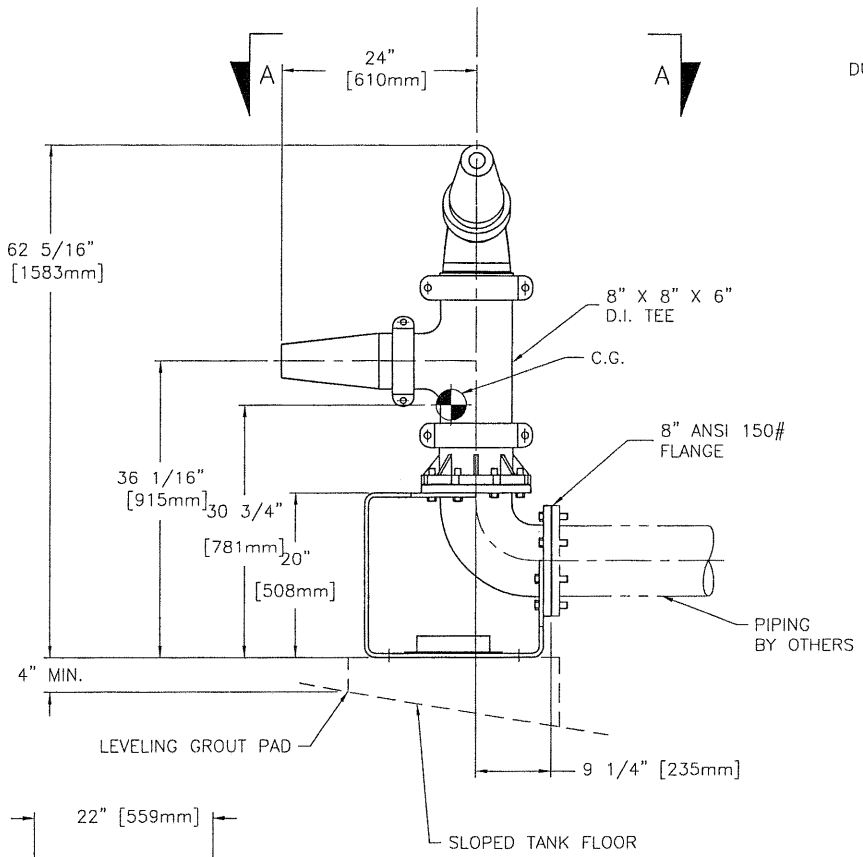
UNLESS OTHERWISE NOTED, TOLERANCES ARE TO BE:
DECIMALS: ONE PLACE ± 0.1
TWO PLACES ± 0.05
THREE PLACES ± 0.010
FRACTIONS ± 1/64"
ANGLES ± 0.5°
MACHINE TO FINISH: ROUGH OR AS CASTING 0.010"
MACHINE TO FINISH: FURNISHED 0.005"
BREAK ALL SHARP EDGES 0.005" R UNLESS NOTED OTHERWISE

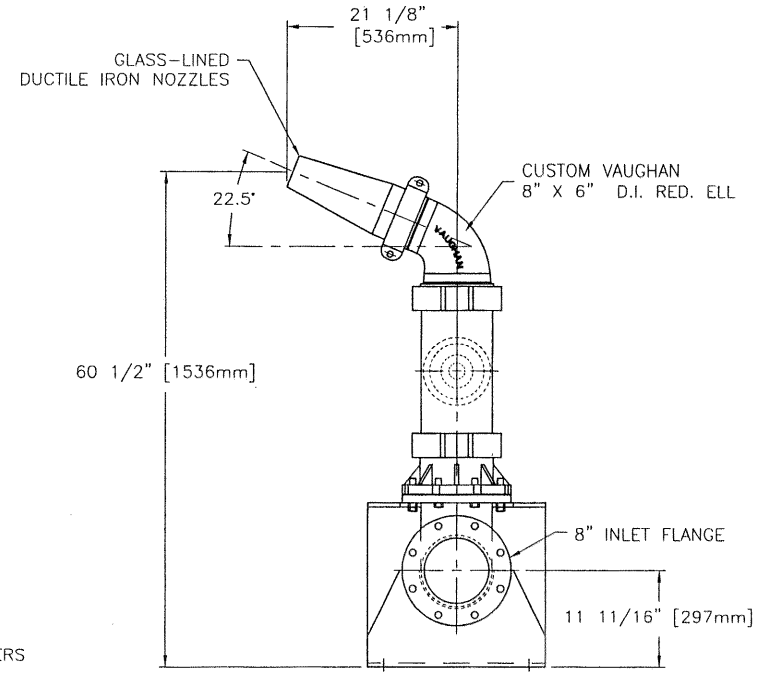
DESIGN	ENGINEERING
GRD	MP

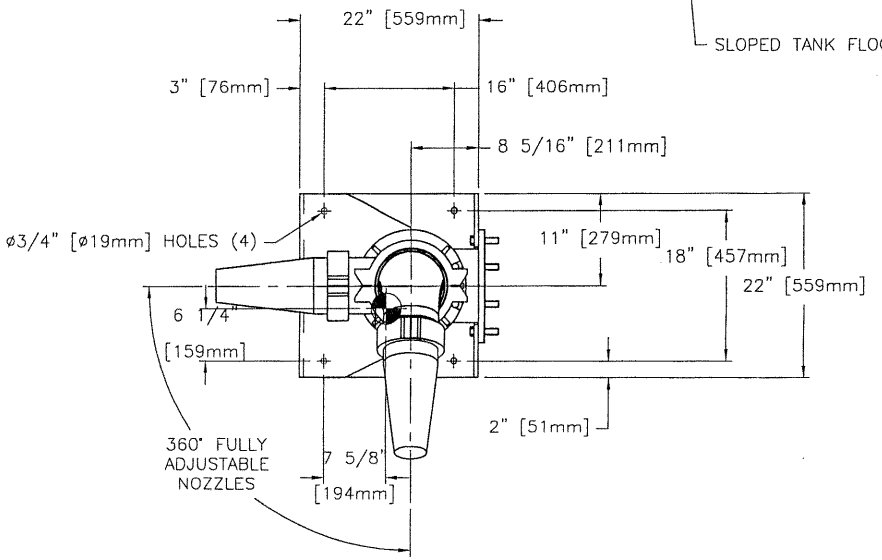
JOB ORDER NUMBER:

DRAWN BY: KCW
DATE: 8/14/12
SCALE: 1/8"=1'
DRAWING NUMBER: 115707
PART NUMBER:
REVISION NUMBER: 0

TITLE:
ROTAMIX SYSTEM
NOZZLE LOCATION PLAN
DIGESTER #11
CITY OF WINNIPEG
NORTH END WPCC







VIEW A-A

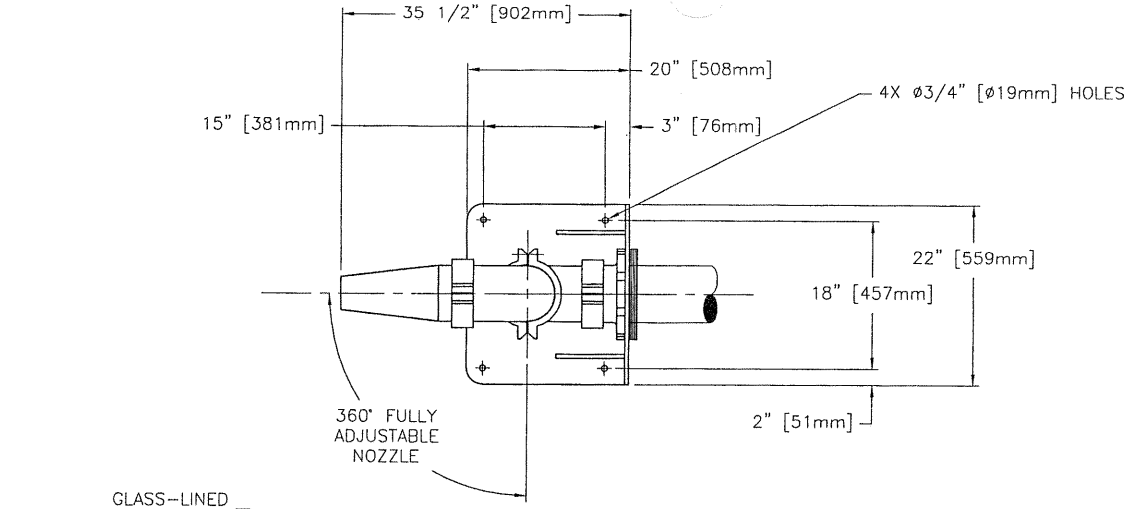
NOTES:

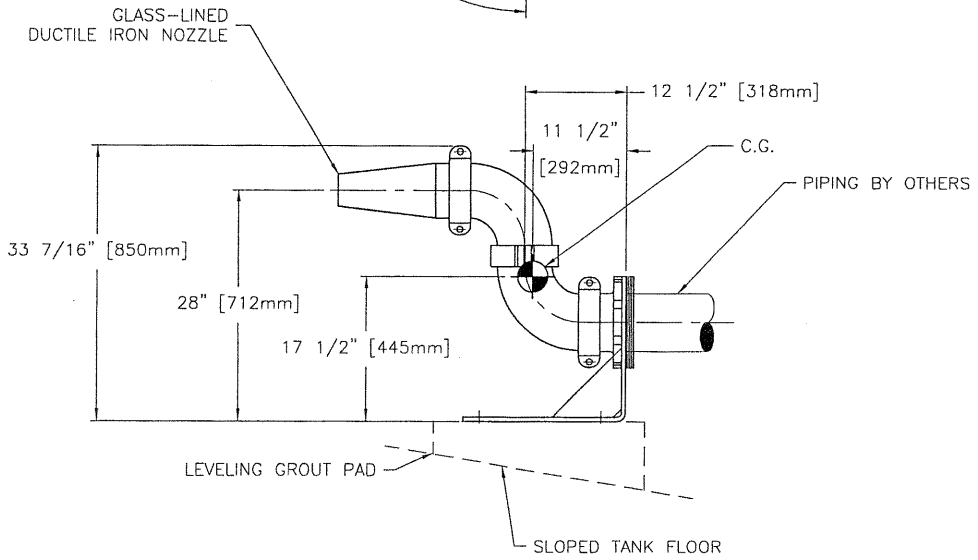
1. MIXING NOZZLE ASSEMBLY WEIGHT: 690 LBS.
2. FINISH: AS SPECIFIED ON LIST OF EQUIP. IN ENGINEERING SUBMITTAL.
3. ALL FASTENERS TO BE 300 SERIES STAINLESS STEEL.
4. THIS NOZZLE IS DESIGNED TO BE AN INTEGRAL PART OF VAUGHAN'S ROTAMIX TM SYSTEM. THE DISCHARGE NOZZLES ARE DESIGNED TO MIX THE DIGESTER OR STORAGE TANK IN A ROTATIONAL MANNER.
5. ALL COMPONENTS ARE MADE OF GLASS-LINED DUCTILE IRON ASTM A536, EXCEPT FOR THE BASE, WHICH IS 1/2" THICK 1018 HR STEEL.
6. 360° FULLY ADJUSTABLE NOZZLES ARE TO BE POSITIONED IN THE FIELD BY VAUGHAN.
7. PROVIDE 4, 5/8" X 7" LONG 316 S.S. ANCHOR BOLTS.

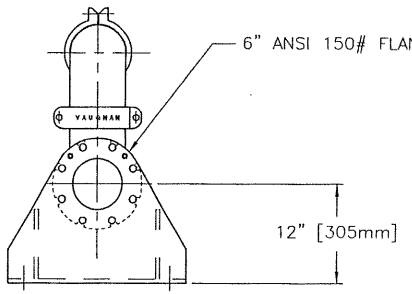
Vaughan
VAUGHAN CO., INC.
364 MONTE-ELMA ROAD
MONTESANO, WA 98563
PHONE: (360) 249-4042
FAX: (360) 249-6155

OUTLINE DIMENSIONS
MODEL: FM8-2N-LPA
W/ 22.5° ELL
ROTAMIX NOZZLE ASSEMBLY

CHECKED	ENGINEER	DRAWN BY	SCALE	PART NUMBER
GRD	GRD	KCW	1" = 1'	
JOB ORDER NUMBER		DATE	DRAWING NUMBER	REVISION NUMBER
		6/14/11	114773	0







CERTIFIED PRINT
GLENN R. DORSCH
CHIEF ENGINEER
VAUGHAN CO. INC.
OCT, 20 2006

NOTES:

1. FINISH: AS SPECIFIED ON LIST OF EQUIP. IN ENGINEERING SUBMITTAL.
2. ALL FASTENERS TO BE 300 SERIES STAINLESS STEEL.
3. THIS NOZZLE IS DESIGNED TO BE AN INTEGRAL PART OF VAUGHAN'S ROTAMIX TM SYSTEM. THE DISCHARGE NOZZLES ARE DESIGNED TO MIX THE DIGESTER OR STORAGE TANK IN A ROTATIONAL MANNER.
4. ALL COMPONENTS ARE MADE OF GLASS-LINED DUCTILE IRON ASTM A536, EXCEPT FOR THE BASE, WHICH IS 1/2" THICK 1018 HR STEEL.
5. 360° FULLY ADJUSTABLE NOZZLES ARE TO BE POSITIONED IN THE FIELD BY VAUGHAN.
6. PROVIDE 4, 5/8" X 7" LONG 316 S.S. ANCHOR BOLTS.
7. MIXING NOZZLE ASSEMBLY WEIGHT: 385 LBS.

AS BUILT

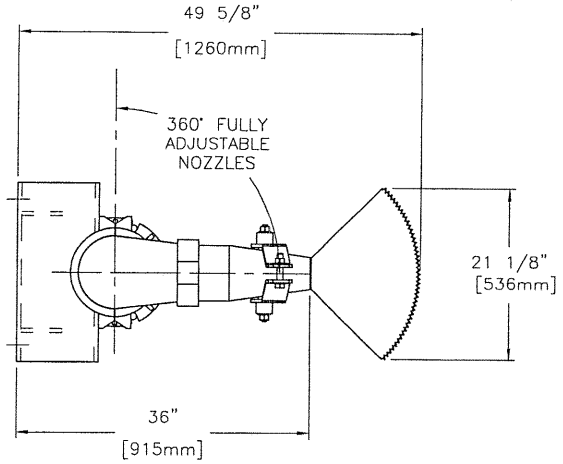
Vaughan
VAUGHAN CO., INC.
364 MONTE-ELMA ROAD
MONTESANO, WA 98563
PHONE: (360) 249-4042
FAX: (360) 249-6155

UNLESS OTHERWISE NOTED, TOLERANCES ARE TO BE: SURFACE FINISH 125 MICROINCHES; 3 PLACE DECIMAL ±0.010"; 2 PLACE DECIMAL ±0.030"; MACHINED HOLES ±0.010"; 3 PLACE DECIMAL ±0.005"; 2 PLACE DECIMAL ±0.010"; MACHINED SURFACES 0.005"; BREAK ALL MACHINED EDGES 0.005" R UNLESS NOTED OTHERWISE

OUTLINE DIMENSIONS
MODEL: FM6-1N-LP
ROTAMIX SYSTEM

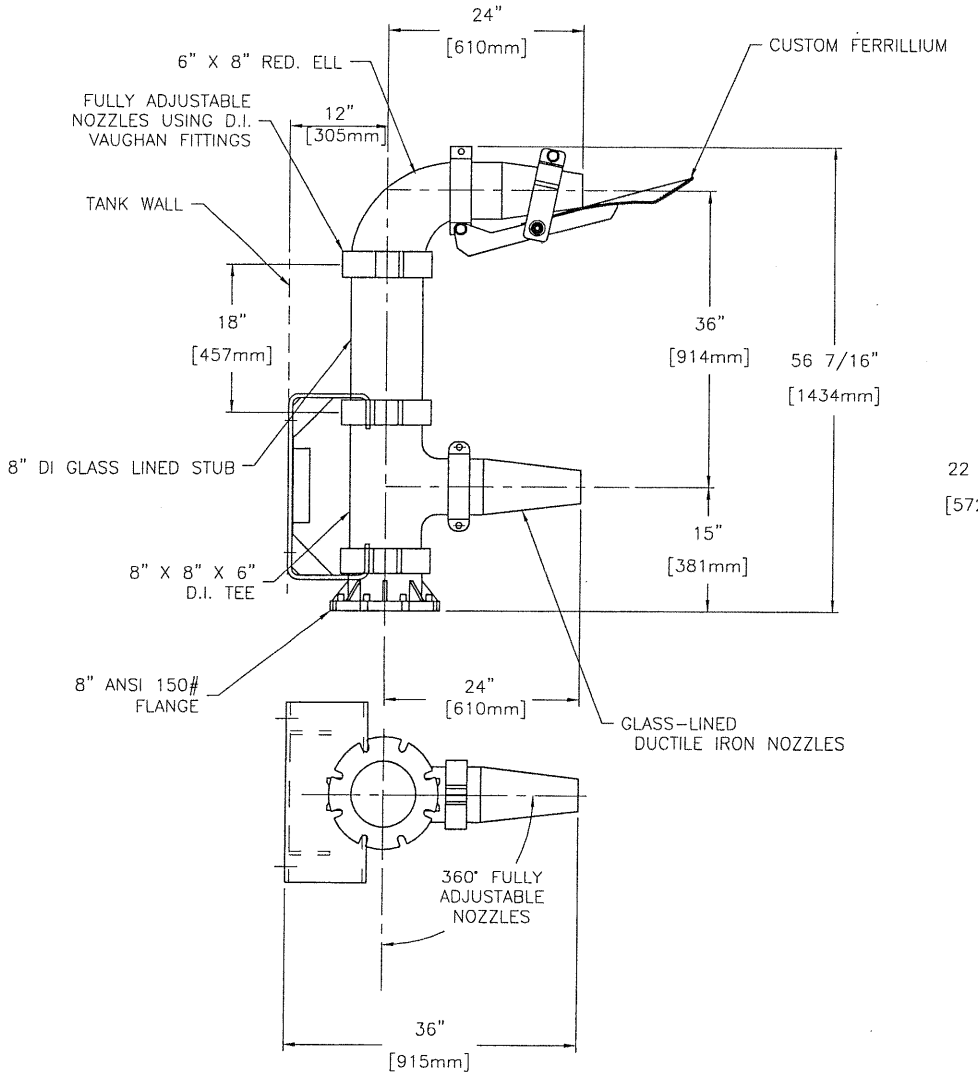
CHECKED	ENGINEER	DRAWN BY	SCALE	PART NUMBER
GRD	GRD	KCW	1"=1'	
JOB ORDER NUMBER		DATE	DRAWING NUMBER	REVISION NUMBER
		8/25/05	110750	0

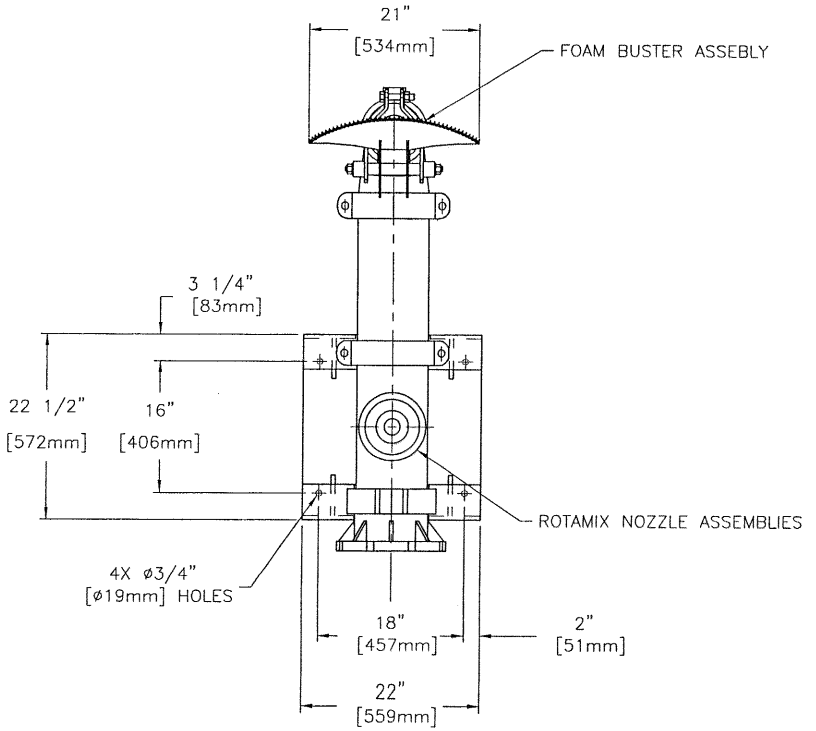
REVISION LIST			
DATE	REV#	DESCRIPTION	BY
3/17/09	1	REVISED FOAMBUSTER NOZZLE	KCW



NOTES:

1. MIXING NOZZLE ASSEMBLY WEIGHT: 697 LBS.
2. FINISH: AS SPECIFIED ON LIST OF EQUIP. IN ENGINEERING SUBMITTAL.
3. ALL FASTENERS TO BE 300 SERIES STAINLESS STEEL.
4. THIS NOZZLE IS DESIGNED TO BE AN INTEGRAL PART OF VAUGHAN'S ROTAMIX TM SYSTEM. THE DISCHARGE NOZZLES ARE DESIGNED TO MIX THE DIGESTER OR STORAGE TANK IN A ROTATIONAL MANNER.
5. ALL COMPONENTS ARE MADE OF GLASS-LINED DUCTILE IRON ASTM A536, EXCEPT DEFLECTOR WHICH IS STAINLESS STEEL.
6. 360° FULLY ADJUSTABLE NOZZLES ARE TO BE POSITIONED IN THE FIELD BY VAUGHAN.





Vaughan
VAUGHAN CO., INC.
364 MONTE-ELMA ROAD
MONTESANO, WA 98563
PHONE (360) 249-4042
FAX (360) 249-6155

TITLE:
OUTLINE DIMENSIONS
WM8-2N W/ FOAM BUSTER
(WALL MOUNTED)
ROTAMIX NOZZLE ASSEMBLY
W/ FOAM BUSTER ASSEMBLY

CHECKED	ENGINEER	DRAWN BY	SCALE	PART NUMBER
GRD	GRD	KCW	1" = 1'	
JOB ORDER NUMBER		DATE	DRAWING NUMBER	REVISION NUMBER
		2/25/09	113128	1

2.2 GLASS-LINED D.I. NOZZLE CONSTRUCTION

A. Nozzles: Shall be ASTM A536 cast ductile iron, glass-lined, with wall thickness of 1" nominal thickness, glass-lined on the nozzle inside diameter and tip per section F below. The nozzle shall incorporate a long straight taper length of at least 12 inches.

B. Assembly Fittings: Shall be ASTM A536 glass-lined cast ductile iron, with 150 lb. flanged piping connection.

C. Base: Shall be fabricated carbon steel, with mounting holes for 5/8" anchor bolts. An 8-lb. zinc anode shall be attached to the base for galvanic corrosion protection.

D. Anchor bolts: Shall be 5/8" inch diameter by 7" long, sufficient length to support thrust loads from nozzles. Construction shall be of 316 stainless steel.

E. Surface preparation: The unit shall be SSPC-SP5 white metal sandblast submerged or wetted parts. Finish coat all surfaces with 3M™ Scotchkote™ 134 Fusion Bonded Epoxy Coating.

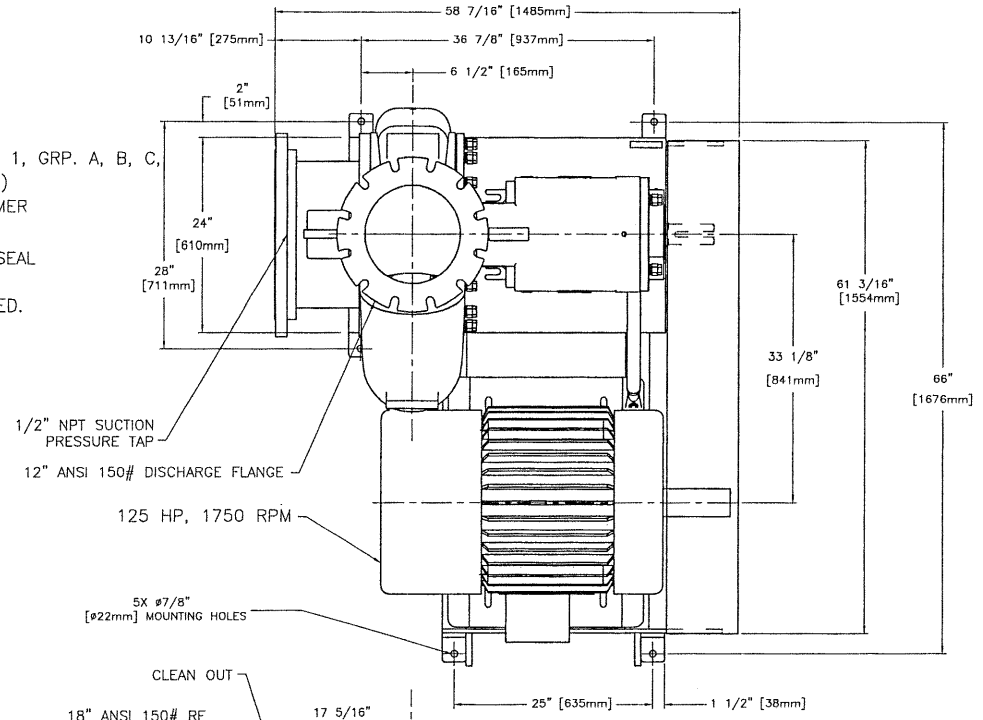
F. GLASS LINING SPECIFICATIONS: Pipe and fittings shall be lined with a specially formulated internal porcelain coating designed for handling sewage, grease, scum and sludge in sewage and wastewater treatment plants, and shall be resistant to adherence of grease and crystalline metal salt deposits within these systems. All metal preparation, application and processing will follow the manufacturers recommended procedure.

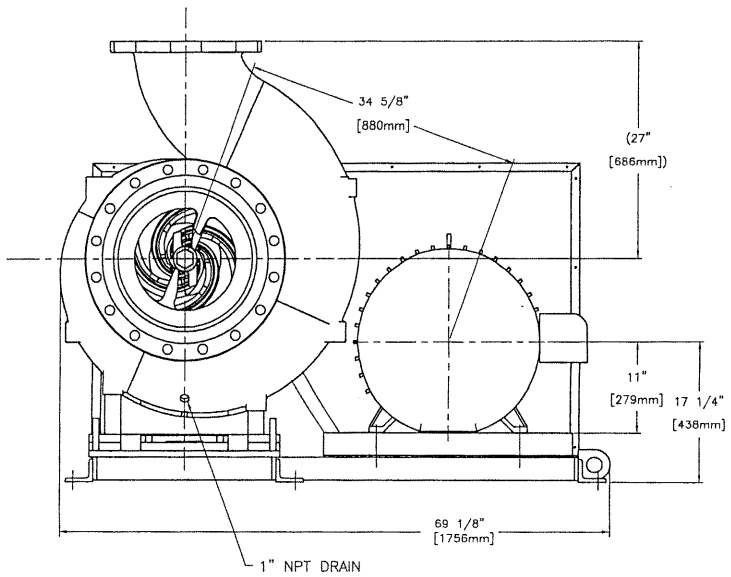
The coating shall consist of special glasses and inorganic materials applied to internal surfaces, fired to a maturing temperature greater than 1300°F, sufficient to form an integral molecular chemical/mechanical bond with the base metal. The resulting bond shall be sufficient to withstand a metal yield of 0.001 inch/inch without damage to the glass.

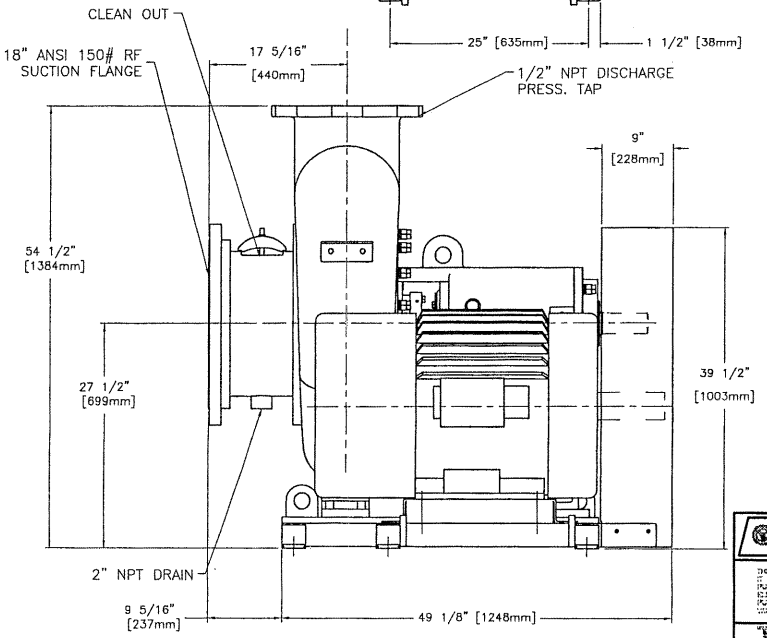
The entire lining system shall have a minimum thickness of .010", a hardness exceeding 5 on the Mohs scale, and a density from 2.5 to 3.0 grams per cubic centimeter. The lining shall be capable of withstanding an instantaneous thermal shock of 350°F without crazing, blistering, or spalling and shall be resistant to corrosion by most solutions between PH-3 and PH-10 at 125°F.

NOTES:

1. PUMP & BASE WEIGHT: 3500 LBS [1588 KGS]
2. MOTOR WEIGHT: 1600 LBS [726 KGS]
3. TOTAL WEIGHT: 5100 LBS [2313 KGS]
4. PERFORMANCE REQUIRED: 8,150 GPM @ 41' TDH AT 720 RPM.
5. MOTOR: 125 HP, 1750 RPM, 575V, 3 PH, 60 HZ, DIV. 2, CLASS 1, GRP. A, B, C, & D, 1.15 SF, TEFC, PREM. EFF., ELECTRIC MOTOR (444T FRAME)
6. FINISH: SANDBLAST & SINGLE COAT OF TNEMEC ZINC FILLED PRIMER & FINISH COATED W/ TNEMEC TYPOXY 27WB EPOXY.
7. MECHANICAL SEAL TO BE VAUGHAN CARTRIDGE TYPE FLUSHLESS SEAL
8. SIDE MOUNT BELT DRIVE INCLUDES: ADJUSTABLE MOTOR MOUNT SAFETY GUARD, BELTS, SHEAVES FOR 720 RPM FINAL PUMP SPEED.
9. 1" NPT DRAIN REQUIRED IN CASING.
10. BUNA-N ELASTOMERS REQUIRED.
11. 316SS EXPANSION TYPE ANCHOR BOLTS
12. MOTOR ON RIGHT LOOKING AT SUCTION
13. VAL-MATIC AIR RELEASE VALVE REQUIRED.
14. SPARE PARTS TO BE SUPPLIED SEE LIST OF EQUIP.
15. FACTORY TESTING REQUIRED SEE LIST OF EQUIP.







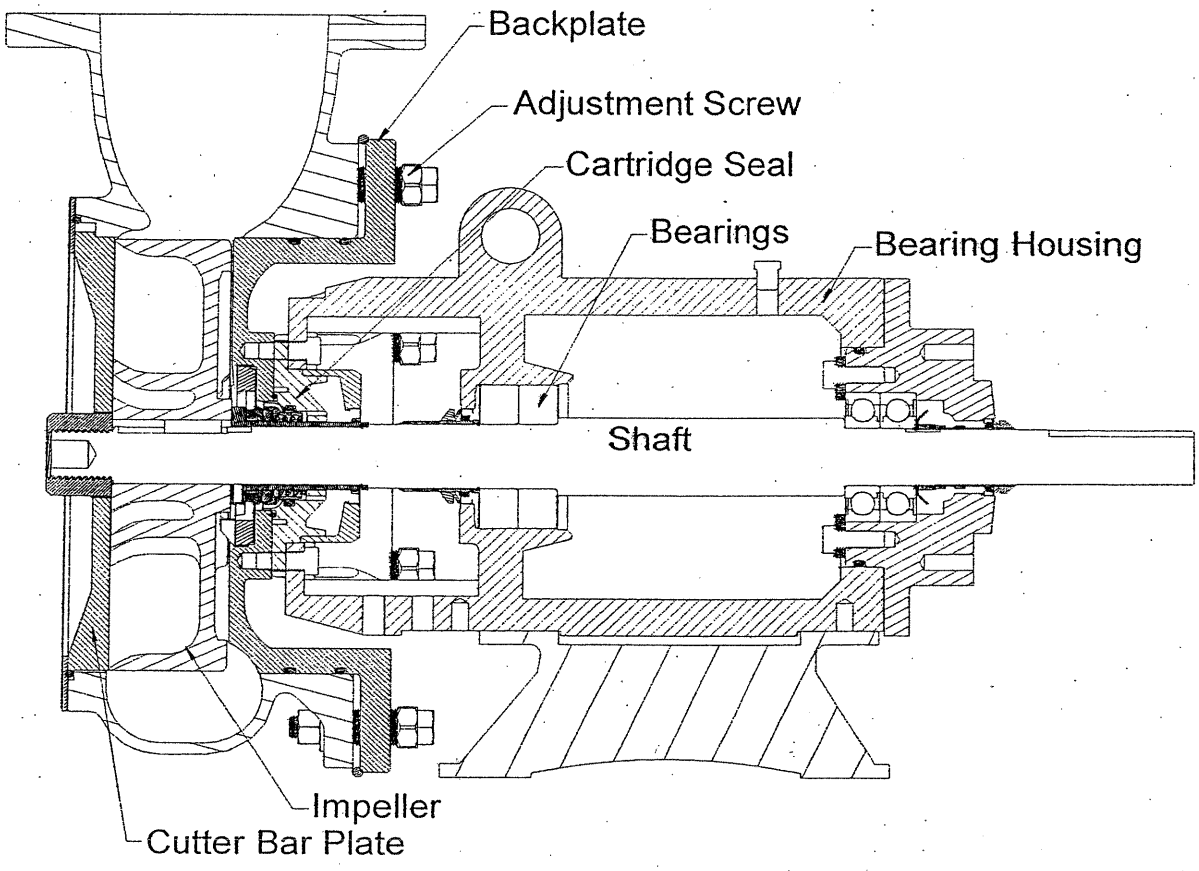
Vaughan

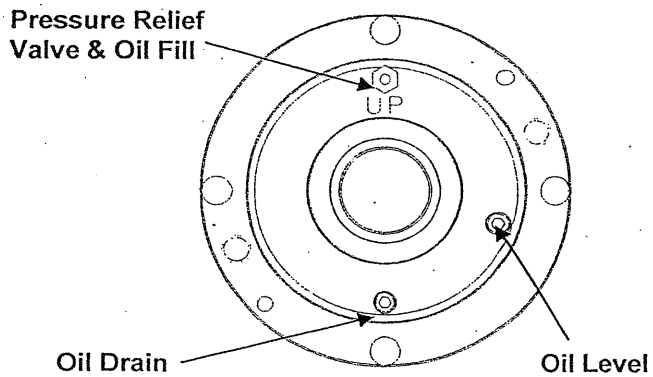
OUTLINE DIMENSIONS
MODEL: HE12W18CSB-210
(2) ROTAMIX SYSTEM PUMP
CITY OF WINNIPEG,
NORTH END WPCC

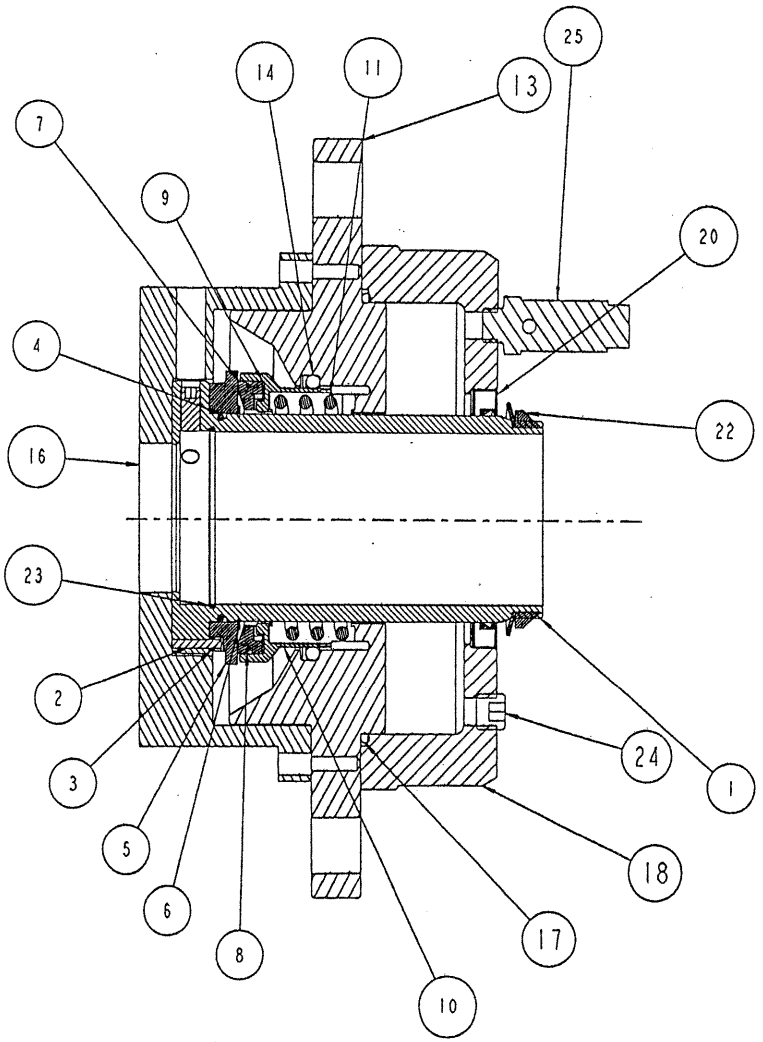
DRAWN	CHECKED	DESIGNED	SCALE	NOT TO SCALE
GRD	GRD	KCW	1:8	
		DATE	DRAWING NUMBER	REVISION NUMBER
		8/13/12	115708	0

HE SERIES PUMPS WITH VAUGHAN E-SERIES CARTRIDGE SEAL O&M Supplement

The Vaughan E-Series chopper pumps with cartridge seal are supplied with a single mechanical seal placed directly behind the impeller. This seal will not require any water flush to keep it clean. However, when contaminated oil starts flowing out of the pressure relief valve during operation, contaminated oil will need to be drained and refilled with fresh oil (see diagram below). Using ISO 46 Turbine oil, fill through the top hole until oil comes out from the 'Oil Level' hole. For 3"-6" pumps, about 2 oz. and for 8"-12" pumps, about 6 oz.







SECTION A-A

NO.	PART NO.	DESCRIPTION	MATERIAL	NOTES
1	V108-852	SEAL SLEEVE	17-4 PH SS, H-900 H.T.	
2	N/A	DOWEL PIN	316 SS	.125 DIA X .750 LONG SS
3	V108-119	DOWEL PIN CUSHION	TEFLON	
4	V850-149	O-RING	BUNA-N OR VITON	
5	V108-395	ROTATING SEAL FACE	CONTROLLED POROSITY Si-C	
6	V801-825	RETAINING RING	SPRING STEEL, AISI 1070	SPIROLOX US-300
7	V108-396	STATIONARY SEAL FACE	CONTROLLED POROSITY Si-C	
8	V850-044	O-RING	BUNA-N OR VITON	
9	V108-397	GASKET	BUNA-N OR VITON	
10	V108-394	STATIONARY MEMBER	316 SS, TEFLON COATED	
11	V108-398	SPRING	M. WIRE, ASTM A228 OR 17-7PH SS	
13	V111-703	GLAND, CBH	DUCTILE IRON OR 316 SS	
14	V850-343	O-RING	BUNA-N OR VITON	
15	N/A	SET SCREW	316 SS	5/16-24 NF X 5/8 LONG SS, 3 REQ'D
16	V108-854	CARTRIDGE CAP	POLYURETHANE	
17	N/A	DOWEL PIN	316 SS	
18	V111-704	GLAND CAP	DUCTILE IRON OR 316 SS	
20	V801-838	LIP SEAL	VITON ELASTOMER, STEEL CASE	CR 29870
21		1/4" NPT PLUG		
22	V801-724	SLINGER	BUNA-N OR VITON	CR 400705
23	V850-037	O-RING	VITON	
24		1/4" NPT PLUG		
25	V801-887	POP SAFETY VALVE		

NOTES:
1. WATER FLUSH NOT REQUIRED.
2. FILL WITH 13 OZ. OF 46W HYDRAULIC OIL FOR PE MODEL PUMPS AND 6 OZ. FOR HE MODEL PUMPS
3. GLAND (#13) & CAP (#18) ARE ASSEMBLED TOGETHER BY 1/4 X 3/4 SOC HD CAP SCREWS (4) & CAPLUGS SH-25 (4)
4. INSTALL POP SAFETY VALVE(ITEM 25) SUCH THAT THE HOLE IS ON THE SIDE (AS SHOWN)

MODEL NAME: 250CBHVSEAL_108851

REV	DATE	DESCRIPTION	BY
7	11SEP16	46W HYDRAULIC OIL WAS 10W ECN2599	AJC
6	11MAY11	ITEM 25 WAS V801-876 ECN2538	YCC
5	10JUL28	ADD V801-876, PRESSURE RELIEF VENT ECN2368	YCC
4	09JUN18	ADD CAP (#16) & SCREWS (#26-29) ECN2089	YCC
3	07SEP7	USE NEW GLAND ECN 1711	YCC
2	05SEP01	ADD NOTES 1 & 2. ECN 1316	RAB
1	03SEP9	ADD 167 O-RING	KHK

Vaughan
VAUGHAN CO., INC
364 MONTE-ELMA ROAD
MONTESANO, WA 98563
(360) 249-4042
FAX (360) 249-6155

TITLE
ASSEMBLY
2.50" CBH
VAUGHAN CARTRIDGE SEAL

UNLESS OTHERWISE NOTED, TOLERANCES ARE TO BE:
SURFACE FINISH: 125 MICROINCHES
DIMENSIONS: WELDING: X.XX= 1/16
DIMENSIONS: MACHINING: X.XX= .020
DIMENSIONS: MACHINING: X.XXX= .010
GEOMETRIC TOLERANCE: RUNOUT ON CYLINDERS: .010
GEOMETRIC TOLERANCE: PARALLELISM: .005
BREAK ALL MACHINED EDGES .005 R UNLESS NOTED OTHERWISE

CHK'D BY	ENGR	DRAWN BY	SCALE	PART NUMBER
		KHK	0.500	V801-310
JO NUMBER		DATE	DRAWING NUMBER	REV
		02OCT1	108851	7

SPECIFICATIONS – 8" – 12" E-SERIES HORIZONTAL CHOPPER PUMPS

The horizontal chopper pump shall be specifically designed to pump waste solids at heavy consistencies without plugging or dewatering of the solids. Materials shall be chopped/macerated and conditioned by the pump as an integral part of the pumping action. The pump must have demonstrated the ability to chop through and pump high concentrations of solids such as plastics, heavy rags, grease and hair balls, wood, paper products and stringy materials without plugging, both in tests and field applications. Pump shall be manufactured by Vaughan Co., Inc.

DETAILS OF CONSTRUCTION

A. Casing, Back Pull-Out Adapter Plate and Wear Plate: The pump casing shall be of volute design, spiraling outward to the 125 lb. flanged centerline discharge. A ½"-NPT pressure tap shall be included on or near the discharge flange. Back pull-out adapter plate shall allow removal of pump components from outboard of the casing, and allow external adjustment of impeller-to-cutter bar clearance. Casing and adapter plate shall be ductile cast iron with all water passages to be smooth, and free of blowholes and imperfections for good flow characteristics. The back pull-out wear plate shall be heat treated low-alloy steel plate. Backplate will include a replaceable Rockwell C 60 steel wear plate adjustable for 0.005-0.050" clearance to cut against the rotating impeller pumpout vanes for removing fiber and debris.

B. Impeller: Shall be semi-open type with pump out vanes to reduce seal area pressure. Chopping/maceration of materials shall be accomplished by the action of the cupped and sharpened leading edges of the impeller blades moving across the cutter bar at the intake openings, with a maximum set clearance between the impeller and cutter bar of 0.015" - 0.025". Impeller shall be cast steel, heat treated to minimum Rockwell C 60 and dynamically balanced. The impeller shall be threaded to the shaft and shall have no axial adjustments and no set screws.

C. Cutter Bar Plate: Shall be recessed into the pump bowl and shall contain at least 2 shear bars extending diametrically across the intake opening to within 0.020" - 0.040" for 8"-10" pumps and 0.040"-0.060" for 12" pumps of the rotating external cutter tooth, for the purpose of preventing intake opening blockage and wrapping of debris at the shaft area. Chopper pumps utilizing individually mounted shear bars, and which do not have a rotating external cutter extending through to the opposite side of the shear bar, shall not be acceptable. Cutter bar shall be alloy steel heat-treated to minimum Rockwell C 60.

D. Upper Cutter: Shall be bolted into the back pull-out adapter plate behind the impeller, designed to cut against the pump-out vanes and the impeller hub, reducing and removing stringy materials from the mechanical seal area. Upper cutter shall be cast steel, heat treated to minimum Rockwell C 60. The upper cutter teeth are positioned as closely as possible to the center of shaft rotation to minimize cutting torque and nuisance motor tripping. The ratio of upper cutter cutting diameter to shaft diameter in the upper cutter area of the pump shall be 3.6 or less.

E. External Cutter: The external cutter shall be used to eliminate binding or build-up of stringy materials at the pump inlet. The external cutter shall consist of opposing cutter wings which shear against the outside surface of the shear bars on the cutter bar plate to within 0.010" - 0.020", an integral cast anvil which shears against the adjacent surface of the shear bars on the cutter bar plate, and a hex head sufficiently sized for ease of removal. The external cutter shall be cast steel and heat treated to a minimum 60 Rockwell C Hardness.

F. Pump Shafting: The pump shaft and impeller shall be supported by ball bearings. All shafting shall be heat treated.

G. Bearings: Shaft thrust in both directions shall be taken up by two back-to-back mounted single-row angular contact ball bearings, mounted in an adjustable position thrust bearing cartridge to permit upper cutter to impeller adjustment. A single spherical roller radial bearing shall also be provided. B10 bearing life shall be minimum 100,000 hours.

H. Bearing Housing: Shall be ductile cast iron, and machined with piloted bearing fits for concentricity of all components. Bearing housing shall be oil bath lubricated with ISO Gr. 100 turbine oil and a side-mounted site glass. Viton® double lip seals riding on stainless steel shaft sleeves are to provide sealing at each end of the bearing housing.

I. Stuffing Box: The stuffing box shall be ductile cast iron. The stuffing box shall be designed to accommodate the flushed mechanical seal, or packing as described below.

J. Seal: [NOTE TO CONSULTING ENGINEER: Please choose one of the 3 options below]:

- Packing design with 5-ring Kevlar packing, split Teflon lantern ring and water fitting. The packing shaft sleeve shall be 316 SS with Nickel-Chrome-Boron coating. Contractor is to provide a 6-10 gal./hr. packing flush with filtered water, a rotameter, throttle valve, and solenoid operated isolation valve interlocked with an auxiliary contact of the motor starter.
- Mechanical seal with throttle bushing and water fitting for seal water flush. The seal shaft sleeve shall be 316 SS. Mechanical seal materials shall be Alloy 20 with silicon carbide faces. Seal shall be positively driven by set-screws. Elastomers shall be of Buna N, and stationary seal member shall be of the cup-mounted type to ensure cushioning of face material from mechanical shock. Contractor is to provide a 6-10 gal./hr. seal flush with filtered water, a rotameter, throttle valve, and solenoid operated isolation valve interlocked with an auxiliary contact of the motor starter.
- Mechanical Seal system *specifically designed to require no seal flush*: The mechanical seal shall be located immediately behind the impeller hub to eliminate the stuffing box and maximize the flushing available from the impeller pumpout vanes. The seal shall be cartridge-type mechanical seal with Viton O-rings and silicon carbide (or tungsten carbide) faces. This cartridge seal shall be a pre-assembled, pre-tested so that no seal settings or adjustments are required from the installer. Any springs used to push the seal faces together must be shielded from the fluid to be pumped. The cartridge shall also include a 17-4PH, heat-treated seal sleeve and a ductile iron seal gland.

K. Inlet Manifold: The pump assembly shall be mounted horizontally with a 150 lb. standard inlet flange, cleanout, 1/2" NPT suction pressure tap, drain connection and mounting feet.

L. Optional Belt Drive: Adjustable brackets shall be used to support an over-head mounted motor. Sheaves and belts shall be properly sized for horsepower ratings, and all guards are to be supplied with the belt drive system.

M. Stainless Steel Nameplates: Shall be attached to the pump and drive motor giving the manufacturer's model and serial number, rated capacity, head, speed and all pertinent data.

N. Drive motor: Shall be 125 HP, 1750 RPM, 575 volts, 3 phase, 60 hertz, 1.15 service factor, foot and C-flange mounted, TEFC enclosure. The motor shall be sized for non-overloading conditions.

O. FINISH: Surface Preparation: SSPC-SP6 commercial sandblast, 3 MDFT zinc-filled primer, and 3 MDFT epoxy finish coat (except Motor).

Vaughan

Project: NORTH END WPCC Digester
Entered By: M Pine rev Aug 13, 2012

CURVE	RPM	HP
A	885	250
B	845	200
C	765	150
D	720	125
E	665	100
F	605	75
G	560	60
H	525	50
I	490	40

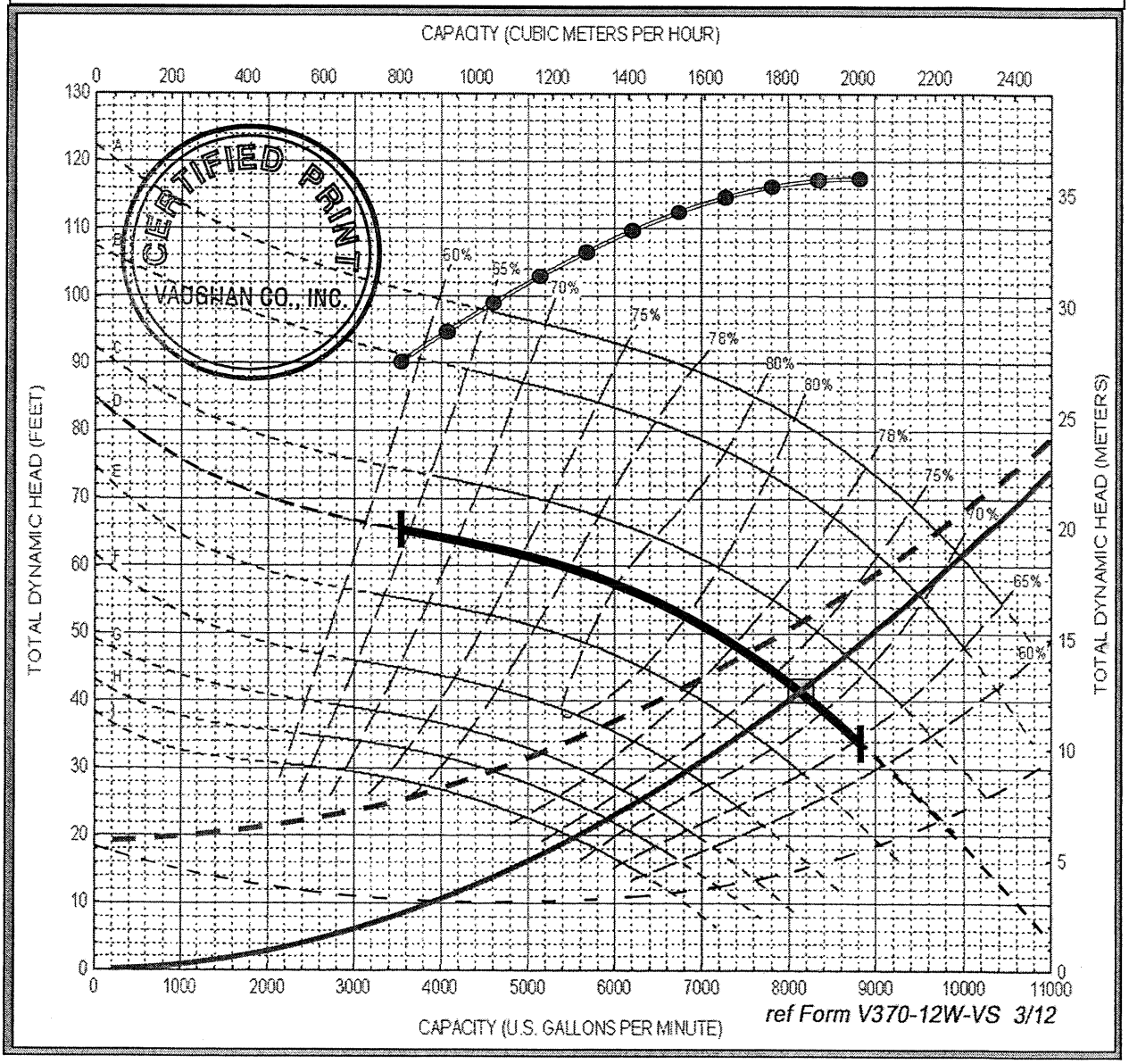
Capacity (GPM) 8150 (M³/HR 1850.9) **TDH (feet)** 41.3 (METERS 12.6)

Pump RPM - Variable Speed	719			
Impeller Diameter (inches)	21.00			
Est. Efficiency at Operating Point	72.9	%		
Estim HP at Operating Point	116.6	HP	86.97	KW
Max HP at Given RPM / Solid Portion	117.1	HP	87.36	KW
Maximum HP corresponds to	8786	GPM	1995.2	M³/HR
Estim Reprime Lift (sea level)	N/A	feet		

PUMP MODEL **E12W**

Type of Friction Calc Used ***WATER*** C = 135

Pump curve — HP required — System Curve (water) — System curve (sludge) — Operating Point *(Note: HP & system curve plotted vs FEET scale)*



NOTE: INFORMATION PROVIDED IS TO BE USED AS A GUIDELINE ONLY - REFER TO PUBLISHED CURVE TO CHECK PERFORMANCE, EFFICIENCY, & HORSEPOWER. FINAL PUMP SELECTION SHALL BE VERIFIED BY PROJECT ENGINEER.

SUCTION SIDE FITTINGS

FRICTION OPTION: *WATER* CVALUE: *135* SUCTION SIDE TOTAL: 3.13

FITTING	FITTING GPM%	FITTING GPM	FITTING CODE	QUANTITY	LENGTH (feet)	START DIAMETER (inches)	END DIAMETER (inches)	FRICTION FACTOR (per 100ft)	VELOCITY (ft/sec)	VELOCITY HEAD (ft)	K VALUE	CALC METHOD1 (feet)	EQUIV LENGTH (feet)	CALC METHOD2 (feet)	FRICTION LOSSES	
S01	100	8150	STRAIGHT INLET	1	0	24.00	24.00	0.40	5.78	0.52	1.00	0.519	120.00	0.475	**0.519**	**0.000**
S02	100	8150	90DEG ELBOW-STANDARD	1	0	24.00	24.00	0.40	5.78	0.52	0.34	0.177	60.00	0.238	**0.238**	**0.000**
S03	100	8150	STRAIGHT PIPE	1	41	24.00	24.00	0.40	5.78	0.52			41.00	0.162	**0.162**	**0.000**
S04	100	8150	90DEG ELBOW-STANDARD	1	0	24.00	24.00	0.40	5.78	0.52	0.34	0.177	60.00	0.238	**0.238**	**0.000**
S05	100	8150	STRAIGHT PIPE	1	10	24.00	24.00	0.40	5.78	0.52			10.00	0.040	**0.040**	**0.000**
S06	100	8150	90DEG ELBOW-STANDARD	1	0	24.00	24.00	0.40	5.78	0.52	0.34	0.177	60.00	0.238	**0.238**	**0.000**
S07	100	8150	PLUG VALVE	1	0	24.00	24.00	0.40	5.78	0.52	0.21	0.107	36.00	0.143	**0.143**	**0.000**
S08	100	8150	STRAIGHT PIPE	1	15	24.00	24.00	0.40	5.78	0.52			15.00	0.059	**0.059**	**0.000**
S09	100	8150	90DEG ELBOW-STANDARD	2	0	24.00	24.00	0.40	5.78	0.52	0.34	0.177	60.00	0.238	**0.475**	**0.000**
S10	100	8150	TEE-BRANCH RUN	2	0	24.00	24.00	0.40	5.78	0.52	0.68	0.354	120.00	0.475	**0.951**	**0.000**
S11	100	8150	GATE VALVE-100% OPEN	1	0	24.00	24.00	0.40	5.78	0.52	0.09	0.047	16.00	0.063	**0.063**	**0.000**
S12																
S13																
S14																
S15																

DISCHARGE SIDE FITTINGS

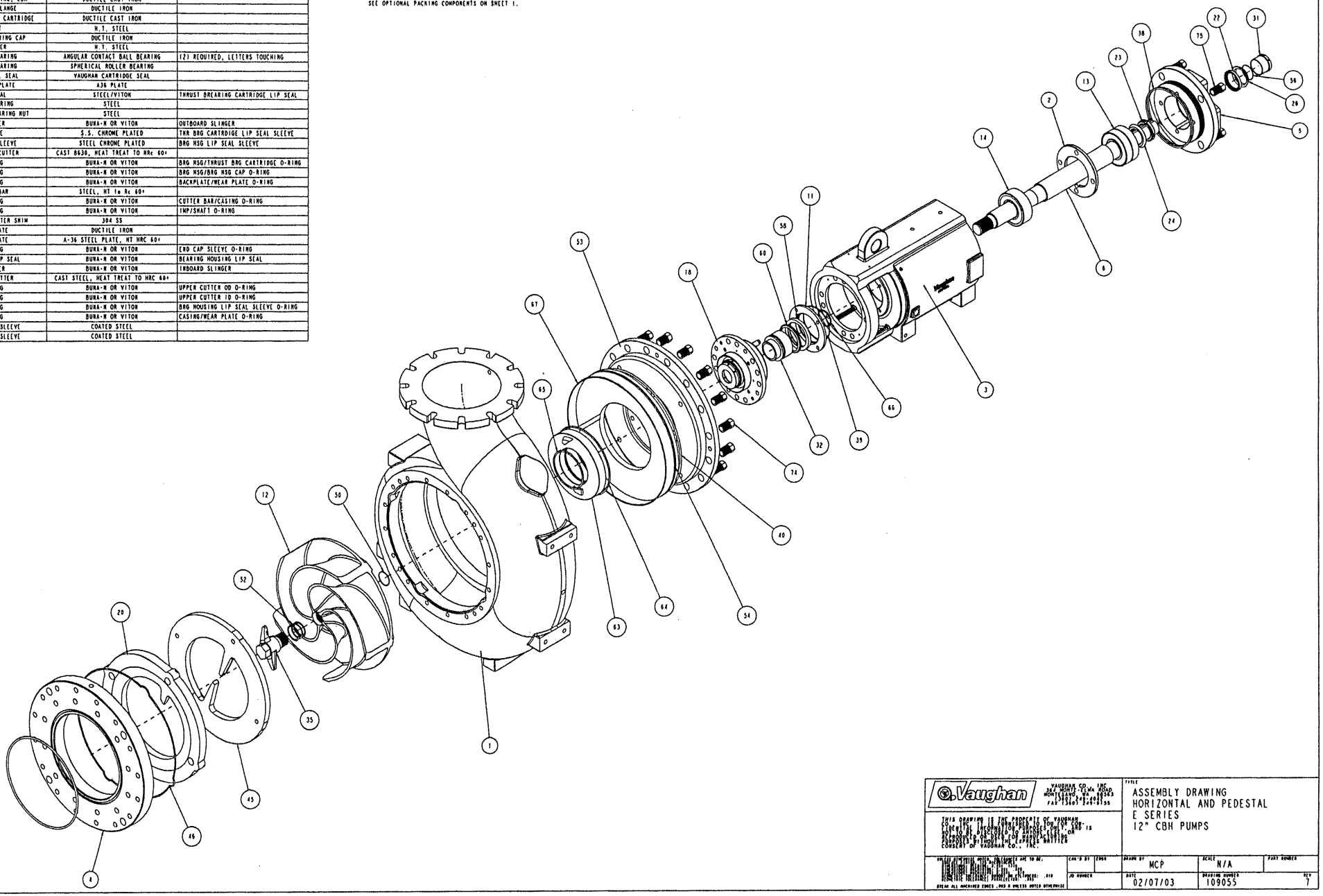
DISCHARGE SIDE TOTAL: 16.04 22.17

FITTING	FITTING GPM%	FITTING GPM	FITTING CODE	QUANTITY	LENGTH (feet)	START DIAMETER (inches)	END DIAMETER (inches)	FRICTION FACTOR (per 100ft)	VELOCITY (ft/sec)	VELOCITY HEAD (ft)	K VALUE	CALC METHOD1 (feet)	EQUIV LENGTH (feet)	CALC METHOD2 (feet)	FRICTION LOSSES	VELOCITY HEAD
D01	100	8150	TEE-BRANCH RUN	1	0	12.00	12.00	11.55	23.12	8.30	0.79	6.593	60.00	6.928	**6.928**	**0.000**
D02	100	8150	TEE-BRANCH RUN	1	0	20.00	20.00	0.96	8.32	1.08	0.71	0.764	100.00	0.962	**0.962**	**0.000**
D03	100	8150	STRAIGHT PIPE	1	9	20.00	20.00	0.96	8.32	1.08			9.00	0.087	**0.087**	**0.000**
D04	100	8150	GATE VALVE-100% OPEN	1	0	20.00	20.00	0.96	8.32	1.08	0.09	0.102	13.33	0.128	**0.128**	**0.000**
D05	100	8150	TEE-BRANCH RUN	1	0	20.00	20.00	0.96	8.32	1.08	0.71	0.764	100.00	0.962	**0.962**	**0.000**
D06	100	8150	STRAIGHT PIPE	1	10	20.00	20.00	0.96	8.32	1.08			10.00	0.096	**0.096**	**0.000**
D07	100	8150	90DEG ELBOW-STANDARD	1	0	20.00	20.00	0.96	8.32	1.08	0.36	0.382	50.00	0.481	**0.481**	**0.000**
D08	100	8150	STRAIGHT PIPE	1	20	20.00	20.00	0.96	8.32	1.08			20.00	0.192	**0.192**	**0.000**
D09	100	8150	45DEG ELBOW-STANDARD	1	0	20.00	20.00	0.96	8.32	1.08	0.19	0.202	26.67	0.256	**0.256**	**0.000**
D10	100	8150	PLUG VALVE	1	0	20.00	20.00	0.96	8.32	1.08	0.21	0.231	30.00	0.289	**0.289**	**0.000**
D11	85.7	6984.55	TEE-THRU RUN	1	0	20.00	20.00	0.72	7.13	0.79	0.24	0.187	33.33	0.241	**0.241**	**0.000**
D12	85.7	6984.55	STRAIGHT PIPE	1	10	20.00	20.00	0.72	7.13	0.79			10.00	0.072	**0.072**	**0.000**
D13	57.1	4653.65	TEE-THRU RUN	1	0	20.00	20.00	0.34	4.75	0.35	0.24	0.083	33.33	0.114	**0.114**	**0.000**
D14	57.1	4653.65	GRADUAL REDUCER	1	0	20.00	16.00	1.01	7.43	0.86	0.07	0.064			**0.064**	**0.000**
D15	57.1	4653.65	STRAIGHT PIPE	1	25	16.00	16.00	1.01	7.43	0.86			25.00	0.253	**0.253**	**0.000**
D16	42.8	3488.2	TEE-THRU RUN	1	0	16.00	16.00	0.59	5.57	0.48	0.25	0.120	26.67	0.158	**0.158**	**0.000**
D17	42.8	3488.2	GRADUAL REDUCER	1	0	16.00	12.00	2.40	9.90	1.52	0.09	0.138			**0.138**	**0.000**
D18	42.8	3488.2	STRAIGHT PIPE	1	12	12.00	12.00	2.40	9.90	1.52			12.00	0.288	**0.288**	**0.000**
D19	28.6	2330.9	TEE-THRU RUN	1	0	12.00	12.00	1.14	6.61	0.68	0.26	0.180	20.00	0.228	**0.228**	**0.000**
D20	28.6	2330.9	STRAIGHT PIPE	1	25	12.00	12.00	1.14	6.61	0.68			25.00	0.285	**0.285**	**0.000**
D21	14.3	1165.45	TEE-BRANCH RUN	1	0	12.00	12.00	0.32	3.31	0.17	0.79	0.135	60.00	0.190	**0.190**	**0.000**
D22	14.3	1165.45	GRADUAL REDUCER	1	0	12.00	8.00	2.27	7.44	0.86	0.12	0.099			**0.099**	**0.000**
D23	14.3	1165.45	STRAIGHT PIPE	1	35	8.00	8.00	2.27	7.44	0.86			35.00	0.796	**0.796**	**0.000**

D24	14.3	1165.45	90DEG ELBOW-RADIUS/DIAM=1	1		8.00	8.00	2.27	7.44	0.86	0.29	0.249	13.33	0.303	**0.303**	**0.000**
D25	7.2	586.8	TEE-BRANCH RUN	1		6.00	6.00	2.59	6.66	0.69	0.92	0.637	30.00	0.777	**0.777**	**0.000**
D26	7.2	586.8	GRADUAL REDUCER	1		6.00	4.00	18.62	14.98	3.49	0.06	0.202			**0.202**	**0.000**
D27	7.2	586.8	GRADUAL REDUCER	1		4.00	2.50	183.27	38.35	22.84	0.06	1.453			**1.453**	**0.000**
D28	7.2	586.8	NOZZLE	1		6.00	2.50									**22.173**
D29																
D30																
D31																
D32																
D33																
D34																
D35																
D36																
D37																
D38																
D39																
D40																
D41																
D42																
D43																
D44																
D45																
D46																
D47																
D48																
D49																
D50																
														TOTALS	19.17	22.17

NO.	DESCRIPTION	MATERIAL	NOTES
1	CASING	CAST DUCTILE IRON	
2	THRUST BEARING CAP	STEEL	
3	BEARING HOUSING, CBH	DUCTILE CAST IRON	
4	SUCTION FLANGE	DUCTILE IRON	
5	THRUST BEARING CARTRIDGE	DUCTILE CAST IRON	
6	SHAFT	N.T. STEEL	
11	INBOARD BEARING CAP	DUCTILE IRON	
12	IMPELLER	N.T. STEEL	
13	THRUST BEARING	ANGULAR CONTACT BALL BEARING	(2) REQUIRED, LETTERS TOUCHING
14	RADIAL BEARING	SPHERICAL ROLLER BEARING	
18	MECHANICAL SEAL	VAUGHAN CARTRIDGE SEAL	
20	SUCTION PLATE	A36 PLATE	
22	LIP SEAL	STEEL/VITON	THRUST BREARING CARTRIDGE LIP SEAL
23	NUT, BEARING	STEEL	
24	RETAINER, BEARING NUT	STEEL	
26	SLINGER	BUNA-N OR VITON	OUTBOARD SLINGER
31	SLEEVE	S.S. CHROME PLATED	THR BRG CARTRIDGE LIP SEAL SLEEVE
32	INBOARD SLEEVE	STEEL CHROME PLATED	BRG HSG LIP SEAL SLEEVE
35	EXTERNAL CUTTER	CAST 8630, HEAT TREAT TO HRc 60+	
38	O-RING	BUNA-N OR VITON	BRG HSG/THRUST BRG CARTRIDGE O-RING
39	O-RING	BUNA-N OR VITON	BRG HSG/BRG HSG CAP O-RING
40	O-RING	BUNA-N OR VITON	BACKPLATE/WEAR PLATE O-RING
45	CUTTERBAR	STEEL, HT to Rc 60+	
46	O-RING	BUNA-N OR VITON	CUTTER BAR/CASING O-RING
50	O-RING	BUNA-N OR VITON	IMP/SHAFT O-RING
52	EXTERNAL CUTTER SHIM	304 SS	
53	BACKPLATE	DUCTILE IRON	
54	WEARPLATE	A-36 STEEL PLATE, HT HRC 60+	
56	O-RING	BUNA-N OR VITON	END CAP SLEEVE O-RING
58	INBOARD LIP SEAL	BUNA-N OR VITON	BEARING HOUSING LIP SEAL
60	SLINGER	BUNA-N OR VITON	INBOARD SLINGER
63	UPPER CUTTER	CAST STEEL, HEAT TREAT TO HRC 60+	
64	O-RING	BUNA-N OR VITON	UPPER CUTTER OD O-RING
65	O-RING	BUNA-N OR VITON	UPPER CUTTER ID O-RING
66	O-RING	BUNA-N OR VITON	BRG HOUSING LIP SEAL SLEEVE O-RING
67	O-RING	BUNA-N OR VITON	CASING/WEAR PLATE O-RING
74	ADJUSTING SLEEVE	COATED STEEL	
75	ADJUSTING SLEEVE	COATED STEEL	

PACKING ASSEMBLY WITH STUFFING BOX MAY BE USED IN PLACE OF VAUGHAN CARTRIDGE SEAL. PACKING SLEEVE ALSO REQUIRED. SEE OPTIONAL PACKING COMPONENTS ON SHEET 1.



TITLE
ASSEMBLY DRAWING
HORIZONTAL AND PEDESTAL
E SERIES
12" CBH PUMPS

DRAWN BY: MCP	SCALE: N/A	PART NUMBER	
DATE: 02/07/03	DRAWING NUMBER: 109055	REV: 7	

REL. S.O.	FRAME	HP	TYPE	PHASE/ HERTZ	RPM	VOLTS
	444T	125	P	3/60	1785	575

AMPS	DUTY	AMB °C/ INSUL.	S.F.	NEMA DESIGN	CODE LETTER	ENCL.
111	CONT	40/F	1.15	B	G	FCXE

E/S	ROTOR	TEST S.O.	TEST DATE	STATOR RES.@25 °C OHMS (BETWEEN LINES)
597904	418143040PE	---	---	.0586

PERFORMANCE

LOAD	HP	AMPERES	RPM	% POWER FACTOR	% EFFICIENCY
NO LOAD	0	30.9	1800	5.25	0
1/4	31.3	40.8	1797	61.8	92.9
2/4	62.6	60.3	1793	81.4	95.5
3/4	93.7	84.4	1790	86.7	95.9
4/4	125	111	1786	87.9	95.8
5/4	156	139	1782	88.0	95.4

SPEED TORQUE

	RPM	TORQUE % FULL LOAD	TORQUE LB.-FT.	AMPERES
LOCKED ROTOR	0	148	544	726
PULL UP	700	143	525	692
BREAKDOWN	1727	260	955	418
FULL LOAD	1786	100	368	111

AMPERES SHOWN FOR 575. VOLT CONNECTION. IF OTHER VOLTAGE CONNECTIONS ARE AVAILABLE, THE AMPERES WILL VARY INVERSELY WITH THE RATED VOLTAGE

REMARKS: XE MOTOR-TYPICAL DATA-NEMA NOM. EFF. 95.8 PCT
GUARANTEED MIN. EFF. 95.4 PCT.

BALDOR
BALDOR · DODGE · RELIANCE

DR. BY C.R. THOMPSON
CK. BY K.W. KANOUFF
APP. BY K.W. KANOUFF
DATE 03/29/95

A-C MOTOR PERFORMANCE DATA

E06852-RBN011
ISSUE DATE 03/29/95

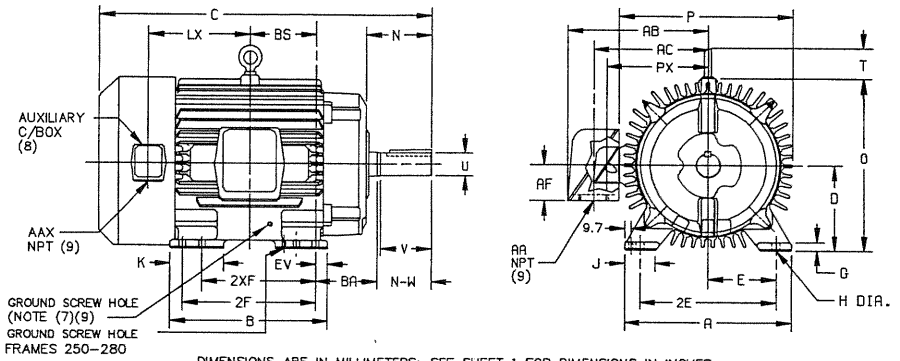
DUTY MASTER ALTERNATING CURRENT MOTORS

SQUIRREL-CAGE INDUCTION
CAST IRON CONSTRUCTION

ENCLOSURE: TOTALLY ENCLOSED
COOLING: FAN COOLED
MOUNTING: FOOT

FRAMES 250T THRU 440TS

841-XL WITH STANDARD OVERSIZED CONDUIT BOX



DIMENSIONS ARE IN MILLIMETERS; SEE SHEET 1 FOR DIMENSIONS IN INCHES

FRAME	A	D(2)	E	G	H	J	K	O	P	T	CAST IRON TERMINAL BOX AA(9)	AB	AC	AF	BA	EV	AUX C/BOX (8) AAX(9)	LX	PX
254T-256T	317.5	158.8	127.0	19.1	14.2	63.5	--	336.6	336.6	62.0	1-1/4	274.6	223.8	63.5	108.0	25.4	3/4	179.3	236.5
284T-286TS	349.3	177.8	139.7	19.1	14.2	63.5	--	374.7	378.0	62.0	1-1/2	320.5	258.8	76.2	120.7	25.4	3/4	193.8	266.7
324T-326TS	393.7	203.2	158.8	22.4	17.5	69.9	114.3	423.9	431.8	62.0	2	392.2	296.9	91.9	133.4	35.1	3/4	222.3	266.7
364T-365TS	431.8	228.6	177.8	22.4	17.5	69.9	98.6	469.9	495.3	74.7	3	457.2	350.8	104.6	149.4	35.1	3/4	231.6	295.1
404T-405TS	482.6	254.0	203.2	28.4	20.6	82.6	117.3	541.3	571.5	74.7	3	489.0	382.5	104.6	168.1	28.7	3/4	244.3	366.8
444T-445TS	533.4	279.4	228.6	28.4	20.6	82.6	133.4	593.9	641.4	82.6	3	563.6	443.0	152.4	190.5	31.8	3/4	282.4	387.4
(1)																			

FRAME SIZE	C	BS	B	2F	(4) 2XF	N	SHAFT AND KEY N-W(6)	U(3)	V	SQ.	LGTH.	WEIGHT KGS. (5)
254T	623.8	127.0	304.8	---	209.6	104.6	101.6	41.28	95.3	9.53	73.2	152
256T	623.8	127.0	304.8	254.0	---	104.6	101.6	41.28	95.3	9.53	73.2	156
284T	697.0	139.7	330.2	---	241.3	127.0	117.3	47.63	111.3	12.70	82.6	215
284TS	661.9	139.7	330.2	---	241.3	91.9	82.6	41.28	76.2	9.53	47.8	215
286T	697.0	139.7	330.2	279.4	---	127.0	117.3	47.63	111.3	12.70	82.6	222
286TS	661.9	139.7	330.2	279.4	---	91.9	82.6	41.28	76.2	9.53	47.8	222
324T	773.2	152.4	374.7	---	266.7	142.7	133.4	53.98	127.0	12.70	98.6	268
324TS	735.1	152.4	374.7	---	266.7	104.6	95.3	47.63	88.9	12.70	50.8	268
326T	773.2	152.4	374.7	304.8	---	142.7	133.4	53.98	127.0	12.70	98.6	286
326TS	735.1	152.4	374.7	304.8	---	104.6	95.3	47.63	88.9	12.70	50.8	286
364T	849.4	155.4	381.0	---	285.8	158.8	149.4	60.33	142.7	15.88	108.0	392
364TS	795.3	155.4	381.0	---	285.8	104.6	95.3	47.63	88.9	12.70	50.8	390
365T	849.4	155.4	381.0	311.2	---	158.8	149.4	60.33	142.7	15.88	108.0	404
365TS	795.3	155.4	381.0	311.2	---	104.6	95.3	47.63	88.9	12.70	50.8	401
404T	973.1	174.8	406.4	---	311.2	190.5	184.2	73.03	177.8	19.05	142.7	553
404TS	896.9	174.8	406.4	---	311.2	114.3	108.0	53.98	101.6	12.70	69.9	549
405T	973.1	174.8	406.4	349.3	---	190.5	184.2	73.03	177.8	19.05	142.7	572
405TS	896.9	174.8	406.4	349.3	---	114.3	108.0	53.98	101.6	12.70	69.9	567
444T	1133.3	209.6	482.6	---	368.3	227.1	215.9	85.73	209.6	22.23	174.8	757
444TS	1038.4	209.6	482.6	---	368.3	131.8	120.7	60.33	114.3	15.88	76.2	750
445T	1133.3	209.6	482.6	419.1	---	227.1	215.9	85.73	209.6	22.23	174.8	844
445TS	1038.4	209.6	482.6	419.1	---	131.8	120.7	60.33	114.3	15.88	76.2	836
(1)												

(1) SPECIAL DIMENSIONS APPLYING TO THIS ORDER ON THIS LINE.

(2) "D" VARIES — 250T - 320T +.0, -.8; 360T - 440T +.0, -1.5

(3) "U" VARIES — HP TO 1.625 DIA. +.000, -.013; 1.625 AND LARGER +.00, -.03

(4) ALL FRAMES HAVE EIGHT MOUNTING HOLES FOR DUAL MOUNTING.

(5) MOTOR WEIGHTS MAY VARY BY 15% DEPENDING UPON RATING.

(6) "N-W" VARIES +.0, -6.4

(7) GROUND SCREW HOLE 3/8-16 TAP 1 TO 200 HP ABOVE 200 HP 1/2-13, SEE NOTE (9)

(8) AUXILIARY CONDUIT BOX SUPPLIED ONLY WHEN REQUESTED

(9) DIMENSIONS ARE IN INCHES

CONDUIT BOX LOCATED ON OPPOSITE SIDE WHEN F-2,W-1, W-4,W-5,W-7, OR C-1 MOUNTING IS SPECIFIED.

IF MOUNTING CLEARANCE DETAILS ARE REQUIRED, CONSULT FACTORY.

MAXIMUM PERMISSIBLE SHAFT RUNOUT WHEN MEASURED AT END OF STD. SHAFT EXTENSION IS .03 T.I.R. UP TO AND INCLUDING 41.28 DIA. AND .038 T.I.R. BALL BEARINGS .05 T.I.R. ROLLER BEARINGS FOR LARGER DIAMETERS.

FRAME-_____ TYPE-_____ CERTIFIED FOR- _____

ORDER-_____ ITEM-_____ HP-_____ RPM-_____ PH- _____ HZ _____ VOLTS _____

SALES ORDER-_____ APPROVED BY-_____ DATE _____

CUSTOMER IS RESPONSIBLE FOR DETERMINING THAT BALDOR'S PRODUCT WILL PERFORM SUITABLY IN THE INTENDED APPLICATION.

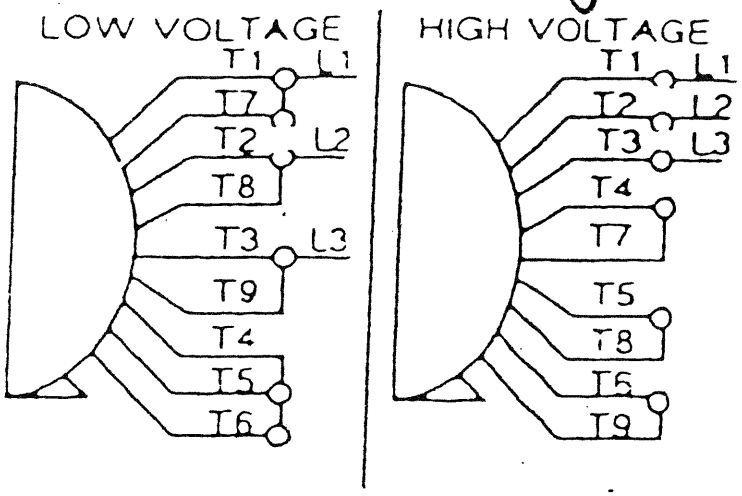
REV. DESC: FIX TITLE BLOCK DESCRIPTION
REV. LTR: C
FILE: \RAG\00005\369
VERSION: 03
REVISED: 01:20:29 07/16/2009
TDR: 000000505887
BY: RAGEC
MTL: -

Baldor • Dodge • Reliance

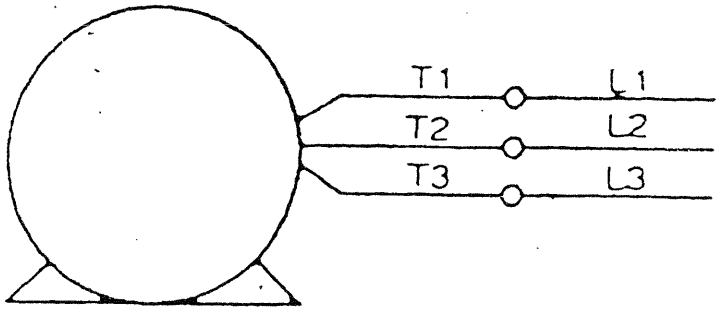
DIM SHT TEFC 250T-440TS STD BRKT 841-XL STD OS CBOX
SH 1 of 1

PUMP MOTOR CONNECTIONS

Dual Voltage



3 PHASE - SINGLE VOLTAGE



To reverse direction of rotation interchange any two line leads

23P05

PROTECTIVE MEASURES TO BE TAKEN BY VAUGHAN CO. AND VAUGHAN'S LONG-TERM STORAGE INSTRUCTIONS
- HORIZONTAL PUMPS -

OFF LOADING AND INSPECTION INSTRUCTIONS:

Prior to shipment Vaughan pumps are carefully crated and inspected to ensure arrival at your site in good condition. On receiving your pump, examine it carefully to assure that no damaged crating or broken parts have resulted from mishandling during shipping. Turn the pump shaft by hand and verify that it turns over smoothly. If the shaft binds, look for debris (or paint) between impeller and cutter bar. Otherwise, shaft binding could indicate damage. If damage has occurred, report to your carrier immediately, and consult your local Vaughan representative.

STORAGE REQUIREMENTS TO BE UNDERTAKEN BY CONTRACTOR:

If equipment is to be stored for longer than two weeks, take the following action:

1. Coat exposed steel with a light layer of grease to protect the equipment from corrosion.
2. Rotate the motor **1/4 turn** once each week to keep the bearings from sitting in one position for extended periods of time.
3. Avoid storing rotating equipment near other vibrating equipment. The vibrations can cause damage to the ball bearings and cause premature failure once the equipment is started up.
4. Store rotating equipment in a clean, dry, heated area away from areas where it could be damaged from impact, smoke, dirt, vibration, corrosive fumes or liquids, or from condensation inside the motor or pump. It is helpful to cover equipment with plastic.

COATING FOR VAUGHAN NOZZLE ASSEMBLIES

3M™ Scotchkote™ Fusion-Bonded Epoxy Coating 134/134W

Product Description

3M™ Scotchkote™ Fusion-Bonded Epoxy Coating 134 is a one-part, heat curable, thermosetting epoxy coating designed for corrosion protection of metal. The epoxy is applied to preheated steel as a dry powder which melts and cures to a uniform coating thickness. This bonding process provides excellent adhesion and coverage on applications such as valves, pumps, pipe drains, hydrants and porous castings. Scotchkote 134 coating is resistant to wastewater, corrosive soils, hydrocarbons, harsh chemicals, and sea water. Powder properties allow easy manual or automatic application by electrostatic or air-spray equipment.

Product Features

- No primer required for most applications.
- Particularly suitable for electrostatic or air-spray application on preheated metal articles.
- Can be electrostatically applied to unheated metal parts and subsequently cured by baking.
- Long gel time allows application on large or complex articles, minimizing fear of runs, sags, laminations, or unsightly overspray.
- Especially useful for coating the inside of pipe or other fabrications where a smooth, corrosion resistant coating is required.
- Can be machined by grinding or cutting to meet close tolerance requirements.
- Allows easy visual inspection of coated articles.
- Can be painted with alkyd paint, acrylic lacquer, polyurethane, or acrylic enamel for color coding.
- Will not sag, cold flow, or become soft in storage. Long term storage under most climatic conditions.
- Lightweight for lower shipping costs.
- Protects over wide temperature range.
- Resists direct burial soil stress.
- High adhesion and toughness.
- Resists cavitation and cathodic disbondment.
- Excellent chemical resistance.
- Suitable for elevated temperature service in presence of H_2S, CO_2, CH_4, crude oil and brine when applied over phenolic primer such as Scotchkote 345.
- Long-term performance history in water, sewage, and other service environments.
- Scotchkote 134 coating has been tested and certified to NSF /ANSI Standard 61, Drinking Water System Components. For NSF certified applications,max approved thickness is 60 mil (1.5 mm).
- Scotchkote 134 FBEC meets the requirements of AWWA Standard C213 and C550.
- Operating temperature dry is 235°F/ 113°C and wet is 175°F/79°C.

General Application Information

1. Remove oil, grease and loosely adhering deposits.
2. Abrasive blast clean the surface to NACE No. 2/SSPC-SP10 ISO 8501:1, Grade SA 2 1/2 near-white metal.
3. Apply mechanical masks or mask with materials such as Scotch Glass Cloth Tape 361 or Scotch Aluminum Foil Tape 425 as required.
4. Preheat article to the desired application temperature per cure specifications.
5. Deposit Scotchkote 134 coating by powder spray to the specified thickness.
6. Cure according to cure specifications.
7. Visually and electrically inspect for coating flaws after the coating has cooled.
8. Repair all defects.

Cure Specifications

Scotchkote 134 coating may be applied to metal articles which have been preheated to a temperature of 300°F/149°C to 475°F/246°C. After application, Scotchkote 134 coating must be cured according to the cure guide to achieve maximum performance properties.

If Scotchkote 134 coating is electrostatically applied to unheated parts, the cure time should be measured from the time the coated part reaches the cure temperature. After cure, the coating may be force cooled using air or water to facilitate inspection and handling.

3M

3M™ Scotchkote™ Fusion-Bonded Epoxy Coating 134 Cure Guide

Temperature of Article at Time of Powder Application	Typical Gel Time	Cure Time
475°F/246°C	40 seconds	7 minutes
450°F/232°C	60 seconds	10 minutes
400°F/204°C	120 seconds	15 minutes
350°F/177°C	330 seconds	25 minutes
425°F/218°C	90 seconds	25 minutes for NSF/ANSI 61 approved applications

Typical Properties

Property	Value
Color	Forest Green
Specific Gravity - Powder (Air Pycnometer)	1.51
Coverage	127 ft²/lb/mil (0,66 m²/kg/mm)
Fluid Bed Density	33 lbs/ft³ (530 kg/m³)
Shelf Life at 80°F/27°C	18 months
Average Gel Time 400°F/204°C	120 seconds
Edge Coverage	12% to 18%
Minimum Explosive Concentration	0.03 oz/ft³ (30,6 g/m³)
Ignition Temperature	986°F/530°C
V.O.C. (As Supplied)	0 g/L, as calculated

Chemical/Pressure/Temperature Resistance

All tests performed on Scotchkote™ Fusion Bonded Epoxy Coating 134 applied over a 1 mil/25,4 µm phenolic primer. Liquid phase for all test conditions: 33% kerosene, 33% toluene, 34% brine solution of 5% NaCl.

Test Conditions	Gas Phase	Results
Autoclave, 120°F/49°C 48 hours, 1500 psi/10.3 MPa	99.5% CO_2 0.5% H_2S	Excellent adhesion, no coating loss or blisters in aqueous, hydrocarbon, or gas phase
Autoclave, 150°F/66°C 48 hours, 2200 psi/15.2 MPa	80% CH_4 12% CO_2 8% H_2S	Excellent adhesion, no coating loss or blisters in aqueous, hydrocarbon, or gas phase
Autoclave, 200°F/93°C 24 hours, 3300 psi/22.8 MPa	86% CH_4 8% CO_2 6% H_2S	Excellent adhesion, no coating loss or blisters in aqueous, hydrocarbon, or gas phase
Autoclave, 300°F/149°C 24 hours, 3000 psi/20.7 MPa	90% CH 10% CO_2 Trace H_2S	Excellent adhesion, no coating loss or blisters in aqueous, hydrocarbon, or gas phase

3M™ Scotchkote Fusion-Bonded Epoxy Coating 134 Test Data

Property	Test Description	Results
Adhesion	Elcometer	> 3000 psi (glue failure)/ 210 kg/cm²
Adhesion to Steel (Shear)	ASTM D 1002 10 mil/254 µm glue line	4300 psi/302 kg/cm² cohesive failure
Impact	Gardner 5/8 in/1,6 cm diameter tup 1/8" x 3" x 3" (0,32 cm x 7,6 cm x 7,6 cm) steel panel	160 in-lbs 1,8 kg•m
Hardness	Barcol ASTM D 2583	23
Abrasion Resistance	ASTM D 4060 CS-17 1000g weight / 5000 cycles	0,07 g loss
Thermal Shock	310°F/154°C to -320°F/-195°C coated pipe	10 cycles, no effect
Penetration	ASTM G 17 -40°F/-40°C to 240°F/116°C	0
Tensile Strength	ASTM D 2370	7300 psi/512 kg/cm²
Elongation	ASTM D 2370	4.2%
Compressive Strength	ASTM D 695	12800 psi/900 kg/cm²
Coefficient of Friction	API RP5L2-1968, App 8	23°
Electric Strength	ASTM D 149	1000 volts/mil (39,4 kv/mm)
Hot Water Resistance	160°F/71°C immersion / 120 days	Good adhesion, no blistering
Electrical Resistivity	ASTM D 257	1.2×10^{15} ohm•cm
Thermal Conductivity	MIL-I-16923E	7×10^{-4} cal/sec/cm²/°C/cm
Water Absorption	3M 10 mil/254 µm free film 30 days	6,5 g/m²
Fungus Resistance	MIL-STD 810-B Method 508	Funginert
Salt Fog	MIL-E-5272C	No effect
Weatherometer	ASTM G 23 5000 hours	Surface chalk
Soil Stress - Burial	Bureau of Reclamation 25 cycles	No effect
Salt Crock	30 day, 5 volt, 5% NaCl sand crock 230°F/110°C	Disbondment diameter 24 mm average
Bendability	3/8"/9,5 mm coupon mandrel bend at 73°F/23°C	30 pipe diameters 1.9° / diameter length

Handling and Safety Precautions

Read all Health Hazard, Precautionary and First Aid, Material Safety Data Sheet, and/or product label prior to handling or use.

Important Notice

All statements, technical information, and recommendations related to 3M's products are based on information believed to be reliable, but the accuracy or completeness is not guaranteed. Before using this product, you must evaluate it and determine if it is suitable for your intended application. You assume all risks and liability associated with such use. Any statements related to the product which are not contained in 3M's current publications, or any contrary statements contained on your purchase order shall have no force or effect unless expressly agreed upon, in writing, by an authorized officer of 3M.

Ordering Information/Customer Service

For ordering technical or product information, or a copy of the Material Safety Data Sheet, call:
Phone: 800/722-6721
Fax: 877/601-1305

Warranty; Limited Remedy; Limited Liability.

Because conditions of product use are outside of our control and vary widely, the following is made in lieu of all express or implied warranties: this product will conform to 3M's published product specifications and be free from defects in material and manufacture on the date of your purchase. **3M MAKES NO OTHER WARRANTIES INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.** If this product is defective upon your receipt, your exclusive remedy shall be, at 3M's option, to replace the 3M product or refund the purchase price of the 3M product. **Except where prohibited by law, 3M will not be liable for any indirect, special, incidental or consequential loss or damage arising from this 3M product, regardless of the legal theory asserted.**

3M

Corrosion Protection Products Division

6801 River Place Blvd.
Austin, TX 78726-9000
www.3M.com/corrosion

80-6111-8506-9

TNEMEC

OMNITHANE® SERIES 1

PRODUCT DATA SHEET

Pump

PRODUCT PROFILE

GENERIC DESCRIPTION Modified Aromatic Polyurethane Primer

COMMON USAGE A single component, moisture-cured resin, containing a proprietary blend of micaceous iron oxide and zinc to function as a primer which is field and shop friendly. May be used in OEM manufacturing, potable water and wastewater immersion with the proper topcoats. May also be used for marginally prepared rusty steel and tightly adhering old coatings for non-immersion maintenance situations.

COLORS 1216 Grayish-Green

SPECIAL QUALIFICATIONS NSF: Certified in accordance with ANSI/NSF Std. 61 for potable water applications (for tanks of 1,000 gallons capacity or greater, pipes 36 inches in diameter or greater or valves 4 inches in diameter or greater) when topcoated (with or without 44-710 Urethane Accelerator) with Std. 61 certified Tnemec coatings.
AISC: Meets AISC requirements for Class B surface with a mean slip coefficient no less than 0.50 and tension creep not in excess of .005 inches (.13 mm) (SSPC-SP5/NACE 1 & SSPC-SP3). Note: Using other products as primers or topcoats voids AISC requirements. Contact your Tnemec representative for specific recommendations.

PERFORMANCE CRITERIA Contact your Tnemec representative for specific test results.

COATING SYSTEM

SURFACER/FILLER/PATCHER Series 218, 219. For additional information contact Tnemec Technical Services.

PRIMERS Self-priming, 90-97, 91-H_2O, 94-H_2O

TOPCOATS Series 1 may be topcoated with a multitude of high performance coatings which include (but are not limited to) Series 1, 20, FC20, 25, 27, 35, 46H-413, 66, N69, N69F, 73, 104, 113, 114, 115, N140, N140F, 161, 400, 406, 1028, 1029, 1074, 1075. Note: If Series 1 is exterior exposed for 1 year or more it must be scarified or recoated with itself before topcoating. Scarification or recoating with itself is required if the Series 1 has been exterior exposed for 3 days or longer and Series 113 is the specified topcoat. Note: Series 25, 35 and 115 require the use of Series 44-900 adhesion promoter when topcoating Series 1. Note: Certain topcoat colors may not provide one coat hiding depending on method of application. Contact your Tnemec representative.

SURFACE PREPARATION

STEEL Immersion & Severe Exposure: SSPC-SP10/NACE No. 2 Near-White Blast Cleaning.
Non-Potable, Non-Immersion Service: Exterior Exposure: SSPC-SP6/NACE No. 3 Commercial Blast Cleaning. Interior Exposure: SSPC-SP3 Power Tool Cleaning.

STEEL MAINTENANCE Abrasive blast cleaning produces the best coating performance. If conditions will not permit this, Series 1 may be applied over SSPC-SP2 or SP3 Hand or Power Tool Cleaned surfaces in non-potable, non-immersion environments.

GALVANIZED STEEL Surface preparation recommendations will vary depending on substrate and exposure conditions. Contact your Tnemec representative or Tnemec Technical Services.

DUCTILE IRON Recommended for immersion and exterior exposure. Please contact your Tnemec representative for specific recommendations.

CONCRETE Allow new concrete to cure for 28 days. For optimum results, abrasive blast referencing SSPC-SP13/NACE 6 Surface Preparation of Concrete and Tnemec's Surface Preparation and Application Guide (Reference ICRI CSP3-5). Contact your Tnemec representative for specific recommendations.

PAINTED SURFACES Test patch is recommended.

ALL SURFACES Must be clean, dry and free of oil, grease and other contaminants.

TECHNICAL DATA

VOLUME SOLIDS 61.0 ± 2.0% (mixed)

RECOMMENDED DFT 2.5 to 3.5 mils (65 to 90 microns) per coat. Note: NSF certification maximum: 3.5 mils.

CURING TIME Without 44-710

Temperature †	To Touch	To Handle	To Recoat
70°F (21°C)	1/4 hour	1 1/2 hours	2 hours
60°F (16°C)	1/4 hour	2 3/4 hours	2 3/4 hours
50°F (10°C)	1/4 hour	5 hours	5 hours

† 50% Relative Humidity. Curing time will vary with surface temperature, humidity and film thickness.
Note: When recoating Series 1 with topcoats other than itself, the minimum recoat time is 16 hours.
Ventilation: When used in enclosed areas, provide adequate ventilation during application and cure.

With 44-710: The use of 44-710 can greatly reduce recoat times. Reference the 44-710 Urethane Accelerator product data sheet. Note: Series 44-710 Accelerator must be used when the surface temperature falls below 50°F (10°C).

VOLATILE ORGANIC COMPOUNDS Unthinned: 2.79 lbs/gallon (334 grams/litre)
Thinned 10% (No. 2 or 3 Thinner): 3.20 lbs/gallon (383 grams/litre)
Thinned 10% (No. 49 Thinner): 2.79 lbs/gallon (334 grams/litre)

HAPS Unthinned: 0.00 lbs/gal solids
Thinned 10% (No. 2 Thinner): 1.19 lbs/gal solids
Thinned 10% (No. 3 Thinner): 0.04 lbs/gal solids
Thinned 10% (No. 49 Thinner): 0.00 lbs/gal solids

THEORETICAL COVERAGE 978 mil sq ft/gal (24.0 m²/L at 25 microns). See APPLICATION for coverage rates.

NUMBER OF COMPONENTS One

OMNITHANE® | SERIES 1

PACKAGING Five-gallon (18.9L) pails (yielding 3 gallons) and one-gallon (3.79L) cans

NET WEIGHT PER GALLON 21.10 ± 0.60 lbs (9.57 ± .27 kg)

STORAGE TEMPERATURE Minimum 20°F (-7°C) Maximum 110°F (43°C)

TEMPERATURE RESISTANCE (Dry) Continuous 250°F (121°C) Intermittent 300°F (149°C)

SHELF LIFE 12 months at recommended storage temperature.

FLASH POINT - SETA 85°F (29°C)

HEALTH & SAFETY Paint products contain chemical ingredients which are considered hazardous. Read container label warning and Material Safety Data Sheet for important health and safety information prior to the use of this product. Keep out of the reach of children.

APPLICATION

COVERAGE RATES

	Dry Mils (Microns)	Wet Mils (Microns)	Sq Ft/Gal (m²/Gal)
Suggested	3.0 (75)	5.0 (125)	326 (30.3)
Minimum	2.5 (65)	4.0 (100)	391 (36.4)
Maximum	3.5 (90)	5.5 (140)	284 (26.4)

Allow for overspray and surface irregularities. Wet film thickness is rounded to the nearest 0.5 mil or 5 microns. Application of coating below minimum or above maximum recommended dry film thicknesses may adversely affect coating performance.

MIXING Stir thoroughly making sure no pigment remains on the bottom of the can. Use a power mixer and keep material under constant agitation while mixing.

THINNING For spray, thin up to 10% or 3/4 pint (380 mL) per gallon with No. 2 Thinner if temperatures are below 80°F (27°C). Thin up to 10% or 3/4 pint (380 mL) per gallon with No. 3 Thinner if temperatures are above 80°F (27°C). For brush or roller, thin up to 10% or 3/4 pint (380 mL) with No. 3 Thinner. Note: No. 49 Thinner may be substituted where there are VOC restrictions. Note: NSF certification requires thinning with No. 2 Thinner. Use of any other thinner voids ANSI/NSF Std. 61 certification.

POT LIFE 24 hours at 77°F (25°C) and 50% R.H. **Caution: This product cures with moisture acting as a catalyst. Incorporation of moisture or moisture laden air (humidity) during use will shorten pot life.** The use of a solvent blanket (small addition of solvent that sits atop the paint in the can) can help to retard a reaction with moisture in the container but agitation will have to be done by manual means, taking care to not disturb the solvent or incorporate it into the paint. Avoid continual agitation at high RPM. When feasible keep containers of material covered during use.

APPLICATION EQUIPMENT Note: When intermediate and finish coats are white or light colors, best hiding of this primer can be achieved by spray application; or when roller applied, by using 1/4" synthetic woven nap roller covers.

Air Spray

Gun	Fluid Tip	Air Cap	Air Hose ID	Mat'l Hose ID	Atomizing Pressure	Pot Pressure
DeVilbiss JGA †	E	765 or 704	5/16" or 3/8" (7.9 or 9.5 mm)	3/8" or 1/2" (9.5 or 12.7 mm)	40-50 psi (2.8-3.4 bar)	10-20 psi (0.7-1.4 bar)

† (with heavy mastic spring) Low temperatures or longer hoses will require additional pressure. Use pressure pot equipped with an agitator and keep pressure pot at same level or higher than the spray gun. Compressed air must be dry.

Airless Spray

Tip Orifice	Atomizing Pressure	Mat'l Hose ID	Manifold Filter
0.017"-0.021" (430-535 microns) Reversible Tip	2400-3000 psi (165-207 bar)	1/4" or 3/8" (6.4 or 9.5 mm)	60 mesh (250 microns)

Use appropriate tip/atomizing pressure for equipment, applicator technique and weather conditions.
Roller: Use a 1/4" or 3/8" (6.4 mm or 9.5 mm) synthetic woven nap cover.
Brush: Use high quality natural or synthetic bristle brushes.

SURFACE TEMPERATURE Minimum 35°F (2°C) Maximum 120°F (49°C)
The surface should be dry and at least 5°F (3°C) above the dew point. Note: Series 44-710 Accelerator must be used if the surface temperature is below 60°F (16°C) and 30% relative humidity, or if the surface temperature is below 50°F (10°C) regardless of humidity level.

AMBIENT HUMIDITY Minimum 20% Maximum 90%

CLEANUP Flush and clean all equipment immediately after use with the recommended thinner or xylene.

6800 Corporate Drive Kansas City, Missouri 64120-1372 1-800-TNEMEC1 Fax: 1-816-483-3969 www.tnemec.com

Typoxy® SERIES 27WB

PRODUCT PROFILE

GENERIC DESCRIPTION Inorganic Hybrid Water-Based Epoxy

COMMON USAGE An advanced generation, low odor, high solids, water-based epoxy coating for protection and finishing of steel and concrete. For use on the interior and exterior of tanks, pipes and equipment. Superior wetting for marginally prepared steel and tightly adhering old coatings. This coating is ideally suited for steel fabrication and OEM applications. Also widely used as a field tie-coat. Provides fast curing and rapid handling capabilities. Patent pending.

COLOR Vaughan Green

FINISH Eggshell

PERFORMANCE CRITERIA Contact your Tnemec representative for specific test results.

COATING SYSTEM

PRIMERS **Steel:** Self-priming or Series 1, L69, L69F, N69, N69F, V69, V69F, 90-1K97, 90-97, H90-97, 91-H_2O, 94-H_2O, 394
Galvanized Steel: Self-priming
Concrete: Self-priming, 215, 218
CMU: Self-priming, 130, 215
Drywall: Self-priming, 151

TOPCOATS Series 6, 30, 35, 73, 113, 114, 115, 156, 157, 158, 180, 181, 280, 281, 287, 290, 291, 297, 400, 406, 435, 446, 740, 750, 1028, 1029, 1070, 1071, 1072, 1074, 1075, 1077, 1078, 1080, 1081

SURFACE PREPARATION

STEEL **Immersion Service:** SSPC-SP10/NACE 2 Near-White Blast Cleaning. **Note: For immersion service, must be primed with either Series 1, 66, L69, L69F, N69, N69F, V69, V69F, 90-1K97, 90-97, H90-97, 91-H_2O, 94-H_2O or 161.**
Non-Immersion Service: SSPC-SP6/NACE 3 Commercial Blast Cleaning
Note: Abrasive blast cleaning generally produces the best coating performance. If conditions will not permit this, Series 27WB may be applied to SSPC-SP2 or SP3 Hand or Power Tool Cleaned surfaces.

GALVANIZED STEEL Surface preparation recommendations will vary depending on substrate and exposure conditions. Consult the latest version of Tnemec Technical Bulletin 98-09 or contact your Tnemec representative or Tnemec Technical Services.

CAST/DUCTILE IRON Contact your Tnemec representative or Tnemec Technical Services.

CONCRETE Allow new concrete to cure 28 days. For optimum results and/or immersion service, abrasive blast referencing SSPC-SP13/NACE 6, ICRI CSP2-4 Surface Preparation of Concrete and Tnemec's Surface Preparation and Application Guide.

CMU Allow mortar to cure for 28 days. Prepare in accordance with SSPC-SP13/NACE 6 to level protrusions and mortar spatter and remove other contaminants.

PAINTED SURFACES **Non-Immersion Service:** Ask your Tnemec representative for specific recommendations.

ALL SURFACES Must be clean, dry and free of oil, grease and other contaminants.

TECHNICAL DATA

VOLUME SOLIDS* 100% (mixed)

RECOMMENDED DFT 4.0 to 14.0 mils (100 to 350 microns) per coat. **Note: Number of coats and thickness requirements will vary with substrate, application method and exposure. Contact your Tnemec representative.**

CURING TIME

Temperature	To Touch	To Handle	To Recoat
95°F (35°C)	30 minutes	1 hour	2 hours
75°F (24°C)	1 hour	2 hours	3 hours
55°F (13°C)	2 hours	4½ hours	6 hours
40°F (5°C)	3 hours	7 hours	15 hours

Curing time varies with surface temperature, air movement, humidity and film thickness. For immersion service cure a minimum of 6 hours at 75°F (24°C).

VOLATILE ORGANIC COMPOUNDS* **Unthinned**
0.10 lbs/gallon
(11 grams/litre)

HAPS 0 lbs/gal solids

THEORETICAL COVERAGE* 1,604 mil sq ft/gal (39.4 m^2/L at 25 microns). See APPLICATION for coverage rates.

NUMBER OF COMPONENTS Two: Part A and Part B (One Part A to One Part B by volume.)

PACKAGING KITS CONSIST OF:

	PART A	PART B	Yield (mixed)
Medium Kit	3 gal pail (partial fill)	6 gal pail (partial fill)	4 gallons (15.1L)
Small Kit	1 gallon can	1 gallon can	2 gallons (7.56L)

SERIES 27WB Typoxy®

TECHNICAL DATA continued

NET WEIGHT PER GALLON*	14.56 ± 0.25 lbs (6.60 ± .11 kg) (mixed)	
STORAGE TEMPERATURE	Minimum 40°F (4°C)	Maximum 90°F (32°C)
TEMPERATURE RESISTANCE	(Dry) Continuous 250°F (121°C)	Intermittent 275°F (135°C)
SHELF LIFE	6 months	
FLASH POINT - SETA	Part A: 147°F (64°C)	Part B: >200°F (93°C)
HEALTH & SAFETY	Paint products contain chemical ingredients which are considered hazardous. Read container label warning and Material Safety Data Sheet for important health and safety information prior to the use of this product. **Keep out of the reach of children.**	

APPLICATION

COVERAGE RATES*

	Unthinned			Thinned 25%		
	Dry Mils (Microns)	Wet Mils (Microns)	Sq Ft/Gal (m^2/Gal)	Dry Mils (Microns)	Wet Mils (Microns)	Sq Ft/Gal (m^2/Gal)
Minimum	4.0 (100)	4.0 (100)	401 (37.3)	4.0 (100)	5.5 (140)	301 (27.9)
Maximum	14.0 (355)	14.0 (355)	115 (10.6)	14.0 (355)	18.5 (470)	86 (8.0)

Note: Roller or brush application may require two or more coats to obtain recommended film thickness. Allow for overspray and surface irregularities. Wet film thickness is rounded to the nearest 0.5 mil or 5 microns. Application of coating below minimum or above maximum recommended dry film thicknesses may adversely affect coating performance.

MIXING

Power mix contents of the container marked Part B, making sure no pigment remains on the bottom. Add the contents of the can marked Part A to Part B while under mechanical agitation. During mixing, scrape the container wall to aid in complete blending of the two components. Continue agitation until the two components are thoroughly mixed. Thin by volume and thoroughly mix after mixing the Part A and Part B components. Do not use mixed material beyond pot life limits. **Note:** A clean mixing blade devoid of paint buildup is needed after each kit to ensure proper mixing of components. Both components should be above 50°F (10°C) prior to mixing.

POT LIFE

1 hour at 77°F (25°C) thinned 25% with water

SPRAY LIFE

45 minutes at 77°F (25°C) when thinned 25% with water.

THINNING

For spray application, thinning is required at 25% or 1 quart (946 mL) per gallon with clean tap water. For brush or roller thin 15% to 25% per gallon with clean tap water.

TEMPERATURE REQUIREMENT

Surface Temperature: Minimum 40°F (4°C), optimum 65°F to 80°F (18°C to 27°C), maximum of 120°F (49°C). The substrate temperature should be at least 5°F (3°C) above the dew point. Coating will not cure below minimum surface temperature.

Material Temperature: For optimum application and handling, the material temperature during application should be between 70°F and 85°F (21°C and 29°C). Temperature will affect the workability. Cool temperatures increase viscosity and decrease workability. Warm temperatures will decrease viscosity and shorten pot life.

APPLICATION EQUIPMENT

Air Spray

Gun	Fluid Tip	Air Cap	Air Hose ID	Mat'l Hose ID	Atomizing Pressure	Pot Pressure
DeVilbiss JGA	E	765 or 704	5/16" or 3/8" (7.9 or 9.5 mm)	3/8" or 1/2" (9.5 or 12.7 mm)	50-70 psi (3.4-4.8 bar)	15-25 psi (1.0-1.7 bar)

Low temperatures or longer hoses require higher pot pressure. Do not allow material to remain in hose.

Airless Spray

Tip Orifice	Atomizing Pressure	Mat'l Hose ID	Manifold Filter
0.017"-0.021" (430-535 microns)	3700-5000 psi (255-345 bar)	1/4" or 3/8" (6.4 or 9.5 mm)	60 mesh (250 microns)

Use appropriate tip/atomizing pressure for equipment, applicator technique and weather conditions.

Roller: Use 3/8" or 1/2" (9.5 mm to 12.7 mm) synthetic woven nap covers.

Brush: Recommended for small areas only. Use high quality natural or synthetic bristle brushes.

CLEANUP

Flush and clean all equipment immediately after use with water, followed by a final flush with MEK or Methyl Acetate.

*Values may vary with color.

TNEMEC COMPANY INCORPORATED
6800 CORPORATE DRIVE, KANSAS CITY, MISSOURI 64120-1372 TEL: 1 800 TNEMEC 1 www.tnemec.com

PRINTED IN USA
27WB

VAUGHAN CO., INC. PRODUCT WARRANTY

CITY OF WINNIPEG, NORTH END WPCC

Vaughan Co., Inc. warrants to the original purchaser/end user all pumps and pump parts manufactured by it to be free from defects in workmanship or material for a period of FIVE (5) years from date of substantial completion not to exceed SIX (6) years from date of shipment. If during said warranty period, any pump or pump parts manufactured by Vaughan Co. prove to be defective in workmanship or material under normal use and service, and if such pump or pump parts are returned to Vaughan Co.'s factory at Montesano, WA, or to a Vaughan authorized Service Facility, transportation charges prepaid, and if the pump or pump parts are found to be defective in workmanship or material, they will be replaced or repaired free of charge. Products repaired or replaced from the Vaughan Co. factory or a Vaughan authorized Service Facility under this warranty will be returned freight prepaid. National Process Equipment, (Vaughan's local representative) shall be responsible for labor for pump or part removal and/or re-installation.

All warranty claims must be submitted in writing to Vaughan Co. not later than thirty (30) days after warranty breach occurrence. The original warranty length shall not be extended with respect to pumps or parts repaired or replaced by Vaughan Co. under this Warranty. This Warranty is voided as to pumps or parts repaired/replaced by other than Vaughan Co. or its duly authorized representatives.

Vaughan Co. shall not be liable for consequential damages of any kind and the purchaser by acceptance of delivery assumes all liability for the consequences of the use or misuse of Vaughan Co. products by the purchaser, its employees or others. Vaughan Co. will not be held responsible for travel expenses, rented equipment, outside contractor's fees, or unauthorized repair service or parts.

This warranty shall not apply to any product or part of product which has been subjected to misuse, accident, negligence, operated in the dashed portion of the published pump curves, used in a manner contrary to Vaughan's printed instructions or damaged due to a defective power supply, improper electrical protection or faulty installation, maintenance, or repair. Wear caused by pumping abrasive or corrosive fluids or by cavitation is not covered under this warranty.

Equipment and accessories including motors purchased by Vaughan Co. from outside sources which are incorporated into any Vaughan pump or any pump part are warranted only to the extent of and by the original manufacturer's warranty or guarantee, if any, which warranty, if appropriate, will be assigned by Vaughan Co. to the purchaser/end user. Baldor motor warranty is three (3) years from date of shipment plus maximum 6 month storage allowance.

THIS IS VAUGHAN CO.'S SOLE WARRANTY AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, WHICH ARE HEREBY EXCLUDED INCLUDING IN PARTICULAR ALL WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Vaughan Co. neither assumes, nor authorizes any person or company to assume for it, any other obligation in connection with the sale of its equipment with the exception of a valid Vaughan "Performance Guarantee" or "Extended Warranty," if applicable. Any other enlargement or modification of this warranty by a representative or other selling agent shall not be legally binding on Vaughan Co.

VAUGHAN CO., INC.

ROTAMIX NOZZLE ASSEMBLY WARRANTY

CITY OF WINNIPEG, NORTH END WPCC

Vaughan Co., Inc. warrants the Rotamix mixing nozzle assembly manufactured by it to be free from defects in workmanship or material for a period of ten (10) years from date of initial startup. If during said warranty period, any components of the mixing assembly wear or corrode through the walls of any of the fittings under normal use in biological sludge mixing service, Vaughan Co. will provide a replacement for the worn part free of charge. This warranty does not cover any labor charges associated with repairing of the mixing assembly.

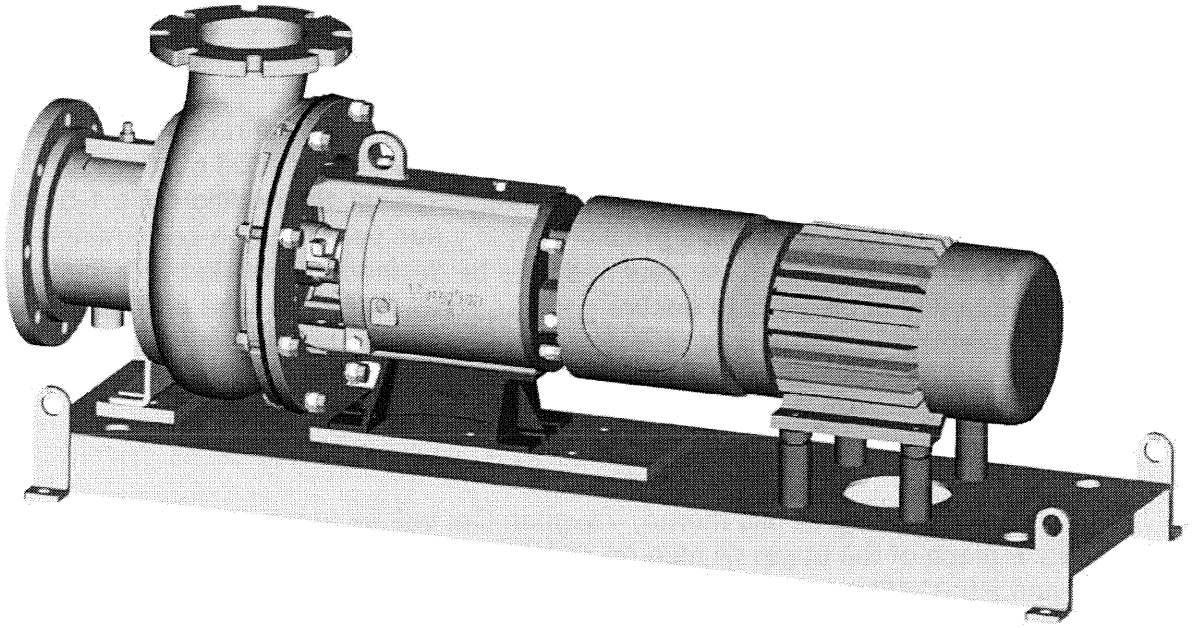
Vaughan Co. assumes no liability for consequential damages of any kind and the purchaser by acceptance of delivery assumes all liability for the consequences of the use or misuse of Vaughan Co. products by the purchaser, his employees or others. Vaughan Co. will not be held responsible for travel expenses, rented equipment, outside contractor's fees, or unauthorized repair service or parts.

This warranty shall not apply to any product or part of product which has been subjected to misuse, accident, negligence, used in a manner contrary to Vaughan's printed instructions or damaged due faulty installation or repair.

THIS IS VAUGHAN CO.'S SOLE WARRANTY AND IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, WHICH ARE HEREBY EXCLUDED INCLUDING IN PARTICULAR ALL WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Vaughan Co. neither assumes, nor authorizes any person or company to assume for it, any other obligation in connection with the sale of its equipment. Any other enlargement or modification of this warranty by a representative or other selling agent shall become his exclusive responsibility.

HORIZONTAL PUMPS
HE SERIES



INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS

VAUGHAN COMPANY, INC.

364 MONTE-ELMA ROAD, MONTESANO, WASHINGTON 98563
PHONE: (360) 249-4042 FAX (360) 249-6155

Form V421 Rev 6, SEPT09

ENGINEERING MEMO

DATE: June 30, 2010
TO: Vaughan Sales Representatives and Customers
FROM: Glenn R. Dorsch, PE; VP/Chief Engineer
SUBJECT: Vaughan Cartridge Seal for Horizontal and Vertical Pedestal Pumps; Pressure Relief Venting Provides Indication for Need to Drain & Refill Seal Reservoir/Collector

Background:

Vaughan Co. has been using the Vaughan flushless cartridge seal in our horizontal and vertical pedestal pumps since 2003 with very good success. This memo discusses the latest change to the Vaughan seal, the addition of a 1-5 psi pressure relief valve. When this pressure relief valve vents sludge-contaminated oil, this is an indication that the seal needs to be drained and refilled with the correct quantity of clean oil to ensure good seal life. Failure to take prompt action to drain the seal of sludge and refill with clean oil could shorten the life of the outboard lip seal, increasing maintenance costs for the end user.

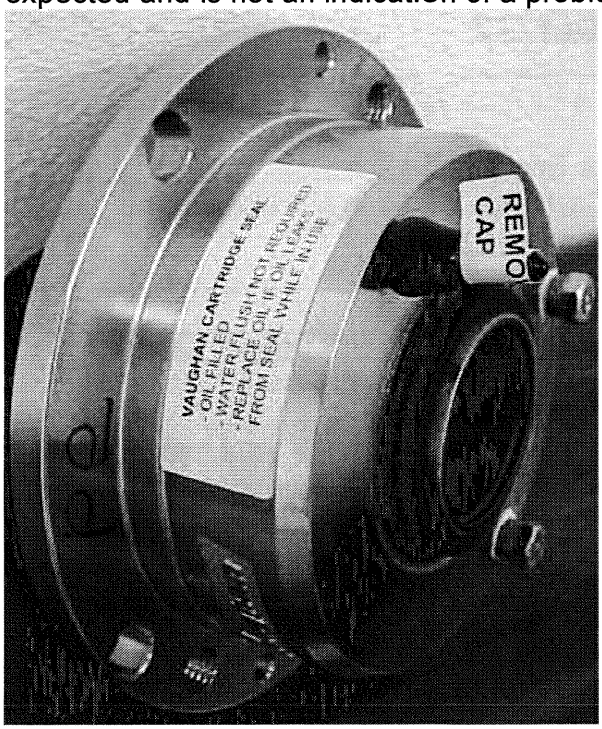
Discussion:

As of the date of this memo, Vaughan Co. will be using a pressure relief valve in place of the upper fill plug on all Vaughan Cartridge Seals, as used in the HE and PE 3"-12" pumps. It is axiomatic that all mechanical seals must leak some finite amount, since without leakage they could not maintain face lubrication. Consequently the oil chamber/collector in the Vaughan Cartridge Seals will, typically, slowly fill over time. Fill time is dependant on several variables including pump model, operating RPM, actual flow and head, vibration, etc. While some pumps may take more than a year to completely fill the oil chamber with contamination other pumps may take only a few months.

Vaughan Co.'s experience has been that it is best to build a small amount of pressure in the oil chamber to help minimize the pressure differential across the seal faces. The 1 to 5 psi pressure relief valve allows that pressure to relieve and give the customer an external indication that he needs to change the oil in the cartridge seal.

The image at the top of the next page shows a Vaughan Cartridge Seal fitted for a parts shipment. As the pressure relief valve uses a metal plunger and seat we have found that a few drops of oil can leak in shipment or during installation when the seal is turned upside down. To prevent this leakage on all

parts orders and new Vaughan pumps with Vaughan cartridge seals, we will use a plastic cap over the pressure relief valve that must be removed at installation, before pump startup. If you are installing a new Vaughan cartridge seal in a pump, a drop or two of oil may show up at the pressure relief valve. This is expected and is not an indication of a problem.



Please note the decal we affix to the cartridge seals stating, among other things, if oil leakage at the seal is observed, that indicates it is time to drain and refill the Cartridge Seal oil chamber. You can see three ports in the back of the seal. The port located at 12:00 is the fill port. The port located at 6:00 is the drain port. And the port located at 4:00 is the level port. The customer will add oil through the fill port until it appears at the level port. He then has the correct amount of oil in an HE pump. When refilling a PE pump the oil must be measured per attached instructions.

The attached Vaughan Seal Oil Fill & Drain document shows how to fill and drain oil in both HE and PE pumps. It includes part numbers for the 1/8 NPT pressure relief valves (as used in the V801-309 seal, 3-6" HE/PE), the 1/4 NPT pressure relief valves (as used in the V801-310 seals, 8-12" HE/PE), and the syringe we have made available to ease changing the oil in these seals. As the ports in the V801-309 seal are limited to 1/8 NPT, the 2 ounce syringe, complete with tubing makes it easy to both add oil to the HE and PE seals, and also to use it as suction gun to remove contaminated oil from the PE seals.

These parts will retro-fit any V801-309 or V801-310 seal currently in the field (the pressure relief valve looks just like a pipe plug, with a rivet through the center of it). We have been advising customers for some time that if they see oil leakage at the seal they need to change the seal oil. Please note that an older design seal can be upgraded to the pressure relief valve for better indication.

Yours truly,

Glenn R. Dorsch

Glenn R. Dorsch, PE
VP/Chief Engineer

ENGINEERING MEMO
Sheet 1 of 2

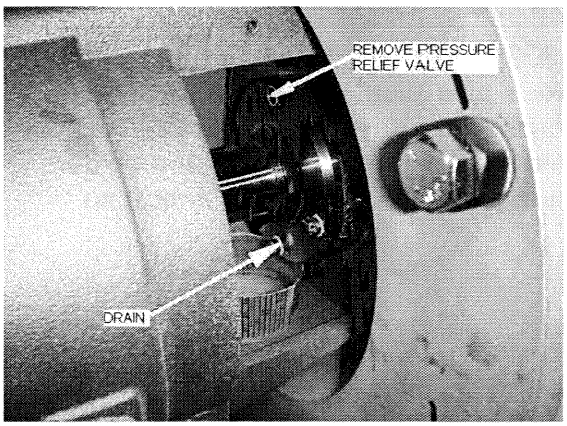
DATE: May 11, 2010
TO: Maintenance Personnel
FROM: Yee Chak, Vaughan Co. Senior Engineer
SUBJECT: Oil Change in Vaughan Cartridge Seals in Horizontal and Pedestal Pumps (Revised with different valve)

INSTRUCTIONS FOR DRAINING AND REFILLING OF OIL IN VAUGHAN CARTRIDGE SEALS

Please observe all Cautions and Warnings as outlined in the Vaughan Horizontal Pumps Installation, Operation, and Maintenance Instructions during this procedure, and whenever working on, or around, Vaughan Chopper Pumps. Note also the following Warning:

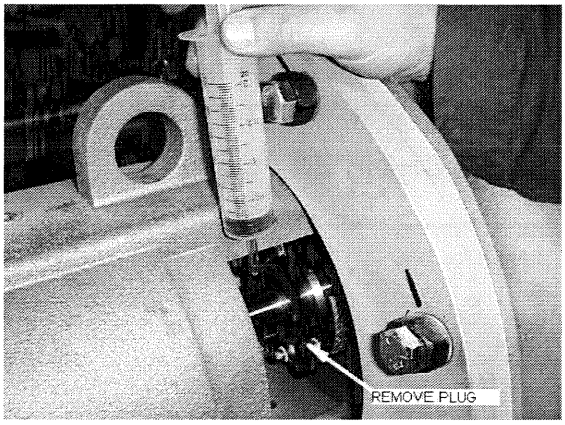
DANGER
Pressure may buildup in the standard mechanical seals used in Vaughan Horizontal or Pedestal pumps. Whenever checking or maintaining the oil in the Vaughan Cartridge Seal, make sure the pump and seal are cool to the touch and use care when removing the oil chamber plugs and pressure relief valve in case any residual pressure exists. If pressure exists plug could become a projectile and/or contaminated oil could spray.

New seals are packaged ready to be installed. When oil starts seeping out of the pressure relief valve during operation, contaminated oil will need to be drained and refilled with fresh oil. To drain and refill oil, follow the instructions below:

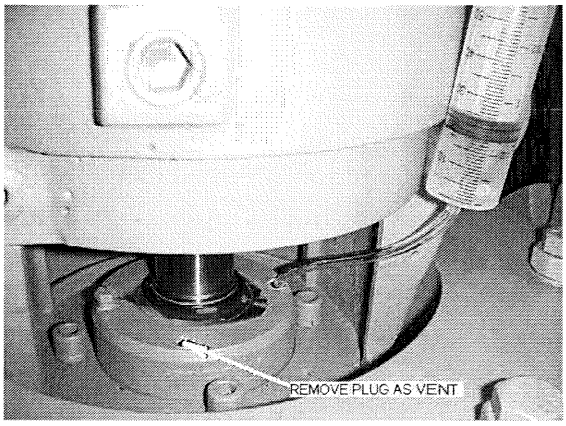


HE Pumps (Drain Oil): Remove guard. Remove the pressure relief valve (V801-886 (3-6" seal), V801-887 (8-12") seal) on top and the plug on the bottom to drain oil. Put a small container below the seal to collect oil. Plug the bottom hole after draining.

ENGINEERING MEMO
Sheet 2 of 2



HE Pumps (Fill Oil): Remove plug on the side. Using a syringe and tubing (V9991343) provided, fill with 46 wt hydraulic oil until oil flows out of the hole on the side. This amounts to about 2 oz. for 3"-6" pumps and 6 oz. for 8"-12" pumps. Plug side hole and install pressure relief valve on the top, with the hole on its side, after filling. Reinstall guard.



PE Pumps: Remove guard. Simply drain and refill using a syringe and tubing provided, with one plug removed as vent. Use 3 oz. of light oil (46 wt. hydraulic oil) to refill for 3"-6" pumps and 13 oz. for 8"-12" pumps. This will fill the seal approx. ¾ full. Reinstall guard.

TABLE OF CONTENTS

INSTALLATION, OPERATION, and MAINTENANCE INSTRUCTIONS

SECTION 1: CAUTIONS AND WARNINGS

DANGER!

- Wear eye protection, rubber gloves, and aprons when working on or inspecting this pump.
- A pump with a tandem seal may have pressure built up in the seal oil chamber. Make sure that the pressure relief valve is vented carefully with the pull ring before service.
- Disconnect electrical power and lock out and tag out circuit breakers to pump motor and associated equipment when inspecting or making adjustments. Duplex pumps with alternating relays must both be locked out; otherwise the pump you are working on may start as "the alternate". Visually confirm that the pump has come to a complete stop before proceeding.
- Pump motors are connected to high voltage. Allow only qualified electricians to service this electrical equipment only in accordance with the latest revision of the National Electrical Code and other applicable requirements.
- This equipment may not meet explosion proof requirements for hazardous environments unless specifically ordered for this purpose. Introducing non-explosion proof equipment into a hazardous environment as defined by the National Electrical Code can cause a dangerous explosion.
- This pump may start automatically if wired to float switches or other equipment. Before inspecting or working on this equipment, always isolate electrical power.
- Keep hands, feet and clothing away from moving machinery.
- Enter tanks or pits with extreme caution and only when using a self-contained breathing apparatus and only when a harness and tether is tied around your waist. Two people should be stationed outside the pit or tank holding onto the harness and tether so they can pull you out of the pit in an emergency. Consult the confined space entry procedures that have been recommended for your location. Pits or tanks may contain dangerous gases that can cause death.
- As it is possible to run Vaughan Chopper and Screw pumps dry, for quality assurance or troubleshooting reasons, it is extremely important to ensure suction and discharge connections are always properly guarded to prevent anything (i.e. foreign objects or pump parts) from being thrown form the pump as a projectile. All pumps must be run with either a) suction and discharge piping in place, or b) blind flanges installed on suction and discharge connections. Blind flanges should be vented to avoid pressure build-up. Note that cast rotating parts could break if metal to metal contact occurs while the pump is running dry.

DANGER!

- Pressure may buildup in the standard mechanical seals used in Vaughan Horizontal or Pedestal pumps. Whenever checking or maintaining the oil in the Vaughan Cartridge Seal, or the Eagle welded metal bellows seal with seal oil chamber, make sure the pump and seal are cool to the touch and use care when removing the oil chamber plugs, in case any residual pressure exists. If pressure exists, plug could become a projectile and/or contaminated oil could spray.

CAUTION!

- This pump uses oil which if spilled can cause a slipping hazard and danger to personnel.
- This pump is a "Chopper Pump". There are sharp corners, edges and pinch areas which can cause serious cuts. Be careful; wear protective gloves whenever possible. If you cut yourself, seek medical help immediately to avoid serious infection.
- Lift pump and motor by pump lifting eyes only. Lifting by any other parts of this equipment may be dangerous or may damage equipment. Do not lift pump and motor assembly using the motor lifting eye.
- Lift pump and motor with an adequately sized hoist or crane. Consult Vaughan Co., Inc. shipping department for weight of your equipment if you are in doubt. Do not allow people under pump assembly while it is being lifted.
- Do not operate this equipment unless safety guards or devices are in place and properly adjusted.
- Shut pump off when adjusting fittings to avoid being sprayed with pumpage. Pumped materials may be hot, corrosive, poisonous, infectious, or otherwise dangerous to personnel.
- Never clean, oil, or repair machinery while in motion.
- Keep electrical control panel area clear to avoid hazard to personnel. If a person should trip and fall into an open panel enclosure, serious electrical burns can result.
- Keep all pit openings covered when not in use. Open pits may contain poisonous gasses or fluids that can injure a person in addition to the falling injuries.
- Make certain all personnel are clear of equipment before operating.

SECTION 2: DESCRIPTION OF THE VAUGHAN E-SERIES HORIZONTAL CHOPPER PUMP

The Vaughan end-suction horizontal chopper pump is specifically designed for pumping debris-laden liquid slurries. Debris is chopped by the pump impeller slicing against it at the suction plate or "Cutter Bar" as it enters the pump, so that particle size is reduced and down-stream plugging problems are greatly reduced. In this way the pump impeller serves a dual function of both pumping and chopping.

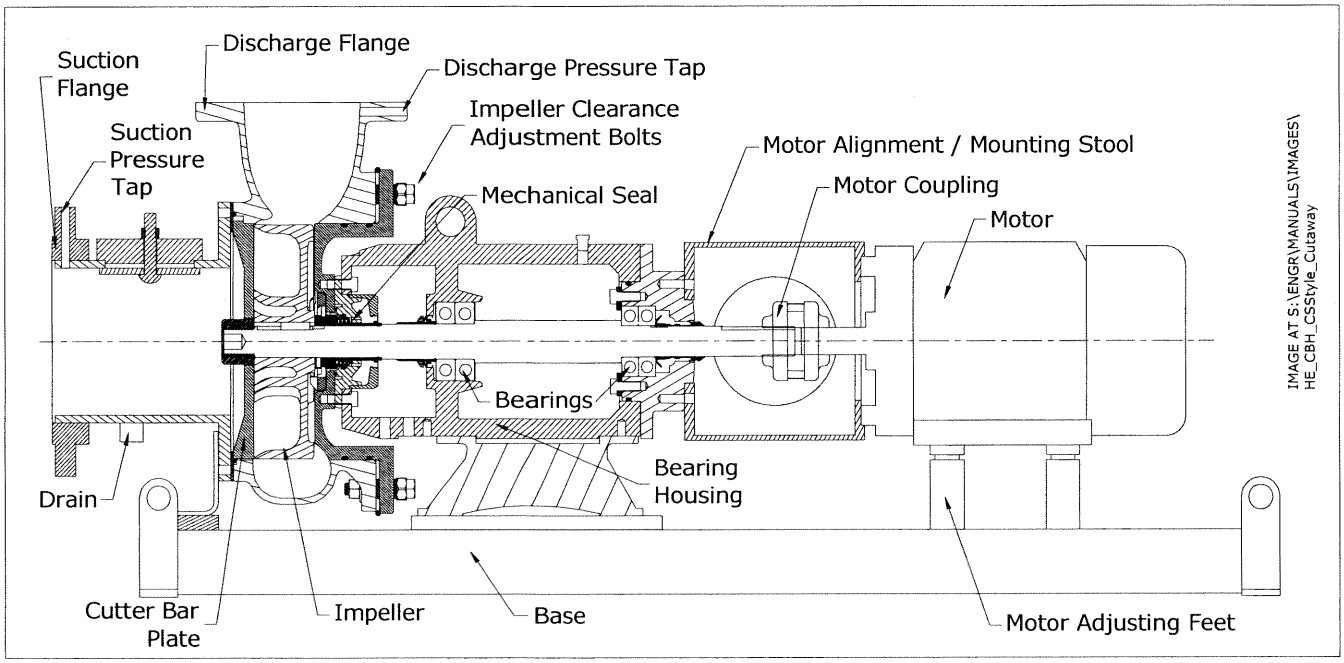
The HE Series chopper pumps offer additional improvements over the previous standard horizontal chopper pumps:

1. The back pullout casing design allows for easy removal of the rotating assembly without disconnecting suction or discharge piping.
2. The impeller-to-cutter bar and impeller-to-upper cutter clearances can be adjusted externally without the use of shims or the need for pump disassembly.
3. New techniques for improving the hydraulic efficiency have been implemented.
4. The HE Series with Vaughan Cartridge Seal has the additional advantage that it does not need a water flush to the mechanical seal.

A. DESCRIPTION OF MAJOR COMPONENTS

CHOPPER IMPELLER: The impeller on the Vaughan pump serves two purposes. It induces flow by propelling liquid material through the pump casing, and also chops solids by slicing against the cutter bar. The leading edge of each impeller blade is sloped forward to create a knife edge. As material enters the pump, it is caught and cut between the knife edges on the impeller blades and the stationary bars of the cutter bar. The standard impeller is made of cast steel and is heat treated to Rockwell 60C.

CUTTER BAR PLATE: The cutter bar plate serves two functions. First, it serves the function of a "wear plate", sealing the intake of the pump. The pressure generated by the impeller is kept inside the pump by the close clearances between the cutter bar plate and the impeller. Second, the cutter bar plate includes two shear bars which span the entrance to the pump. Material is chopped by the pump impeller cutting against these stationary shear bars. The standard cutter bar is made of alloy steel and is heat treated to Rockwell 60C.

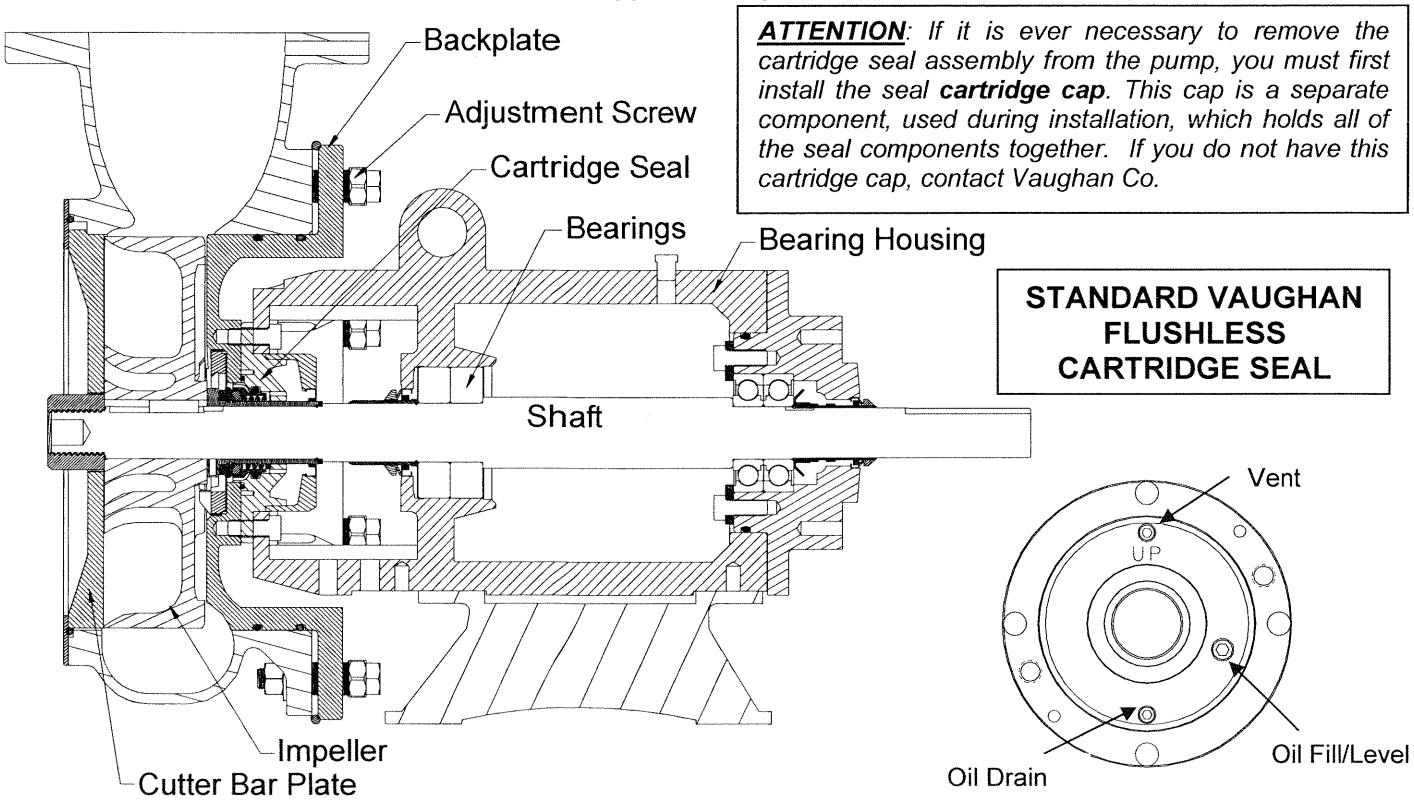


DISINTEGRATOR TOOL: The disintegrator tool, used only when appropriate, is an auxiliary cutter to help prevent blockage at the suction end of the pump. Matted or solid material which would tend to block the opening of the pump can be broken by this tool so flow can continue into the pump. The disintegrator tool is particularly helpful in vegetable and manure pumping. This tool can cause problems if misapplied, because stringy material such as rags, hair, and other fibers can wrap on it and make a ball that can eventually block flow into the pump. If the pump is installed with a disintegrator tool, and suction blockage becomes a problem due to wrapping, the tool should be removed and replaced with a hardened set screw available from Vaughan Co. or from a local bolt house.

MOTOR MOUNTING: Vaughan horizontal End-Suction pumps are usually directly driven by C-Face electric motors through a TB Woods Sure-Flex elastomeric coupling. The motors are rigidly mounted to the pump bearing housing by a machined and piloted motor stool. This piloted mounting ensures proper motor and pump shaft alignment without requiring special alignment of the motor and pump shafts at your plant. If your pump is belt-driven, it will either have the motor mounted to the side of the pump or overhead, depending on how it was ordered. Belt driven pumps have arrangements for motor movement to adjust the belt tension. It is advisable to use flexible conduit to the motor so that the motor can moved with the rotating assembly for adjustment or service to the wetted parts of the pump.

FLUSHLESS MECHANICAL SEAL (Vaughan E-Series Cartridge Seal, STANDARD): The HE Series End-Suction Chopper Pump is usually supplied with a Vaughan flushless, cartridge-type mechanical seal placed directly behind the impeller, shown below. **This seal will not require any water flush to keep it clean.** The only maintenance required of the Vaughan Cartridge Seal is a quarterly check of the oil condition. There are two 1/8" and one ¼" pipe plugs located on the outboard end of the seal. If you find oil that is contaminated or dirty, it can be changed. Drain the oil and refill (see diagram below). For 3"-6" pumps, use 2 oz. and for 8"-12" pumps, use 6 oz. of ISO 46 Turbine oil to refill. This will fill the seal approximately 1/3 full, which is correct.

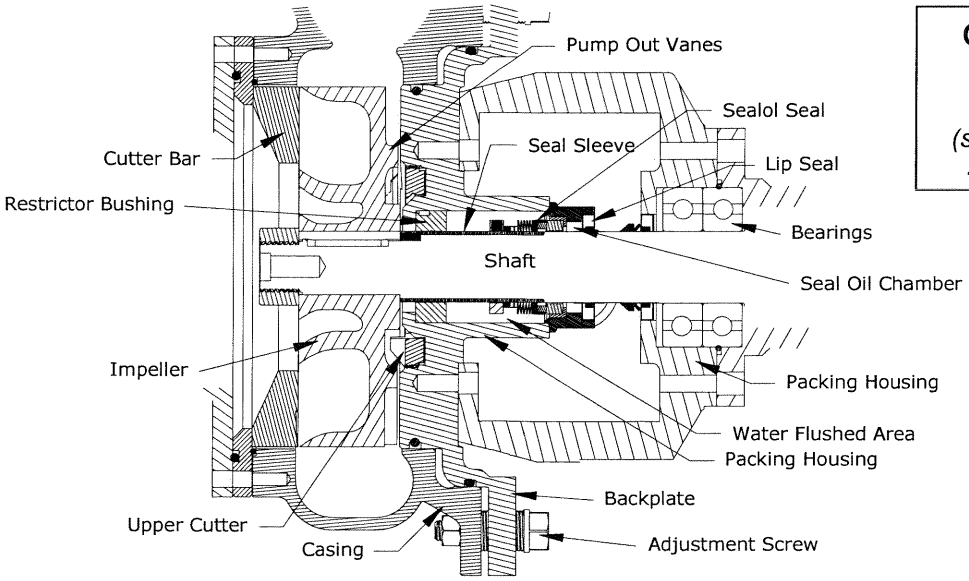
***ATTENTION**: If it is ever necessary to remove the cartridge seal assembly from the pump, you must first install the seal **cartridge cap**. This cap is a separate component, used during installation, which holds all of the seal components together. If you do not have this cartridge cap, contact Vaughan Co.*



STANDARD VAUGHAN FLUSHLESS CARTRIDGE SEAL

DANGER: Pressure may buildup in the standard mechanical seals used in Vaughan Horizontal or Pedestal pumps. Whenever checking or maintaining the oil in the Vaughan Cartridge Seal, or the Eagle welded metal bellows seal with seal oil chamber, make sure the pump and seal are cool to the touch and use care when removing the oil chamber plugs, in case any residual pressure exists. If pressure exists, plug could become a projectile and/or contaminated oil could spray.

MECHANICAL SEAL (Welded bellow type, NON-STANDARD): The HE series End-Suction Chopper pump may also be supplied with a welded bellows mechanical seal with silicon carbide faces. This seal system can be used safely without a seal flush in sewage lift stations where the pumpage is mostly water. For best seal life in sludge or abrasive slurries, always flush the seal chamber with 6-10 GPH of water from a seal flush system pressurized to at least 10 psi above the pump discharge pressure. A flow control device, such as a Rotameter, should always be used to throttle the flow to 6-10 GPH. (Too much flow and pressure can erode the insides of the stuffing box.) See the recommended seal flush installation diagram on page 11.

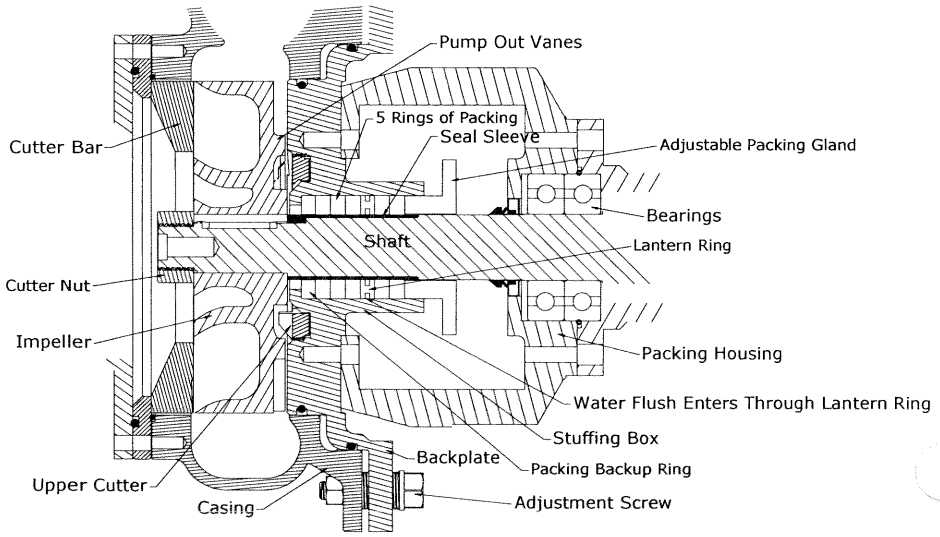


OPTIONAL WELDED BELLOWS SEAL

(standard flushless cartridge seal is shown on page 4.)

DANGER: Pressure may buildup in the standard mechanical seals used in Vaughan Horizontal or Pedestal pumps. Whenever checking or maintaining the oil in the Vaughan Cartridge Seal, or the Eagle welded metal bellows seal with seal oil chamber, make sure the pump and seal are cool to the touch and use care when removing the oil chamber plugs, in case any residual pressure exists. If pressure exists, plug could become a projectile and/or contaminated oil could spray.

PACKING (NON-STANDARD): If your pump was ordered with packing, the packing is typically ½" TFE-impregnated graphite packing with reinforced Kevlar corners. The lantern ring is split glass-filled TFE. All packing components run on a Nickel-Chrome-Boron coated 316 stainless steel shaft sleeve. Packing should always be water flushed. Grease flushing of packing is rarely a reliable method of cooling and lubricating packing. Supply 6-10 GPH seal water at a pressure of about 10 psi above pump discharge pressure. Regulate seal water flow and gland nut tightness until about 6-10 drops per minute leak externally from the packing.



OPTIONAL PACKING ARRANGEMENT

B. PROPER APPLICATIONS FOR VAUGHAN CHOPPER PUMPS

Vaughan Chopper Pumps are used for pumping liquid slurries contaminated with debris which can be chopped and mixed into the slurry. The benefit of chopping the pumpage is that a more homogenous slurry is pumped, making some slurries pumpable that would normally not be, and eliminating downstream plugging in piping and other equipment. Screens located upstream of the pump may often be eliminated, which will cut labor costs. Vaughan pumps are routinely used to pump the following slurries:

1. Sewage and sewage sludge
2. Fish waste.
3. Vegetable waste.
4. Mill scale.
5. Aluminum chips from machining operations.
6. Lead oxide and plastics in battery plants.
7. Oil sludges in oil refineries.
8. Wood chips and paper waste.
9. Animal manures (dairy cow, pigs, and chicken).
10. Feathers mixed with blood and water in poultry plants.
11. Animal fat in rendering and hide processing plants.
12. Plastic debris.
13. Coal slurry.

System design is very important in making any pump work successfully in debris-laden slurries. There must be enough liquid so that liquid and material are able to flow freely to the pump. The piping must be properly designed to be large enough to reduce friction losses, yet small enough to ensure sufficient velocity to keep particles suspended.

C. USES OF VAUGHAN PUMPS THAT MAY CAUSE TROUBLE

If the system is not designed correctly for proper handling of your material, or if the pump is incorrectly chosen for your system, the pump may not work to your satisfaction or the pump may experience early failures of seals or bearings due to cavitation and the resulting vibration. Vibration will damage mechanical seals and bearings fairly quickly.

Common rules of thumb include:

1. A pump must be operated in the safe portion of its pump performance curve. Operation in the dashed lines indicates vibration areas.
2. Operating a pump against very low backpressure damages pumps.
3. Operating a pump against too much backpressure damages pumps.
4. Chopper pump impellers with the largest number of blades are the most efficient, but they also provide the poorest solids handling. Added impeller blades block the inlet and cause increased binding on fiber during chopping. When pumping sewage and similar slurries, choose impellers with the *least* number of blades.
5. When pumping materials that float or settle in a pit, mixing and chopping with the pump may be required before pit pumpout. This can be done by initially directing the discharge back into the pit.
6. A slurry that is too hot cannot be pumped from an open pit. A reasonable limit at 1170 RPM is about 180° F, at 1750 RPM it's about 160° F.
7. A reliable and properly sized electrical supply must be installed for the pump to work properly. If there is too much voltage drop because of an undersized cable or transformer, the motor will not be able to provide full power to the pump and it will stall during chopping of debris.

D. EXPECTED BENEFITS OF VAUGHAN PUMPS

Most customers who install a Vaughan pump see several advantages:

1. Minimal pump attention is required.
2. Chances of pump plugging or binding on tough solid or fibers are minimized.
3. Minimal plugging problems downstream, because the material is preconditioned.
4. Elimination of ancillary grinders or comminutors upstream of the pump.
5. Long and reliable life of the Vaughan pump.

VAUGHAN HORIZONTAL CHOPPER PUMP
STARTUP AND CERTIFICATION CHECKLIST

Pump Serial No. _____ Date: _____

Contact name of person performing startup: _____

Contact phone number: _____

Pump shaft turns freely by hand?	YES ☐	NO ☐
All guards are in place?	YES ☐	NO ☐
All piping attached to pump is being independently supported? (not by the pump)	YES ☐	NO ☐
Is the pump casing vented and filled with liquid?	YES ☐	NO ☐
All piping joints are leaktight?	YES ☐	NO ☐
Pump is turning CW as viewed from the motor end?	YES ☐	NO ☐
Is the oil level in the middle of the range of the sight glass? Is the vent in the top bearing housing plug open?	YES ☐	NO ☐

ELECTRICAL DATA

Motor Mfr: _____ HP: _____ RPM: _____

Nameplate Voltage: _____ Nameplate F.L. Amperage: _____

Operating Voltage: L1-L2 _____ L2-L3 _____ L1-L3 _____

Operating Amperage: L1 _____ L2 _____ L3 _____

SYSTEM DATA

What type of material are you pumping? _____

_____

Temperature (degF) _____ Specific Gravity _____ %Solids _____

Describe your piping system: Total equivalent length of pipe _____FT

Pipe size: _____ in. Elevation change from water level to disch point (ft.) _____

Estimated Total Head (ft): _____ Required Flow (GPM): _____

Image at S:\engr\manuals\images\startup

PUMP OPERATING DATA

Pump Model _____ Impeller Diameter _____

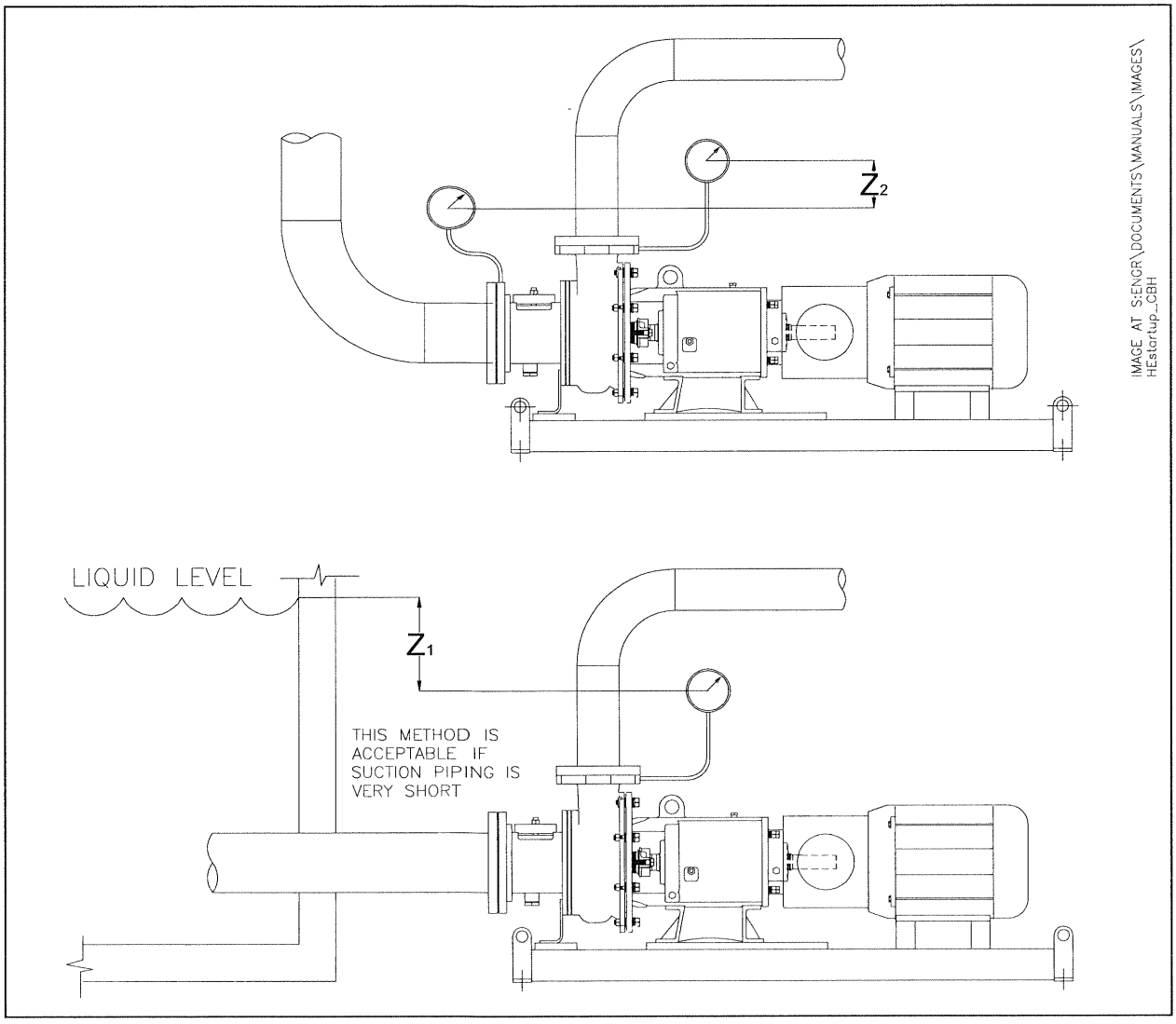
Discharge Pressure (psig) _____ Dim "Z1" _____feet
(distance from liquid level to pressure gauge)

Suction Pressure (psi or in. Hg if negative)_____, Dim "Z2" _____ feet.
(vertical distance between gauges)

Pump Flow (GPM) _____

Is pump running quietly? _____ Noisily?_____ Very noisily? _____

NOTE: If pump is not running quietly, please contact us immediately for help. Severe vibration can damage the pump very quickly.



SECTION 4: INSTALLATION INSTRUCTIONS

A. RECEIPT INSPECTION

Prior to shipment Vaughan pumps are carefully crated and inspected to ensure arrival at your plant in good condition. On receiving your pump, examine it carefully to assure that no damaged or broken parts have resulted from mishandling during shipping. Turn the pump shaft by hand and verify that it turns over smoothly. If the shaft binds, look for debris (or paint) between impeller and cutter bar. Otherwise, shaft binding could indicate damage. If damage has occurred, report to your carrier immediately, and consult your local Vaughan representative.

B. STORAGE CONSIDERATIONS

If equipment is to be stored for longer than two weeks, take the following action:

1. Coat exposed steel with a light layer of grease to protect the equipment from corrosion.
2. Rotate the motor 1/4 turn once each week to keep the bearings from sitting in one position for extended periods of time.
3. Avoid storing rotating equipment near other vibrating equipment. The vibrations can cause damage to the ball bearings and cause premature failure once the equipment is started up.
4. Store rotating equipment in a clean, dry, heated area away from areas where it could be damaged from impact, smoke, dirt, vibration, corrosive fumes or liquids, or from condensation inside the motor or pump. It is helpful to cover equipment with plastic.

C. PUMP MOUNTING

CAUTION

Lift pump and motor with an adequately sized hoist, crane, or forklift. Consult Vaughan Co., Inc. shipping department for weight of your equipment if you are in doubt.

DANGER

Do not allow people under pump assembly while it is being lifted.

Vaughan pumps are heavy and will require a crane to lift into position. Lifting the pump by the lifting lugs at the base is always a safe method for lifting. Do not lift by the motor eye unless the pump has no lifting eyes at the motor end. In these cases, lift with a three point sling; one on the motor eye and two on the base eyes.

Anchors:
Vaughan pumps should be securely bolted to a level, flat floor or slab with stainless steel anchors to minimize operational vibrations. Expansion-type, cast-in place J-bolts, bolts mounted in sleeves, and epoxy anchoring systems are all acceptable anchoring means. Pumps 3-6" discharge size use 4, ½" x 7" long; pumps 8-12" size typically use 6, ¾" x 7" long anchors.

Leveling the Base:
Vaughan Co. assembles and aligns the completed pump and motor assembly on a level surface at the factory and runs the pump at speed to measure dry-run vibration levels and to ensure that no metal-to-metal contact occurs. If the base is not mounted to a level, flat surface in your installation, twisting of the base and pump could occur that can cause metal-to-metal hitting of the cutting parts during operation. Careful shimming is required to properly align the suction piping to the pump and to ensure that the pump base is level (not twisted) and properly aligned to the suction piping. As the pump is shimmed, turn the pump shaft over by hand to ensure that no metal-to-metal contact is occurring. *If metal-to-metal contact is discovered during pump startup and actual pumping, additional shimming may be required to take additional twist out of the base and pump.* Do not completely tighten the anchors until grouting is completed and is properly hardened. Note that this pump is expected to be mounted horizontally. If mounted at an angle, both sets of bearings may not receive adequate oil lubrication. Consult factory as grease lubricated bearings may be required in this situation.

Grouting:

Vaughan Co. recommends that all horizontal pumps be grouted in place. Standard horizontal baseplates include grout holes and vents to facilitate grouting. The purpose of grouting is to prevent shifting of the baseplate, to reduce vibrations (by increasing mass), and to fill in irregularities in the foundation. A typical mixture for grout is one part portland cement and two parts building sand combined with enough water to allow grout to flow under the base. Wet the concrete foundation before grouting the pump in place. A wooden form is needed around the pump base to retain the grout. Add grout until the entire underside of the pump base is filled, working air out with a stiff wire or rod through the grout holes. Cover the exposed grout with wet cloth or burlap to prevent cracking during setup. Remove the wooden forms once the grout is setup and then smoothly finish the exposed surfaces. Fully tighten the anchors only after the grout is completely hardened. Shims used for leveling and alignment may be left in place.

Direct-Drive Motor Adjusters:
Horizontal direct-drive pumps use a machined motor stool aligned to the motor C-Face end bell so that pump/motor coupling alignment is assured. Threaded adjustable motor supports are provided under each of the motor feet that are designed to just touch the pump base when aligned at the factory. The adjusters are held in place by a set-screw. After shimming and grouting, loosen each motor adjuster set-screw and reset the adjusters to that they just touch the base, then re-tighten the set-screw.

Belt-Drive Adjustments:
Horizontal side-mount belt-drive pumps have been aligned at the factory on a flat surface, but since your mounting surface may not be flat, you will need to loosen the belts and re-adjust the belt tension and alignment. (Overhead belt-drive systems may not require any belt-drive adjustment.) Belts that are too tight can cause premature belt or bearing failures, belts that are too loose may experience belt slipping and belt failure. First, align the sheaves to a long straightedge to ensure that the 4 edges of the sheaves all touch the straightedge. Then use a belt tensioning device (available from TB Woods or Browning) to properly adjust the belt tension. Vaughan's bill of material (BOM) for your particular pump and belt-drive system lists the belt tension required by the drive manufacturer. Please request the pump BOM from Vaughan Co. if you don't have it.

D. PIPING

CAUTION
Be sure that all piping connections are tightened and properly supported before operation of this pump.

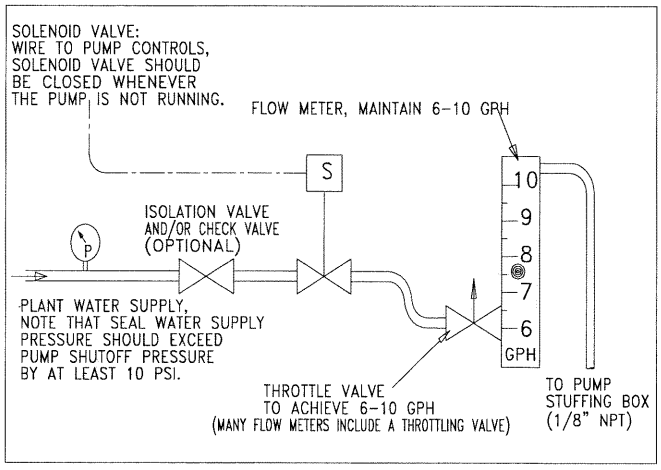
Be sure that the weight of piping connected to the pump suction and discharge flanges is properly supported. Do not expect the pump to support your piping system, as this may cause large stresses on the pump and may cause metal-to-metal interference problems during actual pump operation due to distortion of the pump or base. These stresses can result in a broken or cracked casing or premature bearing and seal failures, as well. Before bolting up piping to the pump, make sure that flanges are closely aligned.

Great care should be taken with suction piping on horizontal and pedestal pumps to avoid restricting flow to the pump. Avoid bends and fittings and keep suction piping as short as possible and as large as possible. *Suction piping must be as large or larger than the pump suction flange*. Long and restrictive runs of suction piping can contribute to gas binding problems, especially in scum and sludge transfer applications. Never install a check valve in the suction piping.

Remember that sludges have significantly higher friction losses than water, so larger diameter piping is always helpful when pumping this material. Maintaining suction velocity below 8 ft/sec is helpful. If you are pumping uphill or into a force main, or if there is more than one pump pumping into a common header, a check valve and an isolation valve will be required on the discharge of the pump. Note that Vaughan pumps have pressure taps on the suction and discharge flanges for installation of pressure gages for testing purposes, particularly important at pump startup.

E. SEAL FLUSHING

The standard mechanical seal used in Vaughan pumps since 2003 is the Vaughan flushless cartridge seal, designated "CS" in the pump model. This seal requires no external flush and is cooled and lubricated by the oil chamber that is part of the seal assembly. Other mechanical seals may be installed in your pump if it was specified this way. Seals other than the Vaughan flushless seal must be flushed with at least 6-10 gallons per hour of clean water. There is a 1/8" NPT fitting on the stuffing box for this purpose. The seal water must be supplied at a pressure at least equal to pump discharge pressure, and regulated with a flow meter to the proper flow of 6-10 GPH. A solenoid valve must be installed to switch the water on and off with the pump motor. A schematic of this system is shown above.



F. MOTORS AND CONTROLS

Most motors provided on Vaughan pumps are TEFC C-Face and are not designed for hazardous environments or rated as explosion proof. However, some applications require explosion-proof motors. If your pump is located in a hazardous location, be sure you ordered and received your pump with an explosion-proof motor and that you use an electrician experienced in hazardous environment wiring and controls.

Vaughan Chopper Pumps, because they cut and condition the material they pump, require motor protection with correctly sized breakers, starters, and overload protection. A Chopper Pump can jam and stall on material too tough to chop, such as steel rebar. Therefore, carefully chosen overload protection for your expensive motor is critical to avoid motor burnout. Note that nuisance tripping during chopping can occur if you do not have an adequately sized circuit breaker. The circuit breaker should *never* open during chopping, only during a short circuit. The starter overloads should trip out on overload, and are typically size for 110% of motor full load amperage rating.

As discussed earlier, it is a good idea to run flexible conduit to the motor to facilitate the back pullout advantages of this pump.

G. HORIZONTAL BEARING SYSTEM

Horizontal Chopper pumps have oil-bath bearing lubrication. The proper oil is ISO grade 100 turbine oil. Oil level is indicated by a sight glass mounted on the side of the bearing housing. For HE pumps, the oil level is correct when oil is in the center of the sight glass. Overfilling the bearing housing can cause heating and oil spillage. The pump must be mounted horizontally.

SECTION 5: PUMP STARTUP INSTRUCTIONS

CAUTION

If the pump is allowed to run backwards for any significant length of time, the impeller can loosen, and eventually damage the pump.

CAUTION

Pump speeds and operating conditions must fall within the acceptable limits of the performance curve of the pump, not on the dashed portions of the curve.

1. All directly-driven Vaughan pumps using C-Flange electric motors are

designed and built for automatic alignment of motor and pump shafts during assembly. If your motor has feet, (4) motor adjusters will have been supplied with your pump. Tighten just enough to support the weight of the motor but no more. Check coupling offset alignment before startup to ensure motor adjuster feet have been properly adjusted. Belt-driven pumps and bare pumps purchased from Vaughan Co. and mounted on customer or dealer-supplied bases will require careful alignment of pump and motor shaft before startup.

2. Perform a pump rotation check to ensure Clockwise rotation (as viewed from the motor end) before startup. At the control panel, hit the "ON" button, then the "OFF" button as fast as possible to "jog" the motor at a slow rate. If the motor turns clockwise, you are ready to start the pump. If the motor turns counterclockwise, (wrong direction), then open the circuit breakers to the motor panel using your plant's normal safety precautions for locking and tagging out breakers, and reverse any two leads on the motor starter in the control panel. Close the breakers to the panel and recheck the motor direction to be sure it's correct.

3. When the startup checklist is completed satisfactorily, review the safety warnings at the beginning of this manual and then start up the pump. To protect your investment, please complete the STARTUP AND CERTIFICATION CHECK-LIST and send or FAX a copy of it to Vaughan Engineering so we can verify that the pump is properly matched to your system.

SECTION 6: NORMAL OPERATION

A. NOISE

Most Vaughan pumps operate at either 1170 or 1750 RPM. At these speeds, the pump is normally quiet running, and the major source of noise is the electric motor. (Higher horsepower, higher head pumps, of course, are noisier.) Sometimes at startup a tank may be full of debris, and the pump will be fairly noisy due to chopping it. This noise should dissipate as the debris is broken up and/or pumped out.

Note that 3510 RPM pumps will be somewhat noisier. At this speed, the normal operating noise will be fairly high (85-90 dbA). Much of this noise will be from the motor fan, but there will be some hydraulic noise. Pay particular attention to the pump casing noise on all pumps. If there are any crackling noises coming from the pump casing, (as if pumping marbles) this could be evidence of cavitation. If these noises persist, please call Vaughan Company to discuss. Cavitation can damage a pump in a very short time period.

B. VIBRATION

Vibration, like noise, should be minimal in the pump unless the pump is doing heavy chopping. If a particularly tough rag, or nylon pantyhose gets caught in the pump, temporary dynamic imbalance and some flow blockage will occur until the rag is chopped up and cleared. These conditions will create an unbalance and vibration. This condition is generally short-lived, and the chopping action of the pump normally clears the obstruction in a short time.

Please note that every effort has been made at the factory to ensure that these pumps operate smoothly and within Hydraulic Institute Standard vibration limits. All impellers are dynamically balanced after impeller machining to less than 0.2 ounce of imbalance. The pump shaft is fully machined to be straight and tightly held by ball bearings so that there is virtually no shaft movement. Your pump should not exhibit any significant vibration or noise in normal operation. If you feel that the pump is noisy or vibrating more than it should, please call Vaughan Company immediately to discuss. Excessive vibration and/or noise may be indicative of system mismatch or other problem that could severely shorten the life of your pump.

SECTION 7: SHUTDOWN INSTRUCTIONS

A. MANUAL SHUTDOWN

DANGER
Be sure to turn off electrical power by opening the breaker at the control panel and by following all plant safety procedures before working on the pump!

In the manual mode of operation, a Vaughan pump is shut down by pushing the "off" button or turning the auto/man/off switch to the "off" position on the front of your control panel. If any repair or maintenance work is to be done on the pump, be sure to follow all the warnings at the beginning of this manual.

B. AUTOMATIC SHUTDOWN

Automatic operation will normally shut the pump down, usually on low pit level. If the pump does not shut down when the pit is empty, the pump may be shut down manually, but you should troubleshoot your level control system to find out why the automatic operation is not working properly. Continued operation of the pump during "snoring" will damage the pump. "Snoring" is a condition where the pump is operating while alternately drawing water and air. The differing loads on the impeller shaft cause high stresses and vibrations that can quickly result in damage.

If you are going to do any maintenance, adjustment, or inspection on this pump or motor, be sure to follow all warnings at the beginning of this manual. Be sure to turn off electrical power by opening the main panel breaker and by following all plant safety procedures, since in the automatic mode, the pump could start automatically if not isolated.

C. EMERGENCY SHUTDOWN

In any kind of emergency when the pump needs to be shut down, operate the manual off switch or push-button on the front of the pump control panel. If any work has to be done on the pump or motor, open the main breaker on the pump control panel so that the pump cannot automatically restart when personnel are near the pump or motor. Be sure to tag the breaker so everyone will know not to turn it back on.

SECTION 8: MAINTENANCE

A. ROUTINE MAINTENANCE

MONTHLY:

1. Check amperage draw to the pump motor and compare to amperage measured at startup. Make sure that amp draw does not exceed allowable amperage to the motor at full load.
2. Check for seal or packing leakage at the stuffing box area. Adjust packing leakage to 6-10 drops per minute, if applicable. If seal leakage is evident, the seal faces can be cleaned (Non-Vaughan seal only). Isolate the pump hydraulically and electrically, (See all warnings at front of manual!) drain intake manifold, remove the 2 bolts on the seal gland, and pull the gland back on the shaft to clean the seal faces. Use isopropyl alcohol or oven cleaner. If cleaning the seal faces does not stop severe leakage, consult the Vaughan Overhaul Manual for instructions on how to replace the mechanical seal.

QUARTERLY:

1. Motor: Inspect electric motor. Make sure that motor drain is not plugged with debris. Clean cooling fins so that dirt buildup will not affect cooling ability of motor. Check for loose or corroded hardware and damaged wiring or conduit.
2. Pump: Inspect pump for loose hardware. Make sure that pump is operating smoothly and without vibration or cavitation.
3. Check oil levels and for oil contamination of the seal chamber. If it is dirty, change it. Note that the oil filled chamber should not be filled completely; see p. 15 for fill volumes.

DANGER
Pressure may buildup in the standard mechanical seals used in Vaughan Horizontal or Pedestal pumps. Whenever checking or maintaining the oil in the Vaughan Cartridge Seal, or the Eagle welded metal bellows seal with seal oil chamber, make sure the pump and seal are cool to the touch and use care when removing the oil chamber plugs, in case any residual pressure exists. If pressure exists, plug could become a projectile and/or contaminated oil could spray.

SEMIANNUALLY:

1. Grease motor bearings with bearing grease as specified by the manufacturer.
2. Perform all quarterly inspections as shown above.

ANNUALLY:

1. Check the clearances between the impeller and cutting surfaces.

Isolate the pump electrically (open & tag breakers) to make sure that the motor can't start accidentally and adjust the clearance between impeller and cutting surfaces. This can be done without any pump disassembly. Remove a motor stool cover and rotate the coupling by hand. Feel for bearing roughness or cutter contact. If the bearings are rough consider overhauling the pump to change bearings.

There are two sets of external adjusters, one set for the impeller/cutterbar gap, and one for the impeller/upper cutter gap. (Refer to the photo that fits your pump on page 16)

Impeller-Upper Cutter Adjustment

Adjust the clearance between the back side of the impeller and the upper cutter before adjusting impeller to cutter bar clearance. HE pumps with a skinny bearing housing don't have external upper cutter adjustments. If you have this model, skip this step. Please follow the following procedures closely. It is important to note that if the adjustment sleeves are turned the wrong way, interference will be felt as described but it will be interference on the front side of the impeller instead of the back. This will cause a confusing problem during the next step when the front clearances are adjusted.

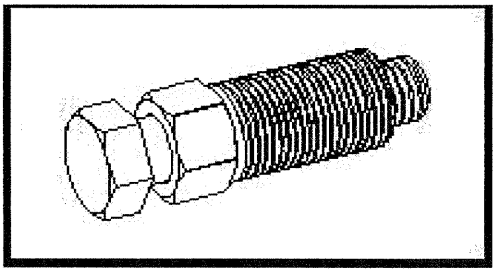
a. Loosen the bolts holding the bearing housing to the baseplate. The motor feet are not bolted to the baseplate. *Don't change the motor feet adjustment!*
b. The upper cutter adjustment is done by adjusting the thrust bearings at the motor end of the bearing housing. Loosen each of the four clamp bolts on the bearing housing cap about ½ turn.
c. To move the impeller closer to the upper cutter, (normal maintenance) rotate each of the adjustment sleeves one flat clockwise (it is important to turn them exactly the same amount to keep everything parallel), and then tighten the clamp bolts onto them. Repeat this step until you feel interference (by turning the coupling by hand) between the impeller and the upper cutter. Once interference is felt, move the impeller back only until it is free. To move the impeller away from the upper cutter, loosen the clamp bolts, rotate the adjustment sleeves *counter clockwise* and then retighten the clamp bolts.

Impeller-Cutter Bar Plate Adjustment

Once the upper cutter adjustment is complete, the cutter gaps on the front of the impeller can be adjusted. The clearance can be adjusted externally by modifying the position of the rotating assembly. To make this adjustment you will be moving the entire rotating assembly, including the impeller, backplate, bearing housing and motor in or out of the casing.

To begin, loosen and back off all of the nuts on the adjustment sleeve clamping bolts between the casing and the casing backplate. Back all adjusting sleeves away from the casing (counter clockwise) except for three approximately equally spaced sleeves that you will use for making the adjustments.

Adjusting Sleeve & Clamp Bolt



a. Adjustment is accomplished by rotating each of the three equally spaced adjusting sleeves counter clockwise by an equal amount, then

tightening the clamping bolts onto them and checking for contact by rotating the shaft again. This step may have to be repeated a couple of times if the pump has some wear on it. Each flat of rotation of the adjustment sleeve hex nut is worth .010" to .012" of cutter movement. Typically the pump won't have more than .020" to .050" of wear.

b. After achieving light contact, find a piece of key stock or other shim material that is slightly larger than the gap now present between the backplate and casing flanges. This will probably be about 3/16" to ¼". Turn the (3) adjustment sleeves clockwise and adjust the gap to the chosen shim stock until the gap is exactly equal at each adjusting sleeve with the clamping bolts tight. This step ensures that the impeller and cutter bar are parallel and the gap is even.

c. Now that the impeller and cutter bar are parallel, repeat step "a" except be more careful to turn the adjustment sleeves evenly to keep the cutters exactly parallel. Close up the gap to find light contact with the clamp bolts tight.

d. When you have the cutters lightly touching, and you think that the contact is fairly uniform, (backplate and casing parallel), unclamp the adjustment sleeves once again and carefully rotate them one flat clockwise. This will give the cutters .010" to .012" clearance. Don't make this clearance tighter than this, because as the pump warms up, the shaft will grow slightly and close this gap.

e. Snug the five unused adjusting sleeves against the casing. Make sure that the adjusting sleeves bottom on the iron, and are not tightening on anything that will crush when the clamp bolts are tightened. Lock all the adjusters down with the clamping bolts, and tighten the bolts that you loosened on the baseplate.

f. After all bolts have been securely tightened, check for smooth shaft rotation by rotating the pump shaft again by hand.

If the proper clearance cannot be achieved, or if other damage requires it, the impeller and cutter bar may need to be replaced. If this becomes necessary, refer to the overhaul manual for the proper procedures for this operation.

2. Check oil in Vaughan cartridge seal.
The only maintenance required of the Vaughan Cartridge Seal is a routine check of the oil condition. There are two 1/8" pipe plugs located on the outboard end of the seal. The upper plug is for filling and the lower plug is for draining. If you find oil that is contaminated or dirty, it can be easily changed. Simply drain the oil and refill. Use 2 oz. of oil (i.e. ISO 46 Turbine oil) for 3-6" pumps to refill, 6 oz. for 8"-12" pumps.

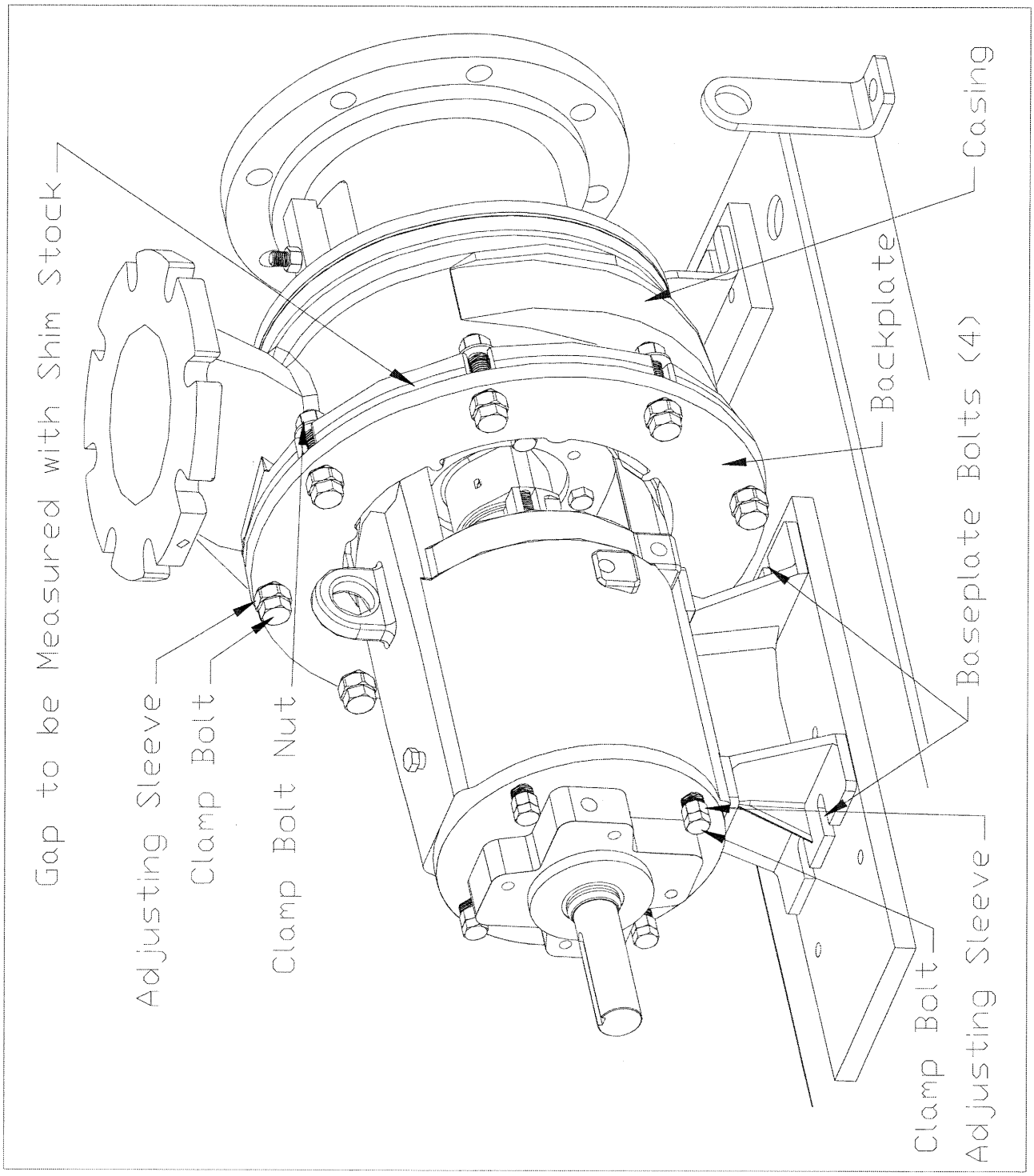
DANGER
Pressure may buildup in the standard mechanical seals used in Vaughan Horizontal or Pedestal pumps. Whenever checking or maintaining the oil in the Vaughan Cartridge Seal, or the Eagle welded metal bellows seal with seal oil chamber, make sure the pump and seal are cool to the touch and use care when removing the oil chamber plugs, in case any residual pressure exists. If pressure exists, plug could become a projectile and/or contaminated oil could spray.

B. CORRECTIVE MAINTENANCE

The Overhaul Instructions for Vaughan Chopper Pumps are listed in a separate manual. Please do not try to overhaul or repair the pump without the overhaul manual and exploded parts assembly breakdown. The overhaul manual was sent with your pump from the factory, but if you do not have a copy of this manual, please call Vaughan Co. Engineering and we will make sure you get proper instructions by overnight delivery, email, or by FAX. A repair video is also available at nominal cost. Vaughan Company's contact numbers are on the front cover of this manual.

HE PUMPS ADJUSTMENT

IMAGE AT S:\ENGR\MANUALS\IMAGES\CBH ADJUSTERS



SECTION 10: TROUBLESHOOTING

The Vaughan Horizontal End-Suction Chopper pump is more susceptible to system problems than Vaughan Wet-Well or Submersible pumps because piping is attached to the pump suction. Piping problems can cause "starving" of the pump before material has a chance to get into the pump. While Vaughan's End-Suction design has obvious advantages over other types of horizontal pumps, problems still can occur.

Following is a troubleshooting chart that will help you get some idea of what problems could be causing your symptoms. If you would like troubleshooting help, please call Vaughan Co. We'll be glad to offer assistance.

POSSIBLE PROBLEMS		SYMPTOMS: Low Discharge Pressure	Loss of Prime	Excessive Power Required	Stuffing Box Leakage	Short Packing or Seal Life	Abnormally High Vibration	Short Bearing Life	Pump Casing Overheating	High Brg. Temp	Low Flow
SUCTION PROBLEMS	Air Pockets in Suction Line		■				■				■
	Pump Not Primed	■	■								■
	Insufficient NPSH	■	■			■	■	■			■
	Suction Line Air Leaks		■				■				■
	Packing Air Leaks		■								■
	Vortexing in Pit at Inlet	■	■			■	■				■
	Intake Openings Plugged	■	■			■	■		■		■
SYSTEM PROBLEMS	Pump Speed Too High		■			■	■	■			
	Pump Speed Too Low	■					■				■
	Pump Rotation Incorrect	■	■	■		■	■				■
	System Head Too High					■	■	■	■		■
	System Head Too Low	■	■	■		■	■	■			
	Specific Gravity Higher than			■							
	Viscosity Higher than Expected	■		■							■
	Operation at Low Capacity					■	■	■	■		
	Improper Parallel Operation of	■				■	■		■		■
	Improper Series Operation of					■					
MECHANICAL PROBLEMS	Pump Discharge Blocked					■	■	■	■	■	■
	Misalignment of Pump/Driver			■	■	■	■	■		■	
	Foundation not Rigid					■	■	■			
	Worn Bearings			■	■	■	■			■	
	Bent Shaft				■	■	■	■			
	Rotating Mbr Contacts Stationary					■	■	■	■		
	Cutter Bar or Impeller Worn	■	■	■			■				■
	Impeller Damaged	■	■	■		■	■				■
	Shaft Running Off Center						■	■	■	■	
	Loss of Fresh Water to Stuffing Box		■		■	■			■		
	Lack of Lubrication			■			■	■		■	
	Improper Repair/Installation of			■		■	■	■		■	
	Dirt in Bearings					■	■	■		■	
	Shaft Sleeve Worn or Scored		■			■					
	Packing Improperly Installed		■			■					
	Improper Packing Material for					■					
	Packing Gland Too Tight			■		■			■		
	Dirt or Grit in Sealing Fluid				■	■					
	Overfill of Bearing Housing							■		■	

VAUGHAN CO., INC. PRODUCT WARRANTY

Vaughan Co., Inc. warrants to the original purchaser/end user all pumps and pump parts manufactured by Vaughan Co. to be free from defects in workmanship or material for a period of one (1) year from date of startup or eighteen (18) months from the date of shipment from Vaughan Co., whichever occurs sooner. If during said warranty period, any pump or pump parts manufactured by Vaughan Co. prove to be defective in workmanship or material under normal use and service, and if such pump or pump parts are returned to Vaughan Co.'s factory at Montesano, WA, or to a Vaughan authorized Service Facility, transportation charges prepaid, and if the pump or pump parts are found to be defective in workmanship or material, they will be replaced or repaired by Vaughan Co. free of charge. Products repaired or replaced from the Vaughan Co. factory or a Vaughan authorized Service Facility under this warranty will be returned freight prepaid. Vaughan Co. shall not be responsible for the cost of labor for pump or part removal and/or re-installation.

All warranty claims must be submitted in writing to Vaughan Co. not later than thirty (30) days after warranty breach occurrence. The original warranty length shall not be extended with respect to pumps or parts repaired or replaced by Vaughan Co. under this Warranty. This Warranty is voided as to pumps or parts repaired/replaced by other than Vaughan Co. or its duly authorized representatives.

Vaughan Co. shall not be liable for consequential damages of any kind and the purchaser by acceptance of delivery assumes all liability for the consequences of the use or misuse of Vaughan Co. products by the purchaser, its employees or others. Vaughan Co. will not be held responsible for travel expenses, rented equipment, outside contractor's fees, or unauthorized repair service or parts.

This warranty shall not apply to any product or part of product which has been subjected to misuse, accident, negligence, operated in the dashed portion of the published pump curves, used in a manner contrary to Vaughan's printed instructions or damaged due to a defective power supply, improper electrical protection or faulty installation, maintenance, or repair. Wear caused by pumping abrasive or corrosive fluids or by cavitation is not covered under this warranty.

Equipment and accessories purchased by Vaughan Co. from outside sources which are incorporated into any Vaughan pump or any pump part are warranted only to the extent of and by the original manufacturer's warranty or guarantee, if any, which warranty, if appropriate, will be assigned by Vaughan Co. to the purchaser/end user.

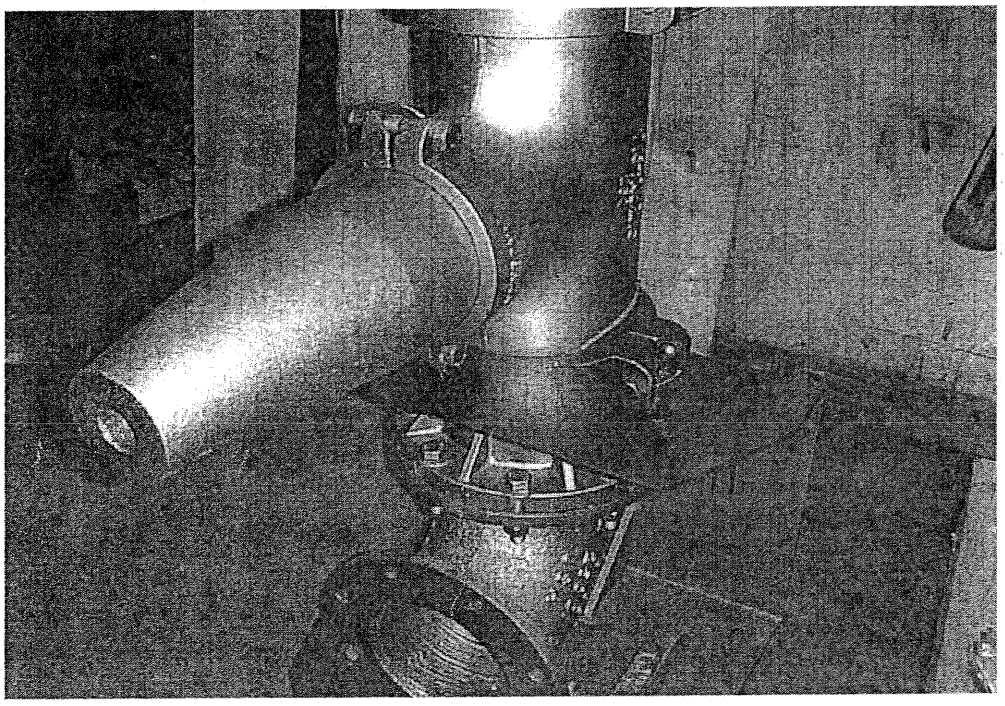
THIS IS VAUGHAN CO.'S SOLE WARRANTY AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, WHICH ARE HEREBY EXCLUDED INCLUDING IN PARTICULAR ALL WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Vaughan Co. neither assumes, nor authorizes any person or company to assume for it, any other obligation in connection with the sale of its equipment with the exception of a valid Vaughan "Performance Guarantee" or "Extended Warranty," if applicable. Any other enlargement or modification of this warranty by a representative or other selling agent shall not be legally binding on Vaughan Co.

ROTAMIX NOZZLE AIMING

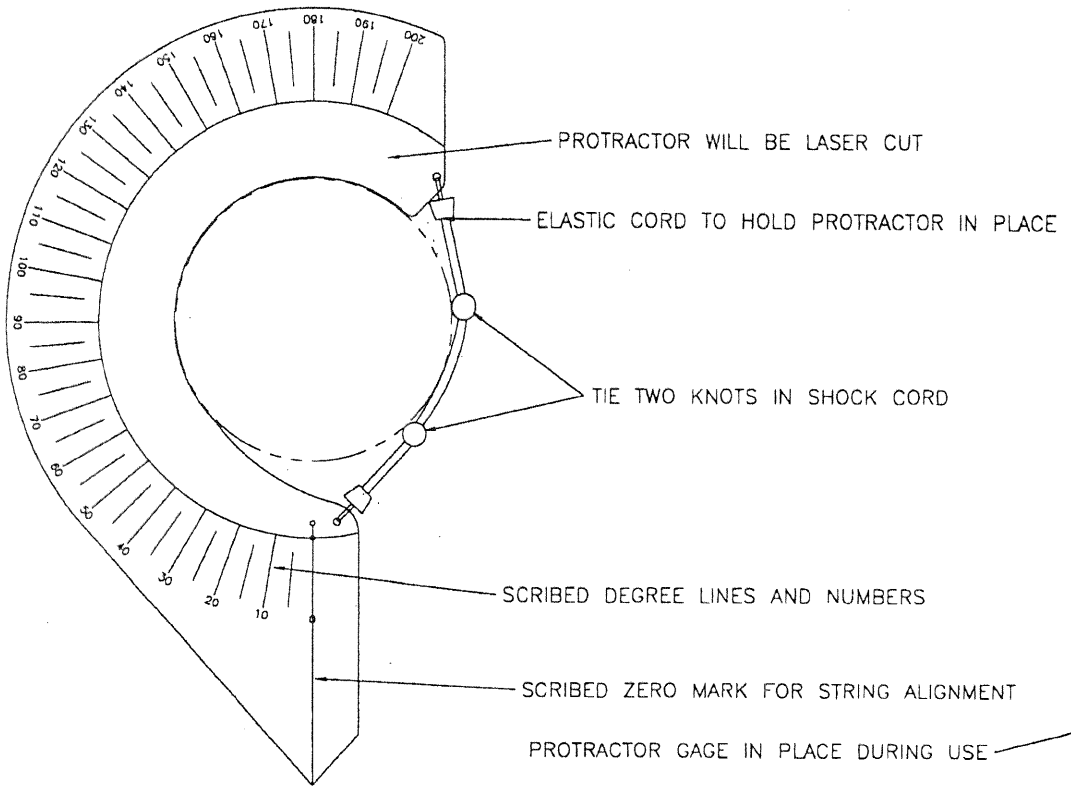
WITH VAUGHAN SUPPLIED PROTRACTOR

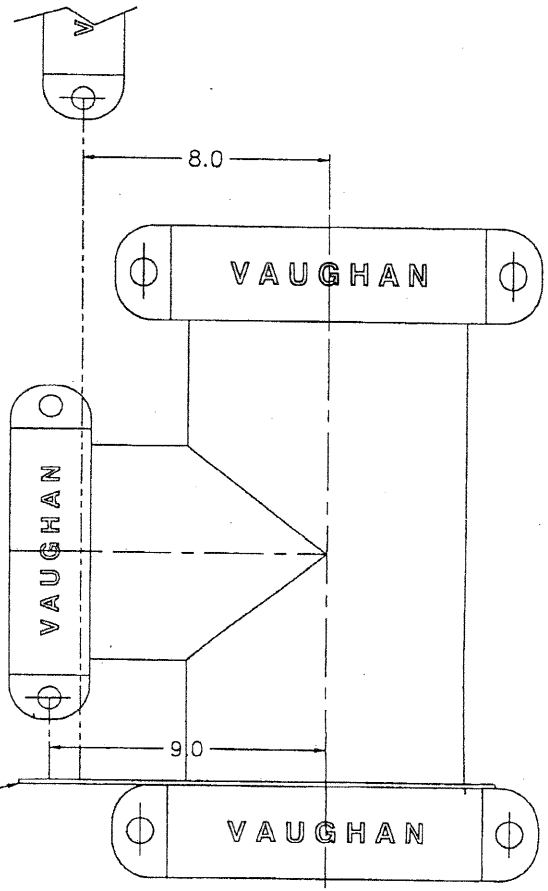
TO BE DONE BEFORE FILLING THE TANK



To perform this procedure, you will need Vaughan nozzle aiming kit, part # V108-205.
This kit includes the aiming protractor, mounting bungee, and plumb bob.
You will also need (2) 1 1/8" wrenches and a ladder tall enough to reach the top nozzle.

VAUGHAN COMPANY INC
364 MONTE-ELMA RD
MONTESANO WA 98563
360-249-4042
360-249-6155 FAX





KIT V108-205 INCLUDES:

1. PROTRACTOR.
2. PLUMB BOB, MMC# 2161A11
3. SHOCK CORD MMC# 8835T21

Vaughan
VAUGHAN CO., INC.
364 MONTE-ELMA ROAD
MONTESANO, WA 98563
PHONE: (360) 249-4042
FAX: (360) 249-6155

UNLESS OTHERWISE NOTED, TOLERANCES ARE TO BE:
SURFACE FINISH: 125 MICROINCHES
DIMENSIONS, WELDING: X.XX = 1/16"
DIMENSIONS, MACHINING: X.XX = 0.030"
DIMENSIONS, MACHINING: X.XXX = 0.010"
GEOMETRIC TOLERANCE, RUNOUT ON CYLINDERS: 0.010"
GEOMETRIC TOLERANCE, PARALLELISM: 0.005"
BREAK ALL MACHINE EDGES 0.005" R UNLESS NOTED OTHERWISE

CHECKED:	ENGINEER:	DRAWN BY:	SCALE:	PART NUMBER:
DGM	DGM	DGM	1:4	V108-205
JOB ORDER NUMBER:		DATE: 11/26/01	DRAWING NUMBER: 108205	REVISION NUMBER: 0

TITLE:
PROTRACTOR GAGE
ROAMIX AIMING

Date: _____

by Vaughan

STARTUP AND CERTIFICATION CHECKLIST

Project Name / Rep: _____ RQ#: _____
Pump Serial No. _____ Assy Serial No. _____ Customer Tag Number: _____
Startup performed by (Agent & Telephone): _____
Customer Contact / Telephone #: _____

PUMP CHECKLIST

Pump shaft turns freely by hand?	Yes	☐	No	☐
All guards are in place?	Yes	☐	No	☐
All piping attached to pump is being independently supported? (not by the pump)	Yes	☐	No	☐
Is the pump casing vented and filled with liquid?	Yes	☐	No	☐
Has vent line been installed at top of volute?	Yes	☐	No	☐
Pump is turning clockwise as viewed from the motor end?	Yes	☐	No	☐
Are expansion joints installed on pump discharge piping?	Yes	☐	No	☐
If yes, is piping anchored between expansion joint and pump discharge, per H.I. Standards?	Yes	☐	No	☐
Perform general check of contractor supplied piping to verify connections, supports & sizing	Yes	☐	No	☐

ELECTRICAL DATA:

Motor Brand: _____ Model: _____ HP: _____ RPM: _____
Nameplate Voltage: _____ Nameplate Full Load Amperage: _____ Service Factor: _____

SYSTEM DATA:

Tank Geometry: _____ Type of process being mixed: _____ % Solids: _____
Tank Type: New ____ Retrofit: ____ If Retrofit, previous system? _____
Sloped Floor: Yes ☐ No ☐ If sloped, slope = _____ degrees.
Required Flow / Head: _____ GPM @ _____ FT TDH Measured Differential Head _____ FT TDH
Required Flow / Head: _____ M3/Hr @ _____ M TDH Measured Differential Head _____ M TDH

STARTUP MEASUREMENTS & OBSERVATIONS:

Measured Differential Head: _____
Operating Voltage: L1-L2: _____ L2-L3: _____ L1-L3: _____
Operating Amperage: L1: _____ L2: _____ L3: _____
Pump Operation: Quiet: ☐ Noisy: ☐ Measured @: _____
Vibration: Acceptable: ☐ Excessive: ☐ Measured @: _____

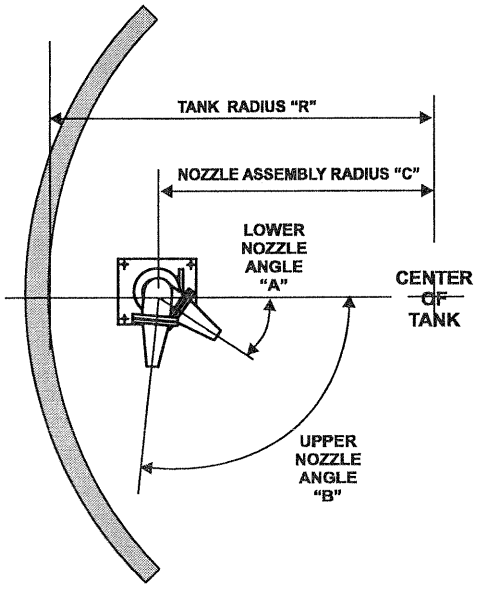
Comments:

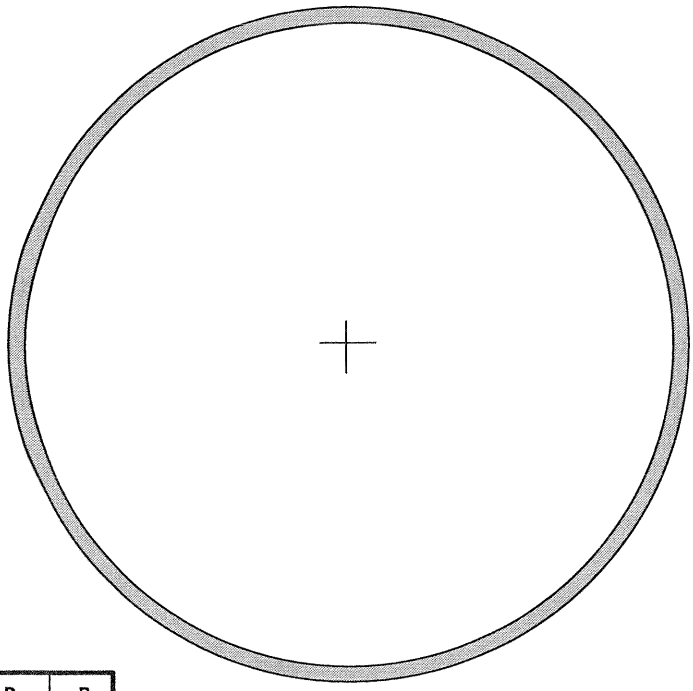
_____

_____

NOZZLE ASSEMBLY DATA

Is Contractor's piping properly installed and bolted to assembly?	Yes	☐	No	☐
All coupling have been checked and tightened after field nozzle adjustment.	Yes	☐	No	☐
Anchor Bolts Installed?	Yes	☐	No	☐
Grouting complete and Assembly Base set level?	Yes	☐	No	☐
Pictures enclosed with this report.	Yes	☐	No	☐



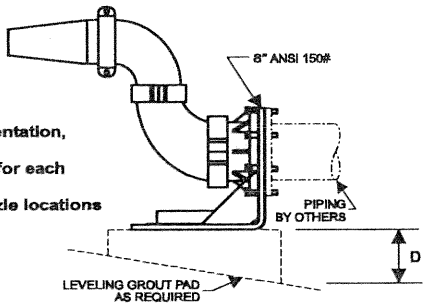


SHOW PIPING LAYOUT AND NOZZLE ASSEMBLY LOCATIONS

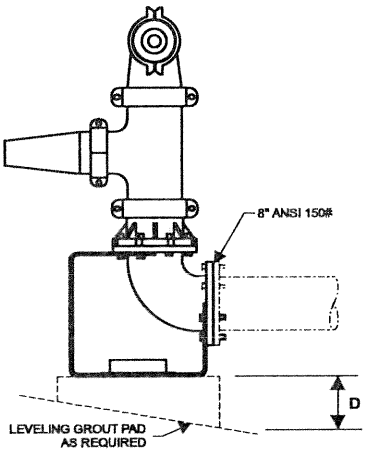
NOZZLE	SINGLE NOZZLE	DOUBLE NOZZLE	A	B	C	D	R
1							
2							
3							
4							
5							
6							
7							
8							

DIRECTIONS:

1. **Measure each nozzle for orientation, elevation and location.**
2. **Fill out chart for items A - R for each nozzle 1 - 8.**
3. **Show piping layout and nozzle locations on top right diagram.**



SINGLE NOZZLE ASSEMBLY



DOUBLE NOZZLE ASSEMBLY

5/2005

ROTAMIX AIMING INSTRUCTIONS

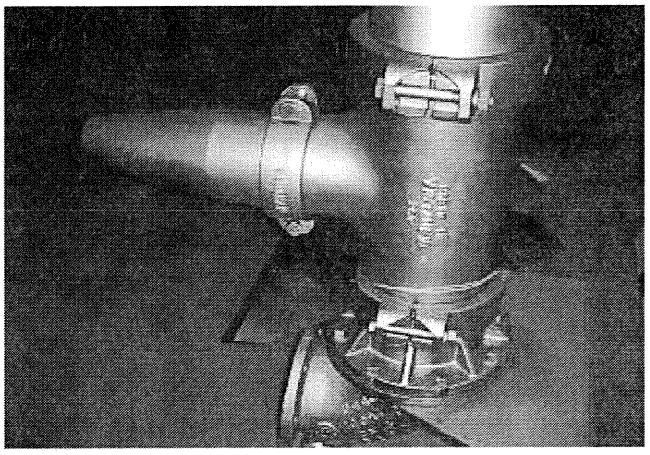
STEP 1

Check nozzle assembly location against the Vaughan supplied layout drawing. Check both the radial and tangential measurements.

To aim the nozzles, loosen the clamp on the vertical pipe just below the lower nozzle and spread it so that it will allow the pipe to rotate without being so loose that it will allow the nozzle assembly to fall.

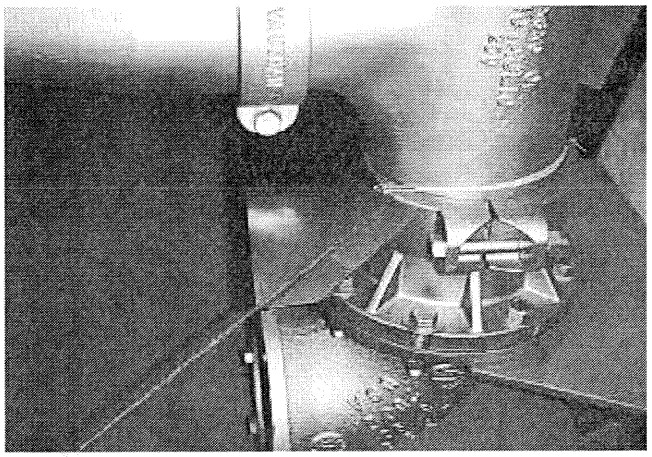
Once the clamp is loose, place the Vaughan supplied protractor on top of it.

There is provision for an elastic tie around the back side of the protractor to hold it in place.



STEP 2

Tie a string to the protractor at the zero point hole, and attach the other end of this string to the center of the tank in some manner. This will align the protractor so that the nozzles can be properly aimed relative to the center of the tank.



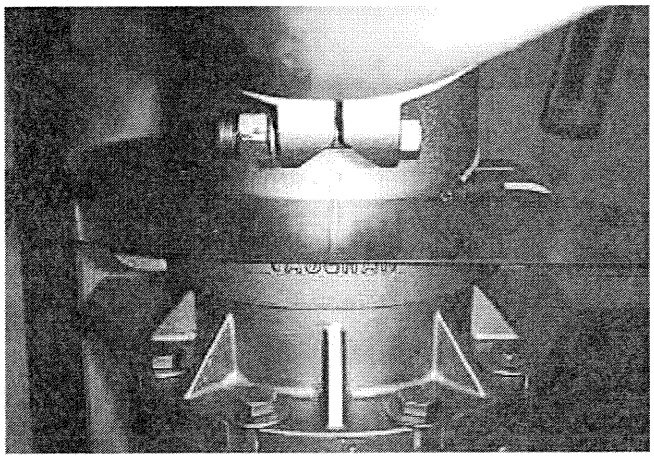
STEP 3

Once the protractor is properly aligned with the tank, you can proceed to aim the nozzles.

Aim the lower nozzle by aligning the center of the lower nozzle clamp with the specified degree mark on the protractor.

See your Nozzle Layout drawing for the proper angles to set your nozzles.

Moving the lower nozzle will tend to move the protractor also. Be sure to recheck the zero point before tightening the lower nozzle clamp.



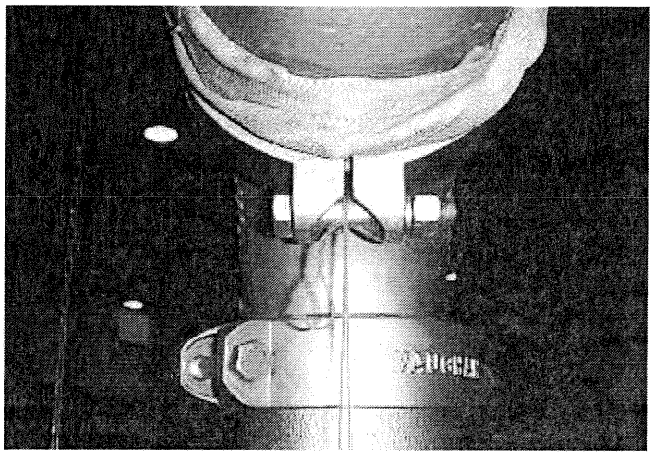
ROTAMIX AIMING INSTRUCTIONS

STEP 4

To aim the upper nozzle, tie the plumb bob string to the bolt on the nozzle clamp as shown. Make sure that it hangs from the the center of the nozzle.

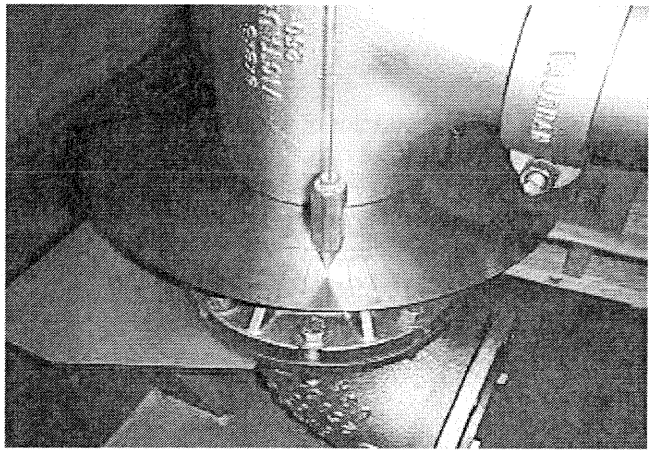
Loosen the clamp on the vertical pipe below the nozzle, and spread it slightly so that the elbow can rotate, but not so much that the nozzle could fall.

The picture shows a sling holding the nozzle for security. If a crane is not available, just make sure that the nozzle can't fall.



STEP 5

The plumb bob will hang directly over the protractor scale. Rotate the upper nozzle until the bob hangs over the degree mark specified for the upper nozzles on your nozzle location plan view drawing.



STEP 6

Tighten all clamps, remove the plumb bob and the protractor, and the job is complete.

VAUGHAN ROTAMIX™ SYSTEM INSTALLATION, OPERATION, AND MAINTENANCE INSTRUCTIONS

Form V372, Rev. 8, January, 2011

DESCRIPTION:

The Vaughan Rotamix™ system is a proprietary (patent 7,025,492) mixing system designed to mix cylindrical, egg-shaped, or rectangular sludge storage tanks or digesters with greater mixing efficiency and lower power requirements than some other systems that have been traditionally used.

The Rotamix™ system consists of one or more Vaughan chopper pumps pumping through a customer-supplied piping system to one or more Vaughan-supplied nozzle assemblies.

The glass-lined ductile iron nozzle assemblies are typically floor-mounted, dual-nozzle systems, but can also be single nozzle systems (generally in rectangular tanks), or roof-mounted nozzle systems (where floor-mounted nozzles cannot be installed). In a cylindrical storage tank and with dual nozzle assemblies, the lower nozzle is aimed more toward the center of of the tank, while the upper nozzle is aimed to create more tangential rotation. *Nozzle aiming must be done per Vaughan instructions once nozzle assembly installation is complete but before the storage tank is closed up*. Please contact your local representative for aiming the nozzles. Nozzles normally cannot be aimed remotely on floor-mounted systems.

A layout drawing of the Rotamix™ system (showing nozzle location and nozzle angles within the tank) is included in your custom Installation, Operation and Maintenance Manual package for your particular project.

RECEIPT INSPECTION:

Description of pump receipt inspection is described in the I,O&M Manual for the Vaughan chopper pump. You should also inspect the nozzle assemblies received for the Rotamix™ system to make sure they have arrived undamaged.

Your best indication of potential shipping damage to equipment is the condition of the crating. If the crating is damaged, look for cracked fittings and clamps or damaged paint.

Report damage to your carrier. Vaughan Co. can also work with you to provide replacement fittings as needed.

STORAGE:

The nozzle assembly epoxy paint are susceptible to damage from prolonged UV exposure. If nozzle assemblies are to be stored for more than two weeks prior to installation they must be either stored indoors or covered. If nozzle assemblies will be exposed to sunlight for more than two weeks after installation they should be covered.

INSTALLATION:

The Vaughan chopper pump is to be installed as described in the pump I,O&M Manual. Note however, that the Rotamix™ system reason for being is to achieve improved efficiency over your previous mixing systems. Therefore the Rotamix™ system piping design should minimize friction losses through the suction and discharge piping. This means using large suction and discharge piping.

For best results choose piping size so that velocity is around 3-5 ft/sec. for suction piping and no more than 8 ft/sec for discharge piping. This is fast enough to avoid particle settling in the piping, but slow enough to minimize friction losses. Vaughan Co. will help you with your system design. Please consult us to be sure your system works as intended.

Use of smaller diameter piping than recommended, results in higher velocities, increased friction loss, and in less effective tank mixing. Also, smaller diameter piping may lead to troublesome gas-binding problems in the mix pump because of decreased pressure at the pump suction that tends to liberate volatile gases from the pumped fluid. Gas binding in the pump can result in complete loss of flow and the necessity to stop the pump and vent all the trapped gas out of the pump casing before restarting the pump.

WARNING!! Follow all confined space entry procedures for entering an enclosed tank. See Vaughan pump I,O&M Manual for other warnings.

Total Rotamix™ flow is determined in consultation with Vaughan Co. Sales Engineering. The total flow is calculated based on your storage tank (or digester) volume and consideration of your tank geometry. Once you know total system flow, you can determine best sizing for suction and discharge piping. Vaughan Co. will help you with piping sizing recommendations.

Nozzle sizing for the nozzle assemblies is also determined at the beginning of the Rotamix™ project in consultation with Vaughan Co. Proper sizing for the nozzles is critically important in making the system work efficiently.

Nozzle aiming is performed once nozzle assembly installation is complete but before the storage or digester tank is closed up. Proper nozzle aiming is critically important and is performed by your Vaughan Co. representative. Please contact him to schedule this very important operation before closing the digester or storage tank.

For roof-mounted nozzles, an arrow will be located on the deckplate which, when mounted in your digester, should point at the center of the tank. This

assures that the nozzles are aiming in the correct direction within your tank to achieve proper mixing.

Finally, location of the nozzle assemblies within the digester is determined in consultation with Vaughan Co. In a cylindrical tank (such as a digester) the floor-mounted nozzles are typically mounted on a circle whose diameter is defined by Vaughan Co. based on the diameter of your storage tank. Also, the nozzle angles are determined by Vaughan Co. The positioning and angles of the nozzles in your digester or storage tank are defined on a Rotamix Nozzle Location Plan drawing specific to your project. This drawing will always be included in the custom Installation, Operation and Maintenance Manual for your particular Rotamix system.

A note on the Vaughan Foambuster: The Vaughan Foambuster is a patented nozzle and splashplate combination that sprays sludge droplets over a large area at the upper surface of a digester to break down and control foam. In some cases, digester mixing systems are purchased with the addition of the Foambuster because of the risk of foaming, particularly in activated sludge plants. The Foambuster nozzle must be mounted above liquid level. Only a few inches of distance is enough to allow the Foambuster to work. Also, the Foambuster needs about 4 ft. of headroom above the height of the nozzle to allow the spray to cover as much of the tank surface as possible. The Foambuster works best with a fixed cover. Finally, the Foambuster is designed to be aimed radially inward toward the center if the Foambuster if located near the outer walls, or aimed radially outward toward the outer walls if the Foambuster is located at the tank center. When the Foambuster is used with the Rotamix system, Rotamix rotates the liquid in the tank below the Foambuster. In this way, one Foambuster can cover all the surface area of the tank as it rotates below the Foambuster.

Vaughan Co. recommends that the Foambuster operates whenever the Rotamix system operates. By taking this approach, if foaming should occur, the Foambuster will always be operating to keep the level of foam broken down and under control. If foaming is allowed to take place when the Foambuster is not operating, foam may adhere to the tank walls, preventing the surface from rotating. If the upper surface does not rotate, the Foambuster will not be effective at controlling foam over the entire upper surface.

A note on system venting:

WARNING!! Explosions can kill or injure! Mixing may liberate gases of decomposition which are highly flammable or explosive. Do not use an open flame or non-explosion-proof equipment in areas where gas is present. Follow all plant safety procedures for hazardous areas.

Sludge pumping systems are likely to generate gases of decomposition and these gases are likely to collect in either the suction piping or in the chopper pump casing. Should this occur, the pump would not work properly when started, since the impeller, when rotating, will collect gas and not be able to fill with the sludge to be

pumped. So gas buildup in the system may keep your pump and Rotamix system from working properly. This can be particularly troublesome if your system is to be operating intermittently. Gas binding is also much more common if your pump has other than a top discharge on the pump casing. That is, side-discharge orientations of the pump casing flange tend to trap more gas in the pump casing. Gas binding problems can keep your mixing system from working properly so this issue must be addressed.

To avoid gas binding problems, you should consider designing in an automatic venting system. Failure to properly vent the pump before each startup can result in a mixing system that doesn't work. *Note that you cannot vent the pump of gas or air when the pump is running.* (The pump casing can be vented through the 1/2"-NPT pressure tap on the casing flange if the pump has a top discharge, or through the ½"-NPT vent on the side of the casing if the pump uses a side discharge configuration.)

There are several ways to successfully vent the pump:

1. You can install an automatic venting system to the pump casing vent in a couple of ways:
   A. You can use a suitable automatic air release valve (ARV) of 2" size available from various manufacturers. (Vaughan Co. has available an air release valve from Val-Matic.) Run the discharge piping to either a drain or back to the digester or tank to be mixed. An automatic air release valve will continually and automatically vent gas or air from the pump casing any time the valve senses that the presence of gas or air at the valve. We feel the ARV is the best approach.
   B. You can use a solenoid-controlled valve (2" is best) controlled by a timer in your control panel, which would open this valve prior to each startup of the pump. Based on experimentation, you can determine how long it takes to vent the gas from the system to completely fill the pump casing before the pump starts. You can then set the timer to this setting. Again, run the piping either to a drain back to the tank you are mixing.

Note also that pumps and piping located outdoors and exposed to the sun are more likely to cause more gas generation in an idle pump and system. Shading the system from the sun using plywood or fiberglass panels can be very helpful to minimizing gas problems.

Roof-Mounted Nozzles:

Roof-mounted nozzles are made of gusseted, heavy-wall pipe and are often long, sometimes reaching lengths of 35' long and longer, and they are often heavy. While these units are designed to be strong enough to withstand the weight and reaction forces of the nozzles, ***you will need to evaluate what impact these forces and moments may have on your cover and support systems***. The weight and total imposed moment at the mixing nozzle assembly deckplate will be listed on the outline dimension drawing for the assembly.

The reaction forces that the nozzle assembly will impose on your cover and onto your mounting flange can be calculated by assuming that each nozzle will have a reaction force of about 80 lbs. The total moment (ft-lbs) imposed onto your digester and mounting flange will be the distance from the deckplate (in feet) to each of the nozzles, multiplied times 80 lbs. The calculated moment for each nozzle must be

summed together to determine the entire moment. For example, a roof-mounted, dual-nozzle assembly with the lower nozzle located 20 ft. below the deckplate and an upper nozzle located at 10 ft. below the deckplate will have a total moment of (20' x 80 lbs) + (10' x 80 lbs.) = 2,400 ft-lbs.

STARTUP:

See the pump I,O&M Manual and all warnings for pump startup and operating instructions.

Before starting the Rotamix™ system, check all piping connections to be sure they are tight and are not stressing up the pump or other equipment. Proper piping alignment and support is critically important to good equipment life. Also, as discussed above, venting all air from the system at initial and all startups is critical to allowing the mixing system to work to its normal capacity. Poor gas venting can often result in poor mixing.

OPERATION:

Operation of the Rotamix™ system involves operation of the Vaughan pump(s). The objective in Rotamix™ operation is achieving effective mixing in your storage tank or digester. This may or may not require operation of the Rotamix™ system on a 100% duty cycle. Many times this system may be operated on a timer, on a duty cycle less than 100%. As a general rule, a Rotamix system requires 30-60 minutes to reach steady state mixing, and it may require several days of mixing after that to achieve a homogeneous slurry in the tank. Note however, that if the Rotamix™ system is operated intermittently, there may be more of a challenge in properly venting the pump of gas prior to each pump startup, and so an automatic venting system should be considered during design. This gas venting issue is discussed above in the Installation section.

Digester mixing:

Experience has shown that the majority of gas generation in a digester occurs while new sludge is being added, and so the Rotamix system should be run during this time. Therefore, if intermittent mixing is going to be used, the Rotamix system should be started about 30 minutes before adding new sludge and should be shut down about 30 minutes after stopping the addition of new sludge. This mode of operation generally amounts to about a 35% to 50% duty cycle and saves a considerable amount of electricity. Vaughan Co. encourages experimentation so that you get the best possible mixing using the lowest possible energy requirements for your system. Generally, the mixing system should be run for at least 2 hours at a time (3 or 4 hours may be better), then perhaps the pump can be shut off for an equal amount of time, say 3 hours on, 3 hours off. Operation of the mixing for short periods of time, such as 15-30 minutes will not provide any useful mixing. Again, most tanks must be run for 30 minutes just to reach full mixing velocity in the tank; active digester mixing occurs *only* after reaching full mixing velocity.

Sludge tank mixing:

Lime stabilized sludge if left unmixed in a sludge storage tank for more than a couple of weeks must be mixed continuously for at least 7 continuous days to get the sludge mixed again. Occasional mixing of lime stabilized sludge will help to get this material to mix easier later. This type of sludge tends to set up like concrete and be unmixable.

For other types of sludges, it is wise to run the mixing system at regular intervals to homogenize the sludge. If sludge has been allowed to sit for any significant period of time, the mixing system will very likely require at least two days (and often more) of continuous operation to thoroughly mix and homogenize the sludge.

Blend tank mixing:

Blend tanks may be mixing polymer thickened sludges (like TWAS) with primary sludges, scum and grease. Because the viscosity of TWAS can be 30 times thicker than primary sludges, mixing systems must often be oversized to provide adequate mixing flow and power, particularly with a maximum level blend tank. Even with oversized mixing systems, in some cases with very viscous TWAS at full level, upper surface mixing will not be evident until tank levels are lowered, perhaps to half full. Nevertheless, mixing is still occurring under the surface in the lower portions of the tank. Anytime thickened sludge can be added low in the tank, at the level of the nozzles, mixing will be more effective. Dumping thickened sludge on the top of the tank where the lowest mixing velocities occurs should be avoided whenever possible since TWAS tends to float and build up a scum layer.

SHUTDOWN:

Shutdown of the Rotamix^{TM} system involves stopping the pump(s). Again, see the pump I,O&M Manual.

Note also that if you are mixing a sludge storage tank that heavy, lime-stabilized sludge should not be permitted to sit stagnant in the system piping. The piping should be flushed with light sludge or water before securing the system. Especially with an open-top storage tank where the sun can heat the piping, the sludge can dry out and ultimately cause plugging of the mixing nozzle(s).

ROUTINE MAINTENANCE:

Roof-mounted nozzle assemblies should be removed from the tank or digester and inspected every 5 years (or sooner in abrasive or corrosive applications). More frequent inspection would be indicated by a decrease in main pump pressure over time, indicating that wear is taking place at the discharge nozzle(s), permitting more flow to exit the nozzle(s). Failure to inspect the nozzle assembly before severe wear takes place could result in mechanical failure of the assembly and the dropping of nozzle components into your mix tank. This would be evident from a sudden decrease in pump discharge pressure, possibly even by the sudden appearance of high-flow pump cavitation noise at the pump.

No routine maintenance is required for Rotamix™ floor-mounted nozzle assemblies as these units have a standard 10-year warranty, are made of ductile cast iron and are completely glass-lined. If you have occasion to enter your digester or storage tank, you will want to inspect the nozzle assemblies and piping to make sure the equipment is in good working order and that the nozzles are still properly aimed. Whenever you check the nozzle system, inspect the nozzle opening to make sure that the glass coating is still intact. If the glass coating is worn away, replace the nozzle. For polyurethane nozzles, measure the discharge diameter to make sure that it is no more than 15 % larger than it was when new. (For example, a new 2.00" dia. nozzle should not be larger than 2.3". If it is larger than 2.3", replace it.) Nozzle exit diameters are defined in the PARTS section of your custom Installation, Operation and Maintenance Manual for your Rotamix system.

Venting systems may require yearly inspections to make sure they are working properly and staying clear of debris. Vaughan always supplies the flushing option with the air release valves we supply.

CORRECTIVE MAINTENANCE:

Replacement of any Rotamix™ nozzle assembly components is self-explanatory. Fittings are attached to each other on the assembly by clamps. Contact Vaughan Co. for pricing on replacement components. The parts list for the nozzle assembly is included in your Rotamix™ system I,O&M Manual Parts Section.

TROUBLESHOOTING:

See the associated Vaughan pump I,O&M manual for the troubleshooting chart. Typical problems that could be encountered in a Rotamix™ system might be:

- A plugged nozzle. This may show up as reduced mixing within your digester or storage tank. Other symptoms of nozzle plugging would be reduced pump electric motor power requirements (lower amps), and higher pump discharge pressure than normal (which should be about 15-17 psi differential pressure across the pump). Because Vaughan chopper pumps are used in this system, nozzle plugging would not be expected until severe wear has taken place in the pump so that effective chopping might be compromised. Pump cutting parts are designed for long life (3-5 years of continuous use), so that such an event should not occur on a new system unless construction debris has gotten into the system piping. Annual inspection of the pump as required in our pump I,O&M manual should help prevent nozzle plugging because of loss of chopping ability.
- A worn nozzle. This would show up as increased mixing within your digester or storage tank. Other symptoms of a worn nozzle would be higher than normal pump electric motor power requirements (higher amps), and lower pump discharge pressure (less than 15-17 psi differential pressure across the pump). You may also hear pump cavitation noise, a crackling sound, similar to pumping gravel. Many people incorrectly interpret cavitation as a pump bearing problem. Nozzles on Vaughan Rotamix™ systems are made of glass-lined ductile cast iron (and sometimes made of abrasion-resistant polyurethane). So nozzle wear should take many years to achieve.

- Pump cavitation from the Rotamix™ system when pumping with your tank at abnormally low levels. Mixing at very lower levels can cause vortexing in your tank, which results in drawing large amounts of air into the pump. Low-liquid-level mixing can also cause the nozzle to discharge above liquid level, a situation that can cause aeration of the fluid in the tank. Either of these situations can cause pump cavitation and vibration, which if allowed to continue, will shorten the life of your pump(s). To stop vortexing, Variable Frequency Drive (VFD) motor control systems can be used. By using a VFD, you can slow the pump (and pump motor) down as tank level decreases and thus reduce pumping power going into the system, thereby avoiding some types of vortexing and cavitation problems. However, Vaughan Co. recommends that the slowest VFD speed used by no slower than 75% of normal pump speed. For example, if 100% speed is at 60 Hz. on your VFD, do not run the VFD at less than 45 Hz. Too slow of a speed reduces pump and system pressure and can result in nozzle plugging.
- Pump cavitation noise could also indicate a mechanical failure in a roof-mounted nozzle assembly. Such a failure could take place after relatively long periods of operational time if the unit is not regularly inspected for wear and if components are not replaced over time. The cavitation noise is caused by high-flow cavitation in the pump because the nozzle flow-restriction against the pump may no longer be present, especially if the nozzle or other parts of the assembly have fallen down into your mix tank.
- Poor mixing performance from the Rotamix™ system may be caused by air or gas binding in the pump(s) or by plugged nozzle(s). Proper venting and filling of the pump casing at each startup is required for the pump to work to its normal capacity. If the pump is partially full of air, it will not generate normal pressure or flow, and therefore the flow through the nozzles will be inadequate. Operating VFD's at speeds slower than 75% of full speed has also resulted in plugged nozzles.

RECOMMENDED PIPING PRACTICES FOR INSTALLING VAUGHAN PUMPS

FORM V435

Rev. 2, March, 2006

Vaughan Company, Inc.

364 Monte-Elma Rd.

Montesano, WA 98563

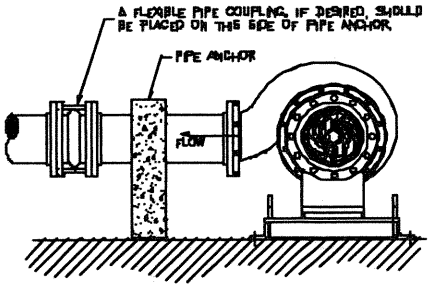
1. Expansion joints not recommended.
2. Hydraulic resonance problems.
3. Piping alignment requirements.
4. Vaughan pump nozzle loading requirements.
5. Recommended piping sizes and velocities for solids and grit pumping.
6. Mixing and recirculation recommendations.
7. Suction piping recommendations:
    a. Suction piping should be equal to or one size larger than pump's suction flange.
    b. Eccentric reducer required for minimal air binding.
    c. Avoiding tees and swirling flow, Y-fittings recommended.
    d. Recommendations for lowest pump noise and vibration.
    e. Recommended submergence for avoiding vortexing, flared suction elbow turned downward for max. submergence.
8. Discharge piping recommendations:
    a. Check valves.
    b. Pump venting methods.
    c. Siphons.
9. Discharge piping recommendations -- Wet-well chopper pumps.
10. Self-priming chopper pumps – piping considerations.
    a. Requirement for bypass piping back to pit.
    b. System check valves may not be needed.
    c. Required suction pipe submergence.
    d. Suction bell recommended on end of suction pipe.

1. Expansion joints -- discharge-side expansion joints not recommended.

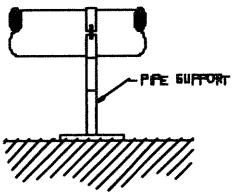
Expansion joints on pump suction and discharge connections are becoming more and more common on pumps as a way to accommodate piping misalignment or piping growth due to temperature. Unfortunately, expansion joints impose two major disadvantages on pumps:

A. They impose a force equal to the pressure in the expansion joint times the cross-section area of the joint. (See PUMP HANDBOOK, McGraw-Hill, p. 12.8. See also "Piping-System Design – A Cause For Concern", from Machine Design Magazine, Sept, 26, 1991, and 2000 Hydraulic Institute Standards, section 1.4.3.5.2.) This force can be very substantial when large pipes are involved, leading to ultra-short pump bearing and seal life. You will also note that because the pump discharge pressures are generally significantly higher than the pump suction pressures that the forces imposed by an expansion joint on the pump discharge are generally going to be significantly higher than those imposed on the suction. Note that expansion joint tie rods generally do not solve the imposed force problem because they are generally not strong enough or stiff enough.

B. They allow the pump and discharge piping to vibrate at the pump vane-pass frequency. The expansion joint acts like a spring between the pump and the piping system, so that the entire system is significantly less stiff, thus tending to vibrate. The driving force for this vibration is the pressure pulses from the operating pump at the vane-pass frequency, which is the pump speed in RPM times the number of impeller blades. Thus, an 1170-RPM pump with a 3-blade impeller will have a vane pass frequency of about 3510 CPM (counts/min.). Vaughan Co. has observed situations where very high amplitude vibrations at this vane pass frequency are evident when measured with a good quality vibration analyzer, and once the discharge-side expansion joint is removed and replaced with a solid spool-piece, the vibration problem is greatly reduced.



BOTH SUCTION AND DISCHARGE PIPES NEAR THE PUMP SHOULD BE SUPPORTED AND RESTRAINED TO AVOID APPLYING FORCES AND MOMENTS TO THE PUMP CASING. IF AN EXPANSION JOINT OR OTHER NON-RIGID COUPLING MUST BE USED, A PIPE ANCHOR SHOULD BE INSTALLED BETWEEN IT AND THE PUMP. IN ADDITION KEEP THE LENGTH AS SHORT AS POSSIBLE.



SHOWN IS A TYPICAL PIPE SUPPORT WHICH CARRIES THE WEIGHT OF THE PIPE AND ITS CONTENTS, BUT DOES NOT AXIALLY RESTRAIN THE PIPE. SUPPORTS OF THIS TYPE ARE NOT CONSIDERED ANCHORS.

The US Hydraulic Institute, section 1.4.3.5.2 of the year 2000 standards, states,

"If it is necessary to use an expansion joint or non-rigid coupling, it is recommended that a pipe anchor be located between it and the pump. Note that an anchor provides axial restraint, whereas a pipe support or guide does not."

Considering the rarity of providing a true anchor capable of absorbing all axial force and vibration from the expansion joint and the associated discharge piping, Vaughan Co. strongly recommends against the use of an expansion joint on the discharge of a Vaughan pump. Note also the discussion below regarding piping system resonance.

2. Hydraulic resonance problems.

The 2000 Hydraulic Institute Standards, section 2.4.10.1 states, "Severe vibration problems are often caused by a resonant condition within the pump/piping system which amplifies normal pump-induced pulsations. Such a condition is referred to as a hydraulic resonance. Hydraulic resonance is defined as a condition of pulse reinforcement in which pulses reflected by the piping system are repeatedly added in phase to the source pulse, producing large pulsation amplitudes. Hydraulic resonance in piping may result in unacceptable noise or vibration, or if uncorrected, it can ultimately result in mechanical fatigue failures in either the piping or pump components.

"...Experience has shown that the following solutions, aimed at alleviating the resonant condition, may prove effective:

1) Alter the resonant piping;
2) Change the pump speed;
3) Change the internal design characteristics of the pump;
4) Insert a pulsation damper on the pump/piping system."

Note that the previous discussion regarding discharge-side expansion joints fits into this discussion of piping resonance. One obvious way to change (i.e., increase) the stiffness of the discharge piping system is to remove the expansion joint, if one was used, and to replace it with a solid spool-piece. Vaughan's experience is that *almost all* piping resonance problems, which we have encountered, have been caused by the discharge-side expansion joint.

3. Piping alignment requirements.

Piping strains or stresses transmitted to the pump by improper piping support systems may cause pump distortion, wear, metal-to-metal contact, or binding. This is particularly true of Vaughan chopper pumps, where running clearances between rotating and stationary cutting parts is typically adjusted to around 0.010" (0.25 mm). Typical Vaughan chopper pumps have 5 cutting systems operating in parallel, all with this close cutting gap, and so are highly

susceptible to deflection problems from imposed piping loads or from a twisted base mounted to a foundation that is not flat.

Aside from the interference or metal-to-metal contact problems that might be encountered in a chopper pump, excessive loads imposed onto the pump by poorly aligned or supported piping can cause severely shortened pump bearing and seal life.

Finally, it is not acceptable to accommodate piping misalignment problems through the use of an expansion joint. (See 2000 Hydraulic Institute Standards, section 3.4.3.11, p.39.) If one is used, an anchor capable of withstanding all axial forces and vibration must be mounted between the expansion joint and the pump discharge flange as is required by the Hydraulic Institute Standards. (See section 1 regarding expansion joints.)

4. Allowable Vaughan pump nozzle loads.

Vaughan Co. adheres to the allowable nozzle loads established in ANSI/HI 9.6.2 from the 2000 Hydraulic Institute Standards. Tables for horizontal, end-suction pumps, vertical in-line pumps, and wet-well type pumps from this document are reproduced on the following pages for reader convenience.

Table 9.6.2.1.1 Allowable individual nozzle loads.
Horizontal end suction pumps in accordance with ASME B73.1M

ASME B73 Designation	Pump Size	Suction						Discharge					
		Forces (lb)			Moments (ft-lb)			Forces (lb)			Moments (ft-lb)		
		F_{xs} max	F_{ys} max	F_{zs} max	M_{xs} max	M_{ys} max	M_{zs} max	F_{xd} max	F_{yd} max	F_{zd} max	M_{xd} max	M_{yd} max	M_{zd} max
AA	1.5 × 1 × 6	1050	750	750	720	170	170	800	1350	3000	410	410	410
AB	3 × 1.5 × 6	1050	1240	1250	900	490	490	800	1350	3000	500	550	510
A10	3 × 2 × 6	1050	1050	1050	900	220	220	800	1350	3000	500	1000	510
AA	1.5 × 1 × 8	1050	1210	1210	720	190	190	800	1350	3000	360	360	360
---	3 × 1.5 × 8[a]	1050	1240	1250	900	490	490	800	1350	3000	440	440	440
A50	3 × 1.5 × 8	2700	1350	1500	1300	370	370	1400	1350	3250	460	460	460
A60	3 × 2 × 8	2700	1350	1500	1300	600	600	1400	1350	3250	660	660	660
A70	4 × 3 × 8	2700	1350	1500	1300	350	350	1400	1350	3250	1200	1460	690
A05	2 × 1 × 10	2340	960	960	1270	220	220	1400	1350	3250	660	660	660
A50	3 × 1.5 × 10	2700	1350	1500	1300	420	420	1400	1350	3250	370	370	370
A60	3 × 2 × 10	2700	1350	1480	1300	310	310	1400	1350	3250	560	560	560
A70	4 × 3 × 10	2300	1350	1500	1300	310	310	1400	1350	3250	1200	1460	690
A80	6 × 4 × 10	2700	1350	1500	1300	1100	1100	1400	1350	3250	1200	1500	690
A20	3 × 1.5 × 13	2700	1350	1500	1300	670	670	1400	1350	3250	530	530	530
A30	3 × 2 × 13	1920	1230	1230	1300	350	350	1400	1350	3250	1200	1270	690
A40	4 × 3 × 13	2700	1350	1500	1300	400	400	1400	1350	3250	1200	1500	690
A80	6 × 4 × 13	2700	1350	1500	1300	1300	1100	1400	1350	3250	1200	1500	690
A90	8 × 6 × 13	3500	3180	2000	1500	1170	1170	1500	3000	3500	1250	2840	2840
A100	10 × 8 × 13	3500	3180	2000	1500	2000	2150	1500	3000	3500	1250	2840	2840
A110	8 × 6 × 15	3500	3180	2000	1500	1480	1480	1500	3000	3500	1250	2840	2840
A120	10 × 8 × 15	3500	3180	2000	1500	1130	1130	1500	3000	3500	1250	2840	2840

NOTES: Please note that certain sizes do not follow a trend of increased allowable nozzle loads with increased pump size. This is due to interaction of individual pump geometry (i.e., nozzle wall thickness, distance from flange face to nozzle connection with casing, etc.).

[a] This is not an ASME size. It is included here as a special Group 1 size that is common among manufacturers.

The allowable individual nozzle loads for Table 9.6.2.1.1 are based on the following formula:

$$\left|\frac{F_{xs}}{F_{xs\,max}}\right| \le 1.0,\ \left|\frac{F_{ys}}{F_{ys\,max}}\right| \le 1.0,\ \left|\frac{F_{zs}}{F_{zs\,max}}\right| \le 1.0,\ \left|\frac{M_{xs}}{M_{xs\,max}}\right| \le 1.0,\ \left|\frac{M_{ys}}{M_{ys\,max}}\right| \le 1.0,\ \left|\frac{M_{zs}}{M_{zs\,max}}\right| \le 1.0,$$

$$\left|\frac{F_{xd}}{F_{xd\,max}}\right| \le 1.0,\ \left|\frac{F_{yd}}{F_{yd\,max}}\right| \le 1.0,\ \left|\frac{F_{zd}}{F_{zd\,max}}\right| \le 1.0,\ \left|\frac{M_{xd}}{M_{xd\,max}}\right| \le 1.0,\ \left|\frac{M_{yd}}{M_{yd\,max}}\right| \le 1.0,\ \left|\frac{M_{zd}}{M_{zd\,max}}\right| \le 1.0,$$

Table 9.6.2.2.1 Allowable nozzle loads (both suction and discharge nozzles). Vertical in-line pumps in accordance with ASME B73.2M

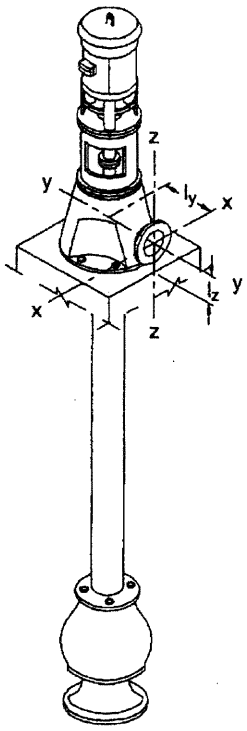
Pump Geometry			Allowable Nozzle Loads (both suction and discharge nozzles)					
			Forces (lb)			Moments (ft-lb)		
Discharge Nozzle Size (inches)	Nominal Impeller Diameter (inches)	SD (inches)	F_x max	F_y max	F_z max	M_x max	M_y max	M_z max
1.5	6	15	410	3976	410	510	720	510
1.5	8	17	360	3976	360	510	720	510
1.5	10	19	320	3976	320	510	720	510
1.5	13	24	255	3976	255	510	720	510
2	6	17	635	6328	635	900	1270	900
2	8 & 10	20	540	6328	540	900	1270	900
2	13	24	450	6328	450	900	1270	900
3	8	22	725	6328	725	1330	1880	1330
3	10	25	638	6328	638	1330	1880	1330
3	13	28	570	6328	570	1330	1880	1330
4	10	28	700	18704	700	1630	2300	1630
4	13	30	650	18704	650	1630	2300	1630

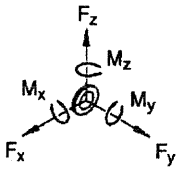
The allowable individual nozzle loads for Table 9.6.2.2.1 are based on the following formula:

$$\left|\frac{F_{xs}}{F_{x\,max}}\right| \le 1.0,\ \left|\frac{F_{ys}}{F_{y\,max}}\right| \le 1.0,\ \left|\frac{F_{zs}}{F_{z\,max}}\right| \le 1.0,\ \left|\frac{M_{xs}}{M_{x\,max}}\right| \le 1.0,\ \left|\frac{M_{ys}}{M_{y\,max}}\right| \le 1.0,\ \left|\frac{M_{zs}}{M_{z\,max}}\right| \le 1.0,$$

$$\left|\frac{F_{xd}}{F_{x\,max}}\right| \le 1.0,\ \left|\frac{F_{yd}}{F_{y\,max}}\right| \le 1.0,\ \left|\frac{F_{zd}}{F_{z\,max}}\right| \le 1.0,\ \left|\frac{M_{xd}}{M_{x\,max}}\right| \le 1.0,\ \left|\frac{M_{yd}}{M_{y\,max}}\right| \le 1.0,\ \left|\frac{M_{zd}}{M_{z\,max}}\right| \le 1.0,$$

Category	Configuration	Flange Position	Application Limits		
			Max. Pressure psi	Max. Temp. °F	Max. Nozzle Size inches
Shaft-driven, suspended pump, for water	Submerged suction	Discharge above base	300	100	36





Nozzle Size	Nozzle Material: Steel					
Dia (in.)	Forces (lb)			Moments (ft.-lb)		
	F_x	F_y	F_z	M_x	M_y	M_z
2	202	182	225	302	409	260
3	323	291	360	474	619	407
4	404	364	450	588	753	506
6	606	546	674	892	1099	770
8	808	728	899	1244	1499	1076
10	1010	910	1124	1667	1994	1445
12	1212	1092	1349	2178	2613	1890
14	1414	1274	1574	2790	3372	2422
16	1616	1456	1798	3507	4272	3043
18	1818	1638	2023	4329	5306	3753
20	2020	1820	2248	5251	6450	4545
22	2222	2002	2473	6260	7669	5406
24	2424	2184	2698	7338	8916	6319
30	3079	2774	3426	10980	12343	9327
36	3694	3329	4111	13691	15528	11367

Tables based upon: $\frac{l_y}{D} = \frac{l_z}{D} \leq 1$

Deviation from the tables is acceptable provided the following relationship is maintained: $\frac{f_x}{F_x} + \frac{f_y}{F_y} + \frac{f_z}{F_z} + \frac{m_x}{M_x} + \frac{m_y}{M_y} + \frac{m_z}{M_z} \leq 1$

Figure 9.6.2.5.1 — Nozzle loads for above pump base (floor) discharge pumps

5. Recommended piping sizes and velocities for solids and grit pumping.

Vaughan Co. has learned a few "rules of thumb" over the years that are listed below:

1) Velocities of 3-8 ft/sec (0.9-2.4 M/sec) result in low friction losses. For best results and the most efficient systems, choose pipe sizes so that this velocity range is achieved. This is particularly true for pumping slurries, such as sewage sludge, where friction losses can be very high.
2) To avoid settling of heavy solids or grit in a horizontal pipeline, velocities of at least 3-5 ft/sec (0.9-1.5 M/sec) must be achieved. These velocities produce turbulent flow sufficient only for horizontal flow.
3) To avoid settling of heavy solids or grit in an elbow at the bottom of a vertical pipeline, velocities of at least 8-10 ft/sec (2.4-3.0 M/sec) must be achieved. These velocities produce turbulent flow sufficient to carry heavy solids vertically uphill in a pipeline.

6. Mixing and recirculation recommendations.

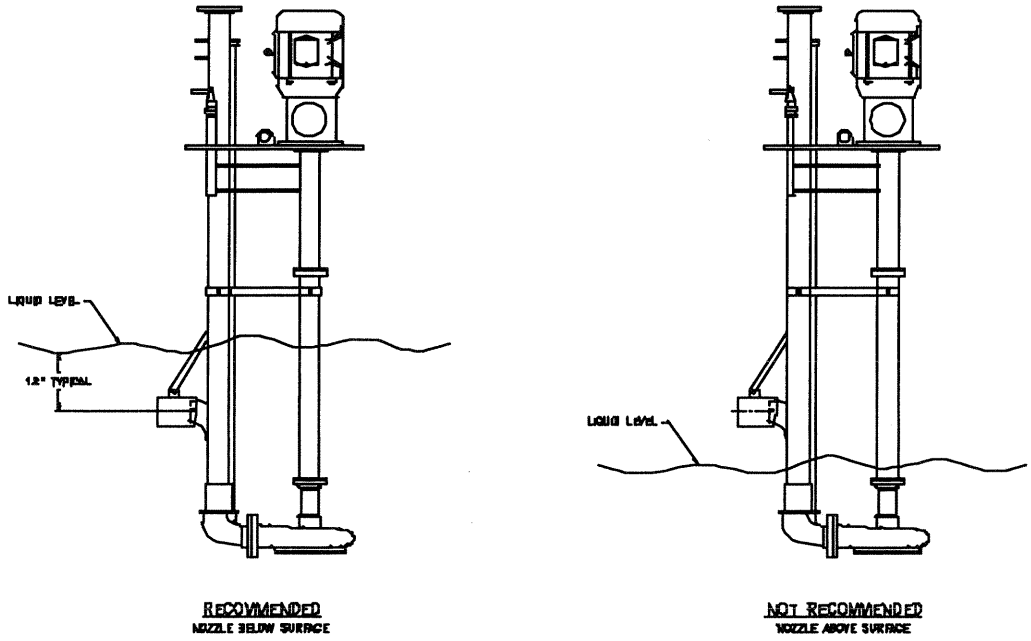
Recirculation piping and the associated nozzle(s) should always be located below liquid level, not above.

Mixing of pits with water and floating debris (for example, bark or plastic debris in scum pits) has proven to be very effective at keeping the system functioning properly as the pit is pumped down. Without mixing the floating debris and homogenizing the pit contents, the floating solids will enter the pump and piping system in a large, concentrated mass just at the end of the pumpdown cycle, as the pump is turned off on low pit level. This creates a problem in getting the pump started at the beginning of the next pumpdown cycle, since debris may be caught inside the pump, between the pump cutting parts, requiring very high motor starting torque.

To effectively mix a pit, it is important for the nozzle to be below liquid level, so that the jetting action from the nozzle is actually pushing against liquid in the pit. There are a couple of reasons why Vaughan specifically recommends against locating a recirculation or mixing nozzle above liquid level:

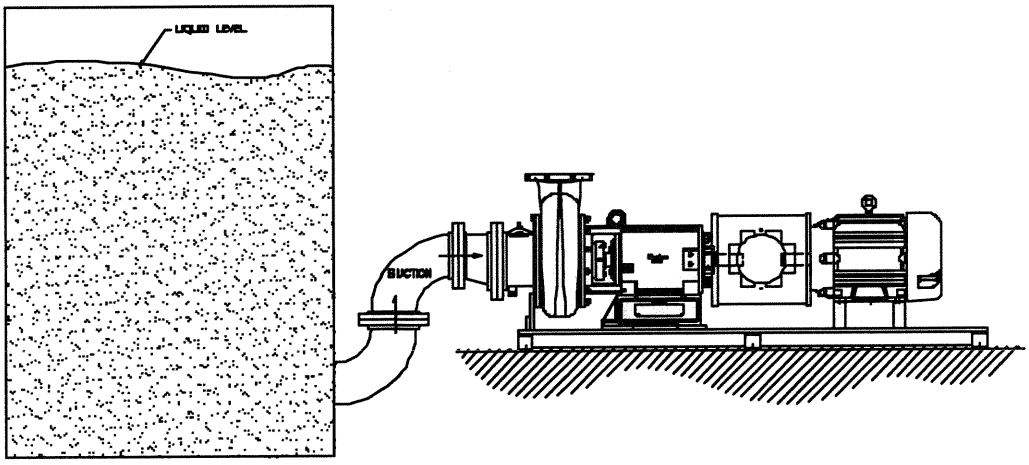
1) Discharging above liquid level aerates fluid in the pit. All centrifugal pumps cavitate when pumping highly aerated fluid. Cavitation causes vibration that can severely shorten mechanical seal life. This cavitation also can severely pit the impeller and cutter bar (suction) plate, shortening cutter parts life.
2) Movement of the pit is created by the reaction force of the nozzle pushing against the liquid in the pit. The reaction force is equal to velocity across the nozzle discharge multiplied by the flow rate going through the nozzle. This force then imparts a torque to the fluid in the pit, rotating the fluid around the pit centerline, so that

the pit is mixed. If the nozzle discharges out in the air, the force imparted to the fluid in the pit is greatly reduced because the reaction force of the nozzle is pushing against air instead of liquid, thus greatly reducing the effectiveness of the mixing system.

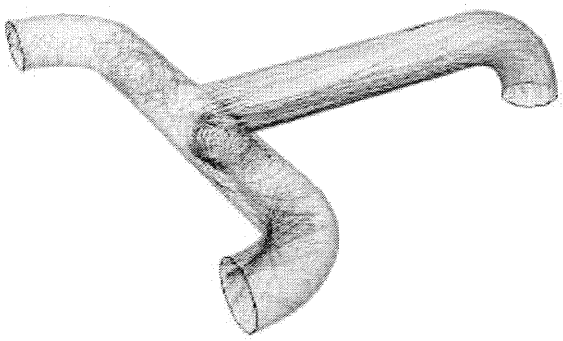


7. Suction piping recommendations.

1) As a general rule, suction piping should be equal to or one size larger pipe size than that used at the suction entrance to the pump. For example, if a Vaughan 8" horizontal pump has a 10" suction flange, then we recommend that at least 10" piping be used, and in many cases, 12" piping will be needed to achieve our recommended 3-5 ft/sec (0.9-1.5 M/sec) of velocity in the piping.
2) To reduce piping down to match the pump suction flange size, an eccentric reducer is recommended. The eccentric reducer should be oriented so that the flat side of the reducer is on the top side of the piping so that air or gas is not trapped in this fitting. Do not make suction changes greater than 4" in pipe size with only one reducer. This rapid change in size will cause non-uniform flow to enter the pump and cause rapid wear and vibration.



3) Avoid the use of tees near the pump on the suction side piping. Tees induce swirling flow in the piping downstream of the tee, causing re-weaving of hair and fiber into rags, which can then plug pumps. Plugging on re-woven rags is less of a problem with chopper pumps, but the swirling flow also hurts pump performance. Y-type fittings provide considerably better flow. Below is an image of a Computational



Fluid Dynamics (CFD) computer simulation study, showing swirling flow in both legs of a tee.

4) For lowest noise and vibration in the pump and longest parts life, the following rules should be followed in suction piping:
   a. Provide uniform, straight-line flow to the pump and make sure all leaks are sealed. Air leaks for self-priming pumps will make them very noisy and may keep them from priming.
   b. Keep suction piping as short and as straight as possible using large piping to minimize friction losses and to maximize suction pressure available to the pump.
   c. Air pockets just prior to the entrance to the pump must be avoided. Suction piping should be designed with no high points that can trap air or gas. When this is not possible adequate vent

lines must be installed to allow manual or automatic removal of air or gas.

d. 8 pipe diameters of straight piping before the pump are recommended after a short radius bend. 3 pipe diameters are recommended after a long radius elbow. Placing an elbow immediately in front of a pump should be avoided, if possible.
e. If larger piping is used compared to the pump's suction connection size, then the suction valves should be of the larger size.
f. A suction-side valve must *never* be used to control system flow. Suction isolation valves must be fully open during pump operation. If a valve must be throttled to control system flow, it should always be accomplished with a discharge-side valve.
g. All gate valves in the suction line should be installed with their stems horizontal to avoid air pockets in the valve body.
h. A check valve should never be used on the suction side of a pump.
i. If an expansion joint is used on the pump suction, an anchor should be used between the pump and joint to keep from imposing large forces onto the pump. This anchor must be capable of absorbing all of the axial forces and vibrations. A piping support is not adequate.
j. Butterfly valves must never be used when pumping liquids containing solids, as the solids can collect on the butterfly disk and block flow to the pump.

5) Greater pipe submergence is required for higher GPM in order to prevent vortex formation and air entrapment in the pumped liquid. The use of a suction bell (inverted reducer) will help to reduce the submergence required and will reduce the entrance losses, providing more available head to the pump. In general, the smaller the diameter of the suction pipe, the greater the recommended submergence is required due to the increased velocity of the flow entering the line. When possible, try to position the inlet to the suction line as close as possible to the bottom of the pit, aiming downward, allowing a distance of approximately 1 ½ x the pipe diameter between the pipe inlet and the bottom. Section 9.8.2.5.4 in ANSI/HI 9.8-1998, *Pump Intake Design*, indicates reasonable minimum values of submergence over the inlet as a function of outlet velocity.

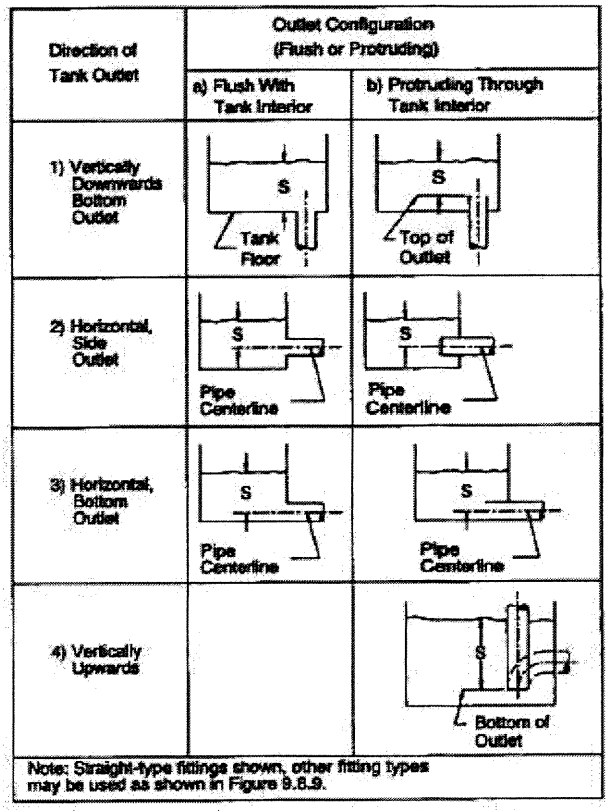


Figure 9.8.8 — Datum for calculation of submergence

9.8.2.5.4 Principles

See Figure 9.8.8, examples 1 through 4. The recommended minimum submergence S of the outlet fitting below the free surface of the liquid within the tank to prevent air core vortices, given tank outlet diameter D, may be obtained from the relationship

$$S/D = 1.0 + 2.3\,F_D$$

Where:

F_D = Froude number = $V/(gD)^{0.5}$

D = outlet fitting diameter

V = outlet fitting velocity

g = acceleration of gravity

8. Discharge piping recommendations for all pump configurations.

1) Butterfly valves must never be used when pumping liquids containing solids, as the solids can collect on the butterfly disk and block flow from the pump.
2) A check valve (or "non-return valve") works best when it is mounted in a horizontal run of piping. When mounted in a vertical run of piping, the valve may get plugged by grit piling up above it, keeping it from opening on pump startup. A check valve is generally required on the discharge side of a pump when:
    a. Parallel pumps are used in the system. The check valve prevents backflow through the idle pump.
    b. Piping is going vertically upwards and discharging above the pump, which is a common arrangement. The check valve prevents backflow through the pump when the pump is shut down on low suction pit level. Backflow through a pump must be prevented, particularly when you are pumping debris, which can plug the pump when it's turning backwards. Also, pumps can be damaged by reverse rotation.

c. A check valve is not recommended for use in a closed loop system, such as a Rotamix mixing system, when there is only one pump in the system. In this situation there can be no backflow through the pump at shutdown and the check valve adds additional headloss and cost for no operational benefits.

3) It is best not to mount a check valve onto the pump casing flange. Providing more piping between the pump and check valve, particularly with a top-discharge pump casing arrangement, can help prevent the collection of gases of decomposition in the pump casing when the pump is idle. Increased volume of piping above the pump allows gas to collect in the piping instead of the pump casing.
4) Sludge pumping systems are likely to generate gases of decomposition and these gases are likely to collect in either the suction piping or in the chopper pump casing. Should this occur, the pump would not work properly when started, since the impeller, when rotating, will collect this gas and not be able to fill with liquid. Gas buildup in the system may keep your pump and system from working properly.

To avoid this problem, you should design in a venting system to allow you to vent at least the pump casing before starting the pump. Note that you cannot vent the pump of gas or air when the pump is running. (The pump casing can be vented through the ¼"-NPT pressure tap on the casing flange if the pump has a top discharge, or through the ½"-NPT vent on the side of the casing if the pump uses a side discharge configuration.)

There are several ways to successfully vent the pump:

- You can install a manual venting system. From the ¼"-NPT or ½"-NPT fitting on the pump casing (use the highest vent point on the casing), immediately increase the piping size to a minimum of 1 ½" (2" is better), install a suitable valve, and then run the piping either to a drain, through the roof to atmosphere, or back to your suction pit or tank. On each pump startup, you will need to manually vent the gas from the pump casing before you start the pump.
- You can install an automatic venting system to the pump casing vent in a couple of ways:
    A. You can use a suitable automatic air release valve of 2" size available from various manufacturers. Run the discharge piping to either a drain or vent through the roof. An automatic air release valve will continually and automatically vent gas or air from the pump casing any time the valve senses the presence of gas or air at the valve.
    B. You can use a solenoid-controlled valve (2" is best) controlled by a timer in your control panel, which would open this valve prior to each startup of the pump. Based on experimentation, you can determine how long it takes to vent the gas from the system to completely fill the pump casing before the pump starts. You can

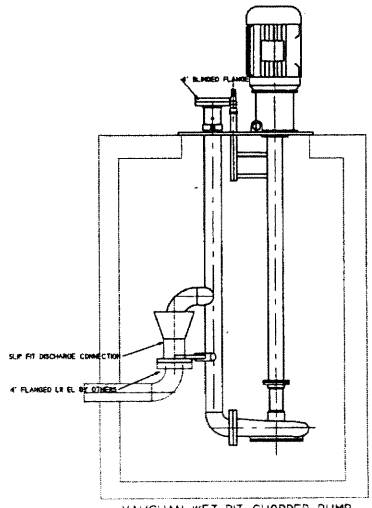
then set the timer to this setting. Again, run the piping either to a drain or vent back to your suction pit or tank.

Note also that pumps and piping located outdoors and exposed to the sun are more likely to cause more gas generation in an idle condition. Shading the system from the sun can be very helpful to minimizing gas problems.

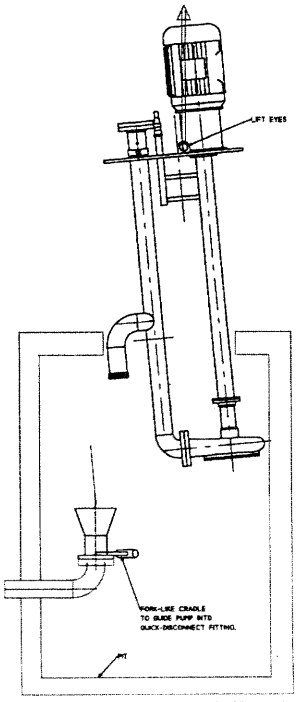
5) Siphon situations can cause plugging problems in solids handling pumps once the pump is shut down. In this situation, fluid will tend to keep flowing through the system even though the pump is no longer turning, and debris may wrap on the impeller vanes. A vacuum and air release valve in the high point of the discharge line will interrupt the siphon when the pump is shut down and prevent this problem.

9. Additional discharge piping recommendations -- Wet-well chopper pumps.

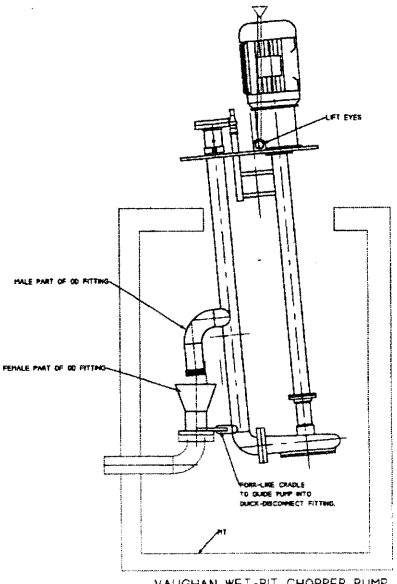
Wet-well type chopper pumps normally are connected to the system discharge piping above the pump deckplate. However, sometimes the customer desires a below-deck discharge connection. Vaughan Co. has devised a quick-disconnect method for below-deck discharge connections on wet-well pumps, as illustrated below. Contact Vaughan Co. Sales Engineering for more detailed information.



VAUGHAN WET-PIT CHOPPER PUMP WITH QUICK-DISCONNECT FITTING SHOWN INSTALLED IN THE PIT



VAUGHAN WET-PIT CHOPPER PUMP WITH QUICK-DISCONNECT FITTING SHOWN BEING LIFTED OUT OF THE PIT.



VAUGHAN WET-PIT CHOPPER PUMP WITH QUICK-DISCONNECT FITTING SHOWN BEING LOWERED INTO THE PIT & QD FITTING.

11. Additional piping considerations – self-priming chopper pumps

1) BYPASS LINES: With all pumps, air may be introduced into the system during normal operation; the volume of air is usually small enough that it does not impact the performance of the pump significantly or present any problems in opening the discharge check valve when the pump is turned on.

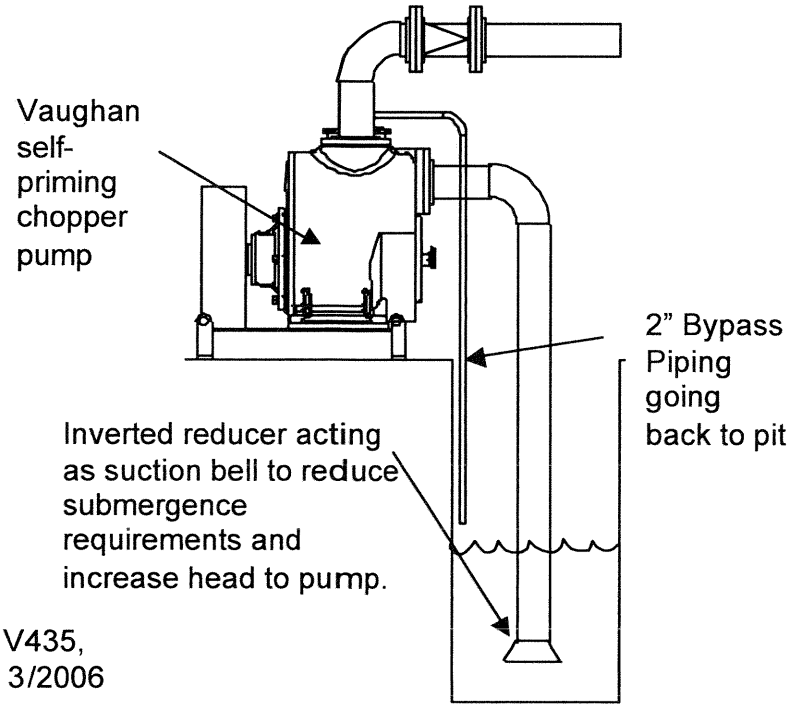
With a self-priming pump, the amount of air present that must be expelled is much greater because of the priming requirements. If there is too much air, there will not be enough pressure buildup on the discharge side of the pump to open the check valve.

Air must be able to escape from the system during priming. If the discharge outlet is not open to atmosphere, another source of venting is required. An air bleed line (or bypass) should be located between the discharge flange and discharge check valve. The system can be operated with no bypass line only if the discharge is vented to atmosphere and no discharge check valve is used.

If there is a check valve installed on the discharge line and/or the discharge is not open to atmosphere, a bypass line *must* be used to allow air to vent to the atmosphere until the pump is primed and all air has been expelled from the system.

The diameter of the bypass must be large enough such that it will not clog, yet not so large that it will significantly reduce the pump's discharge capacity through the rest of the system. A bypass diameter of at least 1 inch should allow for adequate venting and flow of bypass fluids.

2) Since a bypass line will divert some of your pump's output flow back to the suction pit, it may be desirable to install a solenoid-operated valve which can be used to automatically shut off the bypass line after the pump has primed. A timer could be used in



conjunction with the valve to open the valve each time the pump turns on and reprimes, and shuts the valve a set time after priming. In this case, use a 2" line and valve to avoid plugging.

2) System check valves are not needed with Vaughan self-priming chopper pumps, even when parallel pumps are installed, because the pumps have internal check valves built in. In a recirculation system, such as a Vaughan Rotamix system, not using system check valves allows the user to forgo the need for a bypass line because the air or gas in the system can be vented through the discharge nozzles back into the mixing tank.

3) Required suction pipe submergence is of special concern with self-priming chopper pumps. See Vaughan's Installation and Operation Manual for self-priming chopper pumps for detailed recommendations. See also section 7.5 above for more discussion on this.

4) To minimize the problem with suction piping submergence in a pit, Vaughan Co. recommends the use of a suction bell (an inverted reducer) to enlarge the suction opening. This approach also reduces entrance losses to provide more pressure at the suction of the self-priming pump.