



Specifications for: Sussex Regional Reclamation Facility Wastewater Treatment Plant



Prepared for Regulatory Review and Permitting

Overview

The purpose of this specification booklet is to meet the requirements of Section **§6.5.1.6** of 7 Delaware Code Chapter 60: Regulations Governing The Design, Installation And Operation Of On-Site Wastewater Treatment And Disposal Systems. It is being submitted for regulatory review and approval in order to obtain a Construction Permit from DNREC.

Note: Where applicable, sections in the regulations are provided for ease of review using the notation **§6.5**, in reference to the DNREC Regulations Governing the Design, Installation and Operation of On-Site Wastewater Treatment and Disposal Systems, as amended January 11, 2014. These are not intended to provide an exhaustive cross-referencing.

Design Requirements

§6.5.1.6.1.1

The quality of materials and workmanship of all equipment supplied for the SRRF WWTP shall be in accordance with applicable standards and industry best practices. It shall be the responsibility of the equipment supplier to ensure that they exercise proper personnel control, material control, dimensional control, monitoring of fabrication procedures, proper inspections and testing to ensure that all applicable standards and best practices are met. The owner reserves the right to reject any and all pieces of equipment which fail to meet the quality requirements outlined in this specification booklet.

The type, strength, operating characteristics, and ratings of all equipment shall be determined by the equipment manufacturer to meet the performance criteria defined in the Design Engineer Report (DER).

Included Specifications

§6.5.1.6.1.2 - §6.5.1.6.1.10

The equipment described in this specification generally includes the following:

- Influent Screen
- Blowers
- Diffusers
- Flow Meters
- Process Mixers
- Process Pumps
- Clarifiers
- Cloth Media Filters
- UV Disinfection
- Influent and Effluent Pumps and appurtenances
- Cast in Place Concrete Structures
- Piping and Appurtenances

Where applicable capacities, performance curves, startup procedures, O&M procedures and installation instructions have been included.

TABLE OF CONTENTS

<u>Description</u>	<u>Pages</u>
001 Influent Screen	01 - 57
002 Blowers	01 - 18
003 Diffusers	01 - 04
004 Flow Meters	01 - 03
005 Process Mixers	01 - 14
006 Process Pumps	01 - 17
007 Clarifiers	01 - 06
008 Filters	01 - 20
009 UV Disinfection	01 - 02
010 Pump Stations	01 - 27
011 Site Clearing	01 - 04
012 Dewatering	01 - 02
013 Cast-In-Place Concrete	01 - 12
014 Basic Mechanical Materials & Methods	01 - 05

Section 001:

Influent Screen



PARKSON CORPORATION

INSTALLATION OPERATION AND MAINTENANCE MANUAL

FOR

TWO (2) MODEL CBI 1200SR COMBI UNITS

YOUR LOCAL PRODUCT REPRESENTATIVE:

**KERSHNER ENVIRONMENTAL TECHNOLOGIES, LLC
90 PAINTERS MILL ROAD, SUITE 201
OWINGS MILLS, MD 21117
ATTN: ROB KERSHNER**

EQUIPMENT PROVIDED BY:

**PARKSON CORPORATION
29850 N. SKOKIE HWY (U.S. 41)
LAKE BLUFF, IL 60044-1192 • U.S.A.
(847) 473-3700 FAX: (847) 473-0477
SERVICE: 1-888-PARKSON
PARTS (TOLL FREE): 1-800-249-2140**

August 06, 2003

TABLE OF CONTENTS

		Page No.
SECTION ONE	GENERAL INFORMATION	1-1
	Safety Practices	1-1 thru 1-3
	Delivery and Inspection	1-4
	Storage	1-4 & 1-5
SECTION TWO	TECHNICAL DESCRIPTION	2-1
	Application	2-1
	Operation	2-1 & 2-2
	Unit Description	2-2 thru 2-7
SECTION THREE	INSTALLATION	3-1
	Mechanical Work	3-1 thru 3-3
	Electrical Work	3-4 & 3-5
SECTION FOUR	OPERATING INSTRUCTIONS	4-1
	Start Up Procedures	4-1 to 4-3
	Clean Water Check	4-3 & 4-4
	Process Water Check	4-4
	Operating Modes	4-4 thru 4-6
	Enhancing Performance	4-6 & 4-7
	Shutdown and Cleaning Procedures	4-7 & 4-8
SECTION FIVE	MAINTENANCE	5-1
	Daily	5-1 & 5-2
	Weekly	5-2
	Monthly	5-2 thru 5-4
	Semi-Annually	5-5
	Annually	5-6
	Maintenance Schedule	5-7 & 5-8
	Lubrication Chart	5-9
	Warnings	5-10

PREFACE

THE OPERATING AND MAINTENANCE PROCEDURES OUTLINED IN THIS MANUAL ARE INTENDED AS GUIDELINES TO ASSIST THE OPERATING PERSONNEL IN THE DAY-TO-DAY OPERATION AND MAINTENANCE OF THE PARKSON UNIT OR EQUIPMENT. OPERATING PERSONNEL SHOULD ALWAYS FOLLOW PROPER SAFETY PROCEDURES IN ACCORD WITH BOTH INDUSTRY SAFETY STANDARDS AND THEIR OWN COMPANY SAFETY POLICIES WHEN PROCEEDING WITH OPERATION, MAINTENANCE AND REPAIR OF THE EQUIPMENT. THIS MANUAL IS NEITHER DESIGNED NOR INTENDED AS A SUBSTITUTE FOR SAFE OPERATING PROCEDURES WHICH MUST BE FOLLOWED WHILE IMPLEMENTING THE MAINTENANCE/OPERATION PROCEDURES OUTLINED IN THIS MANUAL. IT IS ASSUMED THAT OPERATION AND MAINTENANCE PERSONNEL ARE QUALIFIED AND EXPERIENCED. THE PRIMARY RESPONSIBILITY FOR SAFETY IN THE OPERATION AND MAINTENANCE OF THE PARKSON UNIT IS WITH THE OWNER-OPERATOR AND THE PERSONNEL CONDUCTING THE MAINTENANCE AND OPERATION.

SECTION ONE

Hycor[®] Combi[®] Unit GENERAL INFORMATION

Safety Practices



A SHARP ROTATING SCREW IS LOCATED DIRECTLY INSIDE INLET(S) AND DISCHARGE CHUTE(S).

MACHINE MAY START AUTOMATICALLY.

TO PREVENT SERIOUS INJURY OR DEATH:

- **CONSULT OPERATOR'S MANUAL BEFORE SERVICING.**
- **KEEP AWAY FROM ALL MOVING PARTS, BLADES AND DISCHARGE CHUTE DURING OPERATION.**
- **DO NOT OPERATE THE MACHINE WITHOUT GUARDS AND COVERS IN PLACE.**
- **FOLLOW LOCK OUT PROCEDURES BEFORE SERVICING: LOCK OUT POWER WITH PADLOCK FOR WHICH ONLY YOU HAVE THE KEY.**

IN ADDITION TO THE ABOVE, IN ORDER TO AVOID UNSAFE OR HAZARDOUS CONDITIONS, THE FOLLOWING MINIMUM PROVISIONS MUST BE STRICTLY OBSERVED:

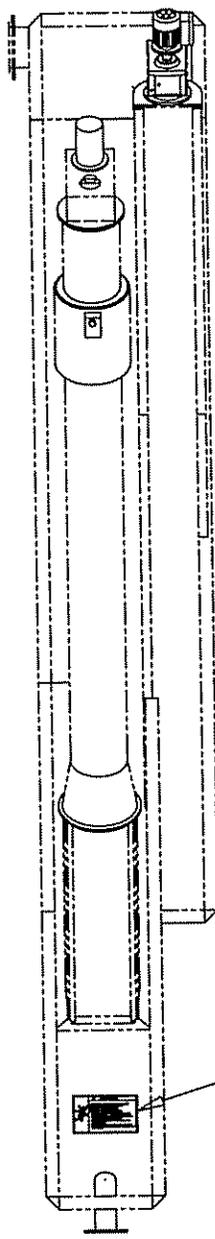
- **THIS EQUIPMENT MUST BE OPERATED AND MAINTAINED ONLY BY AUTHORIZED PERSONNEL WHO HAVE READ AND UNDERSTAND THE OPERATOR'S MANUAL, HAVE BEEN TRAINED IN ITS USE, AND FOLLOWING ANY AND ALL APPLICABLE SAFETY PROCEDURES.**

- **WHEN INSTALLING OR MAINTAINING THE COMBI® UNIT OR ASSOCIATED HARDWARE, BE SURE THAT ANY LIFTING EQUIPMENT IS OF SUFFICIENT CAPACITY BEFORE LIFTING OR MOVING THE COMBI UNIT OR ASSOCIATED HARDWARE.**
- **DO NOT OPERATE A DAMAGED OR MALFUNCTIONING MECHANISM UNTIL NECESSARY ADJUSTMENTS OR REPAIRS HAVE BEEN MADE.**
- **DO NOT OVERLOAD THE COMBI UNIT OR USE IT FOR ANYTHING BUT THE INTENDED USE.**
- **DO PRACTICE GOOD HOUSEKEEPING. ALWAYS INSURE THE COMBI UNIT IS KEPT CLEAN AND THE AREA AROUND THE COMBI UNIT FREE OF POSSIBLE HAZARDS.**
- **ALWAYS OPERATE AND PERFORM MAINTENANCE IN A MANNER THAT PROMOTES SAFE CONDITIONS. ALWAYS USE THE PROPER TOOLS, WEAR THE PROPER CLOTHING, ETC. FOR THE TASK AT HAND.**
- **A MACHINE MAY ONLY BE STARTED WHEN IT HAS BEEN DEFINITELY ESTABLISHED THAT NO PERSONNEL ARE WORKING ON IT.**
- **CHECK THAT THE MACHINE IS SECURELY MOUNTED AND THAT ALL MACHINE COMPONENTS (PARTICULARLY THE COVERS OF DRIVE PARTS) ARE SECURELY FITTED.**
- **KEEP AWAY FROM THE SCREEN INLET OF THE COMBI UNIT. NEVER PLACE ARMS, LIMBS, OR ANY HAND-HELD OBJECT OR TOOL IN DISCHARGE CHUTE OR IN PROXIMITY TO THE SPIRAL UNLESS THE MACHINE IS ELECTRICALLY LOCKED OUT.**
- **KEEP MACHINE COVERS CLOSED TO PREVENT EXPOSURE TO THE ROTATING SPIRAL.**

- **WHEN INSTALLING THIS PRODUCT, ALWAYS MAKE SURE THERE IS A LOCKABLE DISCONNECT WITHIN SIGHT OF THE UNIT.**
- **MAKE SURE ANY ELECTRICAL CONNECTIONS ARE DONE BY QUALIFIED PERSONNEL AND IN ACCORDANCE WITH ALL APPLICABLE CODES AND REQUIREMENTS.**
- **OVERLOAD AND/OR SAFETY SWITCHES ARE EMERGENCY DEVICES. DO NOT USE THE OVERLOAD OR SAFETY SWITCHES TO STOP THE MECHANISM DURING NORMAL OPERATION.**
- **CONTACT WITH MATERIAL PROCESSED OR LUBRICANTS AND OTHER FLUIDS MAY CAUSE INFECTION OR ADVERSE REACTIONS. REPORT ANY CUTS, INJURIES OR EXPOSURE TO SUPERVISOR IMMEDIATELY AND SEEK APPROPRIATE MEDICAL ATTENTION.**
- **PLANT OPERATORS ARE RESPONSIBLE FOR PROPER DISPOSAL OF ALL DISCARDED ITEMS ON THE EQUIPMENT (E.G. OILS, GREASES, WORN AND REPLACED COMPONENTS).**
- **THIS PRODUCT HAS BEEN SUPPLIED WITH WARNING LABELS. SHOULD THEY BECOME DAMAGED, REMOVED OR ILLEGIBLE, PLEASE CONTACT PARKSON CORPORATION FOR NO-COST REPLACEMENT LABELS.**

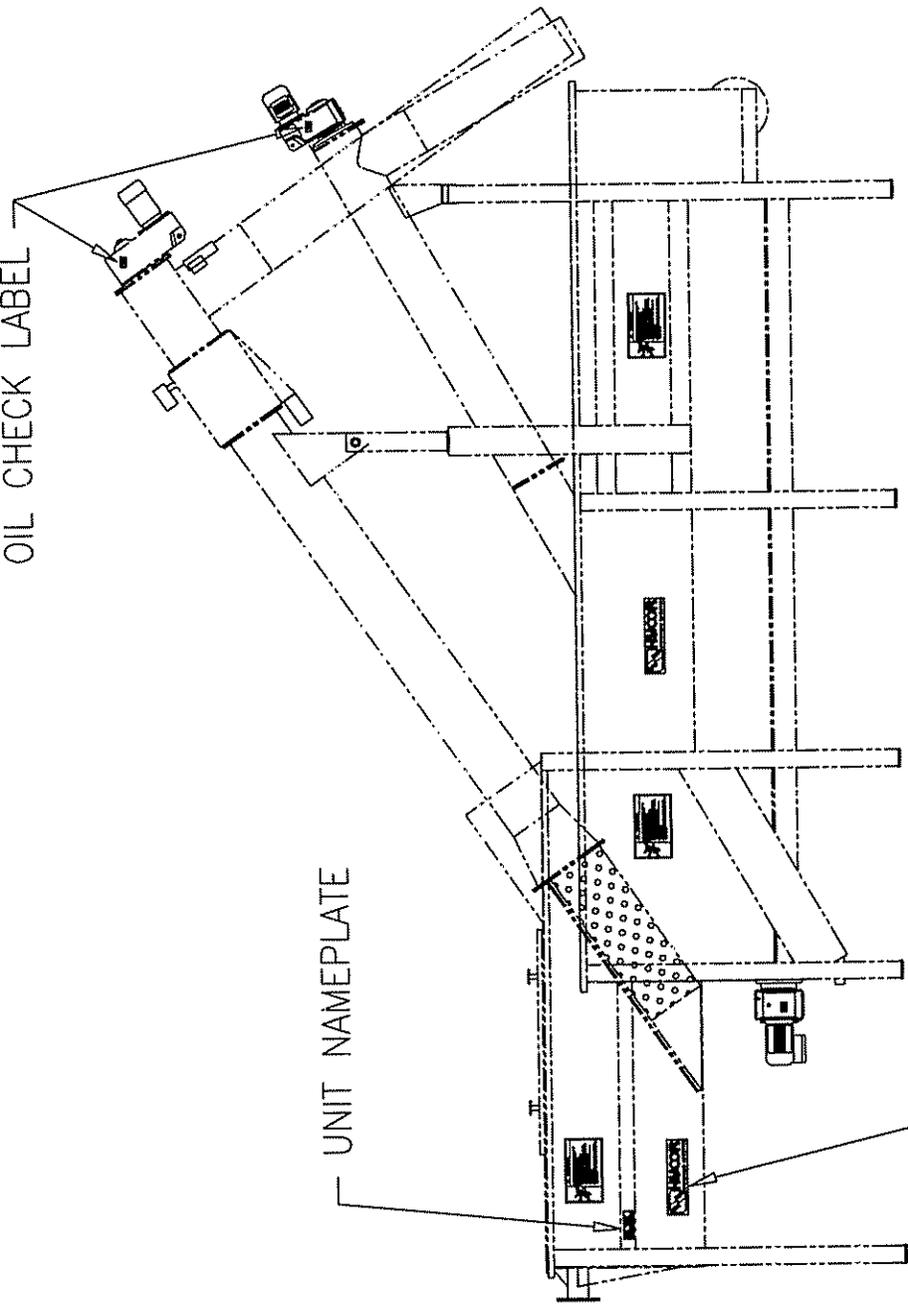
WARNING LABEL PART NUMBERS FOR THIS PRODUCT ARE 3824-003 (DANGER INLET) AND 3824-004 (DANGER DISCHARGE). SEE FIGURE 1-3A FOR PROPER LOCATION.

**CALL TOLL FREE: 1-800-249-2140 OR
FAX: (847) 473-0477
PARKSON CORPORATION
HYCOR® PRODUCTS
ATTENTION: PARTS DEPARTMENT
29850 N. SKOKIE HWY (U.S. 41)
LAKE BLUFF, IL 60044-1192**



DANGER LABEL

OIL CHECK LABEL



UNIT NAMEPLATE

PARKSON LOGO

LABEL LOCATION

1-3A

Delivery and Inspection

The Combi[®] Unit is shipped partially assembled to be assembled and installed by local contractor. Controls are to be installed by local electrical contractor.

After the unit has been unloaded, conduct a visual inspection and count of the shipping containers to determine if any shipping damage or loss of equipment occurred in transit. Be careful not to jar crates and/or to puncture crated materials with lifting forks.

NOTE: You must report, in writing, any damaged or missing parts to the shipping carrier and Parkson Corporation within 48 hours of receipt of the unit. Purchaser shall bear the responsibility for the replacement of equipment, which is determined to be missing after this period.

To assist in identifying correct quantities and parts, reference the attached packing list on the shipping crate. A purchase order shall accompany any order to Parkson Corporation for replacement of parts, which were damaged during shipment. The purchaser shall direct all shipment damage back charges to the carrier.

Storage

For storage under 30 days, the equipment should be covered to be protected from the environment and well ventilated to prevent moisture build-up on surfaces. The unit's electric motor(s) should be operated for 15 minutes once a week, if power is available, or rotated manually at least one full revolution. Upon completion of motor rotation or operation, the unit's spiral should be stopped on a different location to avoid developing flat areas on the spiral. Cover the screen basket area to prevent damage to the brush by UV light. The unit should be isolated from passage of electrical current, shock loads or vibrations during periods of non-operation in order to avoid false brinelling and damage to bearings or other contact surfaces.

For extended storage, a rust prohibiter such as Mobil Vaprotec Concentrate 60032-0, should be added to each gear reducer's lubricating oil. The rust prohibitive will need to be replenished at intervals as specified by the manufacturer. After removal from storage, the gear drives should be drained and filled with a proper lubricant (see Lubrication Chart, page 5-6, for proper oil selections). If the drive motors must be stored for a long period (one month or more) without operating, the motor must be stored in a dry protected area and in the mounting position indicated on the unit nameplate. Store the hardware in the originally supplied shipping crates and protected from moisture, construction dust and corrosive fumes.

CAUTION

STAINLESS STEEL MATERIAL WILL APPEAR TO RUST IF CONTAMINATED WITH WELD SPATTER, CARBON STEEL DUST FROM A GRINDING WHEEL, OR OTHER AIRBORNE OR WATERBORNE CONTAMINANTS. SPECIAL CARE MUST BE TAKEN TO PROTECT THE UNIT AT ALL TIMES.

Some material supplied for this job has had surface preparation and painting. Any bruises, marring and/or scratches caused by loading and unloading the equipment must be immediately touched up in the field prior to any storage.

NOTE: Any equipment painted with prime coats only should get additional coats of paint (to protect the surface under field storage conditions) within 14 days after receipt. Parkson Corporation will not accept any responsibility for rusting due to material, which has not received additional paint in the field.

SECTION TWO

Hycor® Combi® Unit TECHNICAL DESCRIPTION



REVIEW ALL SAFETY PRACTICES LISTED IN SECTION ONE BEFORE PROCEEDING.

Application

The Combi® Unit is designed to screen, convey, and dewater screenings and grit from a typical liquid/solid waste stream.

The dewatered screenings and grit are discharged into receptacles for disposal. The treated liquid effluent is directed downstream for further processing.

The equipment model and size has been selected based upon the specific process requirements of the installation. Do not change the intended use of the equipment or use the equipment in another application without first consulting Parkson Corporation.

Solids that cause frequent clogging of the feed piping or jamming of the screenings spiral must be removed before entering the feed piping.

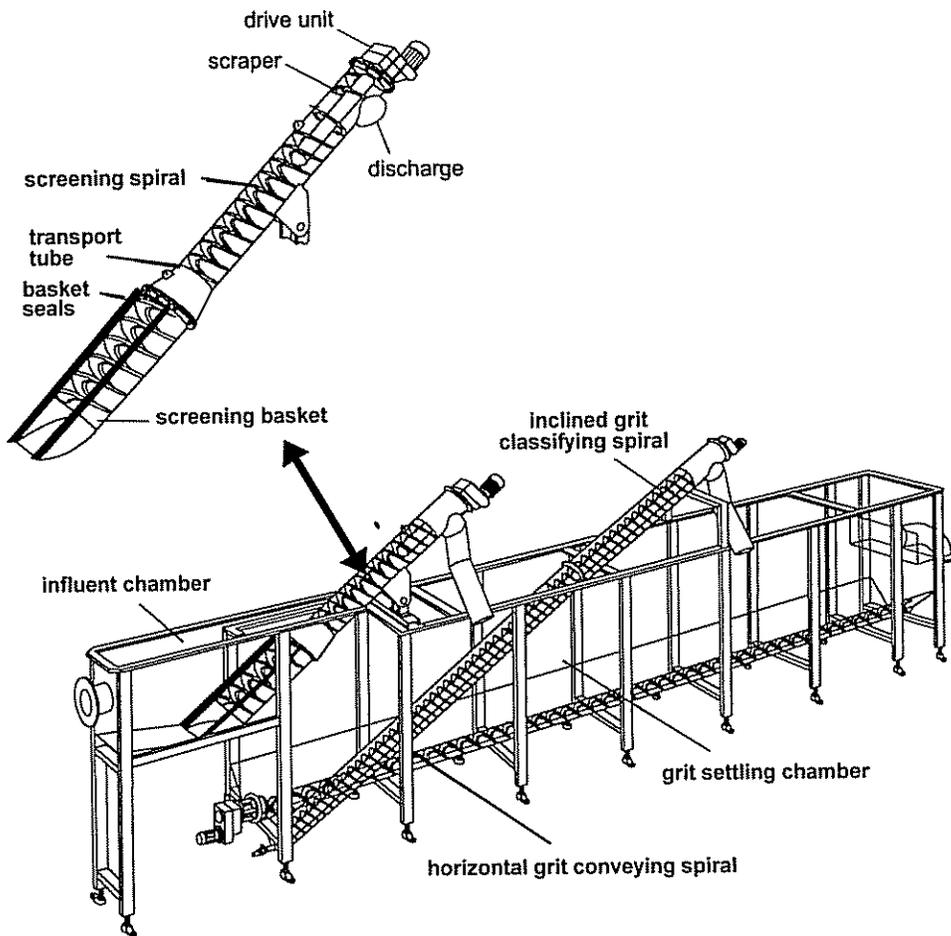
Operation

The Combi® Unit has two main functions: screenings removal and grit removal. The Combi® Unit can also be provided with grease removal. An integral tank ties in all functions of the unit, and directs flow into, through, and out of the unit (see Fig 2-1A, B).

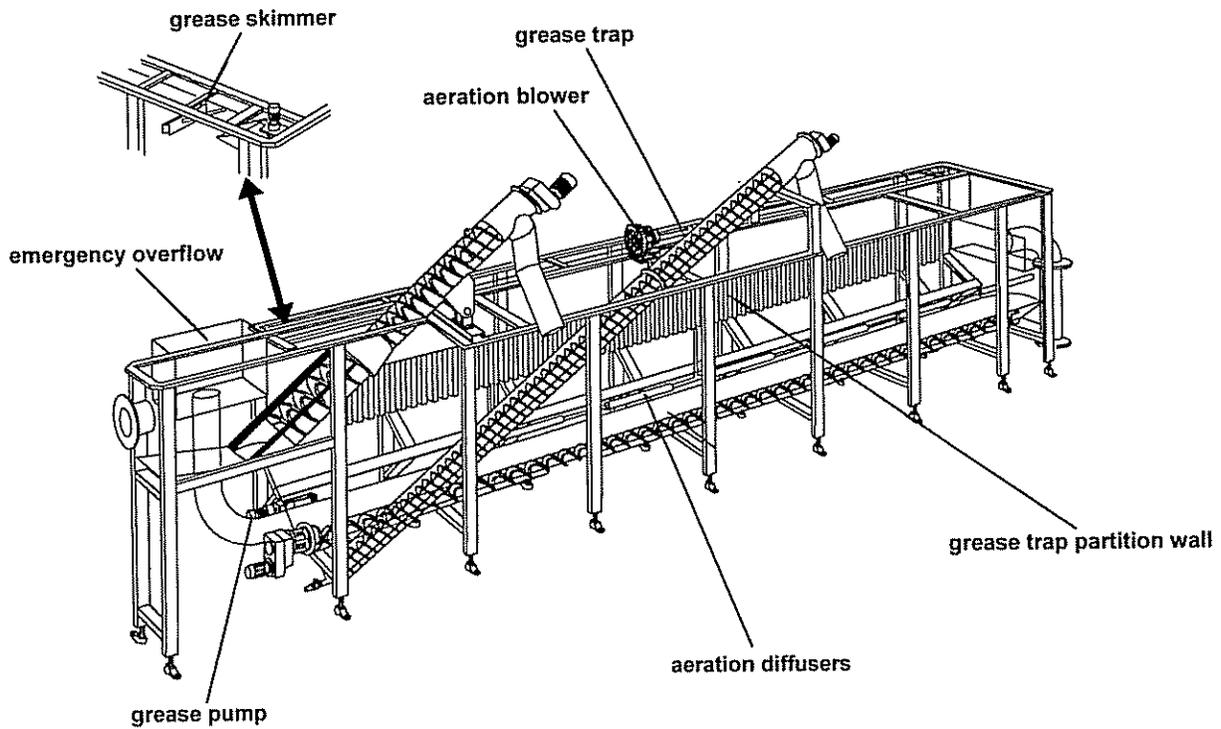
The Combi® Unit receives influent on either a continuous or batch basis.

Coarse solids (screenings) are trapped on the inside of the submerged screen basket of the screenings assembly. The trapped solids cause the screen to "blind" and as a result the level in the influent area of the tank rises. When a preset tank level is reached, the screenings spiral motor turns on and the accumulated solids are conveyed up the transport tube by the rotating spiral.

In the press zone of the screenings assembly the solids are compacted and dewatered. The free water drains through the perforated dewatering screen and is collected in the drain box. This pressate water is returned to the tank, downstream of the screen basket. The press zone spray wash flushes the dewatering screen section of residual solids to prevent plugging of press zone. The compacted solids are pushed into the discharge section, where a rotating serrated cutter breaks apart the plug. Solids fall into the discharge chute and into a receptacle.



COMBI UNIT
FIG 2-1A



COMBI UNIT WITH AERATION, GREASE TRAP, AND OVERFLOW
FIG 2-1B

Screened influent flows into the grit-settling chamber of the unit.

Grit is allowed to settle at the bottom of the settling chamber while organics are carried out of the unit with the effluent flow as the flow discharges over a weir and through an outlet pipe.

On Combi® units provided with grease removal, the grit-settling chamber is provided with aeration, which produces a gentle rolling of the flow as it gradually makes its way to the effluent end of the chamber. The rolling effect allows greases and organics to be released from the grit particles.

Grit that has settled at the bottom of the settling chamber is periodically conveyed to the influent end of the chamber by the horizontal grit-conveying spiral. Accumulated grit is then transported out of the unit by the inclined grit-classifying spiral.

On units with grease removal, grease floats to the top of a partitioned quiescent area of the tank (grease trap). Grease that has accumulated on the surface of the grease trap area is periodically skimmed, and the grease skimmings are directed into the grease pump hopper. After a number of skimming cycles, the grease pump removes the collected grease from the unit.

Controls are provided to coordinate operation of the overall system.

Unit Description

- Screening Removal Section

The main components of the screenings assembly are the screen basket, the shaftless screenings spiral (with brush), the transport tube, the press zone, the discharge section, and the drive (see Fig 2-1A, B).

A stainless steel perforated screen basket sits at an incline in the influent area of the tank, with the front of the basket open to the influent flow.

A shaftless spiral formed of prime painted high-strength carbon steel alloy is positioned in the screen basket. A water resistant brush affixed to the outside edge of the spiral contacts the interior of the screen basket and cleans the screen basket with each revolution.

Rubber seals bolted on either side of the screen basket seal against the Combi unit's tank walls to prevent flow by-pass around the basket.

The stainless steel transport tube consists of a flanged tube with three (3) wear bars bolted to tube ID. The wear bars provide a wear surface for the spiral, and allow drainage of free liquid from the screenings. The lower end of the transport tube is bolted to the screen basket.

The spiral continues through the transport tube, with the flights riding upon the stainless steel wear bars. Spiral flights end just before the press zone. A solid shaft is welded to the final flights, and extends through the press zone, discharge section, and into the gear reducer.

The upper end of the transport tube bolts to the press zone. The press zone consists of a stainless steel tube with a perforated drainage screen, a pressate collection box with a drainpipe connection, and a spray wash nozzle with a spray water pipe connection. Pressate is directed back into the tank through a flexible hose.

The discharge section is a stainless steel tubular assembly bolted between the press zone and the drive system, and is designed to discharge dewatered screenings out of the unit and to direct screenings into a receptacle. A reverse pitched spiral and a serrated scrapper plate are attached to the shaft in the discharge section to ensure that dewatered screenings slough off into the discharge chute.

An access hatch (with safety interlock switch) is provided on the discharge section.

A flexible rubber or rigid stainless steel discharge chute is typically bolted to the stainless steel discharge section to allow operational flexibility while still providing operator protection from the rotating spiral shaft.

The drive system consists of a flanged mounted gear reducer and a direct-coupled motor. The flange of the reducer is fastened to the flange of the discharge section.

The drive shaft extends into and is secured in the hollow bore of the gear reducer.



DO NOT REMOVE THE DISCHARGE CHUTE EXTENSION. THIS EXTENSION IS A SAFETY GUARD.

- Grit Removal Section - Grit Settling Chamber

The cross section and length of the grit-settling chamber is designed to provide the required grit-settling rate. The bottom of the settling chamber is inclined towards a central spiral trough to direct settled grit into the conveying spiral.

- Grit Removal Section - Horizontal Grit Conveying Spiral

The horizontal grit-conveying spiral is used to convey grit along the bottom of the grit settling area toward the inclined grit-classifying spiral. The main components of the horizontal grit spiral assembly are the shaftless spiral, the wear bars, the packing gland, and the drive.

The shaftless spiral is made of a prime painted high-strength carbon steel alloy.

The four (4) stainless steel wear bars are positioned longitudinally and tack welded to the inside the U-shaped trough at the bottom of the unit's tank.

A flange mounted drive is provided at the influent end of the tank, on the outside of the settling chamber. The drive is connected to the spiral by means of carbon steel coupling plates; a coupling plate is welded to the end of the spiral, and a mating coupling plate is welded to the drive shaft that fits into and is secured in the hollow bore of the gear reducer.

A packing gland is secured between the gear reducer and the tank exterior wall. The gland allows the submerged drive shaft to penetrate through the wall of the tank without leakage.

- Grit Removal Section - Inclined Grit Classifying Spiral

The inclined grit-classifying spiral is used to convey accumulated grit out of the unit, and discharge dewatered grit into a receptacle for disposal. The main components of the inclined grit spiral assembly are the shafted spiral, the sectioned grit transport tube with grit discharge, and the drive.

The shafted spiral is formed of a prime painted high-strength carbon steel alloy.

The four (4) stainless steel wear bars are positioned longitudinally and plug welded to the inside of each grit transport tube section. The wear bars support the spiral along the entire length of the transport tube, provide a wear surface for the spiral, and allow drainage of free liquid from the grit. The tube is provided in sections for disassembly during transporting; sections of tube are fastened together by a flange connection.

The grit discharge section is located at the upper end of the grit transport tube, and directs dewatered grit into a chute.

A flange mounted drive is provided at the upper end of the tube, just beyond the discharge section. The drive is connected to the spiral by means of carbon steel coupling plates; a coupling plate is welded to the end of the spiral, and a mating coupling plate is welded to the drive shaft that fits into and is secured in the hollow bore of the gear reducer.

The lower end of the transport tube melds into the tank construction for a smooth transition with the horizontal grit-conveying spiral.

- Tank

The stainless steel tank provides the means to accept influent flow, direct it through screening and grit settling, provide a quiescent zone for the grease trap (when provided on the unit), and finally direct flow over the effluent control weir and out of the unit through the effluent pipe connection.

The tank is provided with the necessary supports for the screenings spiral assembly and inclined grit classifying spiral assembly, and to allow the screenings spiral assembly to pivot to a horizontal maintenance position.

The tank is provided with support legs necessary to support the operating weight of the unit. Each support leg is equipped with an adjustable foot for proper leveling of the unit. An anchor bolthole on each foot allows the unit to be anchored properly after leveling.

The tank is supplied with bolt on covers for odor retention. A hinged access cover (with safety interlock switch) allows viewing of the influent (screenings) area of the tank. Hinged access covers are also provided on units with grease removal, allowing viewing of the grease skimmer ends-of-travel.

Unit may be provided with one or more of the following optional features:

- Grit Removal Section – Aeration

Tubular fine bubble aeration diffusers are mounted on a service track along one side of the settling chamber.

A blower assembly, mounted near the unit, provides the air volume and pressure required to deliver fine bubble aeration to the settling chamber. Blower assembly is provided with the necessary appurtenances for proper operation and servicing of the blower.

Piping, fittings and control valves for the aeration system are typically supplied loose, to be assembled at the jobsite to best suit the installation.

- Grease Removal Section – Grease Trap

The grease trap is an extension of the grit-settling chamber, running along side the settling chamber for the entire length of the chamber. The grease trap is separated from the settling chamber by a partition that allows floating grease to enter while maintaining quiescence in the grease trap area.

- Grease Removal Section – Grease Skimmer

The mechanical grease skimmer consists of a skimmer blade mounted on a float, which allows the skimmer blade to always ride of the surface of the liquid level. The blade is driven through its skimming and retraction by a stainless steel cable, and tension on the cable is maintained by a pulley and spring system.

A gearmotor mounted on the top cover of the grease trap provides the power to drive the skimmer through its cycles. Proximity switches indicate end-of-travel position and home position. Controls dictate forward and reverse direction of the drive based upon skimmer position.

- Grease Removal Section – Grease Pump

A positive displacement pump is hopper-mounted to the grease collection area of the grease trap. A TEFC motor drives the pump, and a standard flange connection is provided for customer discharge piping.

- Solids bagger for confining dewatered solids in odor-retaining bags.

A continuous roll of plastic is encased in a magazine and positioned at the end of the discharge chute(s). After solids fill the bag, the roll is cut, the filled bag is removed, and the roll is tied off to begin a new bag.

- Dual speed motor.

A dual speed motor provides Low (standard) speed and High speed (double the standard speed) in order to provide flexibility in operating the screenings spiral in more demanding applications.

- Restrictor plates.

Plates or discs are designed to increase marginal screenings dewatering results by creating additional backpressure on screenings prior to being discharged. Plates or discs are sandwiched between the press zone flange and the discharge section flange of the screenings assembly.

- Heating jacket for press zone.

The press zone exterior is heat traced, insulated and jacketed with either stainless steel or PVC sheeting. Thermostat control is provided for automatic operation of this feature. Other segments of the unit may also be heat traced as deemed necessary to protect the unit from freezing.

- Septage receiving package.

For units specifically intended to be used to process septage, the tank is fitted with an automated inlet valve, an influent screenings area spray wash system, a dual speed screenings spiral drive, multi-point liquid level controls, and customized controls to allow for automated operation of the system. The inlet valve is designed to restrict access to the unit to authorized users and close upon sensing a high level condition to prevent overflow. Intermediate liquid levels control the speed of the screenings spiral. End of cycle shut down will activate the tank spray wash for rinse down of tank interior. Various operator interface options allow convenient unattended, yet secured, access to the unit by septage haulers.

- Additional spray systems

In specific applications, the addition of spray systems may be required for effective performance and maintenance of the unit. For example, a separate hot water screen basket spray for high grease applications, or a grit washing spray to further reduce organics in the collected grit.

- Screen Basket Agitator (Screenings Washer).

Located upstream of the screen basket, the electric motor driven agitator vigorously mixes incoming screenings, breaking up fecal matter and releasing organics from screenings. Organics pass through the screen while cleaned screenings are transported out of the unit.

Note: a separate Maintenance Manual is provided for units supplied with this option.

See Equipment Drawing to determine which options are included on your equipment.

SECTION THREE

Hycor® Combi® Unit INSTALLATION



DANGER



REVIEW ALL SAFETY PRACTICES LISTED IN SECTION ONE BEFORE PROCEEDING.

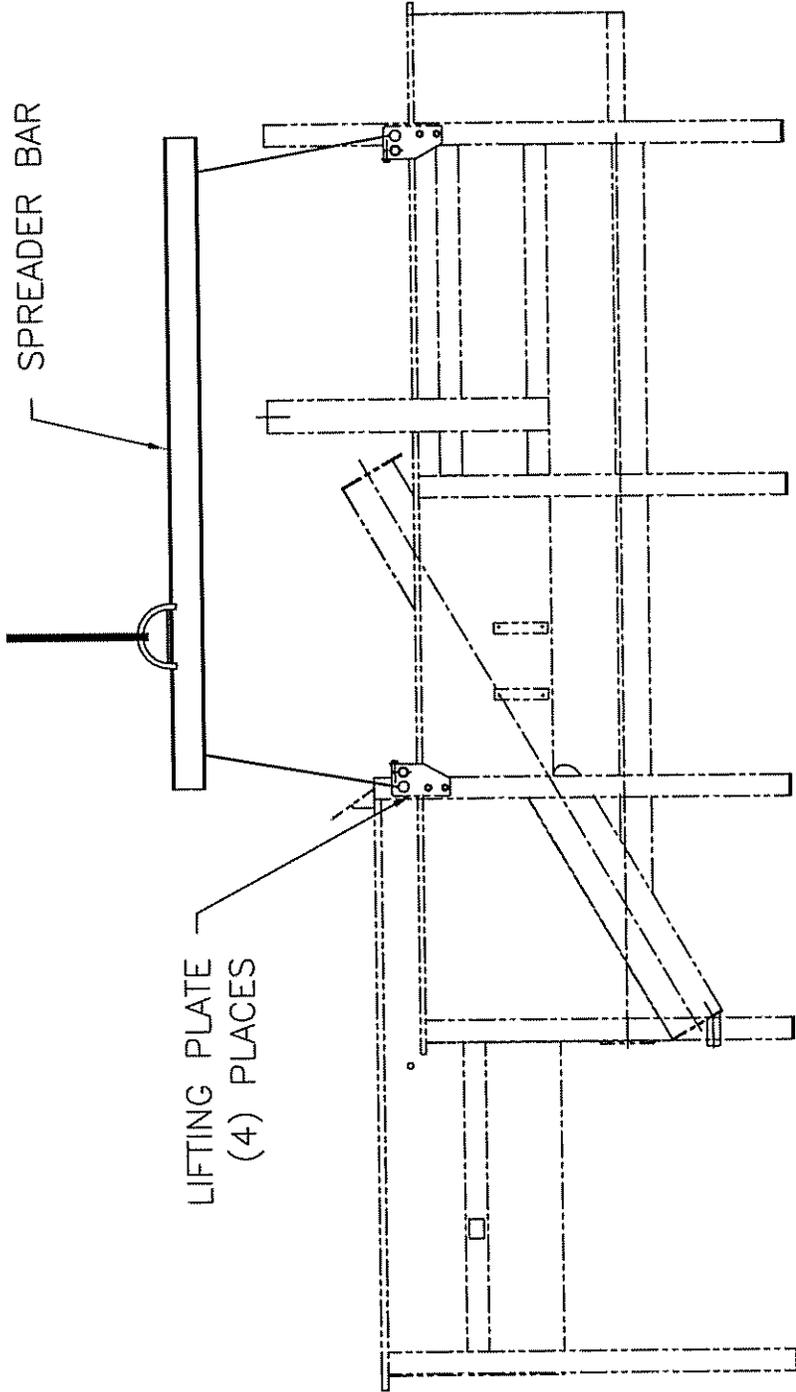
Mechanical Work

The Combi® Unit is shipped partially assembled, skid-mounted with protective crating and ready for site installation. No special site preparation is necessary prior to installation other than a reasonably level mounting surface and suitable anchor bolts for attachment. Prior to starting installation, check the following:

- Verify overall tank dimensions shown on the Equipment Drawing, as well as process connection sizes and locations. If different than shown on Equipment Drawings, contact Parkson Corporation for a resolution.
- Verify wall openings and transport routes are of sufficient size to allow the unit to be positioned and installed in the desired location.
- Verify that lifting and transport equipment of suitable capacity is available. The tank assembly is most often supported and located in the final position by the lifting eyes bolted on the tank.
- Make sure that the unit is free of construction and shipping debris or any other material that would inhibit proper installation or damage unit components.

In case of extreme deviation from Equipment Drawings, modifications may be needed. Contact Parkson Corporation before any modifications are made. Modification made without approval will void the manufacturer's warranty.

Use lifting eyes provided to prevent equipment damage (see Fig 3-1A). Lift unit and carefully maneuver into position. The lifting eyes should be removed from the unit and returned to the manufacturer.

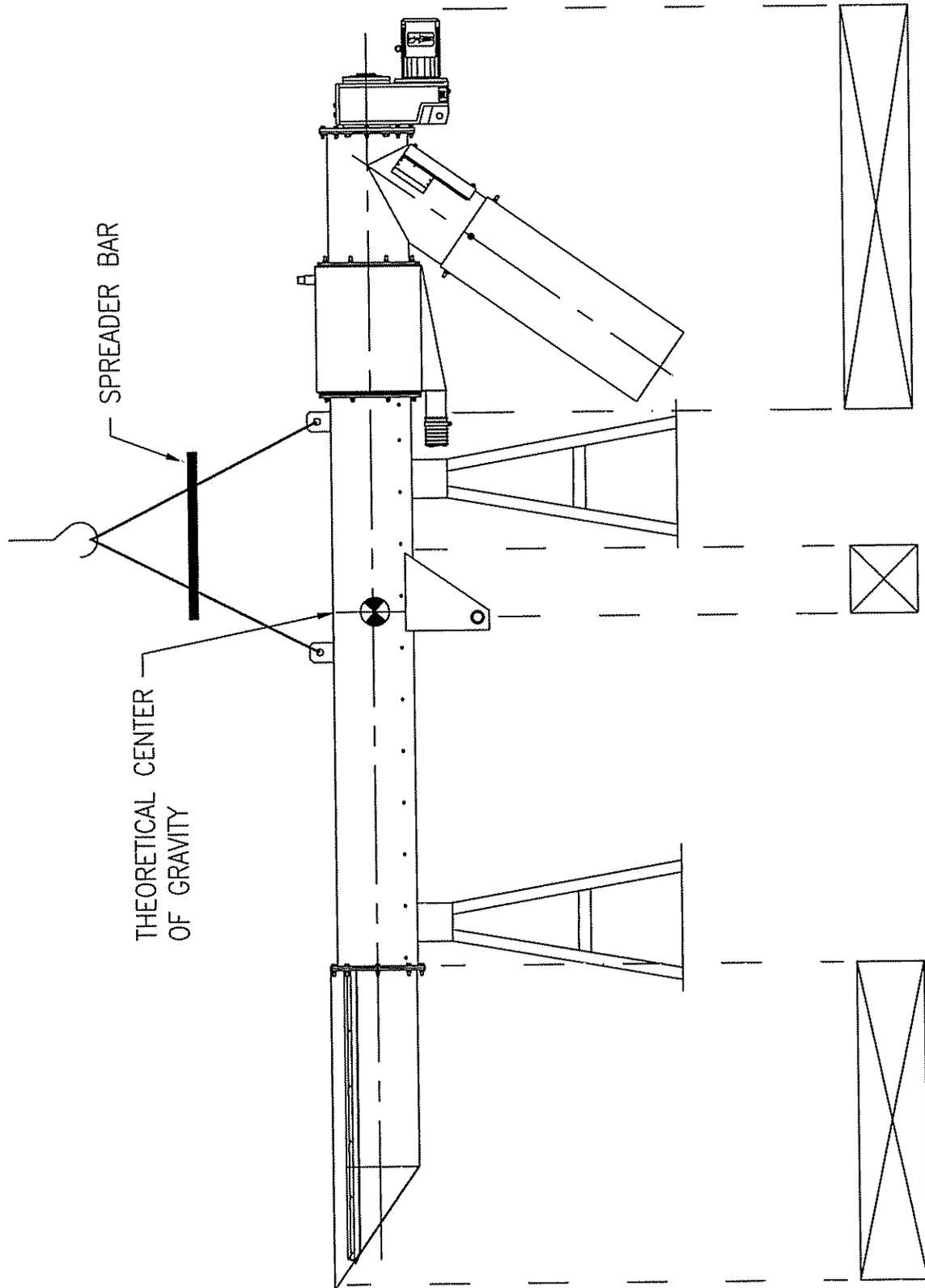


SPREADER BAR

LIFTING PLATE
(4) PLACES

LIFTING POINTS (TANK)

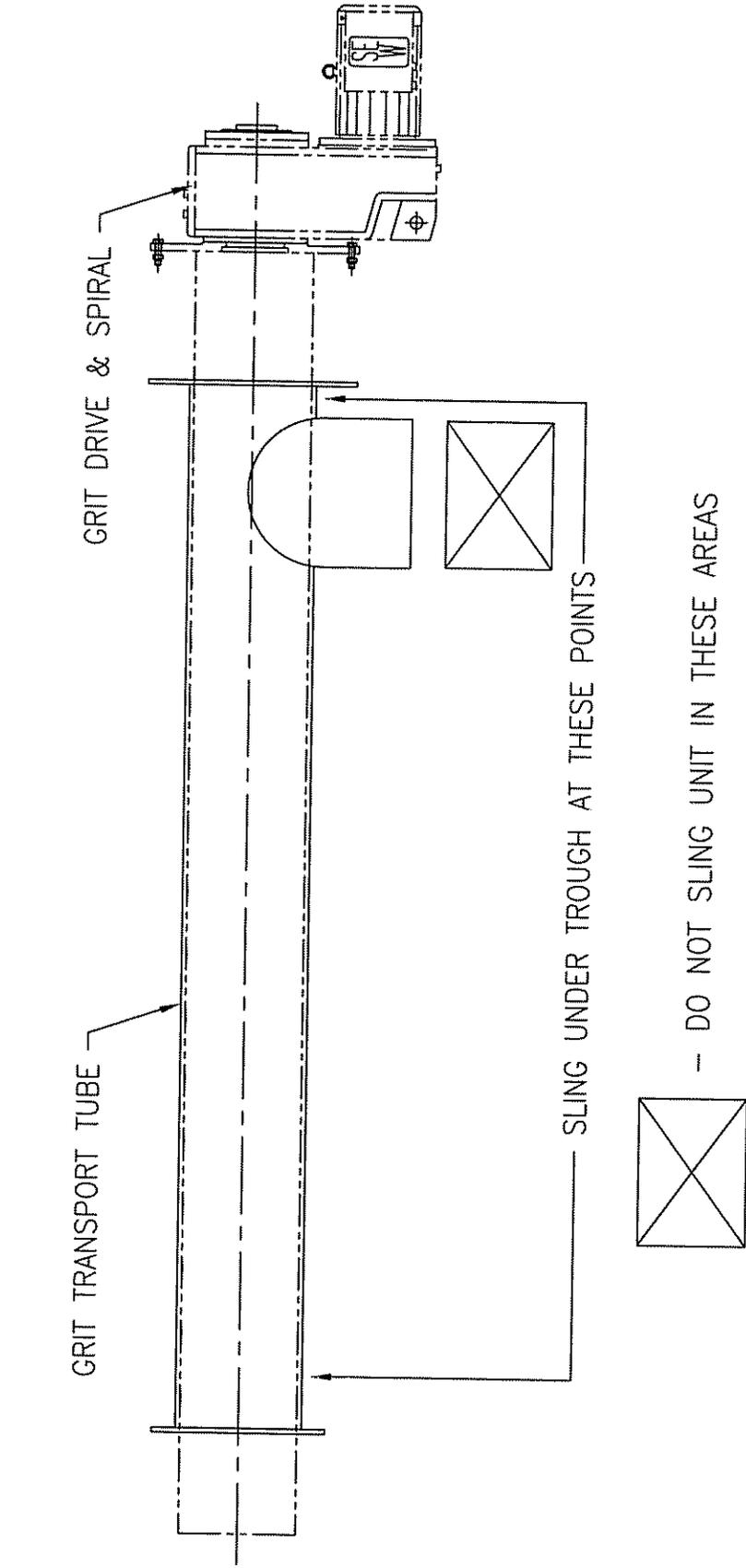
3-1A



- DO NOT SUPPORT UNIT
IN THESE AREAS!!

LIFTING POINTS (SCREENING ASSEMBLY)

CAUTION: USE LOAD-RATED ROPE OR FABRIC SLINGS FOR LIFTING THIS ASSEMBLY
DO NOT USE CHAINS



LIFTING POINTS (INCLINED GRIT SPIRAL)

DANGER

- **WHEN INSTALLING OR MAINTAINING THE COMBI[®] UNIT OR ASSOCIATED HARDWARE, BE SURE THAT ANY LIFTING EQUIPMENT IS OF SUFFICIENT CAPACITY BEFORE LIFTING OR MOVING THE COMBI UNIT OR ASSOCIATED HARDWARE.**
- **WHEN LIFTING THE COMBI UNIT'S TANK, BE SURE THAT THE TANK IS BALANCED BEFORE LIFTING MORE THAN SIX INCHES OFF THE GROUND. DO NOT LIFT PERSONNEL WITH THE TANK OR ALLOW PERSONNEL TO WALK UNDER A TANK BEING LIFTED INTO PLACE.**

The screenings assembly may be positioned and reassembled to the tank by lifting up on the transport tube's lifting eyes (See Fig 3-1B). Remove all covers in the inlet area and secure the screenings assembly by fastening the pivot point to the support. Review Equipment Drawings for clarification. When the screenings assembly is pivoted down into the tank, make sure that the rubber seals contact the tank walls to prevent by-pass.

The horizontal grit-conveying spiral should already be positioned in the tank and secured to its drive.

The inclined grit-classifying assembly may be positioned and reassembled to the tank. Sling the transport tube (See Fig 3-1C) and secure it to the transport tube mounted in the tank. Secure any additional tube bracing, if provided (see Equipment Drawing for details).

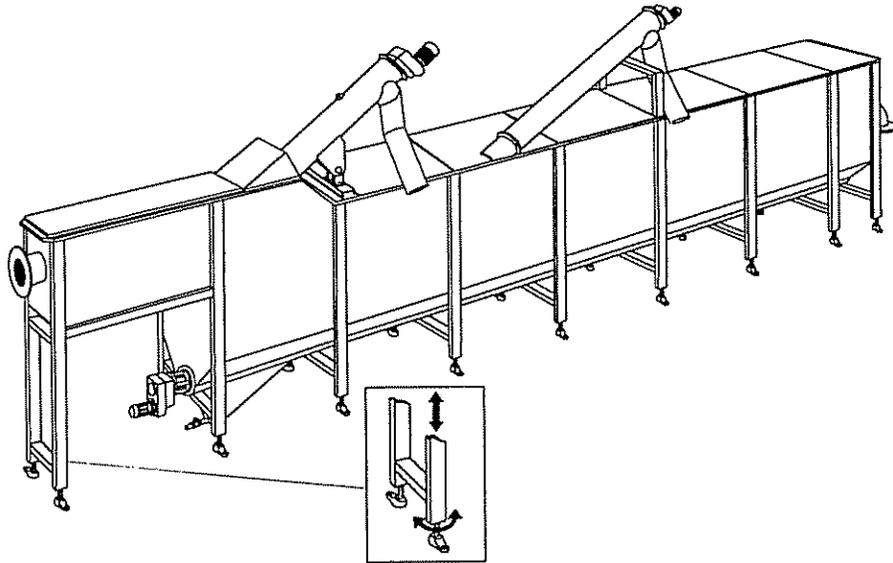
Assemble the drive to the spiral by fastening the coupler plate on the spiral to the coupler plate on the drive shaft.

With the spiral properly supported to prevent permanent deformation, slide the spiral and drive down into the transport tube until the drive flange mates with the mounting flange on the tube. Secure with fasteners provided.

Level the unit by adjusting the feet on the support legs, and anchor into position with suitable anchor bolts (see Fig 3-3A). The screenings assembly and inclined grit classifying assembly centerlines should be square to tank walls and in-line with tank's centerline.

Connect influent and effluent piping. Piping, fittings and valves must be supported independent of the unit.

On units with grease removal, connect the grease pump discharge piping. Piping, fittings and valves must be supported independent of the unit.



SUPPORT LEG HEIGHT ADJUSTMENT
FIG 3-3A

Connect all wash water feed lines. Wash water supply pressure should not exceed 80-psi.

On units with aeration, mount the blower assembly (provided on units with an aeration system) in close proximity to the unit. Run piping, fittings and supports from the blower to the aeration connection on the unit in a manner that is the least obtrusive to the plant operators and allows access to other equipment in the area.

In some installations, a specific location for the blower may have been established. In other installations, the blower assembly may be mounted on the cover of the unit. Unit mounted blowers typically are fitted in the factory, and may only require reassembly of the blower and its piping and fittings. Check Equipment Drawings before beginning blower installation.

Assemble the discharge chutes to the screenings assembly discharge section and to the grit discharge section. Use support brackets mounted on the tank to secure the position of the chutes.

Any additional ship loose items (level sensor) and optional components (bagger, inlet valve, etc.) can now be installed in accordance with the installation drawings.

The Combi unit drive motors have been factory fitted and require no adjustments. Check the oil level in each gear reducer in its installed position. Add oil as required. Verify that the vent plug breathers are in place. If vent plugs are not installed, call factory for replacement.

After all components supplied with the unit are mounted, pivot the screenings assembly to horizontal position to verify clearance for maintenance (see Fig 6-1A).

Electrical Work

Mount the control panel(s) at the desired location.

Connect electrical power from the power supply to the control panel, and from the control panel to each of the electrical devices on the unit (motors, solenoids, switches, etc.). If purchased, a local junction box may have been provided on the unit with select electrical devices pre-wired to simplify electrical installation. Typically, no electrical devices on the unit are pre-wired.

Refer to the motor nameplates for proper power supply and wiring connections. Be sure that unit is well grounded and that all work meets National Electrical Codes as well as local wiring requirements. Refer to component data in Section Nine and control panel drawings in Section Ten for project specific information:



MAKE SURE ANY ELECTRICAL CONNECTIONS ARE DONE BY QUALIFIED PERSONNEL AND ARE IN ACCORDANCE WITH ALL APPLICABLE CODES AND REQUIREMENTS.

TO PREVENT SERIOUS INJURY OR DEATH:

- **NEVER PLACE ARMS, LIMBS, OR ANY HAND-HELD OBJECT OR TOOL IN DISCHARGE CHUTE OR IN PROXIMITY TO THE SPIRAL, UNLESS THE MACHINE IS ELECTRICALLY LOCKED OUT.**
- **WHEN INSTALLING THIS PRODUCT, ALWAYS INSURE THERE IS A LOCKABLE DISCONNECT WITHIN SIGHT OF THE MACHINE.**

Carry out the following checks before starting the unit for the first time.

- Verify that the unit is installed in accordance with the Equipment Drawings.
- Verify that all optional attachments (e.g. bagger) have been correctly installed.
- Verify that the unit has been securely anchored to the foundation.
- Verify that the electrical power supply to the motors and the motor wiring terminations are in agreement and correct.

- Verify that all other electrical connections have been made in accordance with the circuit and wiring diagrams.
- Inspect unit to insure that all packaging material has been removed and the spirals are free to rotate and in the proper position. Confirm that no construction debris is left in the spirals, transport tube, troughs, discharge chutes, or tank.
- If a grease skimmer has been provided, confirm that all shipping material has been removed and that the skimmer can travel without obstruction. Visually check the condition of skimmer components.
- Verify proper lubrication of all unit gear reducers and motors, and confirm installation of breather plugs in gearboxes.
- Check tightness of all piping connections.

SECTION FOUR

Hycor® Combi® Unit OPERATING INSTRUCTIONS



REVIEW ALL SAFETY PRACTICES LISTED IN SECTION ONE BEFORE PROCEEDING.

THIS EQUIPMENT MUST BE OPERATED AND MAINTAINED ONLY BY AUTHORIZED PERSONNEL WHO HAVE READ AND UNDERSTAND THE OPERATOR'S MANUAL, HAVE BEEN TRAINED IN ITS USE, AND FOLLOWING ANY AND ALL APPLICABLE SAFETY PROCEDURES.

Start Up Procedures

Many of these start-up procedures require the use of the supplied controls. When verifying correct operation of the specific devices, confirm that the respective control switches and indicating lights function properly as well.

Check all spirals for proper rotation. When viewed from drive end, the screenings spiral and the inclined grit-classifying spiral should rotate counterclockwise when motor is jogged; when viewed from the influent end of the unit, these spirals should rotate clockwise. For these inclined spirals, material should be conveyed upward toward the discharge end. When the screenings spiral is run dry, lubricate brush with dishwashing soap or light grade oil to reduce wear on brush.

The horizontal grit conveying spiral should rotate clockwise when viewed from its drive end. Material should be conveyed toward the bottom of the inclined grit spiral at the influent end of the unit.



ROTATING SPIRALS ARE LOCATED DIRECTLY BELOW COVERS. NEVER PLACE HANDS OR LIMBS IN COMBI UNIT WITHOUT FIRST LOCKING OUT MACHINE.

If any particular spiral is turning in reverse, turn off all power to the Combi control panel and exchange any two incoming power leads of the specific motor. Jog the motor again to insure proper rotation. Verify that all motors are rotating in the correct direction.

To set the overcurrent protection for each spiral drive, locate each respective current monitor (typically located at the starter). Refer to the instructions provided in the component data in Section Nine for setting the current threshold for each motor.

THE CURRENT MONITORS MUST BE SET PROPERLY TO ENSURE PROTECTION OF EACH DRIVE. FAILURE TO SET THESE MONITORS PROPERLY COULD DAMAGE THE EQUIPMENT.



ADJUSTMENT OF THE CURRENT MONITORS MUST BE ACCOMPLISHED WITH ELECTRICAL POWER SUPPLIED TO THE CONTROL PANEL AND WITH THE UNIT IN OPERATION. THEREFORE, EXTREME CARE MUST BE TAKEN WHEN MAKING THESE ADJUSTMENTS, AS THE POSSIBILITY OF ELECTRICAL SHOCK DOES EXIST.

It is recommended that only a qualified electrician using an insulated screwdriver make the necessary adjustments to the current monitors. Stop and restart the unit several times to confirm the trip point setting is high enough so the unit will not trip out under start up load. Should the unit trip out, make further fine adjustments until the unit can start without tripping out

Upon start up, the sound of the spirals riding on the wear bars may be noticeable. As water fills the tank, as screenings are processed and as the wear bars begin to wear in, the sound should diminish.

If a spiral is jumping and banging as it rotates during dry runs, the spiral may have been bent during shipment or installation. In these cases, the spiral should be repaired before continuing start-up.

Spiral run and delay timers are factory set. However, some adjustments may be required for local site conditions. Timers are found in the control panel or as part of PLC logic. For electro-mechanical timers, set dial as required for the specified timer. For setting PLC timers, consult controls section of this manual.

Test spray solenoid(s) by turning spray selector switches to HAND position. If spray solenoid(s) does not activate, check the wiring connections.

Turn water source on for all spray wash lines. Place spray selector switch(es) to HAND position. Confirm that water is actually flowing through each opened spray system, and that the spray pattern for each respective spray system is correct. The spray wash should continuously flush the respective area of the unit (e.g. press zone or influent screenings area). If necessary, clear plugged orifices and recheck until satisfactory performance is obtained.

Check for leaks in the spray wash piping. Repair leaks, as required.

Set spray wash timer(s) as appropriate for specific installation requirements.



KEEP AWAY FROM THE SCREEN INLET AREA. ROTATING SPIRAL LOCATED DIRECTLY BENEATH COVER. NEVER PLACE ANYTHING (HANDS, LIMBS, HAND-HELD OBJECTS OR TOOLS) INTO THE DISCHARGE CHUTE OR IN PROXIMITY OF THE SPIRALS, UNLESS THE MACHINE IS ELECTRICALLY LOCKED OUT.

On units supplied with a grease skimmer, confirm that each skimmer end-of-travel limit switch and each home position limit switch is functioning properly by placing a metal plate over the switch. This will require another person to verify that the switch signal was received at the main panel.

Confirm the correct rotation of the skimmer drive. The skimming direction is the forward direction – the skimmer blade is in the 'down' position, running along the liquid level surface and pushing skimmings toward the skimmings ramp. Place the skimmer in HAND mode, and use the FORWARD-OFF-REVERSE selector switch to jog FORWARD. Do not run the skimmer continuously until correct operation of the skimmer proximity switches has been confirmed and correct rotation of the skimmer drive is confirmed. If the skimmer blade is not traveling forward when jogged FORWARD, then reverse the motor leads at the skimmer motor starter. Check to confirm proper travel direction.

Confirm the correct rotation of the grease pump (refer to manufacturer's instructions provided in Section Nine).

Confirm that each safety interlock switch cuts off power to the unit.

Confirm that each E-Stop button cuts off power to the unit.

Check all remaining switches and lights on the main panel as well as on any local panels supplied with the equipment. On Septage Receiving Units, the operation of the User Access panel should be confirmed after all other checks are completed and the unit is ready to receive septage.

Clean Water Check

With all dry mechanical checks satisfactorily confirmed, the unit is ready to be filled with clean water. If clean water is not available, then these checks will have to be made with process water.

Confirm that the drain valve on the tank is closed.

Fill tank with clean water until the water level reaches the top of the effluent weir.

Turn the aeration blower to HAND mode and confirm that a good distribution of fine bubbles is being produced along the length of the grit-settling chamber. If one or more aeration diffuser appears to be clogged, confirm that all isolation valves are fully open and that there are no obstructions in the air supply piping. Diffusers are a non-clogging design, but may otherwise be damaged; check for any obvious problems with the affected diffusers.

Check for air leaks in the aeration piping. Repair as required, and recheck.

Turn skimmer to HAND / FORWARD mode, and confirm that the skimmer blade is properly skimming the surface of the grease trap. Also confirm that the skimmer blade travels properly over the skimmings ramp to direct skimmings into the grease pump hopper. Switch the skimmer to HAND / REVERSE mode and confirm that the skimmer retracts in the correct (up) position. Check for smooth operation of the skimmer through its entire cycle. Adjust cable tension if skimmer blade tracks poorly.

Run more clean water into the unit and check for leaks in the influent and effluent piping. Repair leaks, as required, and recheck.

Process Water Check

With all dry mechanical checks & clean water checks satisfactorily confirmed, the unit is ready to be filled with process water.

Always inform all area personnel of the pending start up. Make certain that there are containers in place for receiving the dewatered solids and grit.

Place all selector switches in the AUTO or ON position (as required) for system control.

Monitor performance of all functions of the unit. For Septage applications, allow the unit to process several loads in order to access the functioning of the unit.

Note quality of discharged screenings and grit. The unit may need to run for several hours before discharging screenings and several days before discharging grit.

Adjust level sensor set points, spiral run times, and spray run times as required to optimize unit performance.

Operating Modes

Factory settings shown are defaults. Record any changes required at start up for future reference.

An ultrasonic level-sensing device typically controls the operation of the screenings assembly. The ultrasonic sensor is factory set to control operation of the screenings spiral at various liquid levels in the influent screenings area of the unit. The ultrasonic level controller should be fine-tuned to best suit the specific application. Refer to component data in Section Nine and control drawings in Section Ten for details specific to your equipment.

As flow passes through the screen basket, solids are trapped in the basket causing the water level to rise in the screenings chamber. When the water level reaches a set point, the screenings spiral cycles on and off, according to the control logic.

For a standard control package (single speed motor), the screenings spiral is initiated when the set point is reached. The spiral continues to run for a set amount of time, in order to remove screenings that have accumulated on the screen basket. If the liquid level has not receded by the time the spiral run timer times out, then the spiral will continue to run.

For a dual speed motor control package, the screenings spiral is initiated when Low Speed On set point is reached, and shuts off when the liquid level recedes to Low Speed Off set point. If High Speed On set point is reached, the spiral begins to run in high speed until the liquid level recedes to High Level Off set point.

In both cases, a High Liquid Level alarm level will initiate an alarm condition.

In septage receiving applications, the high level alarm is accompanied by a closure of the inlet valve. The valve remains closed until the liquid level recedes below the alarm level.

It is best to set the Combi[®] unit to operate at a minimum. The screenings spiral should be set to run as infrequently as possible to maximize brush wear. The level sensor should be set to allow screenings to sufficiently build up on the screen. However, care should be taken that at high flows, the screenings area of the tank does not overflow. The screenings spiral off delay timer need only be long enough to clear screenings from the basket and transport these screenings up into the press zone.

The inclined grit classifying spiral cycle timers should be set to allow maximum drainage of free water while preventing excessive grit build-up in the grit chamber of the tank. To produce drier grit, increase the inclined grit spiral off time. For increased rate of grit discharge - increase the inclined grit spiral on time. To remove a greater volume of grit per cycle - increase the horizontal grit spiral duration timer.

Enhancing Performance

The Combi[®] Unit is intended to screen, convey and dewater suspended solids. Normal dewatering results yield between 15%-18% dry solids. Results vary by installation and by application. Site and application concerns may require optional equipment to yield overall acceptable results.

- Restrictor Plates

In order to increase screenings dryness on some applications, a polyurethane orifice disk or stainless steel restrictor plates can be inserted between the press zone flange and the discharge section flange. Depending on the application, solids dryness can increase by as much as 25%.

NOTE: A restrictor should not be used on materials that readily release free water (e.g. paper stock). Restrictors on these applications may produce dewatered solids that are too dry, causing a blockage of solids discharge and possibly damaging the screenings spiral and spiral drive.

- Bagger Device

To reduce odor and to keep surroundings clean, a bagger device can be attached to the screenings or grit discharge chutes. The bagger device contains dewatered screenings or grit in a clear continuous plastic bag. Tie off open end of the plastic roll to form a "bag" for receiving screenings or grit. When "bag" fills to an appropriate level, cut it off and seal end by tying a knot in the roll. Pull off another length of the roll and tie it off as before. Bag should sit on the operating floor or at the bottom of the receptacle to prevent the weight of the collected solids from damaging the bagger attachment.

- Press Zone Heater

In cold climates, heat tracing is affixed to the press zone. The heat tracing is secured between insulation and a PVC or metal jacket. A preset thermostat activates the heat tracing to prevent solids from freezing inside the press zone.

NOTE: Depending on the local climate, additional heating may be required to prevent solids from freezing inside the screenings assembly and/or inclined grit classifying spiral assembly.



FOLLOW LOCK OUT PROCEDURES BEFORE SERVICING: LOCK OUT POWER WITH PADLOCK FOR WHICH ONLY YOU HAVE THE KEY.

Shutdown and Cleaning Procedures

When taking the Combi[®] Unit off-line for a short term shutdown period for maintenance or any other reason, follow the procedures below to save time and help prevent premature wear or extra service requirements.

The screenings assembly should be cleared of screenings by filling the screenings influent area with crushed or cubed ice and manually turning on the screenings spiral. Repeat this process until ice begins to discharge from screenings spiral discharge chute. In cold weather, heat the press zone to melt ice and prevent thermal expansion damage.

The grit settling area may be cleared of grit by manually turning on the horizontal grit spiral and the inclined grit spiral. Open the tank drain line near the bottom of the inclined grit spiral and drain tank level. Wash down interior of the grit settling chamber and the grease trap area; a steam/pressure wash is recommended. Continue to run grit spirals until remaining solids are conveyed to the bottom of the inclined grit spiral. Fill the spiral intersection area with crushed or cubed ice. Run the inclined spiral until ice and remaining solids are discharged from the inclined spiral discharge chute.

Wash the exterior surfaces of the tank.

Check the gearmotors lubrication points and refill as appropriate.

CAUTION:

DO NOT APPLY HOT STEAM DIRECTLY TO PLASTIC OR RUBBER COMPONENTS, AS IT MAY CAUSE DAMAGE OR DEFORMATION OF THESE COMPONENTS.

DO NOT APPLY WATER DIRECTLY TO ELECTRICAL COMPONENTS (MOTOR FANS, E-STOP, ETC.).

SECTION FIVE

Hycor® Combi® Unit
MAINTENANCE



REVIEW ALL SAFETY PRACTICES LISTED IN SECTION ONE BEFORE PROCEEDING.

THIS EQUIPMENT MUST BE OPERATED AND MAINTAINED ONLY BY AUTHORIZED PERSONNEL WHO HAVE READ AND UNDERSTAND THE OPERATOR'S MANUAL, HAVE BEEN TRAINED IN ITS USE, AND FOLLOWING ANY AND ALL APPLICABLE SAFETY PROCEDURES.

THE INFLUENT FEED TO THE SCREEN INLET AREA MUST BE SHUT OFF, BLOCKED OR DIVERTED BY SUITABLE MEANS.

TO PREVENT SERIOUS INJURY OR DEATH:

- **FOLLOW LOCK OUT PROCEDURES BEFORE SERVICING: LOCK OUT POWER WITH PADLOCK FOR WHICH ONLY YOU HAVE THE KEY.**

Follow the maintenance schedule below to minimize unscheduled equipment downtime and extend the lifetime of the machine.

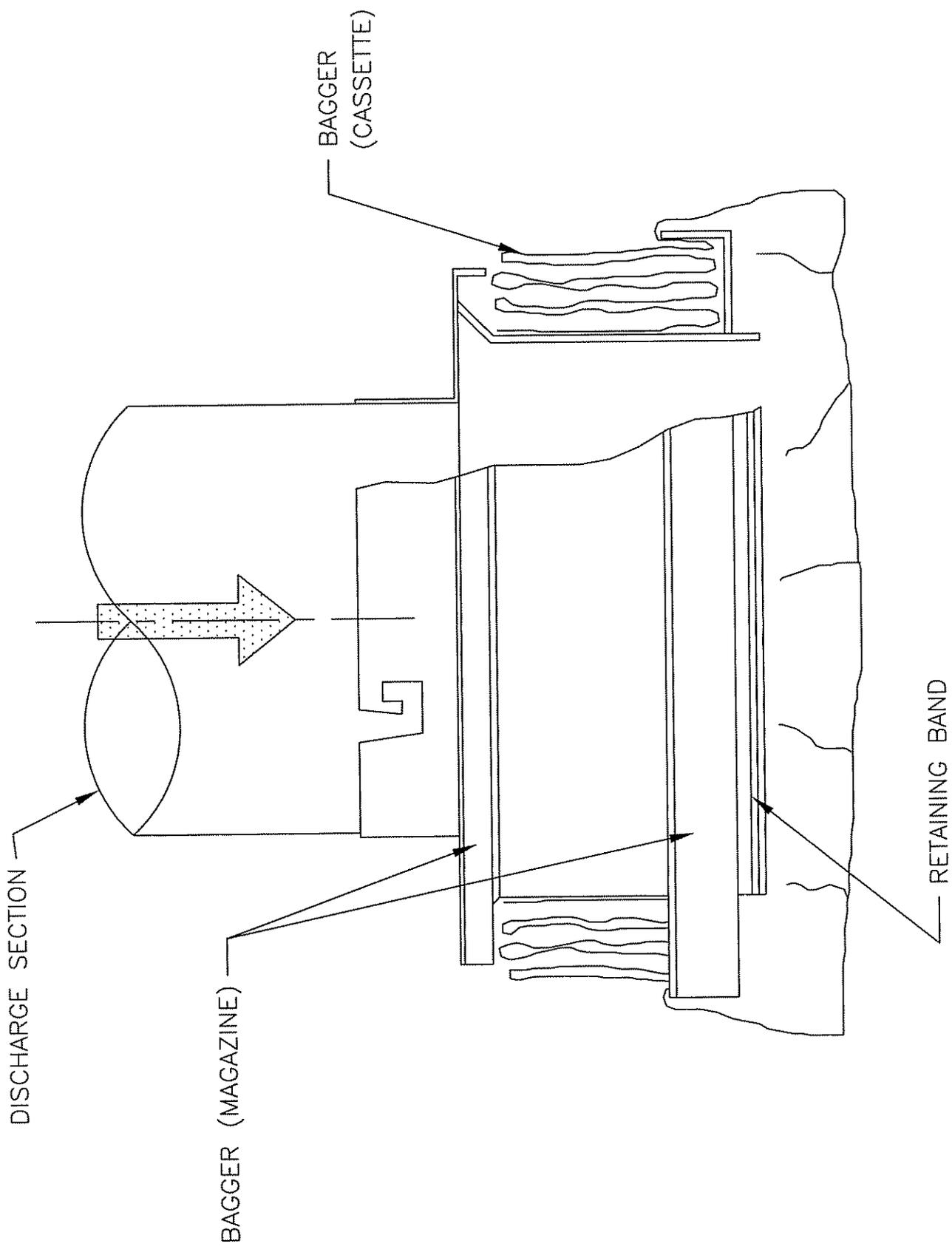
Pivot the screenings assembly into the horizontal position if required (see Fig 6-1A).

Visual inspection of the liquid/solid separation process and mechanical operation of the equipment should be performed on a frequent basis. A visual check for proper liquid/solid separation should be conducted at least once per operating shift. More frequent observation may be needed, depending on the specific application.

Daily

General Visual Inspection

Listen for any unusual noises (clunking sounds, metal scraping, etc.), which could indicate a malfunction. Check for leaks. Check brush for good cleaning contact against the screen basket. Check unit to insure proper operation is maintained. Check that solids are being transported to the discharge point. Inspect solids receptacle to insure that its volume is not in danger of overflowing or backing up into screenings assembly discharge chute. If optional bagger is supplied, replace bag as required (see Fig 5-1A).



BAGGER ASSEMBLY (OPTIONAL)

General Housekeeping

Rinse accumulated solids off of exterior surfaces. Clean other components as needed. Check for screenings and grit accumulation in the screenings influent area of the tank; clean as required.

Weekly

Flush Press Zone

Manually flush press zone dewatering screen by turning on the Press Zone spray system.

Inspect Level Switch Device

Check ultrasonic level switch for malfunction or obstructions that will interfere in the proper operation of the unit. Remove debris as needed.

Wash Screen Basket

On applications with high grease loadings, wash the interior and exterior of the screen basket. High-pressure hot water is recommended for optimal cleaning.

Monthly

Inspect Tank Seals

Check seals for damage, wear or age. Replace if seals are unable to prevent solids from bypassing the screen (see Fig 5-2A).

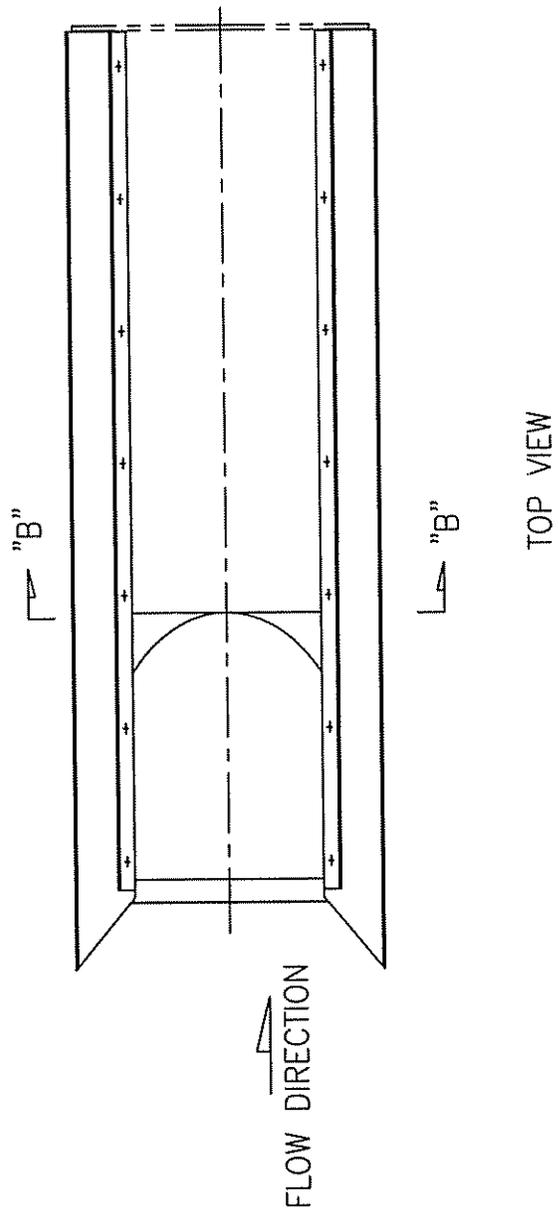
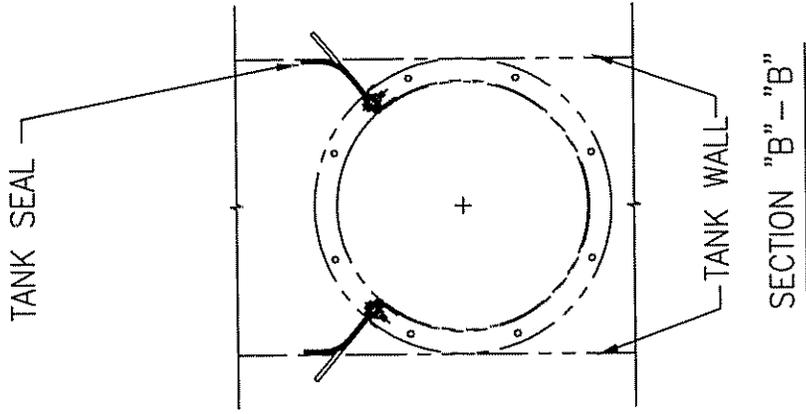
Inspect Wear Bars

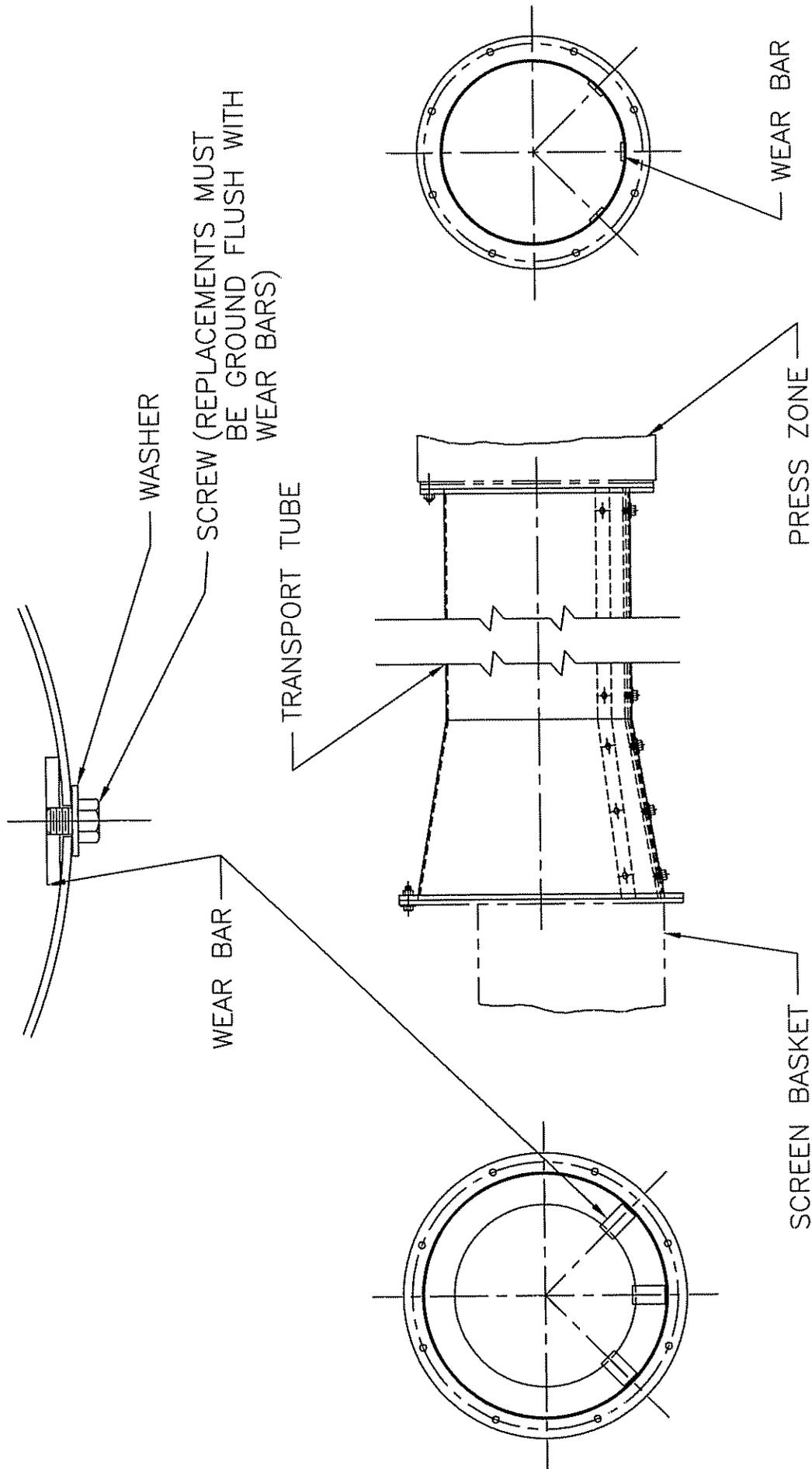
Check screenings and grit assembly wear bars by inspecting the wear bar bolts on each assembly for excessive thread wear. Remove the gauge bolt. If bolt threads measure less than 0.28-inch long, replace wear bars and bolts (see Fig 5-2H).

On Screenings Assembly, if leading edges of wear bars are raised up from screenings transport tube, tighten wear bar bolts. Replace wear bars if leading edges are bent (see Fig 5-2B).

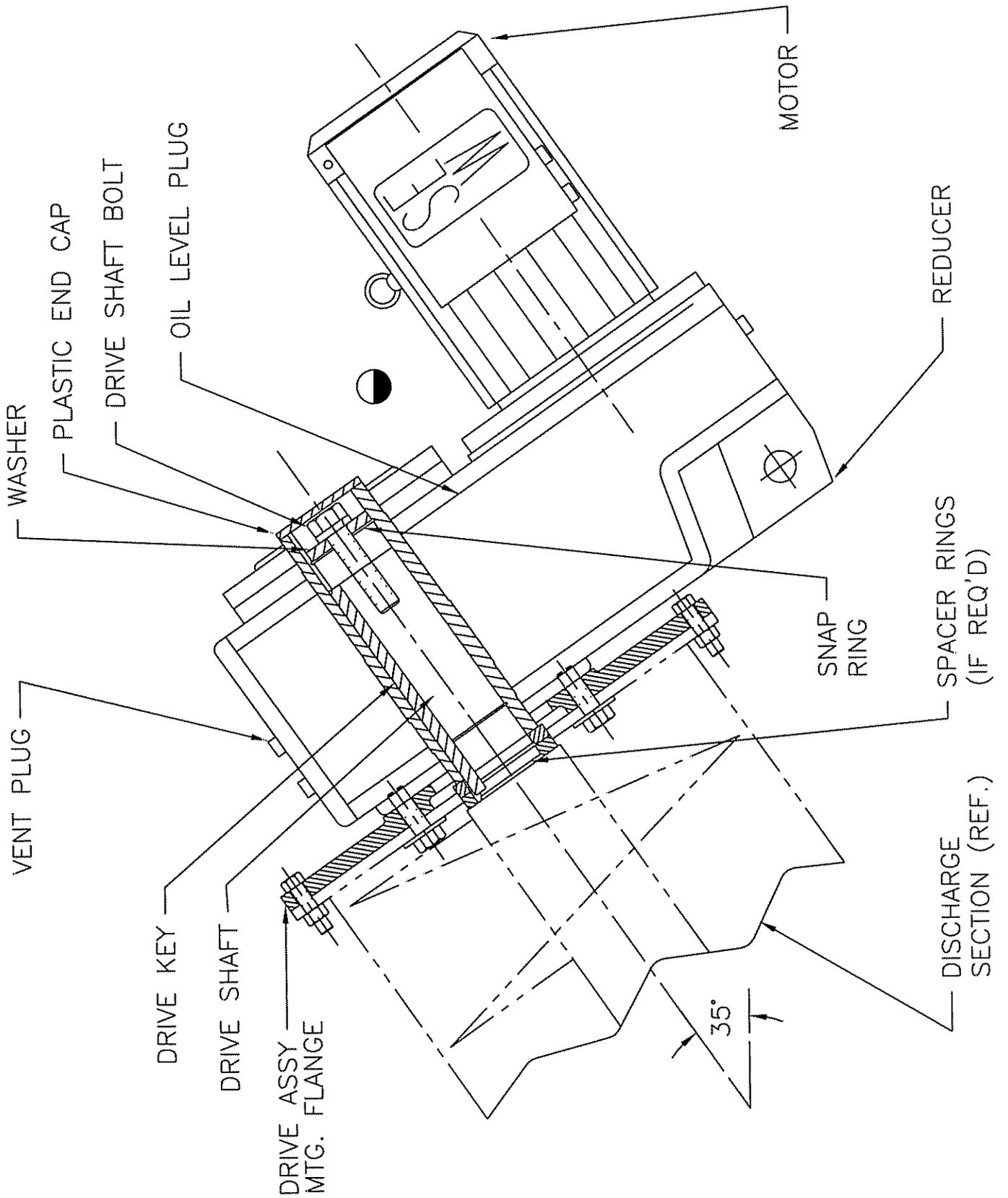
Inspect Shaft Seal Gland

Check the wear of the horizontal grit-conveying spiral's shaft seal (packing) gland and packing material. Under normal operating conditions with a properly adjusted gland, the gland should drip approximately 5 drops per minute. If the bushing has a gap between it and the gland, tighten bolts equally to compress. If gap is completely closed, new packing material is required (see Fig 5-2G).



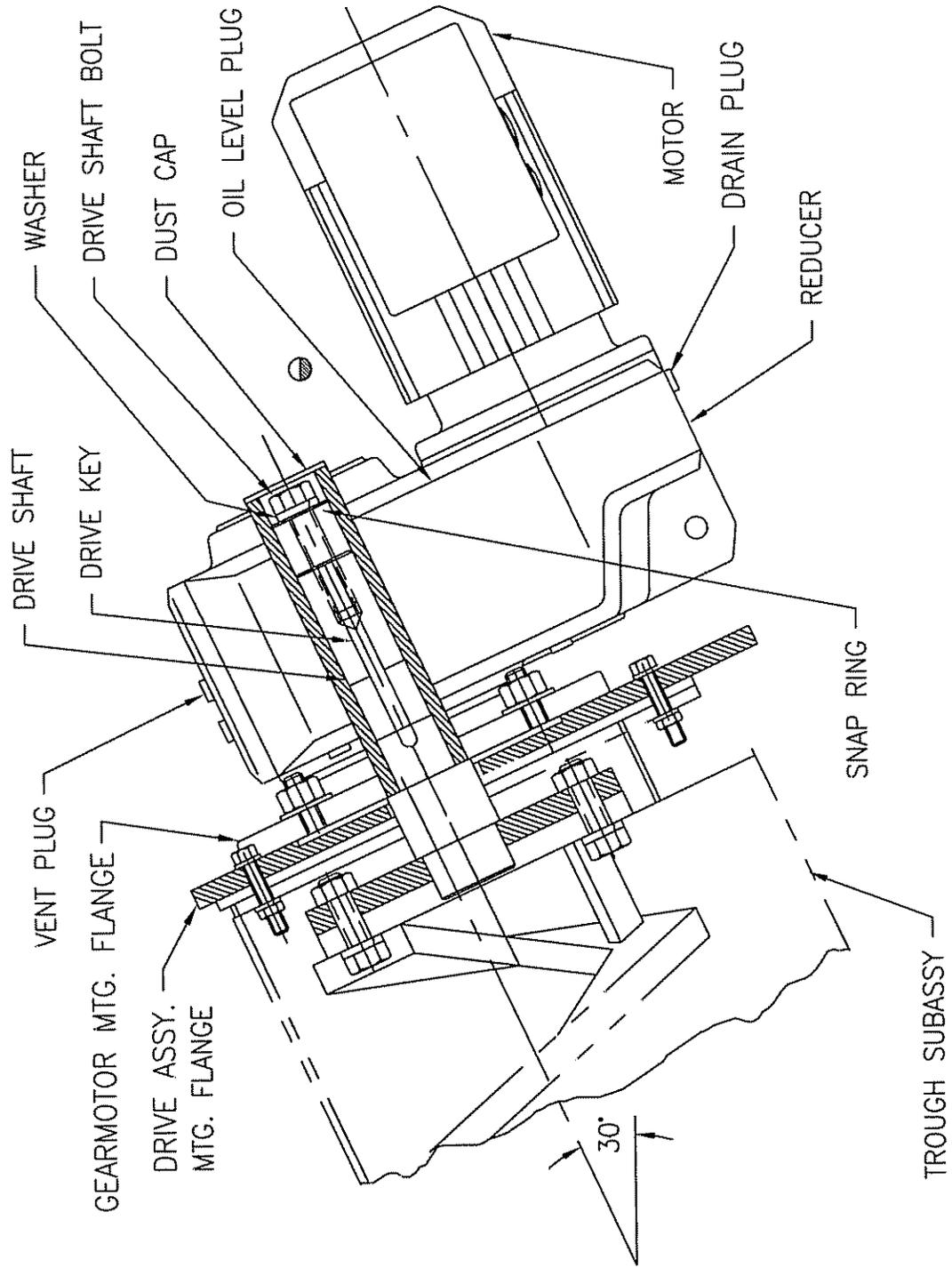


SCREENINGS ASSEMBLY WEAR BAR ATTACHMENT



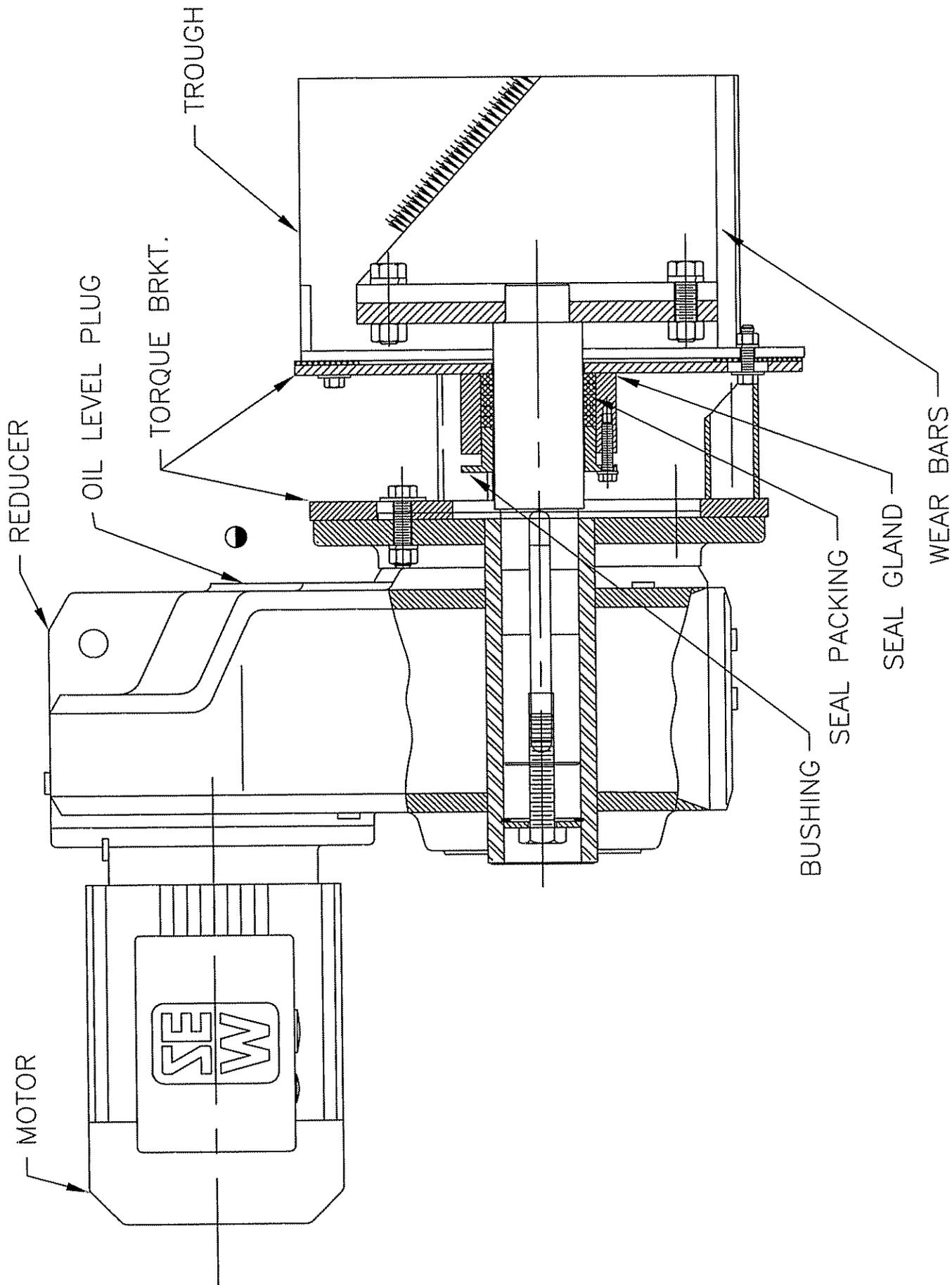
SCREENINGS SPIRAL DRIVE

5-2D

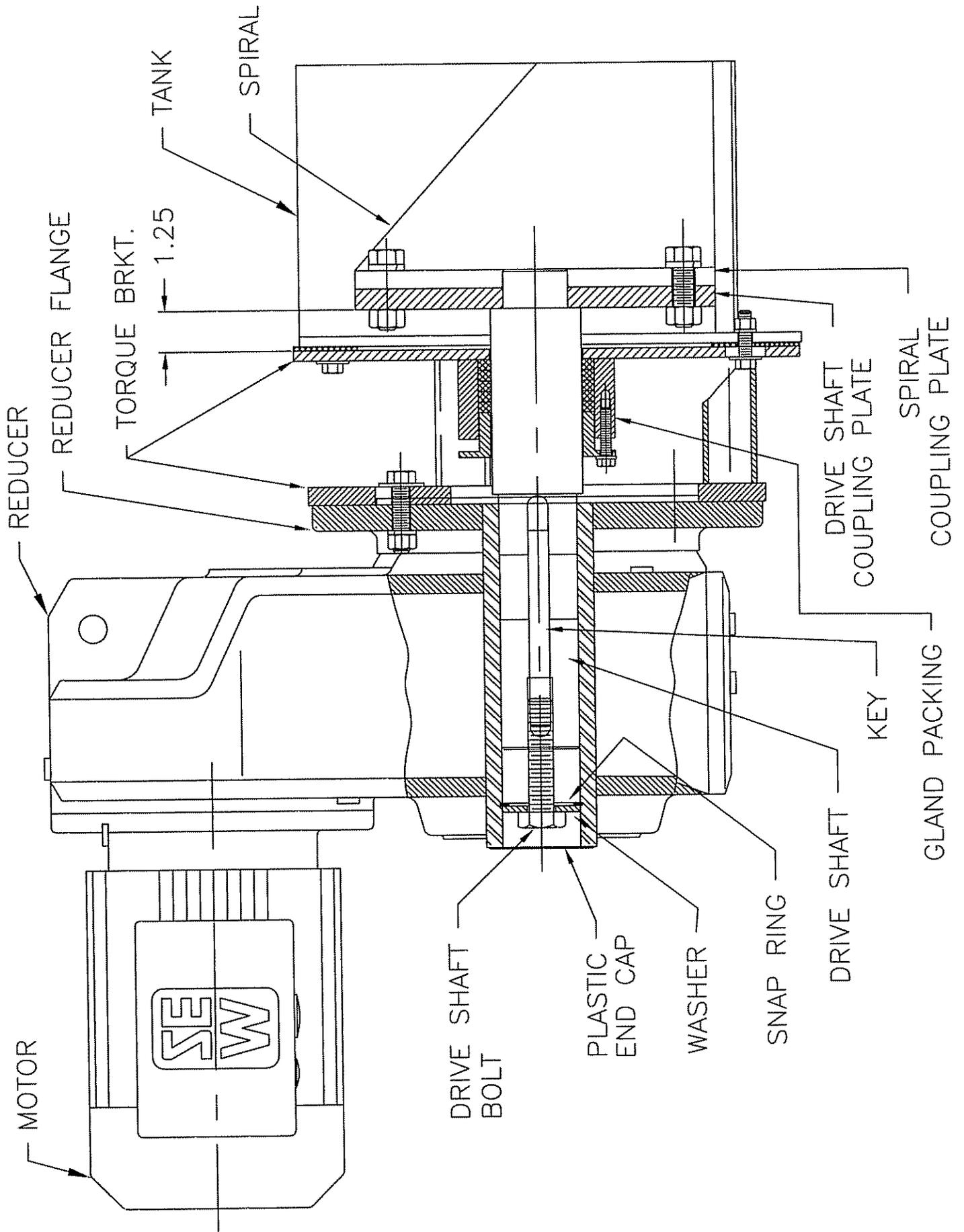


INCLINED GRIT SPIRAL DRIVE

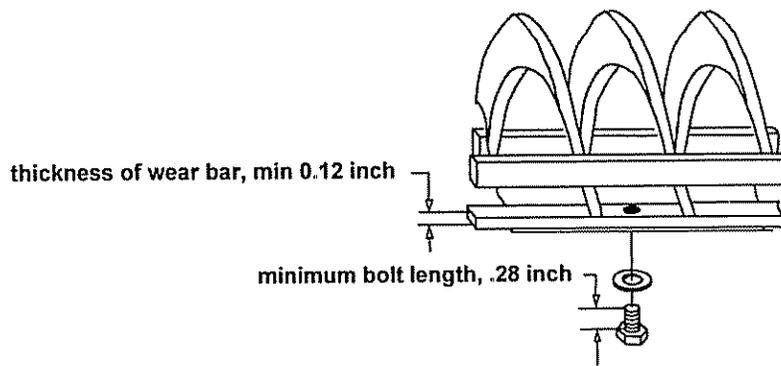
5-2E



HORIZONTAL GRIT SPIRAL DRIVE



HORIZONTAL GRIT SPIRAL DRIVE SHAFT/SPIRAL INTERFACE



GRIT SPIRAL WEAR GAUGE BOLT
FIG 5-2H

Check Gear Reducer Oil Level and Quality

Remove the oil level plug in each reducer and check oil level and quality. If necessary, add oil to bring to proper level. If oil has a burnt odor, presence of water, or some other indication of poor oil quality, flush and replace oil. Monitor oil quality in subsequent checks to confirm that the problem is not recurring (see Fig 5-2D, 5-2E, and 5-2F).

Check Motor and Reducer Exterior

Remove debris from exterior of motor and reducer, particularly between cooling fins and breather plugs.

Check Motor Wire Connections

Confirm that all motor wire connections are tight and properly secured into motor terminal boxes.

Inspect Drain Lines

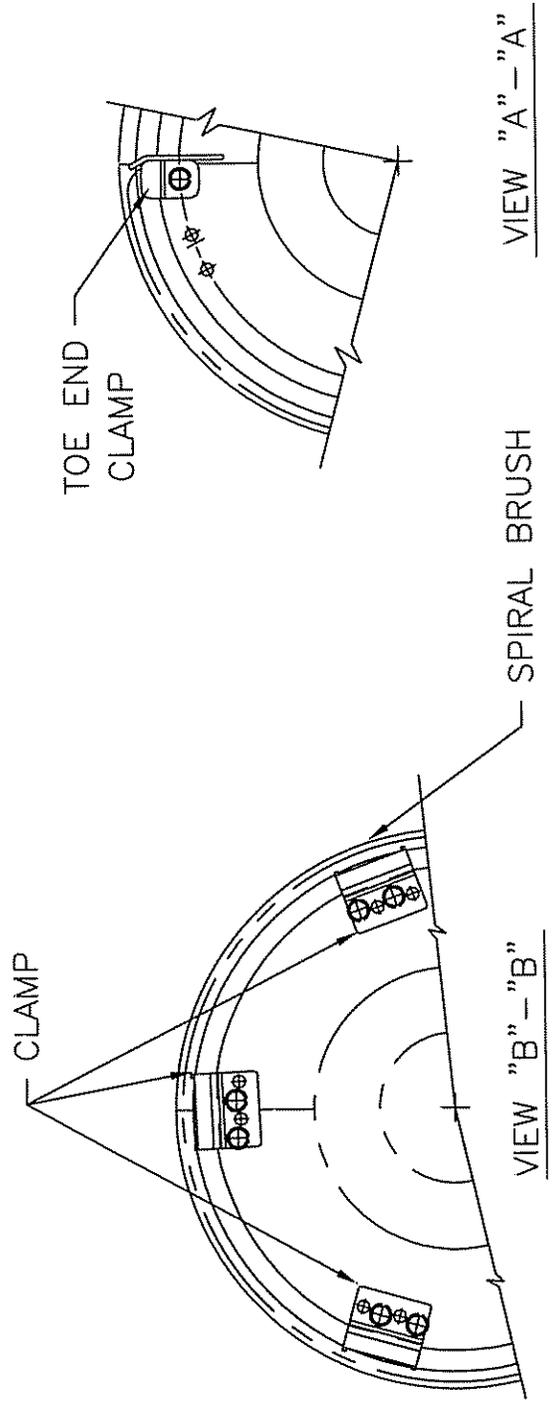
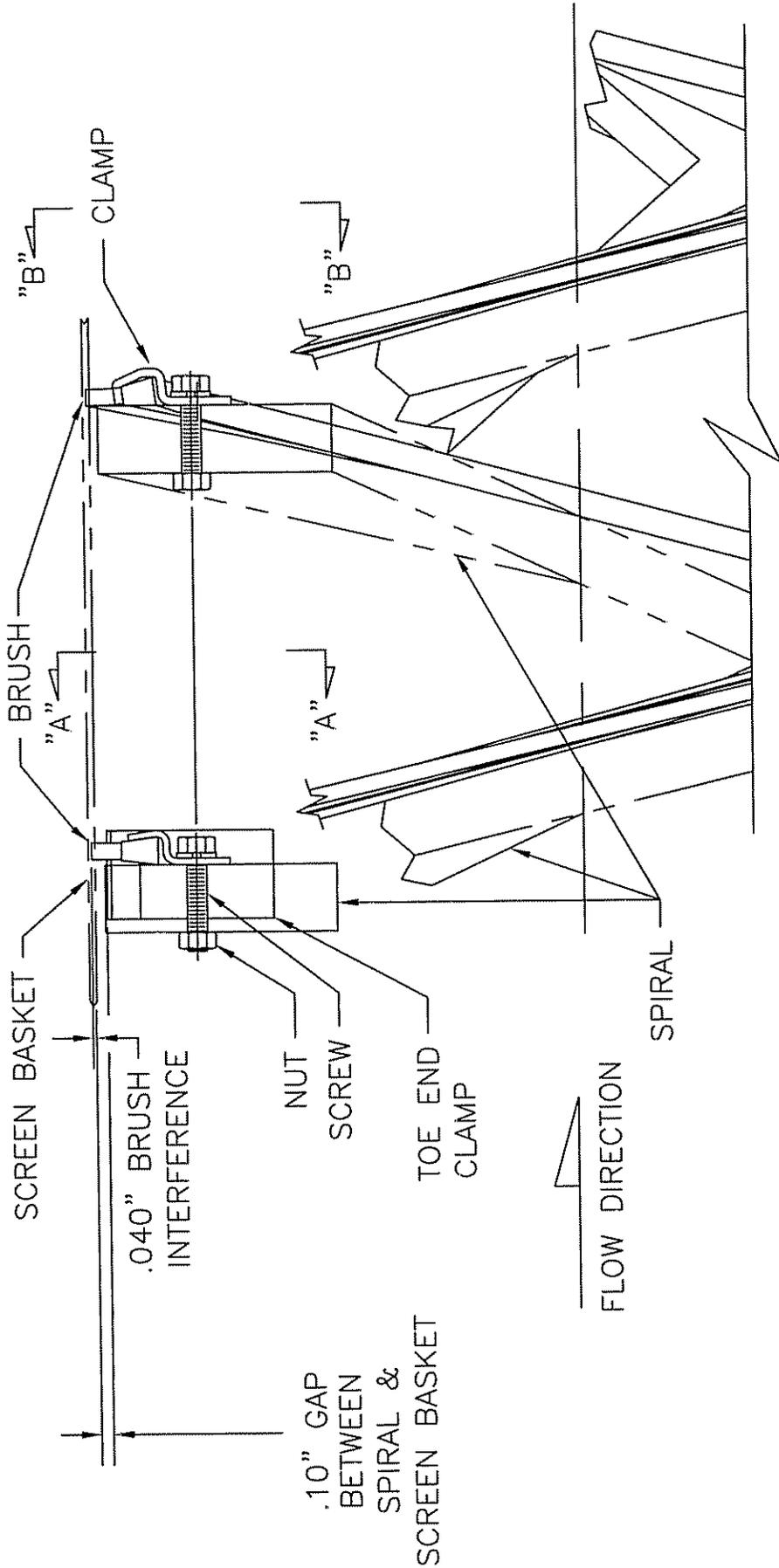
Visually inspect drain lines for cracks or signs of deterioration.

Inspect Brush

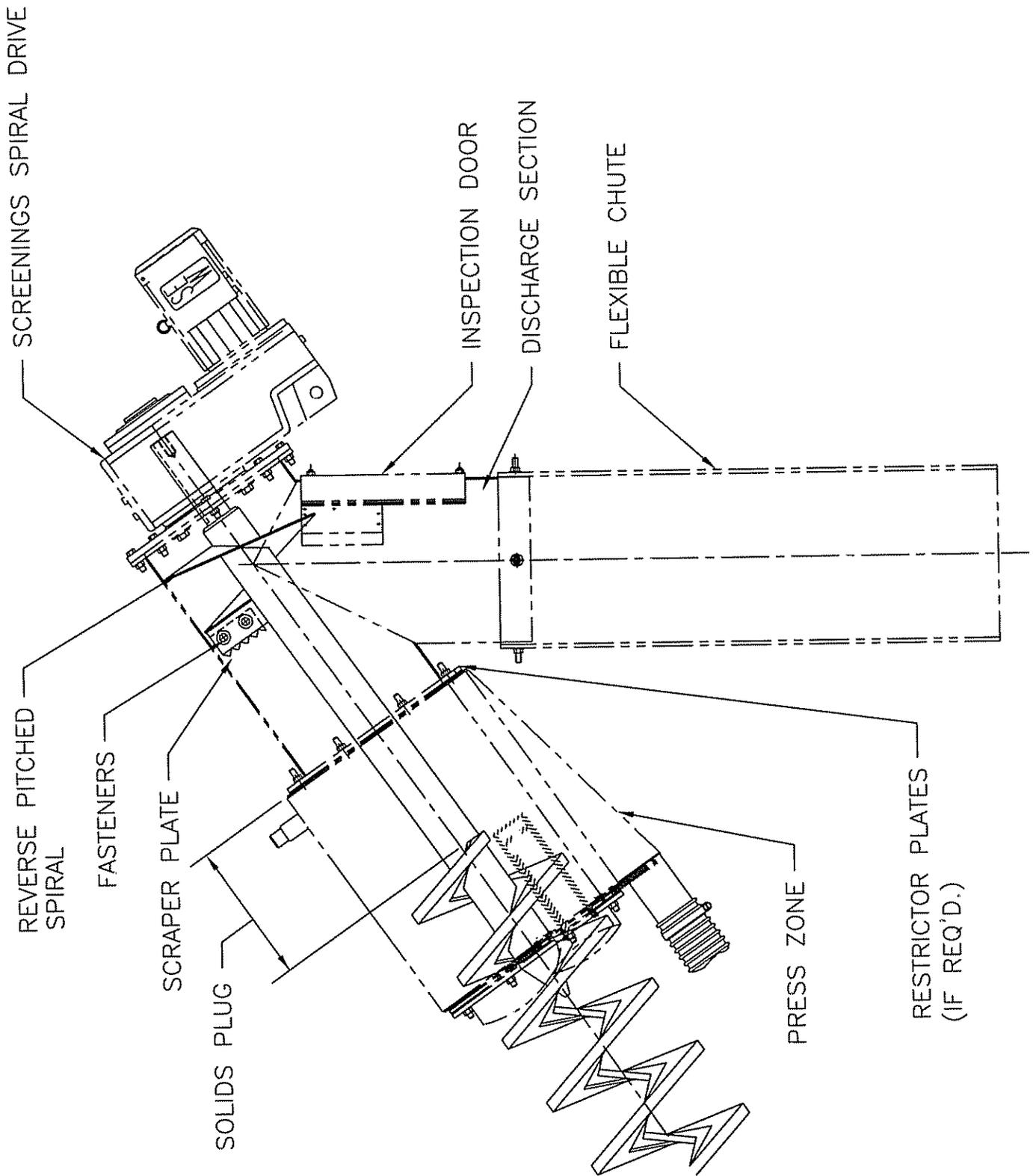
Check screenings spiral brush for excessive wear. The brush should be able to clean screen face of screen basket. Replace when brush bristles are less than .12 inch long or damaged (see Fig 5-3A).

Inspect Scraper Plate

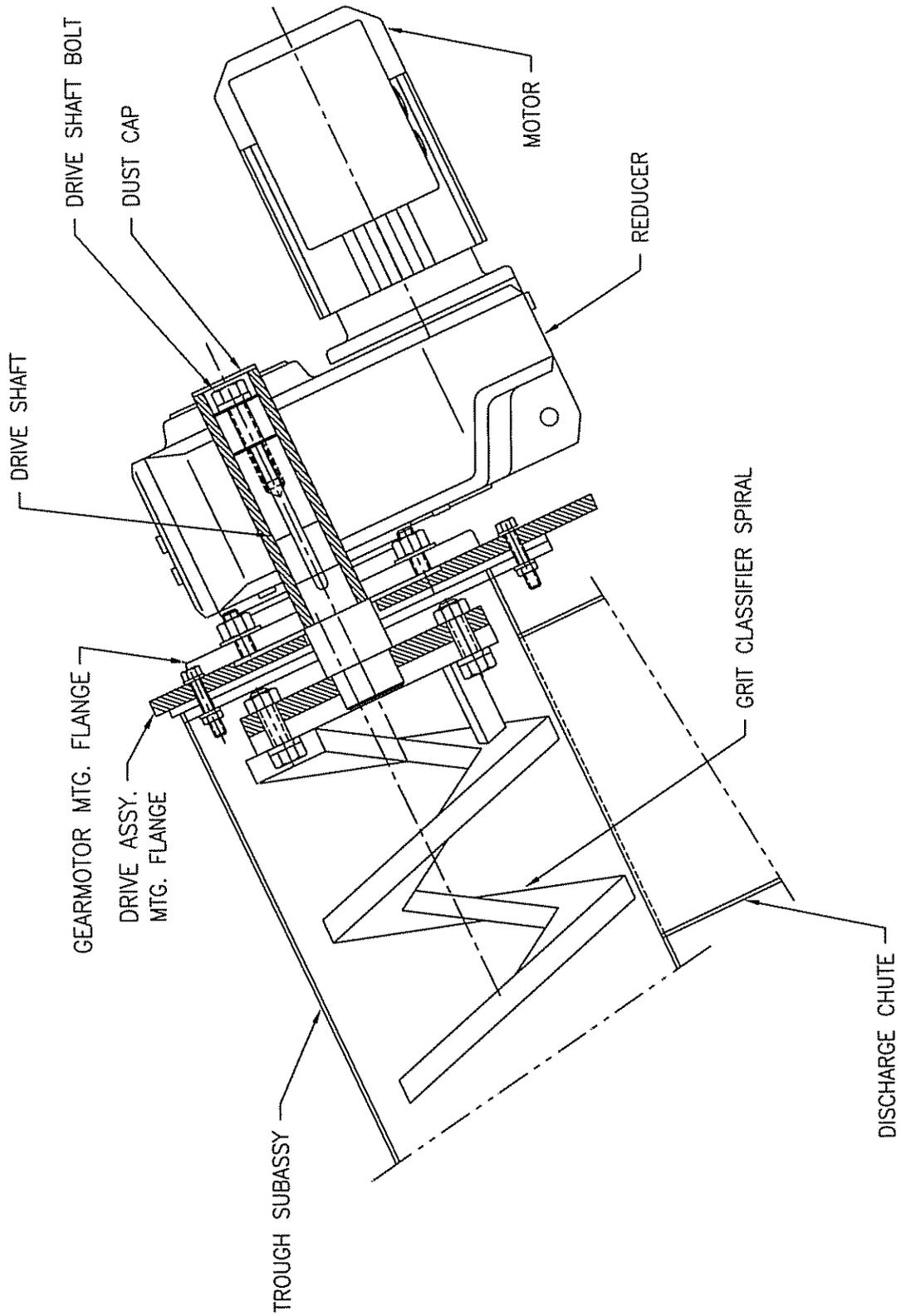
Remove inspection door on discharge chute and inspect the scraper plate. Tighten bolts as necessary. Replace or repair scraper if it is damaged (see Fig 5-3B).



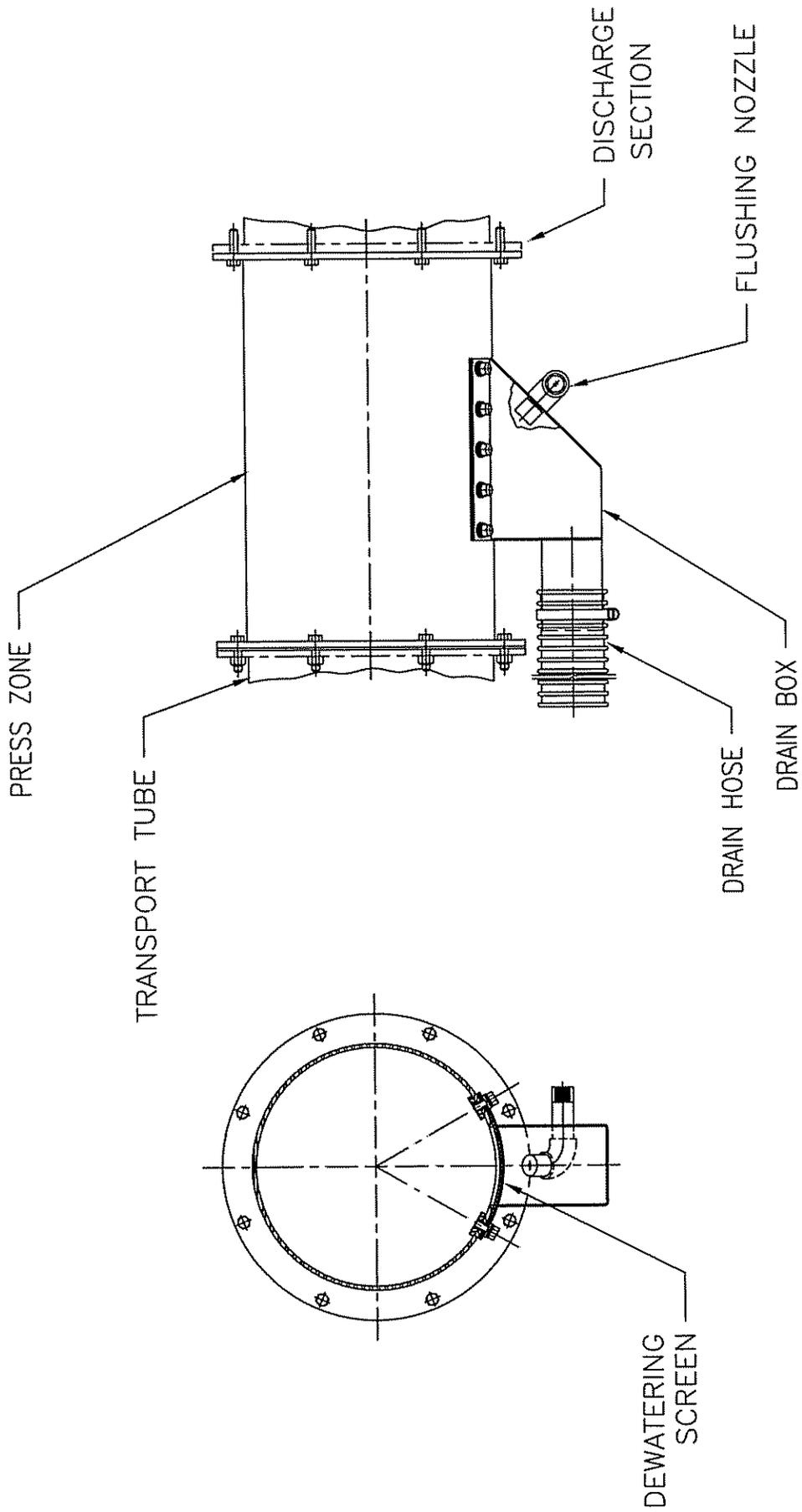
SPIRAL BRUSH ATTACHMENT



SCREENINGS DISCHARGE END VIEW



INCLINED GRIT SPIRAL DISCHARGE END VIEW



PRESS ZONE

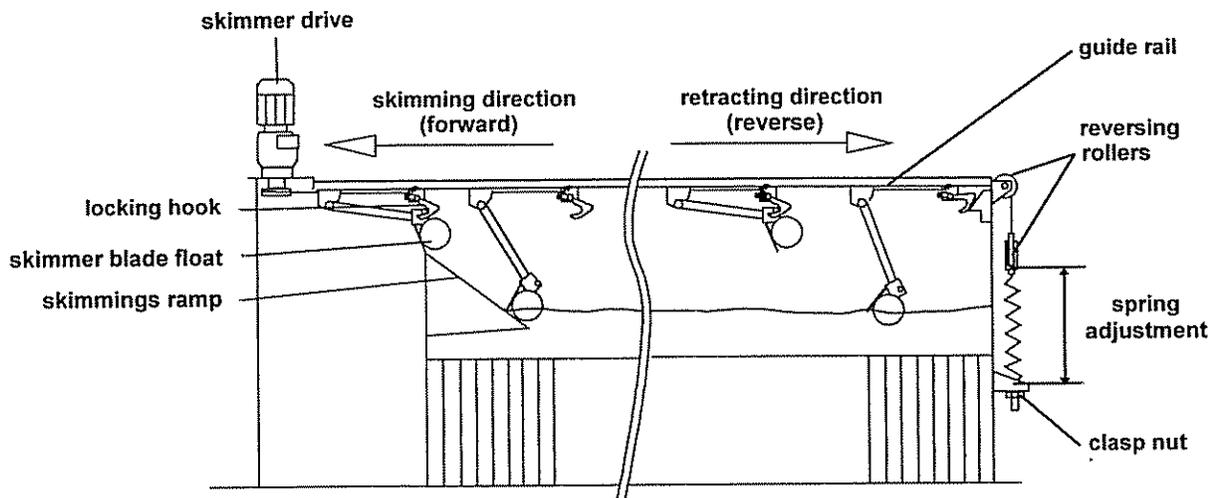
5-3D

Wash Grease Trap and Grease Pump Hopper

Use hot water to wash down the walls of the grease trap and grease pump hopper. Remove accumulated grease on the walls of the trap and hopper that may affect grease removal effectiveness.

Check Condition of Skimmer Cable Guides

Remove tank covers in the grease trap area of the tank. Check condition of the skimmer cable. If cable is damaged (frayed or kinked), replace cable. If cable is not taut, tighten clasp nut to increase cable tension. Spring Adjustment measurement should not exceed 7.50 inches, which corresponds to a spring force of ~ 112 lb (500 N). After adjustment, run skimmer in HAND mode through one full skimming cycle to confirm proper operation (see Fig 5-4A).



GREASE SKIMMER
FIG 5-4A

Check condition of cable guide. If worn, replace guide. Recheck tension and run skimmer in HAND mode through one full skimming cycle to confirm proper operation.

Grease Skimmer Cable and Guides

Remove tank covers in the grease trap area of the tank. Manually apply a thin coat of grease to the inside track of the reversing rollers and to the entire length of skimmer cable and cable guides. In HAND mode, run through one skimming cycle to confirm operation of the skimmer.

Semi-Annually

Check Gear Reducer Output Shaft

Check output shaft for abnormal play on all gear reducers.

Replenish grease lubricant in screenings spiral gear reducer shaft chamber.

Add grease to the screenings spiral gear reducer grease chamber.

Check Spiral

Visually inspect all spirals for wear or warpage.

Inspect Press Zone

Disconnect drain hose from press zone drain box. Remove drain box from press zone. Inspect dewatering screen for damage. Replace if damaged. Check performance of press zone spray nozzle. Replace nozzle if spray pattern is erratic. (See Fig 5-3D)

In order to inspect the spiral and reverse pitch spiral for damage, it is necessary to pivot the screenings sub-assembly into its maintenance position, and remove the drive, the discharge section, and the press zone.

Inspect press zone insulation and thermostat if heater is supplied. Inspect heater jacket for damage. Verify that the entire heater system is in correct and proper working order (see Equipment Drawing).

Inspect Electrically Operated Switches

Verify working order of water spray solenoid valve. Repair or replace as necessary.

Inspect the inspection door interlock switch for proper operation. Repair or replace as necessary.

Inspect all other external electrical switches as required, for appropriate machine operation.

Inspect Inlet Valve (if provided)

Verify the working order of the inlet pinch valve. Inspect valve's body for cracking or other possible damage. Check for leaks. Replace valve liner, if required. (See Inlet Valve data in Section Nine)

Annually

Change Oil in Gear Reducers

Refer to Lubrication Chart in Section Five for proper lubricant and Section Nine for further drive information.

Repack Greaseable Bearings in Gear Reducers

Remove bearings from gear reducers and repack or replace. On gear reducers provided with grease fittings, replenish grease without removing bearing.

Inspect and Clean Unit

Flush and clean the gear unit, as required. Inspect the unit thoroughly and repair or replace damaged or worn parts as necessary.

MAINTENANCE SCHEDULE

PROCEDURE	DAILY	WEEKLY	MONTHLY	SEMI-ANNUALLY	ANNUALLY
General visual inspection.	•				
General housekeeping	•				
Flush press zone.		•			
Inspect level switch devices.		•			
Wash screen basket.		•			
Inspect tank seals.			•		
Inspect wear bars.			•		
Inspect shaft seal gland.			•		
Check gear reducer oil level and quality.			•		
Clean motor and reducer exterior.			•		
Check motor wire connections.			•		
Inspect drain lines.			•		
Inspect brush.			•		
Inspect scraper plate.			•		
Wash grease trap and grease pump hopper.			•		
Check condition of skimmer cable and guides.			•		
Grease skimmer cable and guides.			•		
Check gear reducer output shaft for abnormal play.				•	
Replenish grease in screenings spiral reducer grease chamber.				•	
Check spiral.				•	
Inspect press zone.				•	
Inspect electrically operated switches.				•	
Inspect inlet valve (if provided).				•	

MAINTENANCE SCHEDULE (CONT'D)

PROCEDURE	DAILY	WEEKLY	MONTHLY	SEMI-ANNUALLY	ANNUALLY
Change oil in gear reducers.					•
Repack greaseable bearings in gear reducer.					•
Inspect and clean unit.					•

LUBRICATION CHART

DESCRIPTION	MFR.	GREASE / OIL TYPE	AMOUNT REQUIRED	RECOMMENDED FREQUENCY
Screenings Spiral Reducer	SEW Eurodrive	Mobilgear 630 ISO 220	2.03 gallons	Check oil level and condition monthly. Replace annually.
Screenings Spiral Motor	Baldor	Polyrex EM #2 Polyurea	0.30 oz (0.6 in ³)	Regrease Semi-Annually
Screenings Spiral Reducer Grease Chamber		Mobilux EP #2 Lithium	Fill chamber to capacity (~3 to 4 in ³)	Regrease annually
Inclined Grit Spiral Reducer	SEW Eurodrive	Mobilgear 630 ISO 220	1.14 gallons	Check oil level and condition monthly. Replace annually.
Inclined Grit Spiral Motor	Bauer	Polyrex EM #2 Polyurea	0.30 oz (0.6 in ³)	Regrease Semi-Annually
Horizontal Grit Spiral Reducer	SEW Eurodrive	Mobilgear 630 ISO 220	1.59 gallons	Check oil level and condition monthly. Replace annually.
Horizontal Grit Spiral Motor	Baldor	Polyrex EM #2 Polyurea	0.30 oz (0.6 in ³)	Regrease Semi-Annually
Skimmer Reducer	SEW Eurodrive	Mobilgear 630 ISO 220	0.18 gallons	Check oil level and condition monthly. Replace annually.
Skimmer Motor	Baldor	Polyrex EM #2 Polyurea	0.30 oz (0.6 in ³)	Regrease Semi-Annually
Skimmer Cable and Rollers	Parkson Corporation	Mobilux EP #2 Lithium	As Req'd	Grease Monthly
Grease Pump Motor	Baldor	Polyrex EM #2 Polyurea	0.30 oz (0.6 in ³)	Regrease Semi-Annually
Grease Pump Gear Reducer	Nord Gear	Shell Omala EP220 ISO 220	0.26 quarts	Check oil level and condition monthly. Replace annually.
Grease Pump	Bornemann Pumps	<i>Not Required!</i>	<i>Pump Bearings are Sealed No Lubrication is Required!</i>	<i>Not Required!</i>
Blower Shielded Bearings	Siemens	Unirex EP3 Lithium Complex	see Blower O&M for details	Regrease Semi-Annually
Blower Motor	Baldor	Polyrex EM #2 Polyurea	0.30 oz (0.6 in ³)	Regrease Semi-Annually

Refer to product literature supplied in this manual for additional maintenance instructions.

NOTE: When applying grease lubricants, use same NLGI grade number and base as existing grease. Do not mix grades and bases. Purge all old grease if different grade or base must be used.

Plant operators are responsible for proper use and disposal of all used oils and greases.

 **DANGER** 

WHEN INSTALLING OR MAINTAINING THE COMBI[®] UNIT OR ASSOCIATED HARDWARE, BE SURE THAT ANY LIFTING EQUIPMENT IS OF SUFFICIENT CAPACITY BEFORE LIFTING OR MOVING THE COMBI UNIT OR ASSOCIATED HARDWARE.

DO NOT OPERATE A DAMAGED OR MALFUNCTIONING MECHANISM UNTIL NECESSARY ADJUSTMENTS OR REPAIRS HAVE BEEN MADE.

DO PRACTICE GOOD HOUSEKEEPING. ALWAYS INSURE THE COMBI UNIT IS KEPT CLEAN AND THE AREA AROUND THE COMBI UNIT FREE OF POSSIBLE HAZARDS.

ALWAYS OPERATE AND PERFORM MAINTENANCE IN A MANNER THAT PROMOTES SAFE CONDITIONS. ALWAYS USE THE PROPER TOOLS AND WEAR THE PROPER CLOTHING FOR THE TASK AT HAND.

CONTACT WITH OR EXPOSURE TO MATERIAL PROCESSED OR LUBRICANTS AND OTHER FLUIDS MAY CAUSE INFECTION OR ADVERSE REACTIONS. REPORT ANY CUTS, INJURIES OR EXPOSURE TO YOUR SUPERVISOR IMMEDIATELY AND SEEK APPROPRIATE MEDICAL ATTENTION.

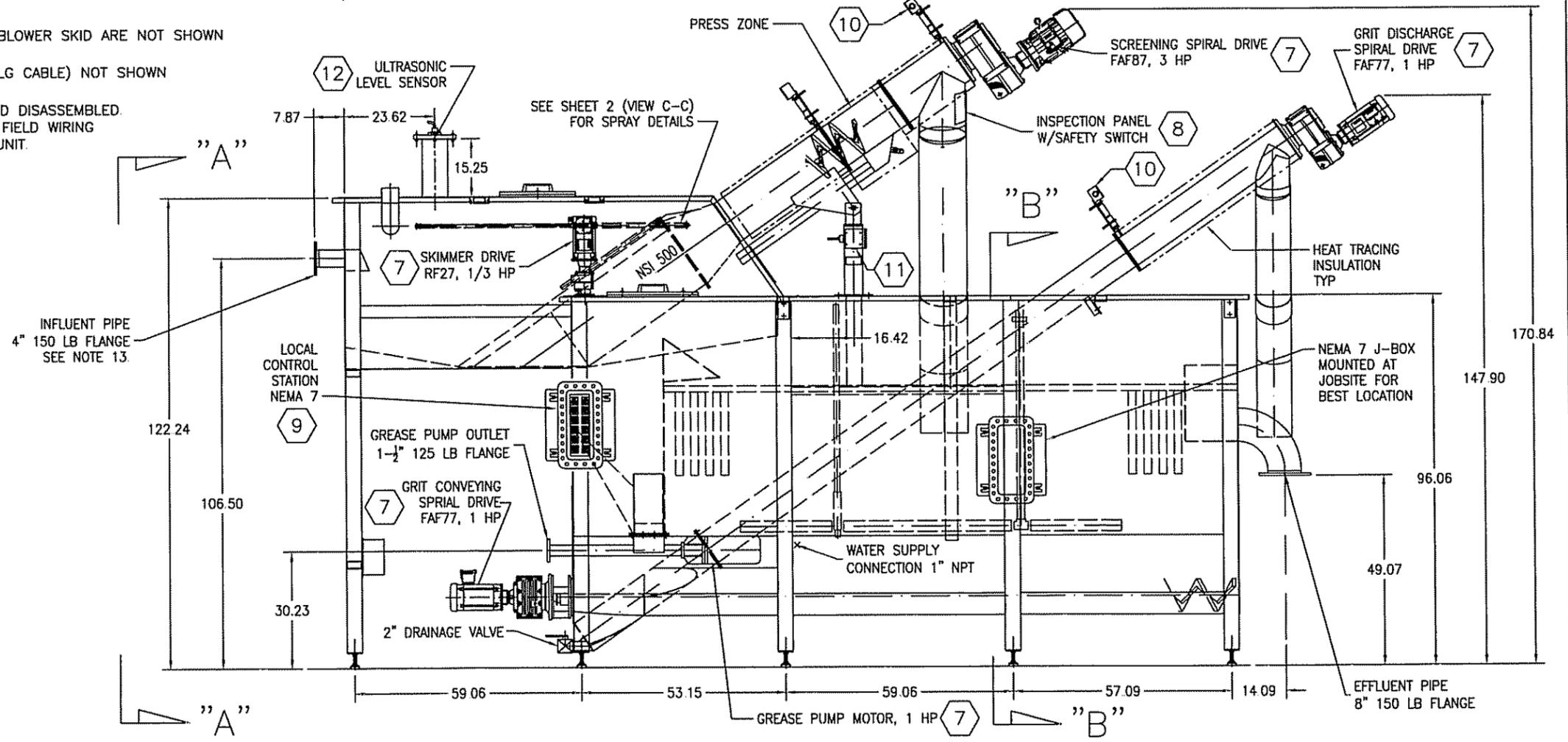
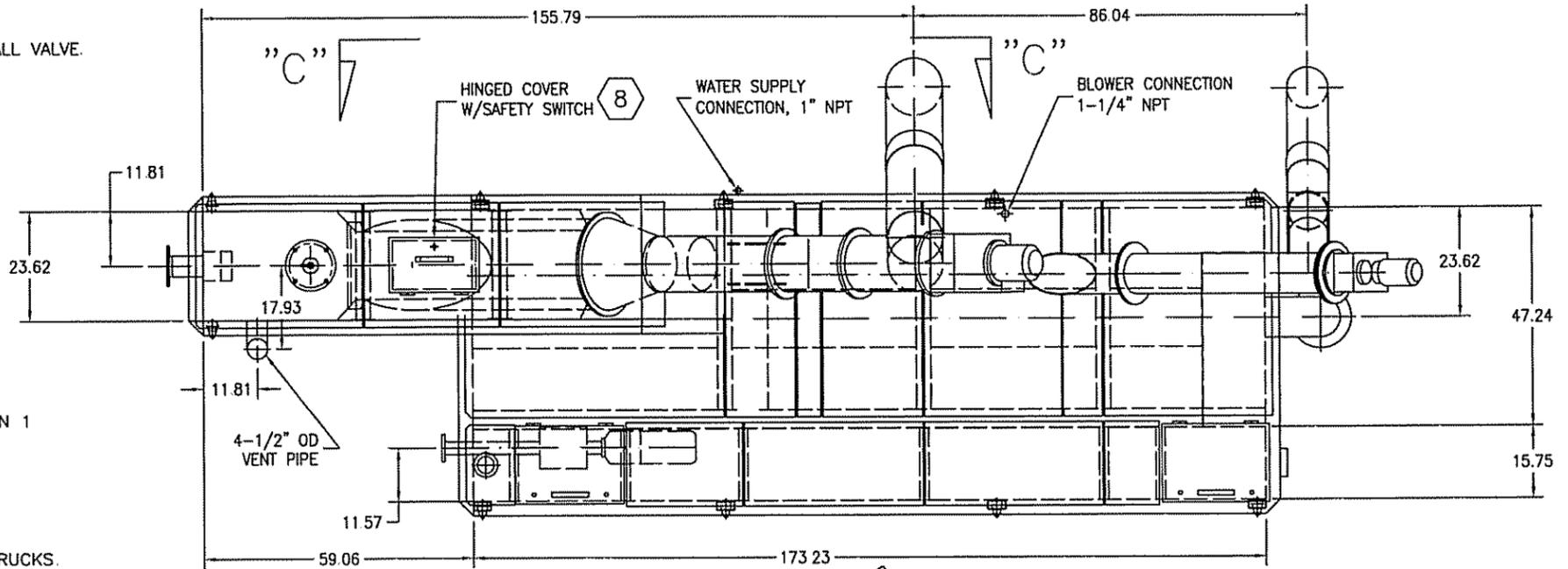
THIS PRODUCT HAS BEEN SUPPLIED WITH WARNING LABELS. SHOULD THEY BECOME DAMAGED, REMOVED OR ILLEGIBLE, PLEASE CONTACT PARKSON CORPORATION FOR NO-COST REPLACEMENT LABELS.

WARNING LABEL PART NUMBERS FOR THIS PRODUCT ARE 3824-003 AND 3824-004. SEE FIGURE ON FIGURE 1-3A FOR PROPER LOCATION.

EQUIPMENT DRAWINGS

NOTE:

1. EACH SPRAY SYSTEM WILL BE PROVIDED WITH A SOLENOID VALVE AND AN ISOLATION BALL VALVE.
2. WEIGHT: 7,500 LB (DRY - UNIT), 1,200 LB (DRY - SCREENINGS ASSEMBLY)
3. DIMENSIONS WRITTEN IN INCHES UNLESS OTHERWISE SPECIFIED.
4. PROVIDE SUFFICIENT FLEXIBILITY IN WATER AND ELECTRICAL CONNECTIONS TO ALLOW THE UNIT TO PIVOT OUT OF THE CHANNEL. ALL INTERCONNECTING WIRING, CONDUIT, AND PIPING FROM UNIT MOUNTED DEVICES WILL BE SUPPLIED BY OTHERS.
5. GROUND CLEARANCE FOR DISCHARGE RECEPTACLE. DO NOT REMOVE RIGID DISCHARGE CHUTE/GUARD.
6. NEMA 7 SOLENOID VALVE: 1/2" NPT CONDUIT CONNECTION.
7. EXPLOSION-PROOF MOTOR: 1/2" NPT CONDUIT CONNECTION. EXCEPTION: 3 HP SCREENINGS SPIRAL MOTOR HAS A 3/4" NPT CONDUIT CONNECTION.
8. NEMA 7 INTERLOCK SWITCH: 1/2" NPT CONDUIT CONNECTION.
9. NEMA 7 LOCAL CONTROL STATION W/ (2) 1-1/2" NPT CONDUIT CONNECTIONS.
10. EXPLOSION-PROOF NEMA 7 HEAT TRACING POWER CONNECTION FOR A CLASS I, DIVISION 1 HAZARDOUS ENVIRONMENT, W/ 3/4" NPT CONDUIT CONNECTION.
11. EXPLOSION-PROOF NEMA 7 THERMOSTAT FOR HEAT TRACING W/ 3/4" NPT CONDUIT CONNECTION.
12. CSA AND FM APPROVED CLASS I, DIVISION 1 ULTRASONIC LEVEL SENSOR: 1" MNPT CONDUIT CONNECTION W/ 10 METER CABLE.
13. TWO (2) UNITS, EACH AS SHOWN ON THE DRAWING, TO BE SUPPLIED.
14. INFLUENT PIPE MUST BE LOCATED TO ALLOW GRAVITY DRAINAGE OF SEPTAGE HAULER TRUCKS.
15. SEE SHEET TWO FOR VIEWS A-A AND B-B.
16. INLET PIPING (INCLUDING PINCH VALVE AND FLOW METER) AND BLOWER SKID ARE NOT SHOWN ON DRAWINGS.
17. SKIMMER PROXIMITY SWITCHES (EACH PROVIDED WITH 1 METER LG CABLE) NOT SHOWN ON DRAWINGS.
18. SCREENINGS SPIRAL AND INCLINED GRIT SPIRAL WILL BE SHIPPED DISASSEMBLED. THESE COMPONENTS MUST BE REASSEMBLED AT THE JOBSITE. FIELD WIRING MUST BE INSTALLED AFTER REASSEMBLY AND INSTALLATION OF UNIT.



PARKSON CORPORATION

Property of PARKSON CORPORATION. All rights reserved. No part of this drawing may be reproduced in any form without permission in writing from PARKSON CORPORATION. PARKSON CORPORATION reserves the right to alter this data or the design of its equipment at any time, without prior notice and without incurring any obligation whatsoever.

Preliminary Information Only
 For Approval Dimensions Certified
 This drawing is limited to functional design, general arrangement and clearance. No responsibility is accepted by PARKSON CORPORATION for other dimensions, quantities, or coordination with other equipment or drawings except as stated in the purchase order.
 By WBS Date 3/21/03

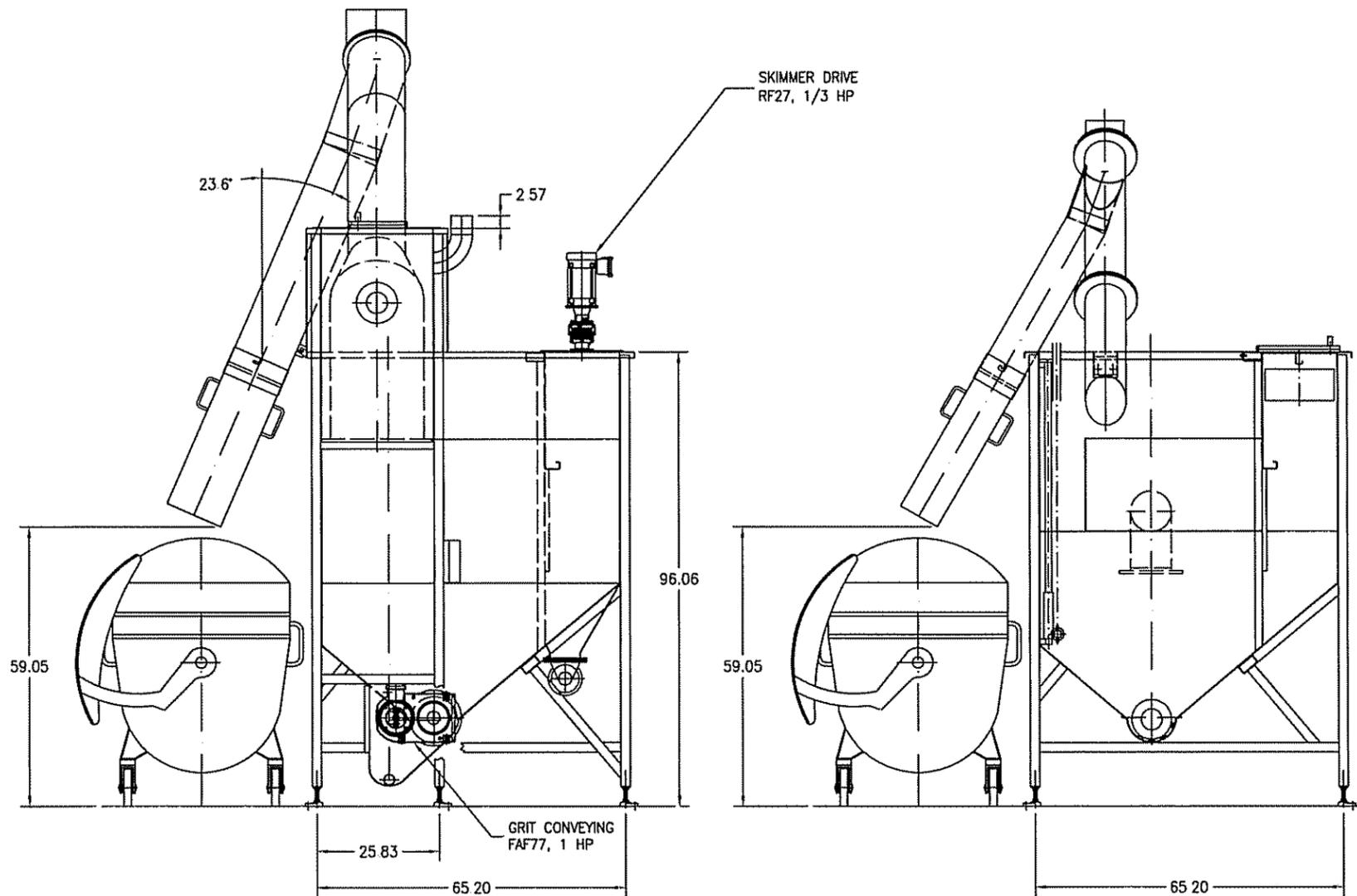
REV	DESCRIPTION	DATE	REFERENCE INFORMATION
A	ENGR RELEASE	3/14/03	

PROJECT NAME

DRAWN BY	DATE
GRB	1/6/03
CHECKED BY	DATE
WBS	01/10/03
SCALE	1/35

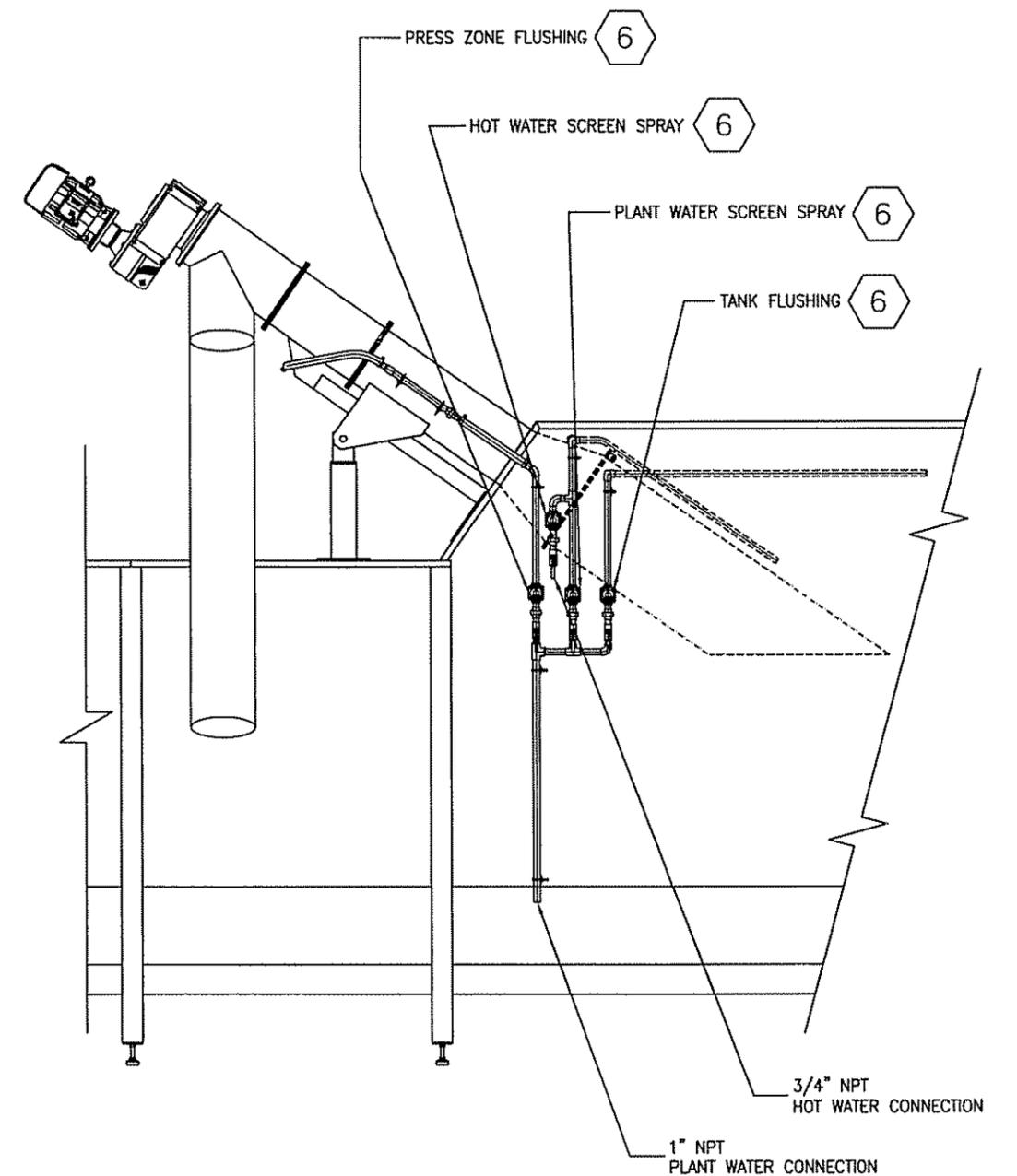
TITLE
COMBI UNIT MODEL CBI 1200SR
DRAWING NO
71010501
REV
A

PROJECT NAME



VIEW "A-A"

SECTION "B-B"



VIEW "C-C"

WATER SPRAY SYSTEMS - HEAT TRACING/INSULATION NOT SHOWN

PARKSON CORPORATION

Property of PARKSON CORPORATION. All rights reserved. No part of this drawing may be reproduced in any form without permission in writing from PARKSON CORPORATION. PARKSON CORPORATION reserves the right to alter this data or the design of its equipment at any time, without prior notice and without incurring any obligation whatsoever.

Preliminary Information Only
 For Approval Dimensions Certified

This drawing is limited to functional design, general arrangement and clearance. No responsibility is accepted by PARKSON CORPORATION for other dimensions, quantities, or coordination with other equipment or drawings except as stated in the purchase order.

By WBS Date 3/21/03

REV	DESCRIPTION	DATE	REFERENCE INFORMATION	PROJECT NAME
A	ENGR RELEASE	3/14/03		

DRAWN BY	DATE	TITLE	DRAWING NO	REV
GRB	1/6/03	COMBI UNIT MODEL CBI 1200SR	71010501	A
CHECKED BY	DATE			
WBS	3/21/03			
SCALE	1/32			

Section 002:

Blowers

Blower Package Parts

Howden Roots Blower

68URAI, 650SFCM, 8.0 PSIG, 2054 RPM, CCW Rotation

Motor:

40 HP, 1800 RPM, TEFC, 460/3/60

Filter / Silencers

Inlet Filter: Universal CCF-5" with paper element

Inlet Silencer: Universal RISY-5"

Discharge Silencer: Universal SDY-5"

Relief Valve

Weighted Type 2.5" set @ 9.0 PSIG

Check Valve

Wafer Type – 5" with EPDM seat

Gauges & Instruments

Pressure Gauge: 2.5" Ø dial, 0-15 PSIG, liquid-filled

Miscellaneous

Flexible Connectors: R&M Standard Flex Fab

Sound Enclosure: 2" thick acoustically treated aluminum panels, vent hood and electric fan, 784 lcfm, 1/10hp, 112/1/60

V-Belt Drive: TB Woods V-Belt Drive Instructions

Safety Precautions

It is important that all personnel observe safety precautions to minimize the chances of injury. Among many considerations, the following should be particularly noted:

- Blower casing and associated piping or accessories may become hot enough to cause major skin burns on contact.
- Internal and external rotating parts of the blower and driving equipment can produce serious physical injuries. Do not reach into any opening in the blower while it is operating, or while subject to accidental starting. Protect external moving parts with adequate guards.
- Disconnect power before doing any work, and avoid bypassing or rendering inoperative any safety or protective devices.
- If blower is operated with piping disconnected, place a strong coarse screen over the inlet and avoid standing in the discharge air stream.

Operating Limitations

A Roots blower or exhauster must be operated within certain approved limiting conditions to enable continued satisfactory performance. Warranty is contingent on such operation.

Maximum limits for pressure, temperature and speed are specified in Table 1 for various models & sizes of blowers and exhausters. These limits apply to all units of normal construction, when operated under standard atmospheric conditions. Be sure to arrange connections or taps for instruments, thermometers and pressure or vacuum gauges at or near the inlet and discharge connections of the unit. These, along with a tachometer, will enable periodic checks of operating conditions.

PRESSURE – The pressure rise, between inlet and discharge, must not exceed the figure listed for the specific unit frame size concerned. Also, in any system where the unit inlet is at a positive pressure above atmosphere a maximum case rating of 25 PSI gauge (1725 mbar) should not be exceeded without first consulting Roots. Never should the maximum allowable differential pressure be exceeded.

On vacuum service, with the discharge to atmospheric pressure, the inlet suction or vacuum must not be greater than values listed for the specific frame size.

TEMPERATURE – Blower & exhauster frame sizes are approved only for installations where the following temperature limitations can be maintained in service:

CAUTION: Never cover the blower inlet with your hand or other part of body.

- Stay clear of the blast from pressure relief valves and the suction area of vacuum relief valves.
- Use proper care and good procedures in handling, lifting, installing, operating and maintaining the equipment.
- Casing pressure must not exceed 25 PSI (1725 mbar) gauge. Do not pressurize vented cavities from an external source, nor restrict the vents without first consulting Roots.
- Do not use air blowers on explosive or hazardous gases.
- Other potential hazards to safety may also be associated with operation of this equipment. All personnel working in or passing through the area should be trained to exercise adequate general safety precautions.

- Measured temperature rise must not exceed listed values when the inlet is at ambient temperature. Ambient is considered as the general temperature of the space around the unit. This is not outdoor temperature unless the unit is installed outdoors.
- If inlet temperature is higher than ambient, the listed allowable temperature rise values must be reduced by 2/3 of the difference between the actual measured inlet temperature and the ambient temperature.
- The average of the inlet and discharge temperature must not exceed 250°F. (121°C).
- The ambient temperature of the space the blower/motor is installed in should not be higher than 120°F (48.8°C).

SPEED – These blowers & exhausters may be operated at speeds up to the maximum listed for the various frame sizes. They may be direct coupled to suitable constant speed drivers if pressure/temperature conditions are also within limits. At low speeds, excessive temperature rise may be a limiting factor

Special Note: The listed maximum allowable temperature rise for any particular blower & exhauster may occur well before its maximum pressure or vacuum rating is reached. This may occur at high altitude, low vacuum or at very low speed. The units' operating limit is always determined by the maximum rating reached first. It can be any one of the three: Pressure, Temperature or Speed.

Installation

Roots blowers & exhausters are treated after factory assembly to protect against normal atmospheric corrosion. The maximum period of internal protection is considered to be one year under average conditions, if shipping plugs and seals are not removed. Protection against chemical or salt water atmosphere is not provided. Avoid opening the unit until ready to start installation, as corrosion protection will be quickly lost due to evaporation.

If there is to be an extended period between installation and start up, the following steps should be taken to ensure corrosion protection.

- Coat internals of cylinder, gearbox and drive end bearing reservoir with Nox-Rust VCI-10 or equivalent. Repeat once a year or as conditions may require. Nox-Rust VCI-10 is petroleum soluble and does not have to be removed before lubricating. It may be obtained from Daubert Chemical Co., 2000 Spring Rd., Oak Brook, Ill. 60521.
- Paint shaft extension, inlet and discharge flanges, and all other exposed surfaces with Nox-Rust X-110 or equivalent.
- Seal inlet, discharge, and vent openings. It is not recommended that the unit be set in place, piped to the system, and allowed to remain idle for extended periods. If any part is left open to the atmosphere, the Nox-Rust VCI-10 vapor will escape and lose its effectiveness.
- Protect units from excessive vibration during storage.
- Rotate shaft three or four revolutions every two weeks.
- Prior to start up, remove flange covers on both inlet and discharge and inspect internals to insure absence of rust. Check all internal clearances. Also, at this time, remove gearbox and drive end bearing cover and inspect gear teeth and bearings for rust.

Because of the completely enclosed unit design, location of the installation is generally not a critical matter. A clean, dry and protected indoor location is preferred. However, an outdoor location will normally give satisfactory service. Important requirements are that the correct grade of lubricating oil be provided for expected operating temperatures, and that the unit be located so that routine checking and servicing can be performed conveniently. Proper care in locating driver and accessory equipment must also be considered.

Supervision of the installation by a Howden Roots Service Engineer is not usually required for these units. Workmen with experience in installing light to medium weight machinery should be able to produce satisfactory results. Handling of the equipment needs to be accomplished with care, and in compliance with safe

practices. Unit mounting must be solid, without strain or twist, and air piping must be clean, accurately aligned and properly connected.

Bare-shaft Units: Two methods are used to handle a unit without base. One is to use lifting lugs bolted into the top of the unit headplates. Test them first for tightness and fractures by tapping with a hammer. In lifting, keep the direction of cable pull on these bolts as nearly vertical as possible. If lifting lugs are not available, lifting slings may be passed under the cylinder adjacent to the headplates. Either method prevents strain on the extended drive shaft.

Packaged Units: When the unit is furnished mounted on a baseplate, with or without a driver, use of lifting slings passing under the base flanges is required. Arrange these slings so that no strains are placed on the unit casing or mounting feet, or on any mounted accessory equipment. DO NOT use the lifting lugs in the top of the unit headplates.

Before starting the installation, remove plugs, covers or seals from unit inlet and discharge connections and inspect the interior completely for foreign material. If cleaning is required, finish by washing the cylinder, headplates and impeller thoroughly with an appropriate solvent. Turn the drive shaft by hand to make sure that the impellers turn freely at all points. Anti-rust compound on the connection flanges and drive shaft extension may also be removed at this time with the same solvent. Cover the flanges until ready to connect piping.

Mounting

Care will pay dividends when arranging the unit mounting. This is especially true when the unit is a "bare-shaft" unit furnished without a baseplate. The convenient procedure may be to mount such a unit directly on a floor or small concrete pad, but this generally produces the least satisfactory results. It definitely causes the most problems in levelling and alignment and may result in a "Soft Foot" condition. Correct soft foot before operation to avoid unnecessary loading on the casing and bearings. Direct use of building structural framing members is not recommended.

For blowers without a base, it is recommended that a well anchored and carefully levelled steel or cast iron mounting plate be provided. The plate should be at least 1 inch (25 mm) thick, with its top surface machined flat, and large enough to provide levelling areas at one side and one end after the unit is mounted. It should have properly sized studs or tapped holes located to match the unit foot drilling. Proper use of a high quality machinist's level is necessary for adequate installation.

With the mounting plate in place and levelled, set the unit on it without bolting and check for rocking. If it is not solid, determine the total thickness of shims required under one foot to stop rocking. Place half of this under each of the diagonally-opposite short feet, and tighten the mounting studs or screws. Rotate the drive shaft to make sure the impellers turn freely. If the unit is to be direct coupled to a driving motor, consider the height of the motor shaft and the necessity for it to be aligned very accurately with the unit shaft. Best unit arrangement is directly bolted to the mounting plate while the driver is on shims of at least 1/8 inch (3mm) thickness. This allows adjustment of motor position in final shaft alignment by varying the shim thickness.

Aligning

When unit and driver are factory mounted on a common baseplate, the assembly will have been properly aligned and is to be treated as a unit for levelling purposes. Satisfactory installation can be obtained by setting the baseplate on a concrete slab that is rigid and free of vibration, and levelling the top of the base carefully in two directions so that it is free of twist. The slab must be provided with suitable anchor bolts. The use of grouting under and partly inside the levelled and shimmed base is recommended.

It is possible for a base-mounted assembly to become twisted during shipment, thus disturbing the original alignment. For this reason, make the following checks after the base has been levelled and bolted down. Disconnect the drive and rotate the unit shaft by hand. It should turn freely at all points. Loosen the unit foot hold-down screws and determine whether all feet are evenly in contact with the base. If not, insert shims as required and again check for free impeller rotation. Finally, if unit is direct coupled to the driver, check shaft and coupling alignment carefully and make any necessary corrections.

In planning the installation, and before setting the unit, consider how piping arrangements are dictated by the unit design and assembly. Drive shaft rotation must be established accordingly and is indicated by an arrow near the shaft.

Typical arrangement on vertical units has the drive shaft at the top with counterclockwise rotation and discharge to the left. Horizontal units are typically arranged with the drive shaft at the left with counterclockwise rotation and discharge down. See Figure 4 for other various unit arrangements and possible conversions.

When a unit is DIRECT COUPLED to its driver, the driver RPM must be selected or governed so as not to

exceed the maximum speed rating of the unit. Refer to Table 1 for allowable speeds of various unit sizes.

A flexible type coupling should always be used to connect the driver and unit shafts.

When direct coupling a motor or engine to a blower you must insure there is sufficient gap between the coupling halves and the element to prevent thrust loading the blower bearings. When a motor, engine or blower is operated the shafts may expand axially. If the coupling is installed in such a manner that there is not enough room for expansion the blower shaft can be forced

back into the blower and cause the impeller to contact the gear end headplate resulting in damage to the blower. The two shafts must be in as near perfect alignment in all directions as possible, and the gap must be established with the motor armature on its electrical center if end-play exists. Coupling manufacturer's recommendations for maximum misalignment, although acceptable for the coupling, are normally too large to achieve smooth operation and maximum life of the blower.

The following requirements of a good installation are recommended. When selecting a coupling to be fitted to the blower shaft Howden Roots recommends a taper lock style coupling to insure proper contact with the blower shaft. If the coupling must have a straight bore the coupling halves must be fitted to the two shafts with a line to line thru .001" interference fit. Coupling halves must be warmed up per coupling manufacturer's recommendations. Maximum deviation in offset alignment of the shafts should not exceed .005" (.13 mm) total indicator reading, taken on the two coupling hubs. Maximum deviation from parallel of the inside coupling faces should not exceed .001" (.03 mm) when checked at six points around the coupling.

When a unit is BELT DRIVEN, the proper selection of sheave diameters will result in the required unit speed. When selecting a sheave to be fitted to the blower shaft Howden Roots recommends a taper lock style sheave to insure proper contact with the blower shaft. This flexibility can lead to operating temperature problems caused by unit speed being too low. Make sure the drive speed selected is within the allowable range for the specific unit size, as specified under Table 1.

Belt drive arrangements usually employ two or more V-belts running in grooved sheaves. Installation of the driver is less critical than for direct coupling, but its shaft must be level and parallel with the unit shaft. **The driver should be mounted on the inlet side of a vertical unit (horizontal piping) and on the side nearest to the shaft on a horizontal unit. SEE PAGE 6 - Acceptable**

Blower Drive Arrangement Options.

The driver must also be mounted on an adjustable base to permit installing, adjusting and removing the V-belts. To position the driver correctly, both sheaves need to be mounted on their shafts and the nominal shaft center distance known for the belt lengths to be used.

CAUTION: Drive couplings and sheaves (pulleys) should have an interference fit to the shaft of the blower (set screw types of attachment generally do not provide reliable service.) It is recommended that the drive coupling or sheave used have a taperlock style bushing which is properly sized to provide the correct interference fit required. Drive couplings, that require heating to fit on the blower shaft, should be installed per coupling manufacturer recommendations. A drive coupling or sheave should not be forced on to the shaft of the blower as this could affect internal clearances resulting in damage to the blower.

Engine drive applications often require special consideration to drive coupling selection to avoid harmful torsional vibrations. These vibrations may lead to blower damage if not dampened adequately. It is often necessary to install a fly-wheel and/or a torsionally soft elastic element coupling based on the engine manufacturer recommendations.

The driver sheave should also be mounted as close to its bearing as possible, and again should fit the shaft correctly. Position the driver on its adjustable base so that 2/3 of the total movement is available in the

direction away from the unit, and mount the assembly so that the face of the sheave is accurately in line with

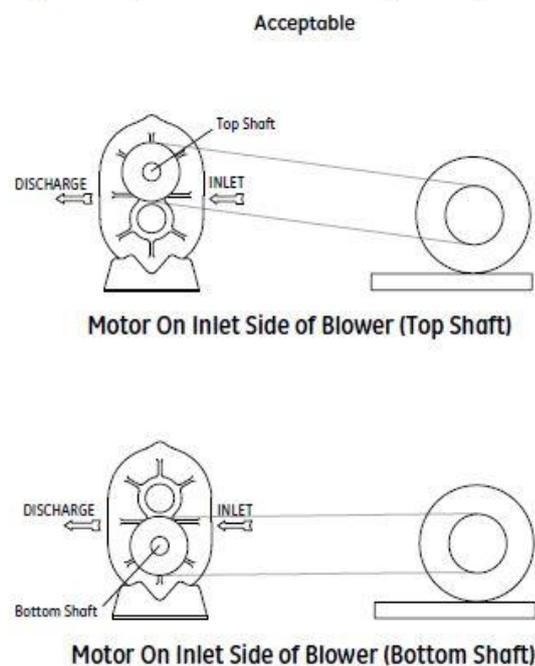
the unit sheave. This position minimizes belt wear, and allows sufficient adjustment for both installing and tightening the belts. After belts are installed, adjust their tension in accordance with the manufacturer's instructions. However, only enough tension should be applied to prevent slippage when the unit is operating under load. Excessive tightening can lead to early bearing concerns or shaft breakage.

Before operating the drive under power to check initial belt tension, first remove covers from the unit connections. Make sure the interior is still clean, and then rotate the shaft by hand. Place a coarse screen over the inlet connection to prevent anything being drawn into the unit while it is operating, and avoid standing in line with the discharge opening. Put oil in the sumps per instructions under **LUBRICATION**.

Piping

Before connecting piping, remove any remaining anti-rust compound from unit connections. Clean pipe should be no smaller than unit connections. In addition, make sure it is free of scale, cuttings, weld beads, or foreign material of any kind. To further guard against damage to the unit, especially when an inlet filter is not used, install a substantial screen of 16 mesh backed with hardware cloth at or near the inlet connections. Make provisions to clean this screen of collected debris after a few hours of operation. It should be removed when its usefulness has ended, as the wire will eventually deteriorate and small pieces going into the unit may cause serious damage.

Fig. 1 - Acceptable Blower Drive Arrangement Options



Above are suggested locations for available accessories.

Pipe flanges or male threads must meet the unit connections accurately and squarely. DO NOT attempt to correct misalignment by springing or cramping the pipe. In most cases this will distort the unit casing and cause impeller rubbing. In severe cases it can prevent operation or result in a broken drive shaft. For similar reasons, piping should be supported near the unit to eliminate dead weight strains. Also, if pipe expansion is likely to occur from temperature change, installation of flexible connectors or expansion joints is advisable.

Figure 3 represents an installation with all accessory items that might be required under various operating conditions. Inlet piping should be completely free of valves or other restrictions. When a shut-off valve cannot be avoided, make sure a full size vacuum relief is installed nearest the unit inlet. This will protect against unit overload caused by accidental closing of the shutoff valve.

Need for an inlet silencer will depend on unit speed and pressure, as well as sound-level requirements in the general surroundings. An inlet filter is recommended, especially in dusty or sandy locations. A discharge silencer is also normally suggested, even though WHISPAIR* units operate at generally lower noise levels than conventional rotary blowers. Specific recommendations on silencing can be obtained from

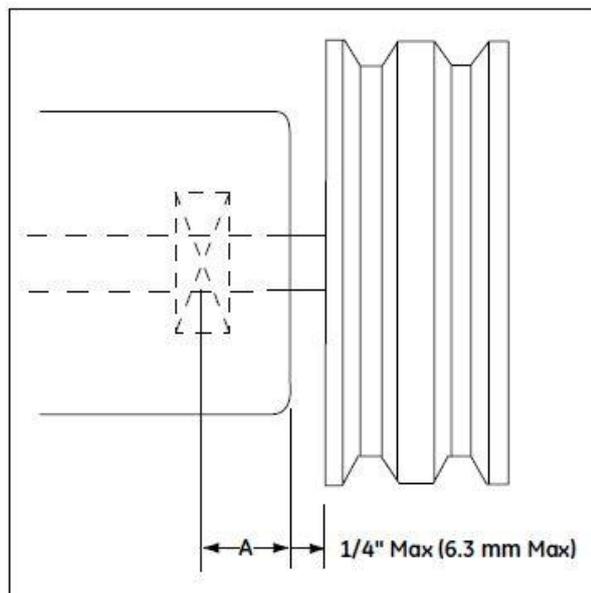
your local Howden Roots distributor. Discharge piping requires a pressure relief valve, and should include a manual unloading valve to permit starting the unit under no-load conditions. Reliable pressure/vacuum gauges and good thermometers at both inlet and discharge are recommended to allow making the important checks on unit operating conditions. The back-pressure regulator shown in Figure 3 is useful mainly when volume demands vary while the unit operates at constant output. If demand is constant, but somewhat lower than the unit output, excess may be blown off through the manual unloading valve.

In multiple unit installations where two or more units operate with a common header, use of check valves is mandatory. These should be of a direct acting or free swinging type, with one valve located in each line between the unit and header. Properly installed, they will protect against damage from reverse rotation caused by air and material back-flow through an idle unit.

After piping is completed, and before applying power, rotate the drive shaft by hand again. If it does not move with uniform freedom, look for uneven mounting, piping strain, excessive belt tension or coupling misalignment.

DO NOT operate the unit at this time unless it has been lubricated per instructions.

Figure 2 - Allowable Overhung Loads for V-belt Drives Roots Universal RAI/URAI-J Units



$$\text{†Belt Pull lbs} = \frac{252100 \cdot \text{Motor HP}}{\text{Blower RPM} \cdot \text{Sheave Diameter in Inches}}$$

$$\text{Shaft Load (lb.in)} = \text{Belt Pull} \cdot \left(A'' + \frac{1}{4}'' + \frac{\text{Sheave Width (\")}}{2} \right)$$

†Based on SF = 1.4 for v-belt drives. If higher SF belt is used, belt load should be increased proportionally and may exceed limits of the blower.

Frame Size	Dim "A"	Max. Allow. Shaft Load (lb.in)	Min Sheave Diameter
22, 24	0.61	150	4.00
32, 33, 36	0.80	400	5.00
42, 45, 47	1.02	730	5.00
53, 56, 59	1.13	1,325	6.00
65, 68, 615	1.36	2,250	8.00
76, 711, 718	1.16	3000	9.50

NOTE:

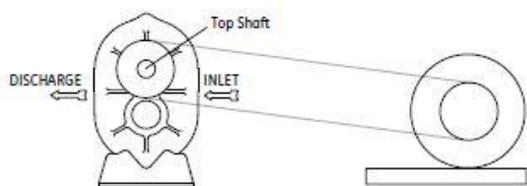
Arc of sheave belt contact on the smaller sheave not to be less than 170°.

Driver to be installed on the inlet side for vertical units, and on the drive shaft side for horizontal units.

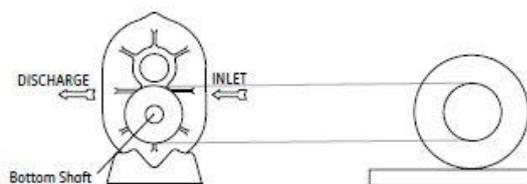
GE recommends the use of two or more 3VX, 5VX or 8VX belts and sheaves.

Acceptable Blower Drive Arrangement Options

Acceptable

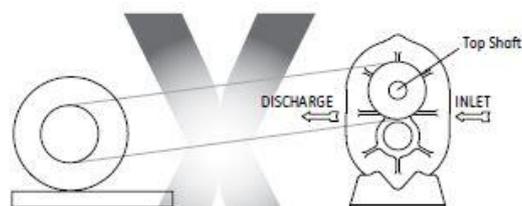


Motor On Inlet Side of Blower (Top Shaft)

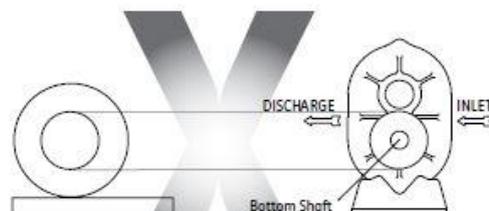


Motor On Inlet Side of Blower (Bottom Shaft)

Unacceptable



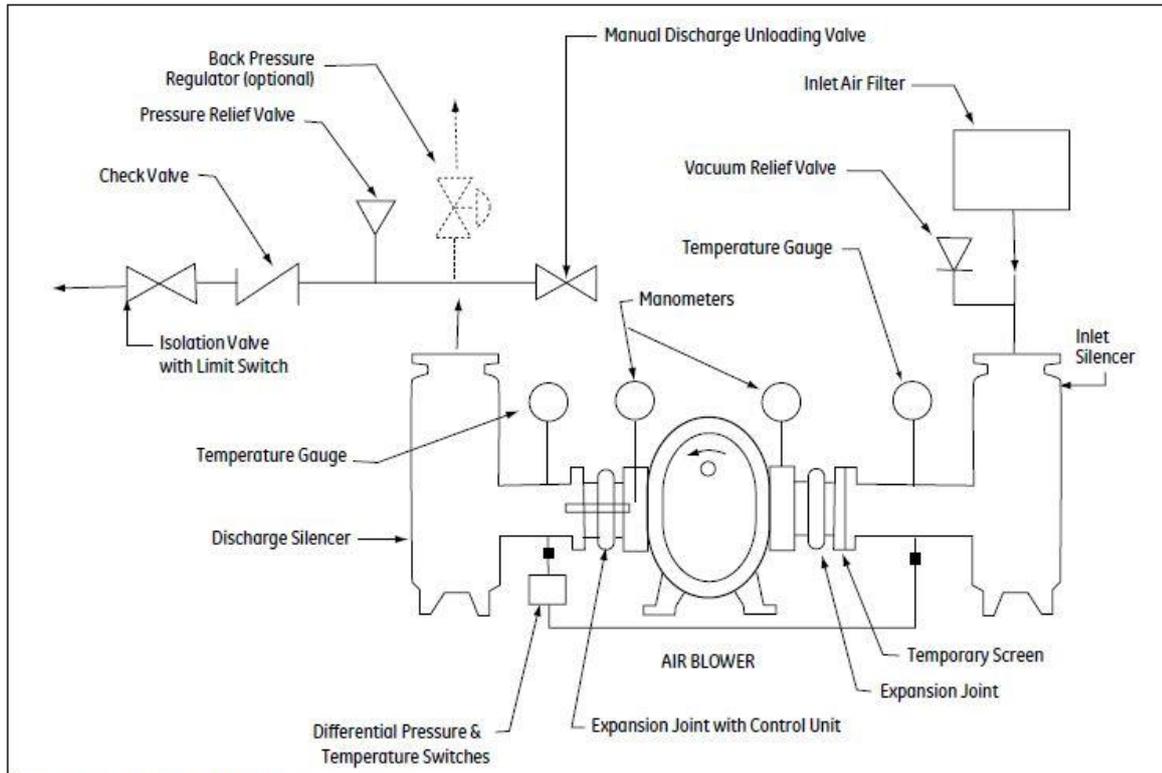
Motor On Discharge Side of Blower (Top Shaft)



Motor On Discharge Side of Blower (Bottom Shaft)

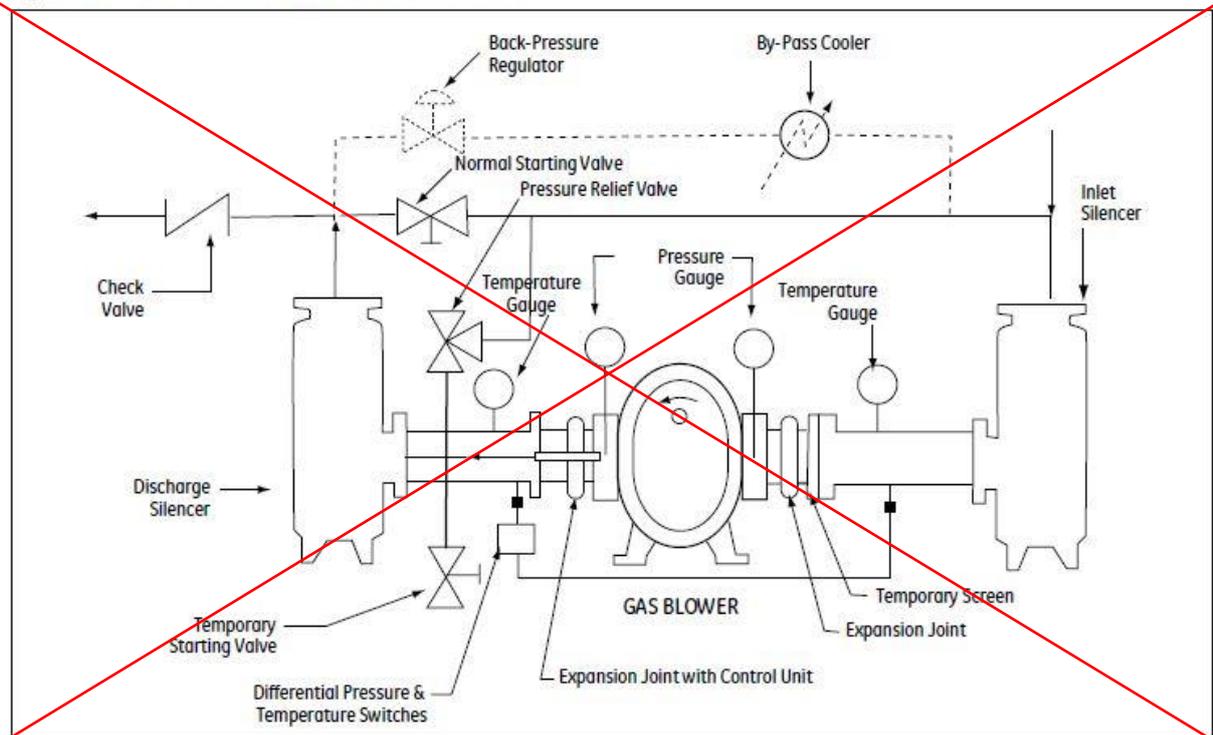
Above are suggested locations for available accessories.

Figure 3a - Air Blower Installations with Accessories



Above are suggested locations for available accessories.

Figure 3b - Gas Blower Installations with Accessories





WORLDWIDE ELECTRIC MOTOR DATA SHEET



PEWWE40-18-324T

HORSEPOWER	40		
RPM / POLES	1800 / 4		
VOLTAGE / PHASE	230 / 460 V / 3		
FRAME	324T		
ENCLOSURE / DEGREE OF PROTECTION	TEFC / IP55		
FREQUENCY	60 HZ Suitable For 50 HZ Operation With 1.0 SF		
FULL LOAD SPEED	1775 RPM		
SERVICE FACTOR	1.25		
INSULATION CLASS	F		
FULL LOAD AMPS; 230 / 460	92.6 / 46.3 A (Usable On 208V At 102 A)		
LOCKED ROTOR AMPS (STARTING); 230 / 460	580 / 290 A		
NO LOAD CURRENT	34 / 17 A		
NEMA CODE LETTER	G		
EFFICIENCY / POWER FACTOR	<u>LOAD</u>	<u>EFF.</u>	<u>P.F.</u>
	100 %	94.1%	0.86
	75 %	94.6%	0.82
	50 %	94.4%	0.73
DUTY CYCLE	S1 / Continuous		
TORQUE	<u>FULL LOAD</u>	<u>LRT</u>	<u>BDT</u>
	118 lb.ft.	160%	260%
SLIP	1.40 %		
NEMA DESIGN	B		
MOMENT OF INERTIA	6.11 lb.ft.²		
MAX. TIME LOCKED ROTOR (Hot)	12 Seconds		
SOUND PRESSURE LEVEL	71 dB (A)		
MAX. AMBIENT TEMPERATURE	40° C		
MAX. ELEVATION	3300 Ft.		
TEMPERATURE RISE (At Full Load)	80° C		
DE BEARING	6312 C3		
ODE BEARING	6311 C3		
REGREASING INT. - DE BEARING	4000 Hours		
REGREASING INT. - ODE BEARING	4000 Hours		
GREASE TYPE	SKF LGHP 2		
MOUNTING	F1		
ROTATION	Bi-Directional		
SHAFT MATERIAL	1045 Carbon Steel		
INVERTER RATING	10:1 CT / 20:1 VT PWM Type		
CONNECTION DIAGRAM	230 / 460 V - 12 Lead Δ		
AREA CLASSIFICATION	Class I, Division 2, Groups A, B, C, D		
APPROXIMATE WEIGHT	531 lbs.		



CC006A



Blower Package Parts

Howden Roots Blower

412 RAM, 1000SFCM, 8.0 PSIG, 3629 RPM, CCW Rotation

Motor:

60 HP, 1800 RPM, TEFC, 460/3/60

Filter / Silencers

Inlet Filter: Universal CCF-6" with paper element

Inlet Silencer: Universal RISY-6"

Discharge Silencer: Universal SDY-6"

Relief Valve

Weighted Type 2.5" set @ 9.0 PSIG

Check Valve

Wafer Type - 6" with EPDM seat

Gauges & Instruments

Pressure Gauge: 2.5" Ø dial, 0-15 PSIG, liquid-filled

Miscellaneous

Flexible Connectors: R&M Standard Flex Fab

Sound Enclosure: 2" thick acoustically treated aluminum panels, vent hood and electric fan, 1850 lcfm, 1/2hp, 120/1/60

V-Belt Drive: TB Woods V-Belt Drive Instructions

Safety Precautions

It is important that all personnel observe safety precautions to minimize the chances of injury. Among many considerations, the following should be particularly noted:

- Blower casing and associated piping or accessories may become hot enough to cause major skin burns on contact.
- Internal and external rotating parts of the blower and driving equipment can produce serious physical injuries. Do not reach into any opening in the blower while it is operating, or while subject to accidental starting. Protect external moving parts with adequate guards.
- Disconnect power before doing any work, and avoid bypassing or rendering inoperative any safety or protective devices.
- If blower is operated with piping disconnected, place a strong coarse screen over the inlet and avoid standing in the discharge air stream.

CAUTION: Never cover the blower inlet with your hand or other part of body.

Operating Limitations

A Roots blower or exhauster must be operated within certain approved limiting conditions to enable continued satisfactory performance. Warranty is contingent on such operation.

Maximum limits for pressure, temperature and speed are specified in Table 1, page 13 for various models & sizes of blowers & exhausters. These limits apply to all units of normal construction, when operated under standard atmospheric conditions. Be sure to arrange connections or taps for instruments such as thermometers and pressure or vacuum gauges at or near the inlet and discharge connections of the unit. These, along with a tachometer, will enable periodic checks of operating conditions.

Pressure – The pressure rise, between inlet and discharge, must not exceed the figure listed for the specific unit frame size concerned. Also, in any system where the unit inlet is at a positive pressure above atmosphere a maximum case rating of 25 PSI gauge (1725 mbar) should not be exceeded without first consulting Roots. Never should the maximum allowable differential pressure be exceeded.

On vacuum service, with the discharge to atmospheric pressure, the inlet suction or vacuum must not be greater than values listed for the specific frame size.

- Stay clear of inlet and discharge openings.
- Stay clear of the blast from pressure relief valves and the suction area of vacuum relief valves.
- Use proper care and good procedures in handling, lifting, installing, operating and maintaining the equipment.
- Casing pressure must not exceed 25 psi (1725 mbar) gauge. Do not pressurize vented cavities from an external source, nor restrict the vents without first consulting Howden.
- Do not use air blowers on explosive or hazardous gases.
- Other potential hazards to safety may also be associated with operation of this equipment. All personnel working in or passing through the area should be trained to exercise adequate general safety precautions.

Temperature – Blower & exhauster frame sizes are approved only for installations where the following temperature limitations can be maintained in service:

- Measured temperature rise must not exceed listed values when the inlet is at ambient temperature. Ambient is considered as the general temperature of the space around the unit. This is not outdoor temperature unless the unit is installed outdoors.
- If inlet temperature is higher than ambient, the listed allowable temperature rise values must be reduced by 2/3 of the difference between the actual measured inlet temperature and the ambient temperature.
- The average of the inlet and discharge temperature must not exceed 250°F. (121°C).
- The ambient temperature of the space the blower/motor is installed in should not be higher than 120°F (48.8°C).

Speed – These blowers & exhausters may be operated at speeds up to the maximum listed for the various frame sizes. They may be direct coupled to suitable constant speed drivers if pressure/temperature conditions are also within limits. At low speeds, excessive temperature rise may be a limiting factor.

Special Note: The listed maximum allowable temperature rise for any particular blower & exhauster may occur well before its maximum pressure or vacuum rating is reached. This may occur at high altitude, low vacuum or at very low speed. The units' operating limit is always determined by the maximum rating reached first. It can be any one of the three: Pressure, Temperature or Speed.

Installation

Howden blowers & exhausters are treated after factory assembly to protect against normal atmospheric corrosion. The maximum period of internal protection is considered to be one year under average conditions, if shipping plugs & seals are not removed. Protection against chemical or salt water atmosphere is not provided. Avoid opening the unit until ready to start installation, as corrosion protection will be quickly lost due to evaporation.

If there is to be an extended period between installation and start up, the following steps should be taken to ensure corrosion protection.

- o Coat internals of cylinder, gearbox and drive end bearing reservoir with Nox-Rust VCI-10 or equivalent. Repeat once a year or as conditions may require. Nox-Rust VCI-10 is petroleum soluble and does not have to be removed before lubricating. It may be obtained from Daubert Chemical Co., 2000 Spring Rd., Oak Brook, Ill. 60521.
- o Paint shaft extension, inlet and discharge flanges, and all other exposed surfaces with Nox-Rust X-110 or equivalent.
- o Seal inlet, discharge, and vent openings. It is not recommended that the unit be set in place, piped to the system, and allowed to remain idle for extended periods. If any part is left open to the atmosphere, the Nox-Rust VCI-10 vapor will escape and lose its effectiveness.
- o Protect units from excessive vibration during storage.
- o Rotate shaft three or four revolutions every two weeks.
- o Prior to start up, remove flange covers on both inlet and discharge and inspect internals to ensure absence of rust. Check all internal clearances.

Because of the completely enclosed unit design, location of the installation is generally not a critical matter. A clean, dry and protected indoor location is preferred. However, an outdoor location will normally give satisfactory service. Important requirements are that the correct grade of lubricating oil be provided for expected operating temperatures, and that the unit be located so that routine checking and servicing can be performed conveniently. Proper care in locating driver and accessory equipment must also be considered.

Supervision of the installation by a Howden Service Engineer is not usually required for these units. Workmen with experience in installing light to medium weight machinery should be able to produce satisfactory results. Handling of the equipment needs to be accomplished with care, and in compliance with safe practices. Unit mounting must be solid, without strain or twist, and air piping must be clean, accurately aligned and properly connected.

Bare-shaft Units: Two methods are used to handle a unit without base. One is to use lifting lugs bolted into the top of the unit headplates. Test them first for tightness and fractures by tapping with a hammer. In lifting, keep the direction of cable pull on these bolts as nearly vertical as possible. If lifting lugs are not available, lifting slings may be passed under the cylinder adjacent to the headplates. Either method prevents strain on the extended drive shaft.

Packaged Units: When the unit is furnished mounted on a baseplate, with or without a driver, use of lifting slings passing under the base flanges is required. Arrange these slings so that no strains are placed on the unit casing or mounting feet, or on any mounted accessory equipment. DO NOT use the lifting lugs in the top of the unit headplates.

Before starting the installation, remove plugs, covers or seals from unit inlet and discharge connections and inspect the interior completely for foreign material. If cleaning is required, finish by washing the cylinder, headplates and impeller thoroughly with a petroleum solvent. Turn the drive shaft by hand to make sure that the impellers turn freely at all points. Anti-rust compound on the connection flanges and drive shaft extension may also be removed at this time with the same solvent. Cover the flanges until ready to connect piping.

Mounting

Care will pay dividends when arranging the unit mounting. This is especially true when the unit is a "bare-shaft" unit furnished without a baseplate. The convenient procedure may be to mount such a unit directly on a floor or small concrete pad, but this generally produces the least satisfactory results. It definitely causes the most problems in leveling and alignment and may result in a "Soft Foot" condition. Correct soft foot before operation to avoid unnecessary loading on the casing and bearings. Direct use of building structural framing members is not recommended.

For blowers without a base, it is recommended that a well anchored and carefully leveled steel or cast iron mounting plate be provided. The plate should be at least 1 inch (25 mm) thick, with its top surface machined flat, and large enough to provide leveling areas at one side and one end after the unit is mounted. It should have properly sized studs or tapped holes located to match the unit foot drilling. Proper use of a high quality machinist's level is necessary for adequate installation.

With the mounting plate in place and leveled, set the unit on it without bolting and check for rocking. If it is not solid, determine the total thickness of shims required under one foot to stop rocking. Place half of this under each of the diagonally-opposite short feet, and tighten the mounting studs or screws. Rotate the drive shaft to make sure the impellers turn freely. If the unit is to be direct coupled to a driving motor, consider the height of the motor shaft and the necessity for it to be aligned very accurately with the unit shaft. Best unit arrangement is directly bolted to the mounting plate while the driver is on shims of at least 1/8 inch (3mm) thickness. This allows adjustment of motor position in final shaft alignment by varying the shim thickness.

Aligning

When unit and driver are factory mounted on a common baseplate, the assembly will have been properly aligned and is to be treated as a unit for leveling purposes. Satisfactory installation can be obtained by setting the baseplate on a concrete slab that is rigid and free of vibration, and leveling the top of the base carefully in two directions so that it is free of twist. The slab must be provided with suitable anchor bolts. The use of grouting under and partly inside the leveled and shimmed base is recommended.

It is possible for a base-mounted assembly to become twisted during shipment, thus disturbing the original alignment. For this reason, make the following checks after the base has been leveled and bolted down. Disconnect the drive and rotate the unit shaft by hand. It should turn freely at all points. Loosen the unit foot hold-down screws and determine whether all feet are evenly in contact with the base. If not, insert shims as required and again check for free impeller rotation. Finally, if unit is direct coupled to the driver, check shaft and coupling alignment carefully and make any necessary corrections.

In planning the installation, and before setting the unit, consider how piping arrangements are dictated by the unit design and assembly. Drive shaft rotation must be established accordingly and is indicated by an arrow near the shaft.

Typical arrangement on vertical units has the drive shaft at the top with counterclockwise rotation and discharge to the left. Horizontal units are typically arranged with the drive shaft at the left with counterclockwise rotation and discharge down. See Figure 4 for other various unit arrangements and possible conversions.

When a unit is DIRECT COUPLED to its driver, the driver RPM must be selected or governed so as not to exceed the maximum speed rating of the unit. Refer to Table 1, page 13 for allowable speeds of various unit sizes.

A flexible type coupling should always be used to connect the driver and unit shafts.

When direct coupling a motor or engine to a blower you must ensure there is sufficient gap between the coupling halves and the element to prevent thrust loading the blower bearings. When a motor, engine or blower is operated the shafts may expand axially. If the coupling is installed in such a manner that there is not enough room for expansion the blower shaft can be forced back into the blower and cause the impeller to contact the gear end headplate resulting in damage to the blower. The two shafts must be in as near perfect alignment in all directions as possible, and the gap must be established with the motor armature on its electrical center if end-play exists. Coupling manufacturer's recommendations for maximum misalignment, although acceptable for the coupling, are normally too large to achieve smooth operation and maximum life of the blower.

The following requirements of a good installation are recommended. When selecting a coupling to be fitted to the blower shaft Roots recommends a taper lock style coupling to ensure proper contact with the blower shaft. Coupling halves must be fitted to the two shafts with a line to line thru .001" interference fit. Coupling halves must be warmed up per coupling manufacturer's recommendations. Maximum deviation in offset alignment of the shafts should not exceed .005" (.13 mm) total indicator reading, taken on the two coupling hubs. Maximum deviation from parallel of the inside coupling faces should not exceed .001" (.03 mm) when checked at six points around the coupling.

When a unit is BELT DRIVEN, the proper selection of sheave diameters will result in the required unit speed. When selecting a sheave to be fitted to the blower shaft Roots recommends a taper lock style sheave to ensure proper

contact with the blower shaft. This flexibility can lead to operating temperature problems caused by unit speed being too low. Make sure the drive speed selected is within the allowable range for the specific unit size, as specified under Table 1, page 13.

Belt drive arrangements should employ two or more V-belts running in grooved sheaves. Installation of the driver is less critical than for direct coupling, but its shaft must be level and parallel with the unit shaft. **The driver should be mounted on the inlet side of a vertical unit (horizontal piping) and on the side nearest to the shaft on a horizontal unit.** The driver must also be mounted on an adjustable base to permit installing, adjusting and removing the V-belts. To position the driver correctly, both sheaves need to be mounted on their shafts and the nominal shaft center distance known for the belt lengths to be used.

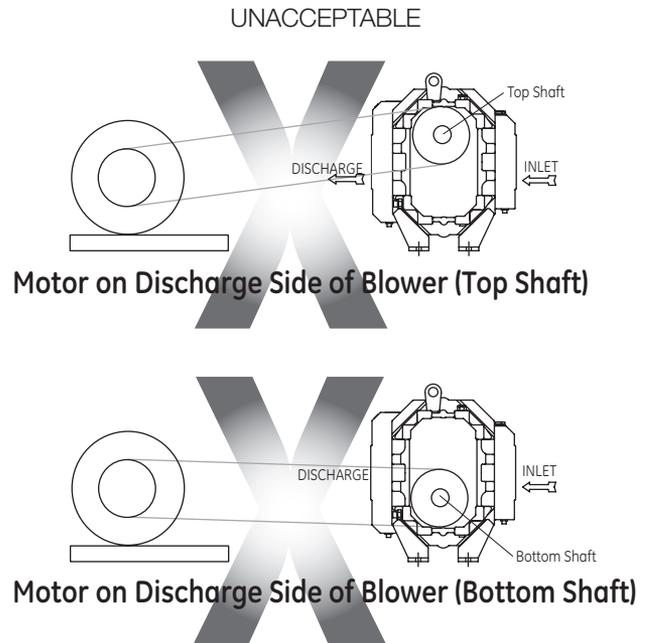
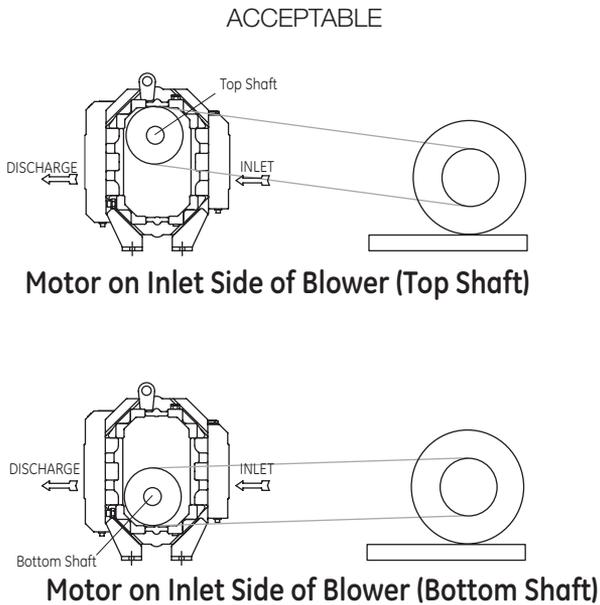
CAUTION: Drive couplings and sheaves (pulleys) should have an interference fit to the shaft of the blower (set screw types of attachment generally do not provide reliable service.) It is recommended that the drive coupling or sheave used have a taper lock style bushing which is properly sized to provide the correct interference fit required. Drive couplings, that require heating to fit on the blower shaft, should be installed per coupling manufacturer recommendations. A drive coupling or sheave should not be forced on to the shaft of the blower as this could affect internal clearances resulting in damage to the blower.

Engine drive applications often require special consideration to drive coupling selection to avoid harmful torsional vibrations. These vibrations may lead to blower damage if not dampened adequately. It is often necessary to install a fly-wheel and/or a torsionally soft elastic element coupling based on the Engine manufacturer recommendations.

The driver sheave should also be mounted as close to its bearing as possible, and again should fit the shaft correctly. Position the driver on its adjustable base so that 2/3 of the total movement is available in the direction away from the unit, and mount the assembly so that the face of the sheave is accurately in line with the unit sheave. This position minimizes belt wear, and allows sufficient adjustment for both installing and tightening the belts. After belts are installed, adjust their tension in accordance with the manufacturer's instructions. However, only enough tension should be applied to prevent slippage when the unit is operating under load. Excessive tightening can lead to early bearing concerns or shaft breakage.

Before operating the drive under power to check initial belt tension, first remove covers from the unit connections. Make sure the interior is still clean, then rotate the shaft by hand. Place a coarse screen over the inlet connection to prevent anything being drawn into the unit while it is operating, and avoid standing in line with the discharge opening. Put oil in the sumps per instructions under **LUBRICATION**.

Acceptable Blower Drive Arrangement Options



Piping

Before connecting piping, remove any remaining anti-rust compound from Unit connections. Clean pipe should be no smaller than unit connections. In addition, make sure it is free of scale, cuttings, weld beads, or foreign material of any kind. To further guard against damage to the unit, especially when an inlet filter is not used, install a substantial screen of 16 mesh backed with hardware cloth at or near the inlet connections. Make provisions to clean this screen of collected debris after a few hours of operation. It should be removed when its usefulness has ended, as the wire will eventually deteriorate and small pieces going into the unit may cause serious damage.

Pipe flanges or male threads must meet the unit connections accurately and squarely. **DO NOT** attempt to correct misalignment by springing or cramping the pipe. In most cases this will distort the unit casing and cause impeller rubbing. In severe cases it can prevent operation or result in a broken drive shaft. For similar reasons, piping should be supported near the unit to eliminate dead weight strains. Also, if pipe expansion is likely to occur from temperature change, installation of flexible connectors or expansion joints is advisable.

Figure 3, page 11 represents an installation with all accessory items that might be required under various operating conditions. Inlet piping should be completely free of valves or other restrictions. When a shut-off valve can not be avoided, make sure a full size vacuum relief is installed nearest the unit inlet. This will help protect against unit overload caused by accidental closing of the shut-off valve.

Need for an inlet silencer will depend on unit speed and pressure, as well as sound-level requirements in the general surroundings. An inlet filter is recommended, especially in

dusty or sandy locations. A discharge silencer is also normally suggested, even though WHISPAIR™ units operate at generally lower noise levels than conventional rotary blowers. Specific recommendations on silencing can be obtained from your local Roots distributor.

Discharge piping requires a pressure relief valve, and should include a manual unloading valve to permit starting the unit under no-load conditions. Reliable pressure/vacuum gauges and good thermometers at both inlet and discharge are recommended to allow making the important checks on unit operating conditions. The back-pressure regulator shown in Figure 3, page 11 is useful mainly when volume demands vary while the unit operates at constant output. If demand is constant, but somewhat lower than the unit output, excess may be blown off through the manual unloading valve.

In multiple unit installations where two or more units operate with a common header, use of check valves is mandatory. These should be of a direct acting or free swinging type, with one valve located in each line between the unit and header. Properly installed, they will protect against damage from reverse rotation caused by air and material back-flow through an idle unit.

After piping is completed, and before applying power, rotate the drive shaft by hand again. If it does not move with uniform freedom, look for uneven mounting, piping strain, excessive belt tension or coupling misalignment.

DO NOT operate the unit at this time unless it has been lubricated per instructions.

Lubrication

Due to sludge build-up and seal leakage problems, Roots recommendation is DO NOT USE Mobil SHC synthetic oils in Roots blowers.

LUBRICATION: For Units with Splash Lubrication on Both Ends.

- The specified and recommended oil is Roots Synthetic oil of correct viscosity per Table 2, page 13.
- The proper oil level should be half way or middle of the sight gauge when the blower is not operating. **DO NOT OVERFILL OIL SUMP/S** as damage to the blower may occur.
- Oil level may rise or fall in the gauge during operation to an extent depending somewhat on oil temperature and blower speed.
- It is recommended that the oil be changed after initial 100 hours of operation.
- Proper service intervals of the oil thereafter are based on the discharge air temperature of the blower. Please refer to the information below to properly determine the oil service intervals.
- If you choose to use another oil other than the specified and recommended Roots Synthetic, use a good grade of industrial type non-detergent, rust inhibiting, anti-foaming oil and of correct viscosity per Table 2, page 13.
- Roots does **NOT** recommend the use of automotive type lubricants, as they are not formulated with the properties mentioned above.

Normal life expectancy of the specified and recommended Roots Synthetic oil is approximately 6000 hours with an oil temperature of 180°F (82°C) or less. As the oil temperature increases by increments of 15°F (8°C), the oil life is reduced by half for each 15°F (8°C) increase. Example: Oil temperatures of 195°F (90.5°C) will produce a life expectancy reduced by half or 3000 hours oil service life.

Normal life expectancy of petroleum based oils is about 2000 hours with an oil temperature of about 180°F (82°C). As the oil temperature increases by increments of 15°F (8°C), the life is reduced by half for each 15°F (8°C) increase. Example: Oil temperatures of 195°F (90.5°C) will produce life expectancy reduced by half or 1000 hours oil service life.

NOTE: To estimate oil temperature, multiply the discharge temperature of the blower by 0.80. Example: if the discharge air temperature of the blower is 200° F, it is estimated that the oil temperature is 160° F.

Bearings and oil seals are lubricated by the action of the timing gears or oil slingers which dip into the main oil sumps causing oil to splash directly on gears and into bearings and seals. A drain port is provided below each bearing to prevent an excessive amount of oil in the bearings. Seals located inboard of the bearings in each headplate effectively retain oil within the sumps. Any small leakage that may occur should the seals wear passes into a cavity in each vented headplate and is drained downward. Oil sumps on each end of the blower are filled by removing top vent plugs, Item (21), and filling until oil reaches the middle of the oil level sight gauge, Item (37).

Initial filling of the sumps should be accomplished with the blower not operating, in order to obtain the correct oil level. Approximate oil quantities required for blowers of the various models and configurations are listed in Table 3, page 13.

The oil level should not fall below the middle of the site gauge when the blower is idle.

Proper lubrication is usually the most important single consideration in obtaining maximum service life and satisfactory operation from the unit. Unless operating conditions are severe, a weekly check of oil level and necessary addition of lubricant should be sufficient. During the first week of operation, check the oil levels in the oil sumps about once a day, and watch for leaks. Replenish as necessary. Thereafter, an occasional check should be sufficient.

More frequent oil service may be necessary if the blower is operated in a very dusty location.

Roots Synthetic oil is superior in performance to petroleum based products. It has high oxidation stability, excellent corrosion protection, extremely high film strength and low coefficient of friction. Typical oil change intervals are increased 2-3 times over petroleum based lubricants. Also, Roots Synthetic oil is 100% compatible with petroleum based oils. Simply drain the oil in the blower and refill the reservoirs with Roots Synthetic oil to maintain optimum performance of your Roots blower.

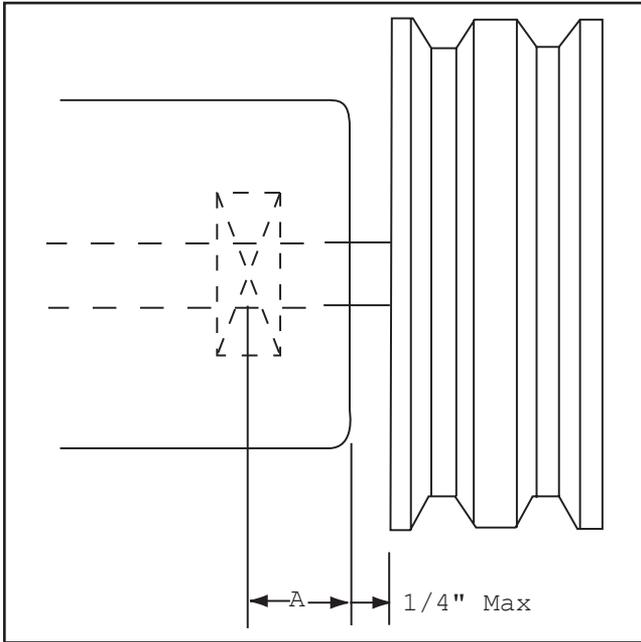


Figure 2 - Allowable Overhung Loads for V-belt Drive 400-600 RAM and RAM-J Blowers

$$^1\text{Belt Pull lbs} = \frac{275000 \cdot \text{Motor HP}}{\text{Blower RPM} \cdot \text{Sheave Diameter}}$$

$$\text{Shaft Load (lb.in)} = \text{Belt Pull} \cdot \left(A + \frac{1}{4} + \frac{\text{Sheave Width}}{2} \right)$$

¹Based on SF = 1.4 for v-belt drives. If higher SF belt is used, belt load should be increased proportionally and may exceed limits of the blower.

Frame Size	Dimension "A"		Min Sheave Diameter	Max Sheave Width
	Standard Unit	Max Allowable Shaft Load (lb-in.)		
404, 406 409, 412, 418	2.11	3,200	7.10	3.06
612, 616, 624	2.67	7,975	8.50	4.44

NOTE:

Arc of sheave belt contact on the smaller sheave not to be less than 170°.

Driver to be installed on the inlet side for vertical units, and on the drive shaft side for horizontal units.

Howden recommends the use of two or more 3VX, 5VX or 8VX matched set or banded belts and sheaves.

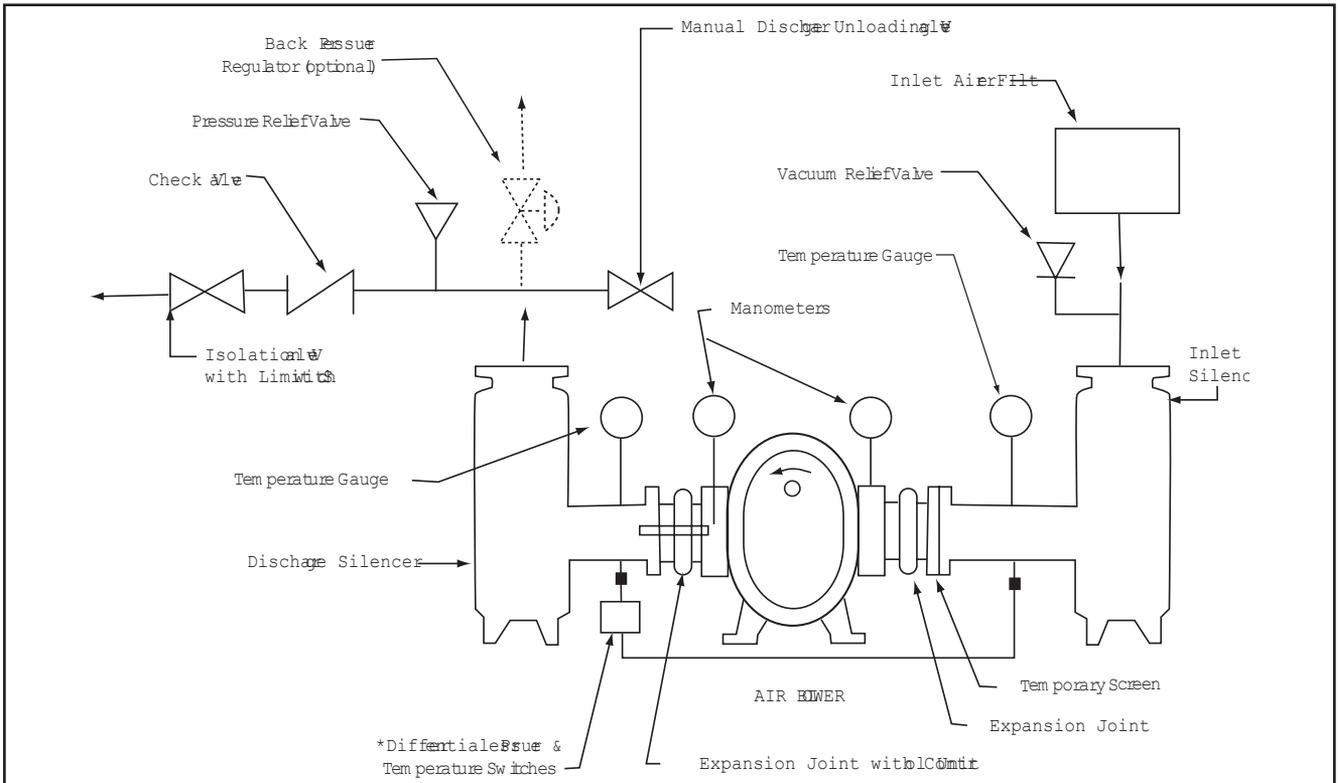


Figure 3 - Air Blower Installation with Accessories



WORLDWIDE ELECTRIC MOTOR DATA SHEET

PEWWE60-18-364T



HORSEPOWER	60		
RPM / POLES	1800 / 4		
VOLTAGE / PHASE	230 / 460 V / 3		
FRAME	364T		
ENCLOSURE / DEGREE OF PROTECTION	TEFC / IP55		
FREQUENCY	60 HZ Suitable For 50 HZ Operation With 1.0 SF		
FULL LOAD SPEED	1780 RPM		
SERVICE FACTOR	1.25		
INSULATION CLASS	F		
FULL LOAD AMPS; 230 / 460	144 / 72 A (Usable On 208V At 159 A)		
LOCKED ROTOR AMPS (STARTING); 230 / 460	870 / 435 A		
NO LOAD CURRENT	56 / 28 A		
NEMA CODE LETTER	G		
EFFICIENCY / POWER FACTOR	<u>LOAD</u>	<u>EFF.</u>	<u>P.F.</u>
	100 %	95.0%	0.82
	75 %	95.1%	0.79
	50 %	94.9%	0.70
DUTY CYCLE	S1 / Continuous		
TORQUE	<u>FULL LOAD</u>	<u>LRT</u>	<u>BDT</u>
	177 lb.ft.	205%	250%
SLIP	1.10 %		
NEMA DESIGN	B		
MOMENT OF INERTIA	14.7 lb.ft.²		
MAX. TIME LOCKED ROTOR (Hot)	16 Seconds		
SOUND PRESSURE LEVEL	73 dB (A)		
MAX. AMBIENT TEMPERATURE	40° C		
MAX. ELEVATION	3300 Ft.		
TEMPERATURE RISE (At Full Load)	80° C		
DE BEARING	6313 C3		
ODE BEARING	6312 C3		
REGREASING INT. - DE BEARING	3000 Hours		
REGREASING INT. - ODE BEARING	4000 Hours		
GREASE TYPE	SKF LGHP 2		
MOUNTING	F1		
ROTATION	Bi-Directional		
SHAFT MATERIAL	1045 Carbon Steel		
INVERTER RATING	10:1 CT / 20:1 VT PWM Type		
CONNECTION DIAGRAM	230 / 460 V - 12 Lead Δ		
AREA CLASSIFICATION	Class I, Division 2, Groups A, B, C, D		
APPROXIMATE WEIGHT	769 lbs.		



CC006A



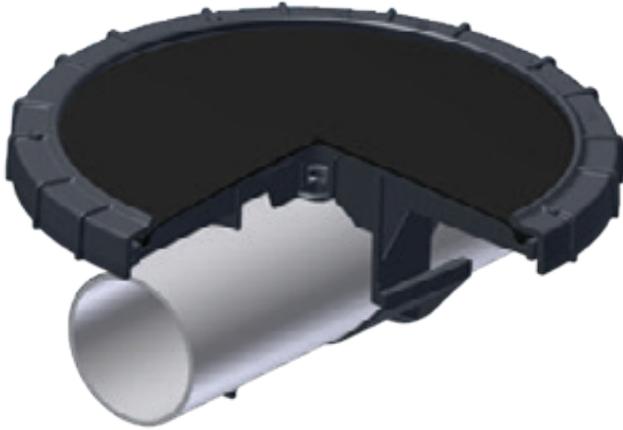
Section 003:

Diffusers

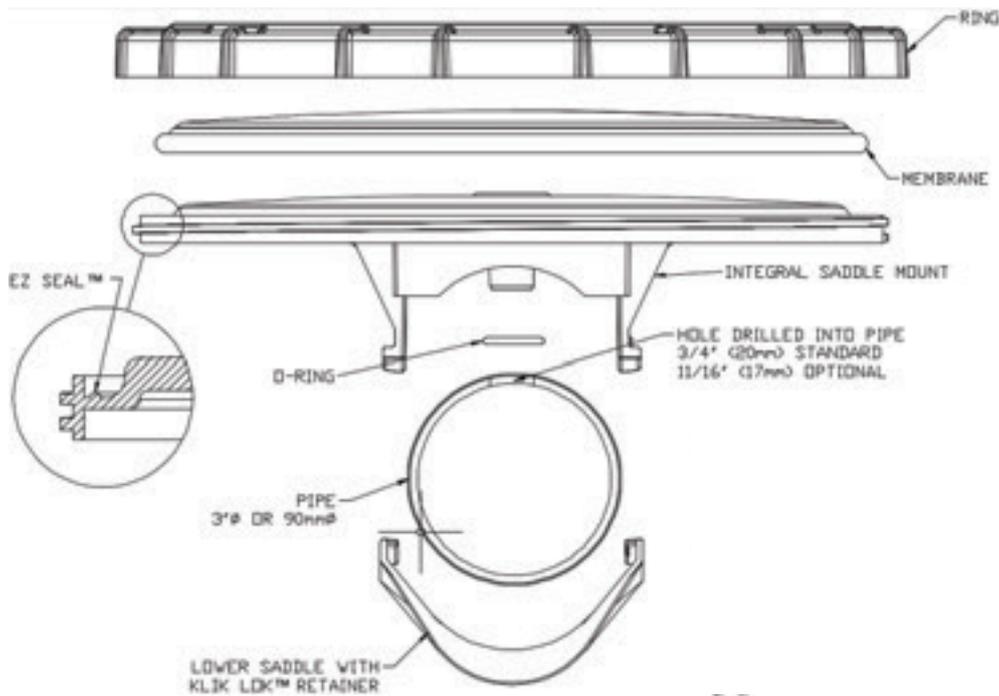


PRODUCT SPECIFICATIONS

FlexAir™ ISM Disc Integral Saddle Mount



- Glass-fiber-reinforced polypropylene construction for maximum chemical, temperature, and UV resistance
- Premium quality membrane materials available: EPDM, silicone, urethane, PTFE MATRIX™
- High-capacity membrane option available for maximum airflow and low operating pressure
- Triple-check valve design minimizes entry of liquid/solids into piping. Ideal for on / off applications
- Integral Saddle Mount provides ease of installation and maintenance with maximum mechanical strength
- Mounts on any pipe material (PVC, ABS, CPVC, SS, etc.)
- 12" disc available to fit 3" and 90 mm pipe sizes; 9" disc available to fit 3", 4", 90 mm, and 110 mm pipe sizes
- Patented EZ-Seal™ for quick membrane installation



METRIC					ENGLISH				
Diffuser Type/ Perforation	Design Airflow Nm ³ /h	Overall Diameter mm	Active Surface Area m ²	Dry Weight kg	Diffuser Type/ Perforation	Design Airflow scfm	Overall Diameter in	Active Surface Area ft ²	Dry Weight lb
9" Nanopore	0-4	273	0.038	0.85	9" Nanopore	0-3	10.75	0.41	1.9
9" Micropore	0-9.5	273	0.038	0.85	9" Micropore	0-6	10.75	0.41	1.9
9" High-Cap	0-16	273	0.038	0.85	9" High-Cap	0-10	10.75	0.41	1.9
12" Nanopore	0-6	336	0.059	1.2	12" Nanopore	0-4	13.20	0.64	2.6
12" Micropore	0-16	336	0.059	1.2	12" Micropore	0-10	13.20	0.64	2.6
12" High-Cap	0-29	336	0.059	1.2	12" High-Cap	0-18	13.20	0.64	2.6

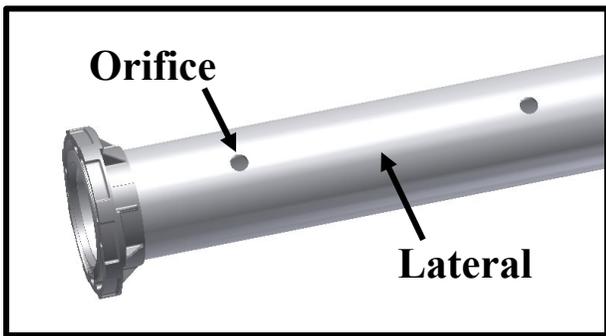
ISM Disc Diffuser Installation

R.2019-04-16

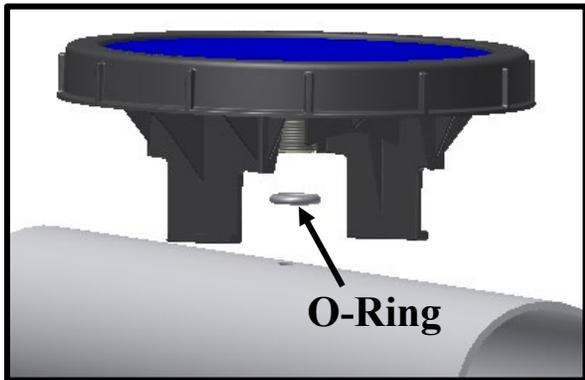
Prior to installation, ensure that all air piping is clean and free of debris. Familiarize yourself with all components.

Tools required for installation/maintenance include:

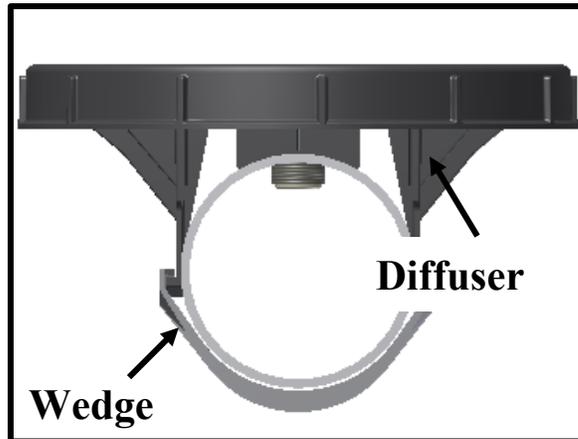
- Bubble/laser level (Not provided by EDI).
- Tightening Tool (Purchased through Diffuser Express).
- Torque Wrench (Not provided by EDI).



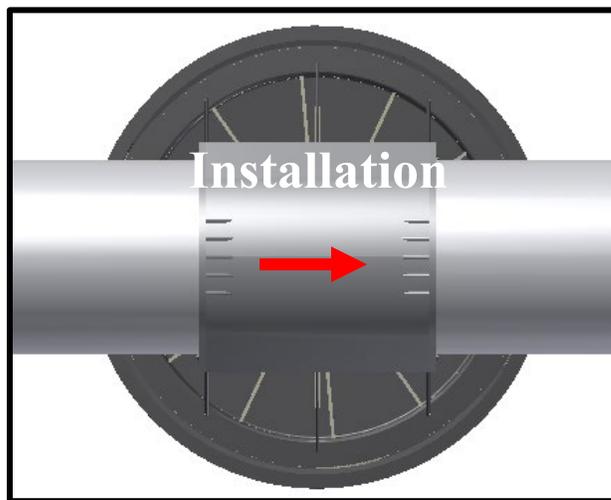
- 1) Install O-ring over the inlet air stub on the diffuser saddle prior to installing the diffuser on lateral. DO NOT PRE-INSTALL O-RING. DO NOT USE ANY MASTIC OR OTHER ADHESIVE.
- 2) Place the diffuser on the piping with the inlet air stub engaged in the orifice hole in the piping.



- 3) Install the lower saddle. Tighten the lower saddle until the Click-Loc teeth are engaged.



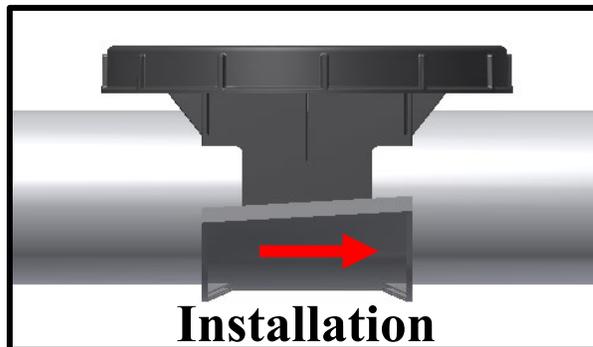
Follow the arrow that has been molded into the lower saddle for direction of installation. There are teeth on one side of the wedge and on one side of the saddle, these should match up to be installed properly.



Note

Do not use metallic mallets or hammers as they may crack or shatter the lower saddle or damage the diffuser. When properly tightened, the diffuser assembly should be level and resist rotation.

- 4) Tighten lower saddle to approximately 1/2" to 3/4" (12 mm to 19 mm) beyond upper saddle. This will engage all 3 locking teeth on the upper saddle.



PRODUCT SPECIFICATION SHEET

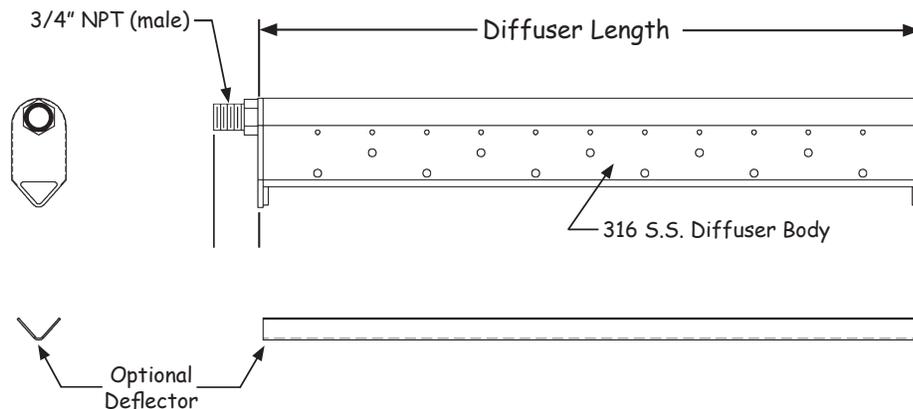
EDI MaxAir™ SS diffuser provides broad band, coarse bubble aeration for maximum mixing efficiency. The unit is available in 24 inch or 12 inch length. A full 48 inch air release perimeter is provided with the 24 inch unit and 24 inch air release perimeter for the 12 inch. Features multi-level air metering orifice design. This provides full air release uniformity and mixing efficiency over the entire operating range of the unit.

MaxAir SS diffusers are ideal for the most demanding aeration and mixing applications including flow equalization, channel aeration, aerobic digesters, industrial, and mixing and scouring applications including RBC, MBR, IFAS, and MBBR.

The diffuser may be operated under a wide range of applications including intermittent and high solids applications. Optional closed bottom design provides a mechanism to preclude the backflow of large particles into the diffuser and piping components.

The MaxAir SS diffuser is designed for long service life. All components are 316 stainless steel. Inlet and end component are single piece cast steel. End plates are attached to the diffuser body with a continuous weld.

MaxAir SS diffusers employ a 3/4 inch diameter NPT (male) threaded inlet with integral hex for ease on installation.



Diffuser Type	Design Airflow		Diffuser Length		Orifice Size		Dry Weight		Net Operating Buoyancy	
	scfm	m ³ _N /h	in	mm	ft ²	m ²	lb	kg	lb	kg
12" Model (Open)	0-30	0-47	12.4	315	0.840	0.0780	1.5	0.68	1.6	0.72
24" Model (Open)	0-55	0-87	24.4	620	0.840	0.0780	2.1	0.98	4.0	1.81
12" Model (w/ Deflector)	0-30	0-47	12.4	315	0.840	0.0780	1.7	0.80	1.3	0.60
24" Model (w/ Deflector)	0-55	0-87	24.4	620	0.840	0.0780	2.3	1.1	3.8	1.7

- Optimum oxygen transfer efficiency is achieved when operating in the middle to low end of the airflow range. The approximate operating pressure of the diffuser at the mid-range is 2 to 4 inches (0.5 - 1.0 kPa).



Environmental Dynamics Inc.

5601 Paris Road • Columbia, MO 65202 USA
+1 877.EDI.AIR8 (334.2478) +1 573.474.9456

For Parts Information:
parts@wastewater.com
www.diffuserexpress.com

For System Information:
systems@wastewater.com
www.wastewater.com

Operation Instructions

Description of the Aeration-Mixing System

The aeration-mixing system employs a main air header and valved lateral piping system to distribute air throughout the basin. EDI normally designs the aeration system piping to provide uniform air distribution without adjustment to the isolation/throttling valves on the laterals. However, these valves are typically provided for direct control of airflow distribution on large aeration systems or for process control. Airflow distribution will be reviewed at the time of start-up by an EDI field service representative. If process demands dictate a revised airflow distribution pattern, contact EDI for guidance on modification to the system.

Normal Operation of the Aeration System

The following procedures should be followed on a regular basis to assure consistent and satisfactory performance of the aeration-mixing system.

The air rate to the system may be adjusted to maintain the desired dissolved oxygen levels in the basin. When adjusting the airflow rate, the diffusers should be operated within the normal operating range of the diffuser. Excessive airflow rates will result in high pressure drops across the diffuser and reduced oxygen transfer performance. Low airflow rates may result in incomplete utilization of the diffuser membrane and reduced air distribution.

The aeration-mixing system is designed to provide uniform aeration. Positive dissolved oxygen concentrations should be present throughout the entire system during normal operation. A dissolved oxygen profile analysis may be used to confirm the performance of the aeration system. Typically, the dissolved oxygen levels are measured at the inlet, the outlet, and the midpoint locations of each basin to determine the aeration system performance. In regulating the system airflow to control

dissolved oxygen levels, the diffuser units should be operated within their minimum and maximum airflow limits.

In applications where water level variations may exist between aeration basins supplied by a single blower, the isolation valves may need to be adjusted to maintain adequate airflow distribution. This normally requires valving back the air to the basin with the reduced water level. NOTE: It is important to confirm the operating airflow range of the diffuser units before valving back any isolation valve. Damage could result to the aeration diffuser if airflow is above the recommendations noted in the Headloss Calculations. Please consult EDI Engineering Department to confirm operating procedure before adjusting any aeration isolation/throttling valve.

Normal Operation of the Blower System

The Aeration-Mixing System normally utilizes a centrifugal or positive displacement (PD) blower system consisting of one or more blower units for normal operation plus one on-line spare unit. All blower units including the spare unit must be operated on a regular basis to maintain their proper working condition. EDI recommends that blower units be operated sequentially with idle blower units brought on-line weekly. EDI does not recommend the simultaneous operation of on-line and spare blowers for an extended period. This operating condition may deliver airflows exceeding the air capacity of the diffuser units.

All blower components should be serviced on a regular basis. For additional information concerning proper blower operation, service requirements or service intervals, reference the Blower Operation and Maintenance manual.

Shutdown Conditions

If air service is interrupted at any time, it should be restored as soon as possible. When restarting positive displacement blower units, the start-up

pressure surge should be reduced by down-weighting the pressure relief valve (PRV) or operating the blow-off valve. Once the blower is operational, reset the PRV or slowly close the blow-off valve over a five- to ten-minute period. The PRV must be set properly to prevent overloading of the blower system. Operate manual water purge devices if provided. If the PRV releases air for an extended period of time, the relief setting should be checked.

When diffusers are installed in basins or lagoons and are not going to be in operation for an extended time (4 to 6 weeks), the diffusers should be covered with approximately 4 feet of water.

- In the summer, this protects the diffusers from excessive heat and provides UV protection.
- In winter, EDI recommends that the diffusers be covered with a sufficient amount of water so that if ice forms there is always a minimum liquid clearance that measures approximately 4 feet between the bottom of the formed ice and the diffuser system. This water buffer will keep the ice and its possible damaging effects away from the diffuser system.

Furthermore, the system may be idle or remain active during this period. If the aeration system will be active, operate the system at a minimum air flow so as to avoid movement of ice.

The water level in the basin/lagoon should never be lowered if there is ice present. The weight of the ice or breaking into pieces will invariably cause severe damage to membranes and/or piping.

Slowly starting up the aeration system will aid in the melting of the formed ice. This is to be done with great caution as not to exert any undue forces on piping or equipment that penetrates or is entrapped in the ice surface, and to avoid damage from ice movement as blocks of ice become free to move.

If the basin is to be idle for a prolonged time period, the basin should be drained and cleaned. NOTE: Maintain the minimum airflow to the system during the drain-down procedure. For maximum protection of the aeration system, refill the basin to completely submerge the aeration system. This provides thermal protection in the event of severe cold or hot weather conditions.

Contact EDI for additional operation and maintenance information if it is necessary to decrease the system airflow during cold weather.

Operation of the Diffuser Unit

The diffuser unit has no moving parts and requires very little maintenance for long-term operation. EDI recommends that the air supply to the diffusers be maintained at all times for optimum performance. The airflow to the diffuser units must be kept within the ranges noted in the Headloss Calculations to maintain the structural and operating characteristics of the diffuser membrane. Continuous application of high airflows, greater than denoted for normal operation, may result in physical damage to the diffuser membrane. NOTE: Use caution when adjusting several lateral throttling valves in the same piping system. This procedure can result in elevated airflows in sections of the basin, exceeding the maximum allowable airflow to each diffuser unit.

Section 004: Flow Meters

Description

3.1 System components

A SITRANS F M MAG 5000/6000 flowmeter system includes:

- Transmitter (type SITRANS F M MAG 5000/6000)
- Sensor (types: SITRANS F MAG 1100/1100F/3100/3100 P/5100 W)
- Communication module (optional) (types: HART, PROFIBUS PA/DP, MODBUS RTU RS 485, Foundation Fieldbus H1, Devicenet)
- SENSORPROM memory unit

Communication solutions

The SITRANS F USM II range of add on modules, presently including HART, Foundation Fieldbus, MODBUS RTU RS 485, PROFIBUS PA / DP and Devicenet, are all applicable with the SITRANS F M MAG 6000 transmitter.

3.2 Operating principle

The transmitters are microprocessor-based with a built-in alphanumeric display in several languages. The flow measuring principle is based on Faraday's law of electromagnetic induction. Magnet coils mounted diametrically on the measuring pipe generate a pulsed electromagnetic field. The liquid flowing through this electromagnetic field induces a voltage.

The transmitters evaluate the signals from the associated electromagnetic sensors, convert the signals into appropriate standard signals such as 4 ... 20 mA, and also fulfil the task of a power supply unit providing the magnet coils with a constant current.

The transmitter consists of a number of function blocks which convert the sensor voltage into flow readings.

3.3 Applications

The pulsed DC-powered magnetic flowmeters are suitable for measuring the flow of almost all electrically conductive liquids, pastes, and slurries with max. 40% solids.

The main applications can be found in the following sectors:

- Water and waste water
- Chemical and pharmaceutical industries
- Food & beverage industry
- Mining and cements industries

3.4 Features

- Pulp and paper industry
- Steel industry
- Power generation; utility and chilled water industry

3.4 Features

Power supply

2 different types of power supply are available. A 12 ... 24 V AC/DC and a 115 ... 230 V AC switch mode type.

Coil current module generates a pulsating magnetizing current that drives the coils in the sensor. The current is permanently monitored and corrected. Errors or cable faults are registered by the self-monitoring circuit.

Input circuit amplifies the flow-proportional signal from the electrodes. The input impedance is extremely high: $>10^{14} \Omega$ which allows flow measurements on fluids with conductivities as low as 5 $\mu\text{S/cm}$. Measuring errors due to cable capacitance are eliminated due to active cable screening.

Digital signal processor converts the analog flow signal to a digital signal and suppresses electrode noise through a digital filter. Inaccuracies in the transmitter as a result of long-term drift and temperature drift are monitored and continuously compensated for via the self-monitoring circuit. The analog to digital conversion takes place in an ultra low noise ASIC with 23 bit signal resolution. This has eliminated the need for range switching. The dynamic range of the transmitter is therefore unsurpassed with a turn down ratio of minimum 3000:1.

CAN communication

The transmitter operates internally via an internal CAN communication bus. Signals are transferred through a signal conditioner to the display module and to/from internal/external option modules and the dialog module.

Dialog module

The display unit consists of a 3-line display and a 6-key keypad. The display shows a flow rate or a totalizer value as a primary reading.

Output module

The output module converts flow data to analog, digital and relay outputs. The outputs are galvanically isolated and can be individually set to suit a particular application.

3.5 MAG 5000/MAG 6000 versions

The transmitters are designed in various versions and offer high performance and easy installation, commissioning and maintenance.

Standard version



The standard version is an IP67 version for compact or remote installation. Its robust design ensures a long lifetime if installed outdoors.

Blind version



This version carries all the normal MAG 5000/6000 features, except those associated with the display and keypad.

Both current and digital outputs are available.

Factory setting of current output in unit is switched off when delivered.

CT version



The MAG 5000/6000 CT version is a custody transfer-approved transmitter.

It is approved according to:

- Cold water pattern approval (MAG 5000/6000 CT):
 - OIML R 49
- Cold water pattern approval (MAG 6000 CT only):
 - MI-001
- Hot water pattern approval (MAG 6000 CT only):
- Heat meter pattern approval (MAG 6000 CT only):
 - OIML R 75
- Other media than water (MAG 6000 CT only):
 - OIML R 117

* Energy metering

- PTB K7.2

SV version (MAG 6000 only)



This version is identical to the standard MAG 6000 transmitters except for the following additional functions:

- Zero point adjustment
- Adjustable excitation frequency up to 44 Hz

Section 005: Process Mixers

Section 005.1:

Initial Anaerobic & Anoxic

3 Product Description

3.1 General description

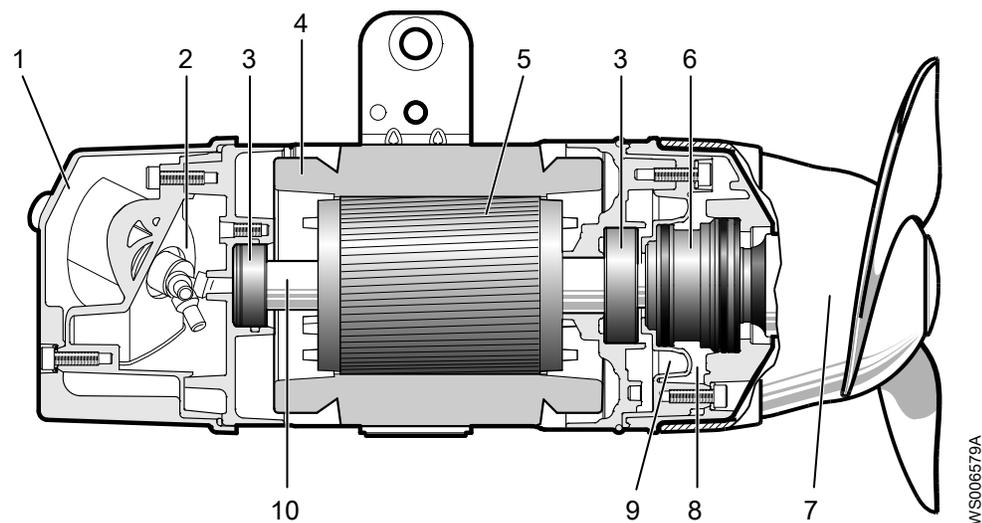
Mixer design

The mixer is submersible and driven by an electric motor.

Intended use

The product is intended for moving waste water, sludge, raw and clean water. Always follow the limits given in [Application limits](#) on page 55. If there is a question regarding the intended use of the equipment, please contact a Xylem representative before proceeding.

Illustration



Parts

Position	Part	Description
1	Cable entry	Spacer sleeve, compressible rubber bushings, and washers to relieve the cable
2	Junction box	Completely sealed off from the surrounding liquid
3	Bearings	Deep-groove ball bearing
4	Thermal contacts	For more information, see Monitoring equipment .
5	Electric motor	For information about the motor, see Motor data on page 55
6	Mechanical face seal	One stationary and one rotating seal ring
7	Propeller	Double-bladed propeller available in different angles
8	Oil housing	A housing with oil that lubricates and cools the seals, and acts as a buffer against penetrating liquid
9	Inspection chamber	Any leakage through the inner seal will be directed to the inspection chamber

Position	Part	Description
10	Shaft	Integrated rotor, completely sealed off from the surrounding liquid

Monitoring equipment

The following applies to the monitoring equipment of the mixer:

- The stator incorporates thermal contacts connected in series that activates the alarm at overtemperature.
- The thermal contacts open at 140°C (285°F).
- The sensors must be connected to either the MiniCAS II monitoring unit or an equivalent unit.
- The monitoring equipment must be of a design that makes automatic restart impossible.
- The mixer can be equipped with an inspection sensor FLS for sensing the presence of any liquid in the connection chamber.
- The mixer can be equipped with a Variable Frequency Drive (VFD).

Spare parts

Modifications to the unit/installation should only be carried out after consulting with the local sales and service representative. Original spare parts and accessories authorized by the manufacturer are essential for compliance. The use of other parts can invalidate any claims for warranty or compensation. For more information contact your local sales and service representative.

Mixer versions

Standard versions:

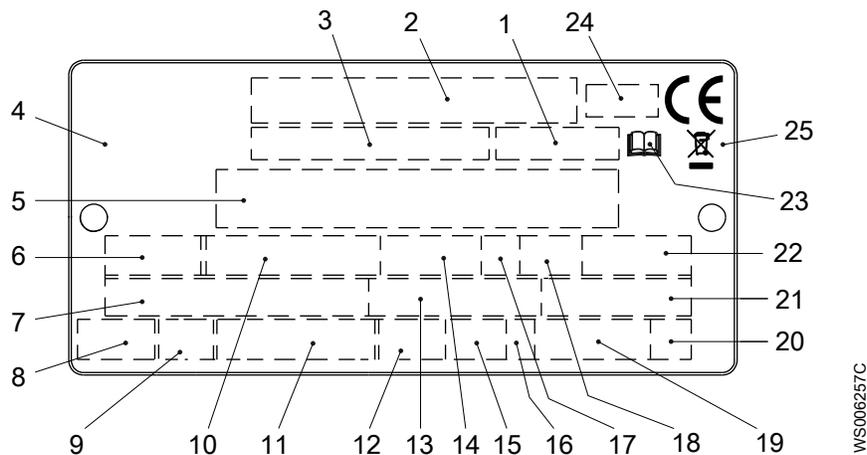
- High-grade steel (ASTM 316L)
- Warm-liquid version

Ex-approved versions:

- High-grade steel (ASTM 316L)

3.2 The data plate

The data plate is a metal label that is located on the main body of the products. The data plate lists key product specifications. Specially approved products also have an approval plate.



1. Curve code or Propeller code
2. Serial number
3. Product number
4. Country of origin
5. Additional information
6. Phase; type of current; frequency
7. Rated voltage
8. Thermal protection

WS006257C

9. Thermal class
10. Rated shaft power
11. International standard
12. Degree of protection
13. Rated current
14. Rated speed
15. Maximum submergence
16. Direction of rotation: L=left, R=right
17. Duty class
18. Duty factor
19. Product weight
20. Locked rotor code letter
21. Power factor
22. Maximum ambient temperature
23. Read installation manual
24. Notified body, only for EN-approved Ex products
25. WEEE-Directive symbol

Figure 1: The data plate

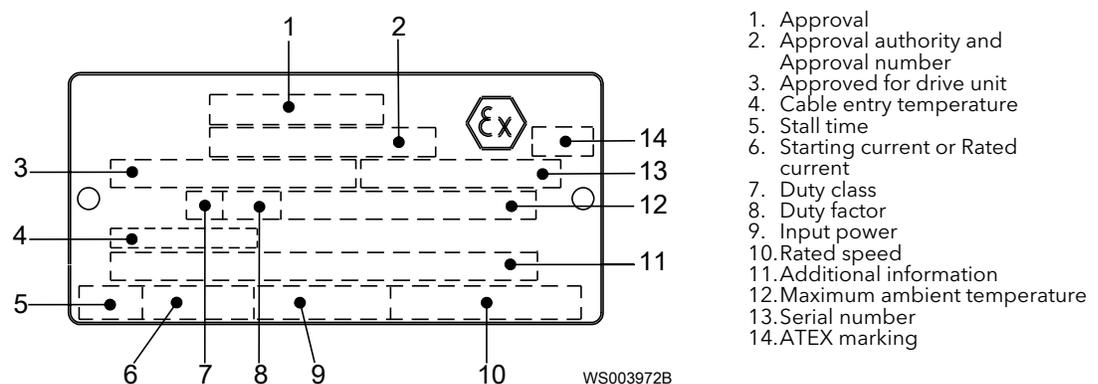
3.3 Approvals

Product approvals for hazardous locations

Product	Approval
4610.490 4620.490	<p>European Norm (EN)</p> <ul style="list-style-type: none"> • ATEX Directive • EN 60079-0:2012/A11:2013, EN 60079-1:2007, EN 13463-1:2009, EN 13463-5:2011 •  II 2 G c Ex d IIB T3 Gb
	<p>IEC</p> <ul style="list-style-type: none"> • IECEx scheme • IEC 60079-0, IEC 60079-1 • Ex d I Mb • Ex d IIB T3 Gb
	<p>FM (FM Approvals)</p> <ul style="list-style-type: none"> • Explosion proof for use in Class I, Div. 1, Group C and D • Dust ignition proof for use in Class II, Div. 1, Group E, F and G • Suitable for use in Class III, Div. 1, Hazardous Locations
	<p>CSA Ex</p> <ul style="list-style-type: none"> • Explosion proof for use in Class I, Div. 1, Group C and D

EN approval plate

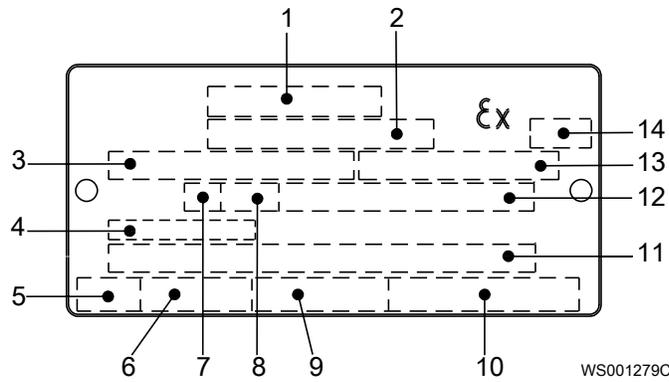
This illustration describes the EN approval plate and the information that is contained in its fields.



IEC approval plate

This illustration describes the IEC approval plate and the information that is contained in its fields.

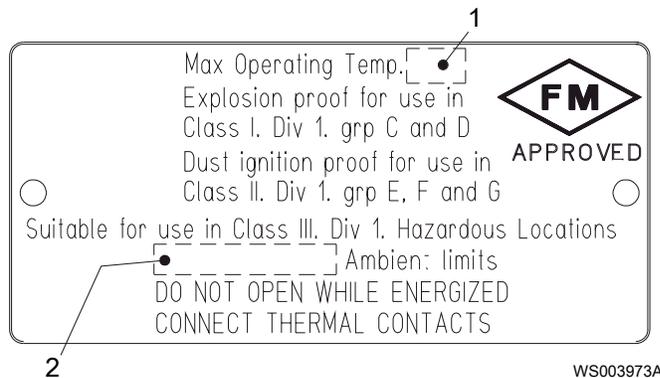
International Norm; not for EU member countries.



1. Approval
2. Approval authority and Approval number
3. Approved for drive unit
4. Cable entry temperature
5. Stall time
6. Starting current or Rated current
7. Duty class
8. Duty factor
9. Input power
10. Rated speed
11. Additional information
12. Maximum ambient temperature
13. Serial number
14. ATEX marking

FM approval plate

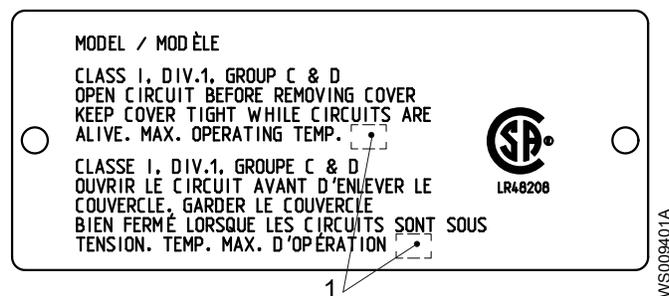
This illustration describes the FM approval plate and the information that is contained in its fields.



1. Temperature class
2. Maximum ambient temperature

CSA approval plate

This illustration describes the CSA approval plate and the information that is contained in its fields.



1. Temperature class

3.4 Product denomination

Reading instruction

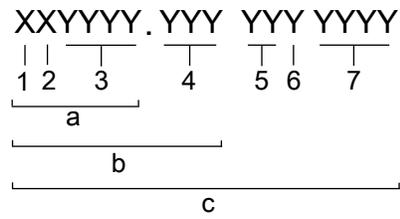
In this section, code characters are illustrated accordingly:

X = letter

Y = digit

The different types of codes are marked up with a, b and c. Code parameters are marked up with numbers.

Codes and parameters



WS006265B

Type of Callout	Number	Indication
Type of code	a	Sales denomination
	b	Product code
	c	Serial number
Parameter	1	Hydraulic end
	2	Type of installation
	3	Sales code
	4	Version
	5	Production year
	6	Production cycle
	7	Running number

8 Technical Reference

8.1 Motor data

Feature	Description
Motor type	Squirrel-cage 4-pole induction motor
Frequency	50 Hz 60 Hz
Supply	1-phase (only 4620) or 3-phase
Starting method	<ul style="list-style-type: none"> • Direct on-line • Variable Frequency Drive (VFD)
Maximum starts per hour	30 evenly-spaced starts per hour
Voltage variation	<ul style="list-style-type: none"> • Continuously running: Maximum $\pm 5\%$ • Intermittently running: Maximum $\pm 10\%$
Voltage imbalance between the phases	Maximum of 2%
Stator insulation class	F (155°C [311°F])

Motor encapsulation

Motor encapsulation is in accordance with IP68.

8.2 Application limits

Data	Description
Liquid temperature	<ul style="list-style-type: none"> • Maximum 40°C (104°F) • Warm liquid version: 60°C (140°F) or 90°C (195°F)
Liquid density	1100 kg/m ³ (9.2 lb per US gal) maximum
pH of the mixed liquid	1-12
Depth of immersion	Maximum 20 m (65 ft)

Section 005.2

Final Anoxic & Anaerobic Mixers

3 Product Description

3.1 General description

Mixer design

The mixer is submersible and driven by an electric motor.

Intended use

The product is intended for moving waste water, sludge, raw and clean water. Always follow the limits given in [Application limits](#) on page 55. If there is a question regarding the intended use of the equipment, please contact a Xylem representative before proceeding.

Illustration

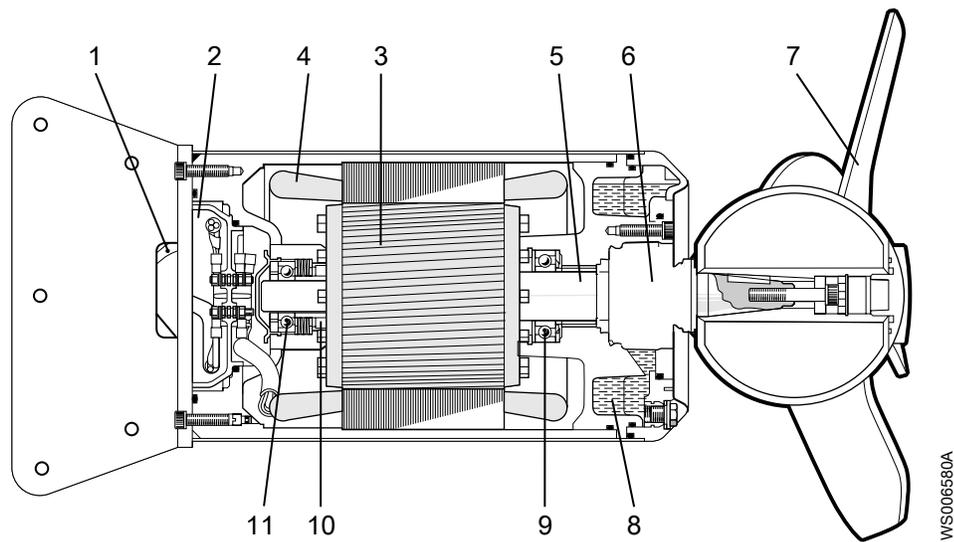


Figure 1: Versions .310 and .390

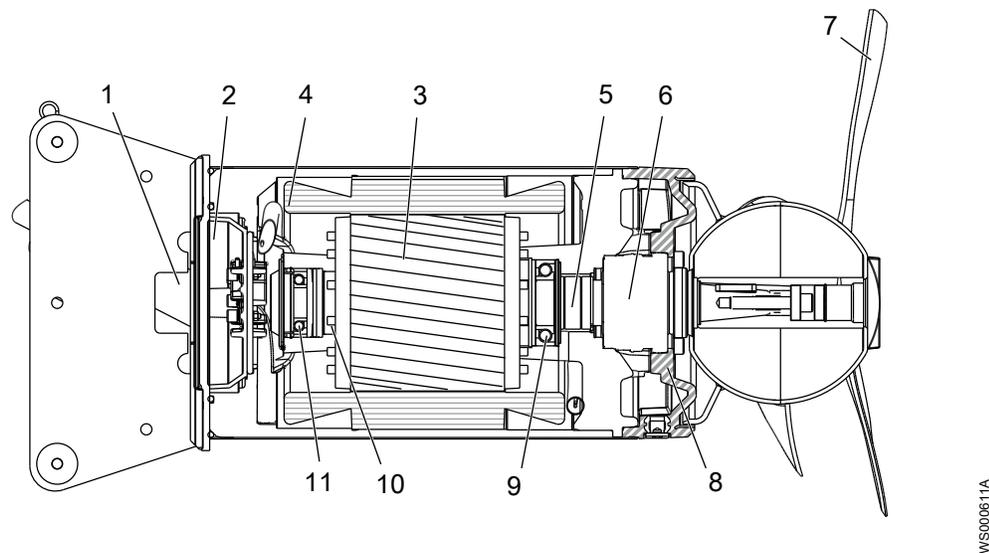


Figure 2: Versions .412 and .492

Parts

Position	Part	Description
1	Cable entry	Spacer sleeve, compressible rubber bushings, and washers to relieve the cable
2	Junction box	Completely sealed off from the surrounding liquid
3	Electric motor	For information about the motor, see Motor data on page 55
4	Thermal contacts	For information about the thermal contacts, see Monitoring equipment
5	Shaft	Integrated rotor, completely sealed off from the surrounding liquid
6	Mechanical face seal	One stationary and one rotating seal ring
7	Propeller	Triple-bladed propeller available in different angles and materials
8	Oil housing	A housing with oil that lubricates and cools the seals, and acts as a buffer against penetrating liquid
9	Main bearing	Angular-contact ball bearing
10	Support bearing	Cylindrical roller bearing
11	Support bearing	Angular-contact ball bearing

Monitoring equipment

The following applies to the monitoring equipment of the mixer:

- The stator incorporates thermal contacts connected in series that activates the alarm at overtemperature.
- The thermal contacts open at 140°C (285°F).
- The sensors must be connected to either the MiniCAS II monitoring unit or an equivalent unit.
- The monitoring equipment must be of a design that makes automatic restart impossible.
- The mixer can be equipped with an inspection sensor FLS for sensing the presence of any liquid in the stator housing.
- The mixer can be equipped with a Variable Frequency Drive (VFD).

Spare parts

Modifications to the unit/installation should only be carried out after consulting with the local sales and service representative. Original spare parts and accessories authorized by the manufacturer are essential for compliance. The use of other parts can invalidate any claims for warranty or compensation. For more information contact your local sales and service representative.

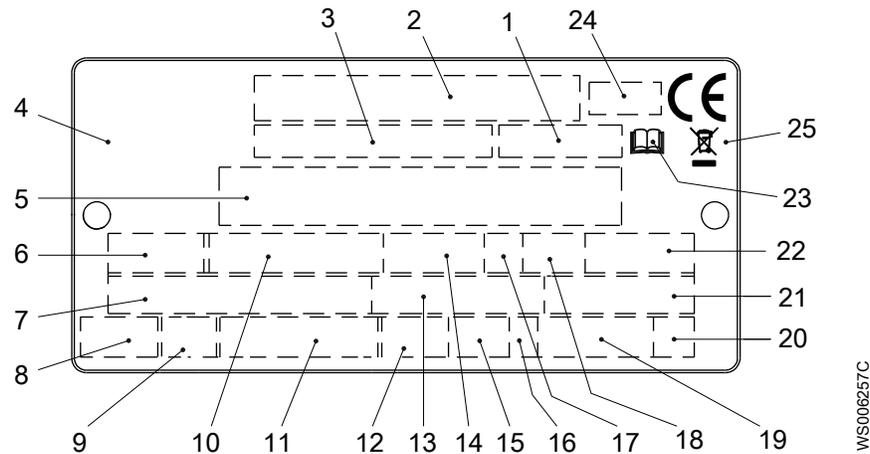
Mixer versions

Standard and Ex-approved versions:

- Stainless steel (ASTM 304)
- High-grade steel (ASTM 316L)
- Warm-liquid version

3.2 The data plate

The data plate is a metal label that is located on the main body of the products. The data plate lists key product specifications. Specially approved products also have an approval plate.



1. Curve code or Propeller code
2. Serial number
3. Product number
4. Country of origin
5. Additional information
6. Phase; type of current; frequency
7. Rated voltage
8. Thermal protection
9. Thermal class
10. Rated shaft power
11. International standard
12. Degree of protection
13. Rated current
14. Rated speed
15. Maximum submergence
16. Direction of rotation: L=left, R=right
17. Duty class
18. Duty factor
19. Product weight
20. Locked rotor code letter
21. Power factor
22. Maximum ambient temperature
23. Read installation manual
24. Notified body, only for EN-approved Ex products
25. WEEE-Directive symbol

Figure 3: The data plate

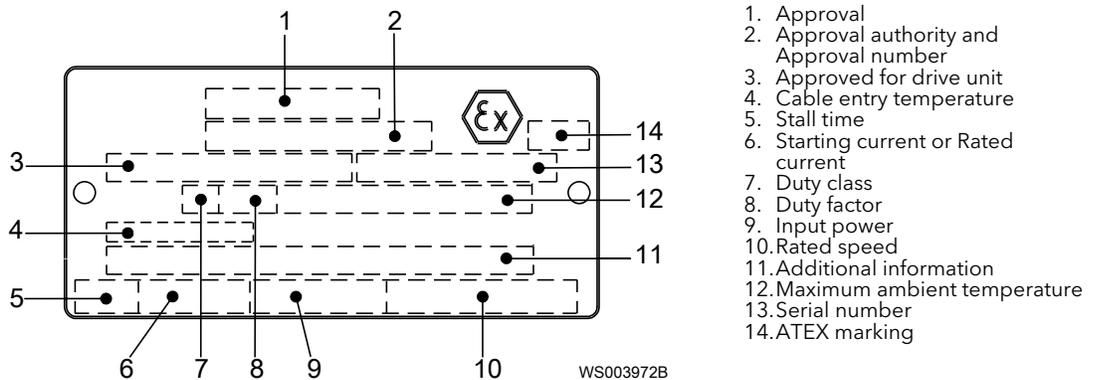
3.3 Approvals

Product approvals for hazardous locations

Product	Approval
4630.390 4630.492 4640.390 4640.492	<p>European Norm (EN)</p> <ul style="list-style-type: none"> • ATEX Directive • EN 60079-0:2012/A11:2013, EN 60079-1:2007, EN 13463-1:2009, EN 13463-5:2011 • Ex I M2 c Ex d I Mb • Ex II 2 G c Ex d IIB T3 Gb
	<p>IEC</p> <ul style="list-style-type: none"> • IECEx scheme • IEC 60079-0, IEC 60079-1 • Ex d I Mb • Ex d IIB T3 Gb
	<p>FM (FM Approvals)</p> <ul style="list-style-type: none"> • Explosion proof for use in Class I, Div. 1, Group C and D • Dust ignition proof for use in Class II, Div. 1, Group E, F and G • Suitable for use in Class III, Div. 1, Hazardous Locations
	<p>CSA Ex</p> <ul style="list-style-type: none"> • Explosion proof for use in Class I, Div. 1, Group C and D

EN approval plate

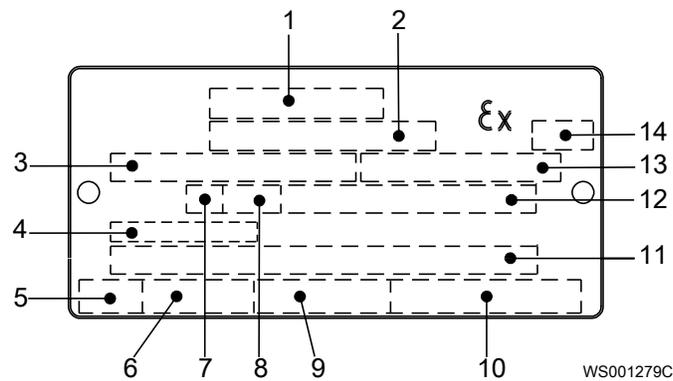
This illustration describes the EN approval plate and the information that is contained in its fields.



IEC approval plate

This illustration describes the IEC approval plate and the information that is contained in its fields.

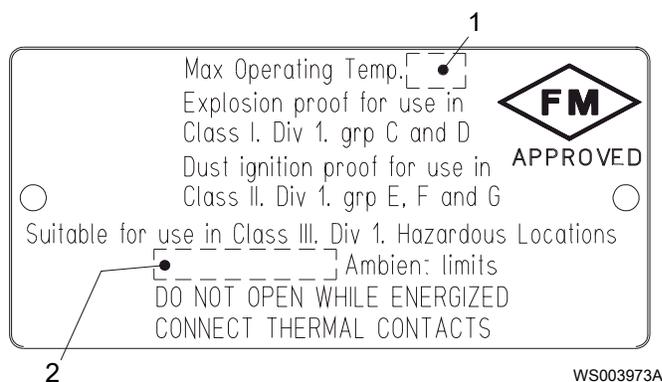
International Norm; not for EU member countries.



1. Approval
2. Approval authority and Approval number
3. Approved for drive unit
4. Cable entry temperature
5. Stall time
6. Starting current or Rated current
7. Duty class
8. Duty factor
9. Input power
10. Rated speed
11. Additional information
12. Maximum ambient temperature
13. Serial number
14. ATEX marking

FM approval plate

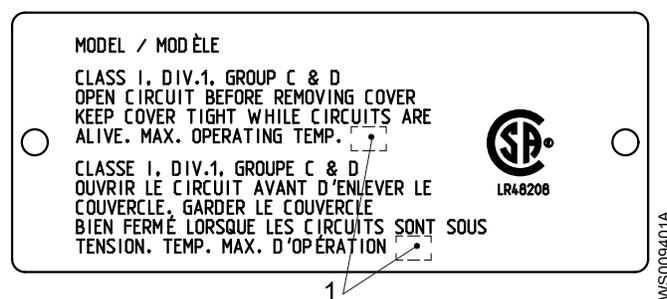
This illustration describes the FM approval plate and the information that is contained in its fields.



1. Temperature class
2. Maximum ambient temperature

CSA approval plate

This illustration describes the CSA approval plate and the information that is contained in its fields.



1. Temperature class

3.4 Product denomination

Reading instruction

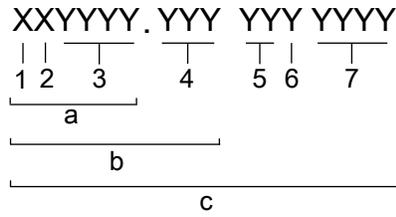
In this section, code characters are illustrated accordingly:

X = letter

Y = digit

The different types of codes are marked up with a, b and c. Code parameters are marked up with numbers.

Codes and parameters



WS006265B

Type of Callout	Number	Indication
Type of code	a	Sales denomination
	b	Product code
	c	Serial number
Parameter	1	Hydraulic end
	2	Type of installation
	3	Sales code
	4	Version
	5	Production year
	6	Production cycle
	7	Running number

8 Technical Reference

8.1 Motor data

Feature	Description
Motor type	Squirrel-cage induction motor
Frequency	50 Hz 60 Hz
Supply	3-phase
Starting method	<ul style="list-style-type: none"> • Direct on-line • Variable Frequency Drive (VFD)
Maximum starts per hour	30 evenly-spaced starts per hour
Voltage variation	<ul style="list-style-type: none"> • Continuously running: Maximum $\pm 5\%$ • Intermittently running: Maximum $\pm 10\%$
Voltage imbalance between the phases	Maximum of 2%
Stator insulation class	H (180°C [356°F])

Motor encapsulation

Motor encapsulation is in accordance with IP68.

8.2 Application limits

Data	Description
Liquid temperature	<ul style="list-style-type: none"> • Maximum 40°C (104°F) • Warm liquid version: 60°C (140°F) or 90°C (195°F)
Liquid density	1100 kg/m ³ (9.2 lb per US gal) maximum
pH of the mixed liquid	1-12
Depth of immersion	Maximum 20 m (65 ft)

Section 006:

Process Pumps

Section 006.1:

Mixed Liquor Recycle Pumps

3 Product Description

Products included

Pump	Non-explosion proof drive unit	Explosion proof drive unit	High Efficiency motor (LSPM)	C-hydraulic	D-hydraulic	F-hydraulic	G-hydraulic	M-hydraulic (Grinder)	N hydraulic (Hard-Iron™)	Adaptive N™ hydraulic
3085.060	X									X ¹
3085.070		X								X ¹
3085.092		X		X	X	X	X		X	
3085.160	X									X ³
3085.172	X							X		
3085.183	X			X	X	X	X		X	
3085.190		X								X ³
3085.760	X									X ²
3085.770		X								X ²
3085.820	X		X						X	
3085.830		X	X						X	
3085.891		X						X		
3085.900	X		X							X ³
3085.910		X	X							X ³
3085.920	X		X							X ¹
3085.930		X	X							X ¹
3085.960	X		X							X ²
3085.970		X	X							X ²
¹ Hard-Iron™ ² Stainless steel ³ Cast iron, gray										

Pump-specific information

For the specific weight, current, voltage, power ratings, and speed of the pump, see the data plate of the pump.

3.1 Pump design

The pump is submersible, and driven by an electric motor.

Intended use

The product is intended for moving wastewater, sludge, raw and clean water. Always follow the limits that are given in [Technical Reference](#) on page 67. If there is a question regarding the intended use of the equipment, please contact a local sales and service representative before proceeding.



DANGER: Explosion/Fire Hazard

Special rules apply to installations in explosive or flammable atmospheres. Do not install the product or any auxiliary equipment in an explosive zone unless it is rated explosion-proof or intrinsically-safe. If the product is rated explosion-proof or intrinsically-safe, then see the specific explosion-proof information in the safety chapter before taking any further actions.

NOTICE:

Do NOT use the unit in highly corrosive liquids.

Spare parts

- Modifications to the unit or installation should only be carried out after consulting with Xylem.
- Original spare parts and accessories that are authorized by Xylem are essential for compliance. The use of other parts can invalidate any claims for warranty or compensation. For more information contact your Xylem representative.

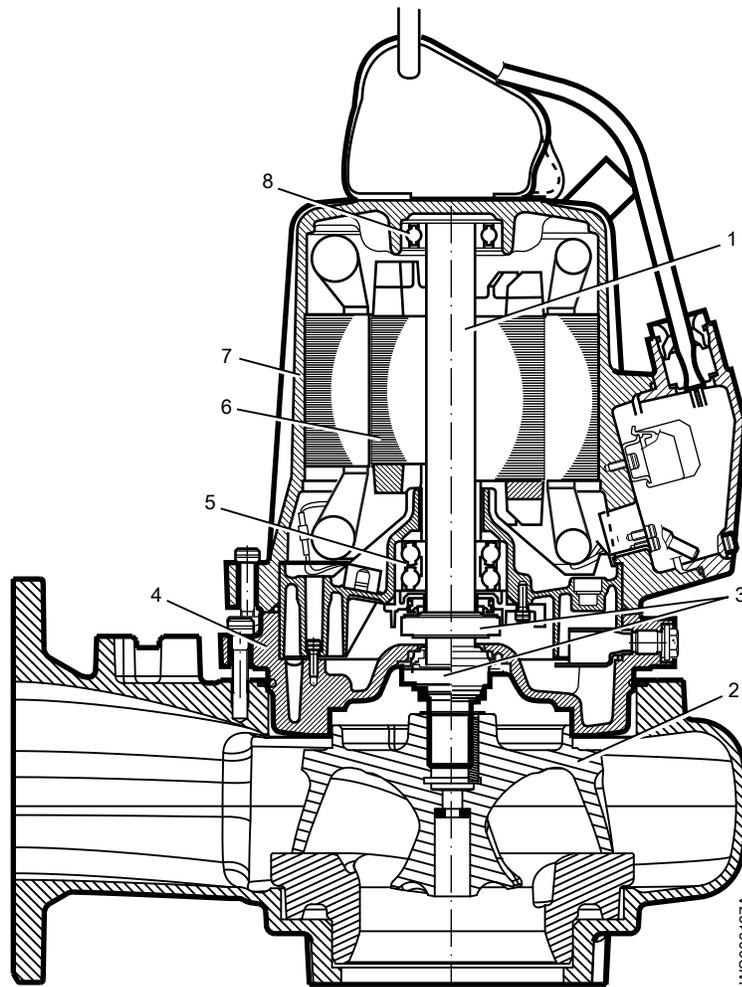
Pressure class

LT	Low head
MT	Medium head
HT	High head
SH	Super high head

Exterior™ product concept

Exterior™ is a product concept including N-technology, Premium efficiency motor, and the intelligent control SmartRun™.

Parts



Position	Denomination	Description
1	Shaft	The shaft is made of stainless steel with an integrated rotor.
2	Impeller	There are multiple types of impellers. For information about the pumps impellers, see Parts List.
3	Mechanical seals	One inner and one outer seal in a combination of materials: <ul style="list-style-type: none"> • Aluminium oxide Al_2O_3 • Silicon carbide RSiC • Corrosion-resistant cemented carbide WCCR For information about the pumps mechanical seals, see Parts List.
4	Oil housing	The oil housing includes a coolant that lubricates and cools the seals; the housing acts as a buffer between the pumped fluid and the drive unit.
5	Main bearing	The bearing consisting of a two-row angular contact ball bearing.
6	Motor	For information about the motor, see Technical Reference on page 67.
7	Stator housing	The pump is cooled by the ambient liquid/air.
8	Support bearing	The bearing consisting of a single-row ball bearing.

3.2 Monitoring equipment

The following applies to the monitoring equipment of the pump:

- The stator incorporates three thermal contacts connected in series that activate the alarm and stops the pump at overtemperature
- The thermal contacts open at 125°C (257°F).

- Ex-approved pumps must have thermal contacts connected to the control panel.
- The sensors must be connected to either the MiniCAS II monitoring equipment or an equivalent equipment.
- The monitoring equipment must be of a design that makes automatic restart impossible.
- Information in the junction box shows if the pump is equipped with optional sensors.

Optional sensors

FLS FLS is a miniature float switch for detection of liquid in the stator housing. Due to its design it is best suited for pumps in a vertical position. The FLS sensor is installed in the bottom of the stator housing.

CLS CLS is a sensor for detection of water in the oil housing. The sensor initiates an alarm when the oil contains approximately 35% water. The sensor is installed in the bearing housing/bearing holder with its sensing part in the oil housing. The CLS sensor is not applicable to Ex-approved pumps.

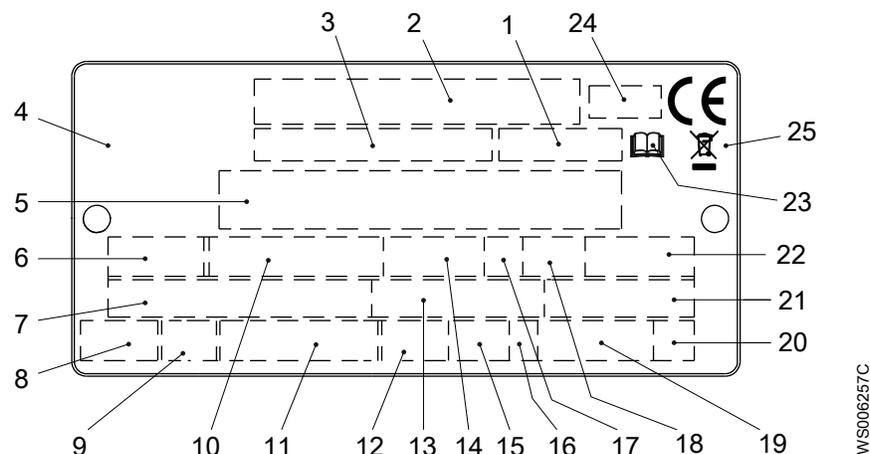
NOTICE:

The CLS sensor body is made of glass. Handle the sensor with care.

One CLS and one FLS sensor can be used in the same pump, if they are connected in parallel.

3.3 The data plate

The data plate is a metal label that is located on the main body of the products. The data plate lists key product specifications. Specially approved products also have an approval plate.



1. Curve code or Propeller code
2. Serial number
3. Product number
4. Country of origin
5. Additional information
6. Phase; type of current; frequency
7. Rated voltage
8. Thermal protection
9. Thermal class
10. Rated shaft power
11. International standard
12. Degree of protection
13. Rated current
14. Rated speed
15. Maximum submergence
16. Direction of rotation: L=left, R=right
17. Duty class
18. Duty factor
19. Product weight
20. Locked rotor code letter
21. Power factor
22. Maximum ambient temperature
23. Read installation manual

WS006257C

- 24. Notified body, only for EN-approved Ex products
- 25. WEEE-Directive symbol

Figure 1: The data plate

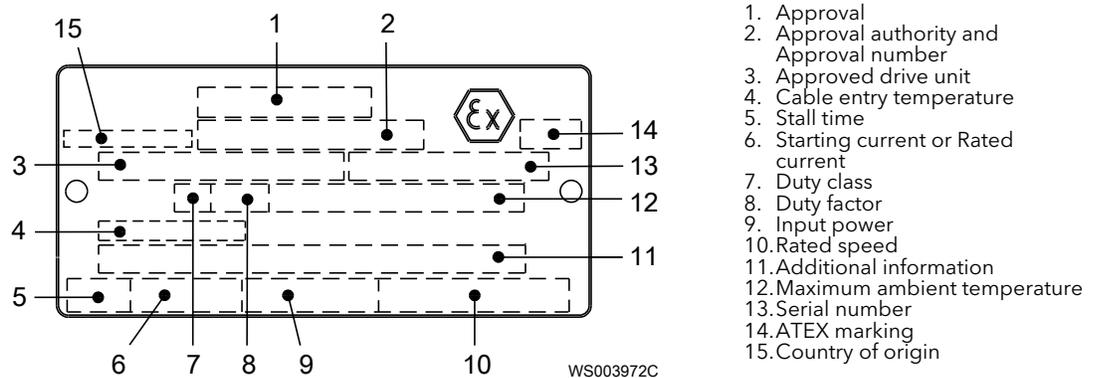
3.4 Approvals

Product approvals for hazardous locations

Pump	Approval
<ul style="list-style-type: none"> • 3085.070 • 3085.092 • 3085.190 • 3085.770 • 3085.830 • 3085.891 	European Norm (EN) <ul style="list-style-type: none"> • ATEX Directive • EN 60079-0:2012/A11:2013, EN 60079-1:2014, EN ISO 80079-36:2016, EN ISO 80079-37:2016 •  II 2 G Ex db h IIB T4 Gb
<ul style="list-style-type: none"> • 3085.910 • 3085.930 • 3085.970 	IEC <ul style="list-style-type: none"> • IECEx scheme • IEC 60079-0:2011, IEC 60079-1:2014; IEC 80079-36:2016; IEC 80079-37:2016 • Ex db h IIB T4 Gb
	FM (FM Approvals) <ul style="list-style-type: none"> • Explosion proof for use in Class I, Div. 1, Group C and D • Dust ignition proof for use in Class II, Div. 1, Group E, F and G • Suitable for use in Class III, Div. 1, Hazardous Locations
	CSA Ex <ul style="list-style-type: none"> • Explosion proof for use in Class I, Div. 1, Group C and D

EN approval plate

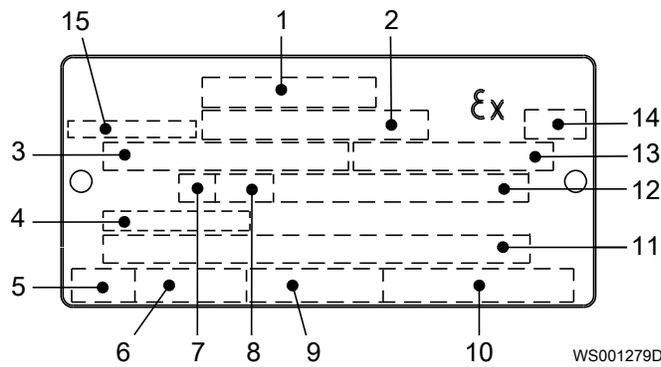
This illustration describes the EN approval plate and the information that is contained in its fields.



IEC approval plate

This illustration describes the IEC approval plate and the information that is contained in its fields.

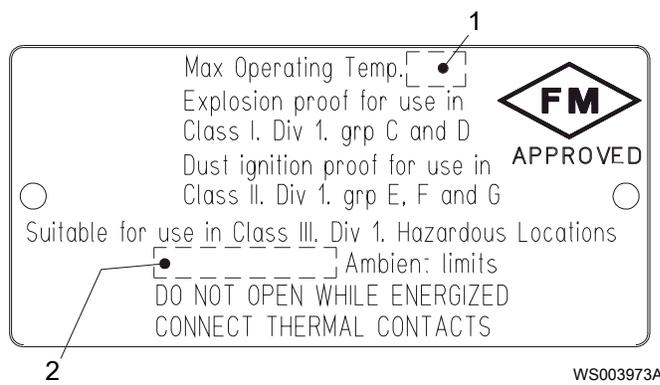
International Norm; not for EU member countries.



1. Approval
2. Approval authority and Approval number
3. Approved drive unit
4. Cable entry temperature
5. Stall time
6. Starting current or Rated current
7. Duty class
8. Duty factor
9. Input power
10. Rated speed
11. Additional information
12. Maximum ambient temperature
13. Serial number
14. ATEX marking
15. Country of origin

FM approval plate

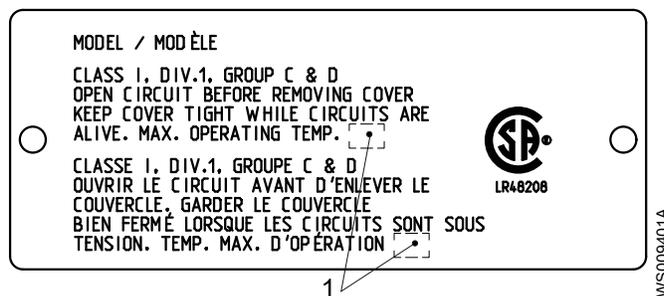
This illustration describes the FM approval plate and the information that is contained in its fields.



1. Temperature class
2. Maximum ambient temperature

CSA approval plate

This illustration describes the CSA approval plate and the information that is contained in its fields.



1. Temperature class

3.5 Product denomination

Reading instruction

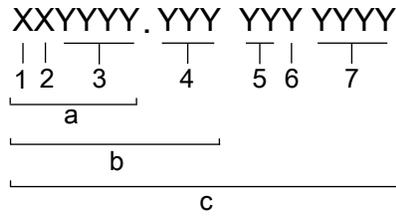
In this section, code characters are illustrated accordingly:

X = letter

Y = digit

The different types of codes are marked up with a, b and c. Code parameters are marked up with numbers.

Codes and parameters



WS006265B

Type of Callout	Number	Indication
Type of code	a	Sales denomination
	b	Product code
	c	Serial number
Parameter	1	Hydraulic end
	2	Type of installation
	3	Sales code
	4	Version
	5	Production year
	6	Production cycle
	7	Running number

8 Technical Reference

8.1 Application limits

Data	Description
Liquid temperature	40°C (104°F) maximum The pump can be operated at full load only if at least half the stator housing is submerged. 3085.060, 3085.160, 3085.183, 3085.760: <ul style="list-style-type: none"> Warm-liquid version: 70°C (158°F) maximum
pH of the pumped media (liquid)	5.5–14
Liquid density	1100 kg/m ³ (9.2 lb per US gal) maximum
Depth of immersion	Maximum 20 m (65 ft)
Other	For the specific weight, current, voltage, power ratings, and speed of the pump, see the data plate of the pump.

8.2 Motor data

Feature	Description
Motor type	3085.060/.070/.092/.160/.172/.183/.190/.760/.770/.891: <ul style="list-style-type: none"> Squirrel-cage induction motor 3085.820/.830/.900/.910/.920/.930/.960/.970: <ul style="list-style-type: none"> Line-started, permanent-magnet synchronous motor
Frequency	50 Hz or 60 Hz
Supply	1-phase or 3-phase
Starting method	Star-delta Soft starter Direct on-line Variable Frequency Drive (VFD)
Maximum starts per hour	30 evenly-spaced starts per hour
Code compliance	IEC 60034-1
Voltage variation without overheating	±10%, if it does not run continuously at full load
Voltage imbalance tolerance	2%
Stator insulation class	H (180°C [356°F])

Motor encapsulation

Motor encapsulation is in accordance with IP68.

Section 006.2

Nitrate Recycle Pumps

3 Product Description

Products included

Pump	Non-explosion proof drive unit	Explosion proof drive unit	High Efficiency motor (LSPM)	C-hydraulic	D-hydraulic	F-hydraulic	H hydraulic	L hydraulic	P hydraulic	M-hydraulic (Grinder)	Chopper hydraulics	N hydraulic (Hard-Iron™)	Adaptive N™ hydraulic
3127.060	X												X ¹
3127.070		X											X ¹
3127.091		X		X	X	X	X	X	X				
3127.095		X										X	
3127.161	X												X ³
3127.170	X									X			
3127.182	X			X	X	X	X	X	X				
3127.185	X											X	
3127.191		X											X ³
3127.350	X										X		
3127.390		X									X		
3127.761	X												X ²
3127.771		X											X ²
3127.820	X		X									X	
3127.830		X	X									X	
3127.840	X		X								X		
3127.850		X	X								X		
3127.890		X								X			
3127.901	X		X										X ³
3127.911		X	X										X ³
3127.920	X		X										X ¹
3127.930		X	X										X ¹
3127.961	X		X										X ²
3127.971		X	X										X ²
¹ Hard-Iron™ ² Stainless steel ³ Cast iron, gray													

Pump-specific information

For the specific weight, current, voltage, power ratings, and speed of the pump, see the data plate of the pump.

3.1 Pump design

The pump is submersible, and driven by an electric motor.

Intended use

The product is intended for moving wastewater, sludge, raw and clean water. Always follow the limits that are given in *Technical Reference* on page 76. If there is a question regarding the intended use of the equipment, please contact a local sales and service representative before proceeding.



DANGER: Explosion/Fire Hazard

Special rules apply to installations in explosive or flammable atmospheres. Do not install the product or any auxiliary equipment in an explosive zone unless it is rated explosion-proof or intrinsically-safe. If the product is rated explosion-proof or intrinsically-safe, then see the specific explosion-proof information in the safety chapter before taking any further actions.

NOTICE:

Do NOT use the unit in highly corrosive liquids.

Spare parts

- Modifications to the unit or installation should only be carried out after consulting with Xylem.
- Original spare parts and accessories that are authorized by Xylem are essential for compliance. The use of other parts can invalidate any claims for warranty or compensation. For more information contact your Xylem representative.

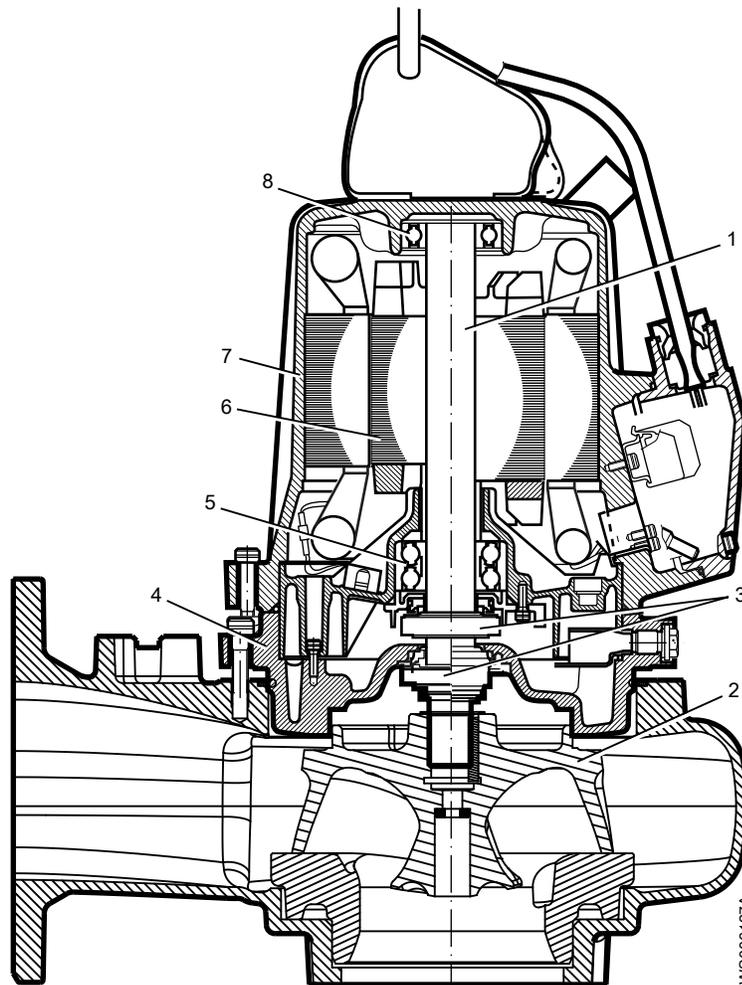
Pressure class

LT	Low head
MT	Medium head
HT	High head
SH	Super high head

Experior™ product concept

Experior™ is a product concept including N-technology, Premium efficiency motor, and the intelligent control SmartRun™.

Parts



Position	Denomination	Description
1	Shaft	The shaft is made of stainless steel with an integrated rotor.
2	Impeller	There are multiple types of impellers. For information about the pumps impellers, see Parts List.
3	Mechanical seals	One inner and one outer seal in a combination of materials: <ul style="list-style-type: none"> • Aluminium oxide Al_2O_3 • Corrosion-resistant cemented carbide WCCR For information about the pumps mechanical seals, see Parts List.
4	Oil housing	The oil housing includes a coolant that lubricates and cools the seals; the housing acts as a buffer between the pumped fluid and the drive unit.
5	Main bearing	The bearing consisting of a two-row angular contact ball bearing.
6	Motor	For information about the motor, see Technical Reference on page 76.
7	Stator housing	The pump is cooled by the ambient liquid/air.
8	Support bearing	The bearing consisting of a single-row ball bearing.

3.2 Monitoring equipment

The following applies to the monitoring equipment of the pump:

- The stator incorporates three thermal contacts connected in series that activate the alarm and stops the pump at overtemperature
- The thermal contacts open at 125°C (257°F).
- Ex-approved pumps must have thermal contacts connected to the control panel.

- The sensors must be connected to either the MiniCAS II monitoring equipment or an equivalent equipment.
- The monitoring equipment must be of a design that makes automatic restart impossible.
- Information in the junction box shows if the pump is equipped with optional sensors.

Optional sensors

FLS FLS is a miniature float switch for detection of liquid in the stator housing. Due to its design it is best suited for pumps in a vertical position. The FLS sensor is installed in the bottom of the stator housing.

CLS CLS is a sensor for detection of water in the oil housing. The sensor initiates an alarm when the oil contains approximately 35% water. The sensor is installed in the bearing housing/bearing holder with its sensing part in the oil housing. The CLS sensor is not applicable to Ex-approved pumps.

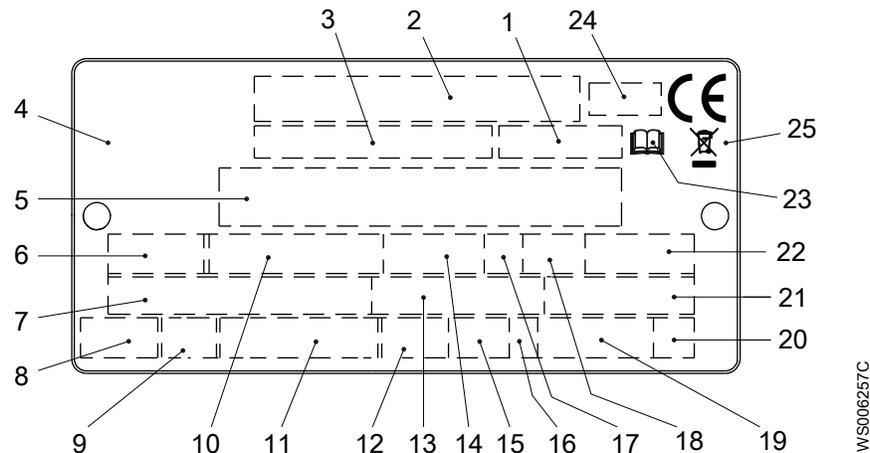
NOTICE:

The CLS sensor body is made of glass. Handle the sensor with care.

One CLS and one FLS sensor can be used in the same pump, if they are connected in parallel.

3.3 The data plate

The data plate is a metal label that is located on the main body of the products. The data plate lists key product specifications. Specially approved products also have an approval plate.



1. Curve code or Propeller code
2. Serial number
3. Product number
4. Country of origin
5. Additional information
6. Phase; type of current; frequency
7. Rated voltage
8. Thermal protection
9. Thermal class
10. Rated shaft power
11. International standard
12. Degree of protection
13. Rated current
14. Rated speed
15. Maximum submergence
16. Direction of rotation: L=left, R=right
17. Duty class
18. Duty factor
19. Product weight
20. Locked rotor code letter
21. Power factor
22. Maximum ambient temperature
23. Read installation manual

WS006257C

24. Notified body, only for EN-approved Ex products
 25. WEEE-Directive symbol

Figure 1: The data plate

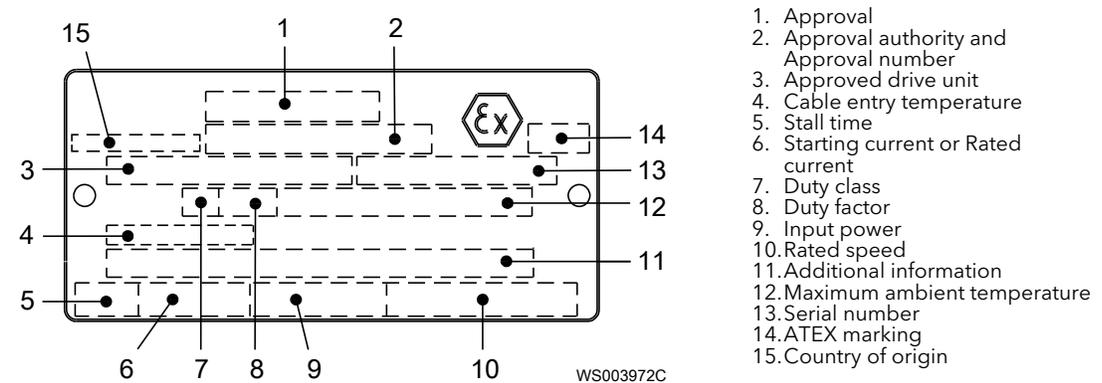
3.4 Approvals

Product approvals for hazardous locations

Pump	Approval
<ul style="list-style-type: none"> • 3127.070 • 3127.091 • 3127.095 • 3127.191 • 3127.390 • 3127.771 • 3127.830 	European Norm (EN) <ul style="list-style-type: none"> • ATEX Directive • EN 60079-0:2012/A11:2013, EN 60079-1:2014, EN ISO 80079-36:2016, EN ISO 80079-37:2016 • Ex I M2 Ex db h I Mb • Ex II 2 G Ex db h IIB T4 Gb
<ul style="list-style-type: none"> • 3127.850 • 3127.890 • 3127.911 • 3127.930 • 3127.971 	IEC <ul style="list-style-type: none"> • IECEx scheme • IEC 60079-0:2011, IEC 60079-1:2014; IEC 80079-36:2016; IEC 80079-37:2016 • Ex db h I Mb • Ex db h IIB T4 Gb
	FM (FM Approvals) <ul style="list-style-type: none"> • Explosion proof for use in Class I, Div. 1, Group C and D • Dust ignition proof for use in Class II, Div. 1, Group E, F and G • Suitable for use in Class III, Div. 1, Hazardous Locations
	CSA Ex <ul style="list-style-type: none"> • Explosion proof for use in Class I, Div. 1, Group C and D

EN approval plate

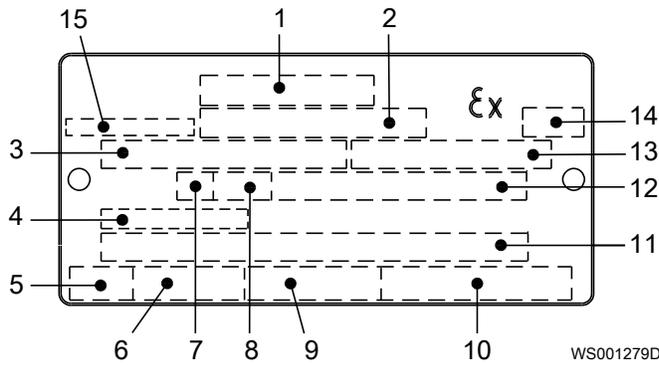
This illustration describes the EN approval plate and the information that is contained in its fields.



IEC approval plate

This illustration describes the IEC approval plate and the information that is contained in its fields.

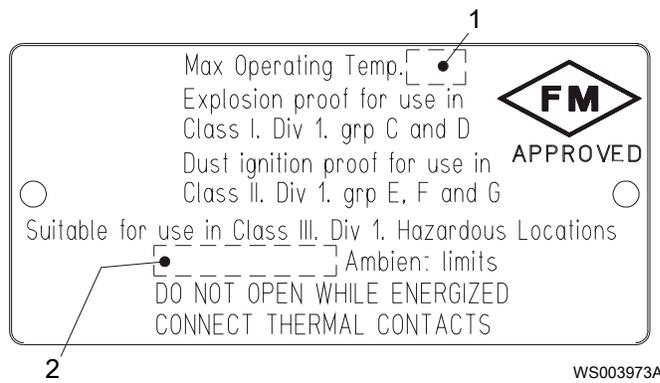
International Norm; not for EU member countries.



1. Approval
2. Approval authority and Approval number
3. Approved drive unit
4. Cable entry temperature
5. Stall time
6. Starting current or Rated current
7. Duty class
8. Duty factor
9. Input power
10. Rated speed
11. Additional information
12. Maximum ambient temperature
13. Serial number
14. ATEX marking
15. Country of origin

FM approval plate

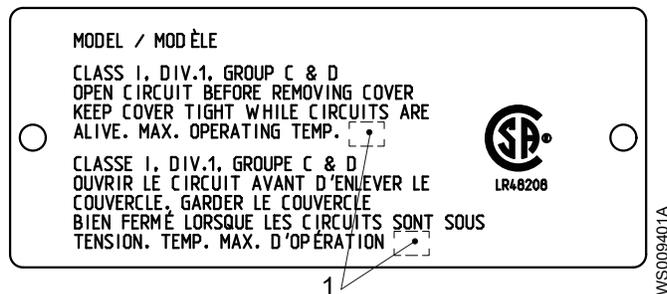
This illustration describes the FM approval plate and the information that is contained in its fields.



1. Temperature class
2. Maximum ambient temperature

CSA approval plate

This illustration describes the CSA approval plate and the information that is contained in its fields.



1. Temperature class

3.5 Product denomination

Reading instruction

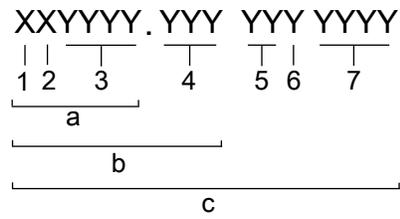
In this section, code characters are illustrated accordingly:

X = letter

Y = digit

The different types of codes are marked up with a, b and c. Code parameters are marked up with numbers.

Codes and parameters



WS006265B

Type of Callout	Number	Indication
Type of code	a	Sales denomination
	b	Product code
	c	Serial number
Parameter	1	Hydraulic end
	2	Type of installation
	3	Sales code
	4	Version
	5	Production year
	6	Production cycle
	7	Running number

8 Technical Reference

8.1 Application limits

Data	Description
Liquid temperature	40°C (104°F) maximum The pump can be operated at full load only if at least half the stator housing is submerged. 3127.060/.161/.182/.185/.350/.761 warm-liquid version: <ul style="list-style-type: none"> Warm-liquid version: 70°C (158°F) maximum
pH of the pumped media (liquid)	5.5–14
Liquid density	1100 kg/m ³ (9.2 lb per US gal) maximum
Depth of immersion	Maximum 20 m (65 ft)
Other	For the specific weight, current, voltage, power ratings, and speed of the pump, see the data plate of the pump.

8.2 Motor data

Feature	Description
Motor type	3127.060/.070/.091/.095/.161/.170/.182/.185/.191/.350/.390/.761/.771/.890: <ul style="list-style-type: none"> Squirrel-cage induction motor 3127.820/.830/.840/.850/.901/.911/.920/.930/.961/.971: <ul style="list-style-type: none"> Line-started, permanent-magnet synchronous motor
Frequency	50 Hz or 60 Hz
Supply	1-phase or 3-phase
Starting method	Star-delta Soft starter Direct on-line Variable Frequency Drive (VFD)
Maximum starts per hour	30 evenly-spaced starts per hour
Code compliance	IEC 60034-1
Voltage variation without overheating	±10%, if it does not run continuously at full load
Voltage imbalance tolerance	2%
Stator insulation class	H (180°C [356°F])

Motor encapsulation

Motor encapsulation is in accordance with IP68.

Section 007:

Clarifiers

1.1 Introduction

This manual provides basic installation instructions for Polychem Systems rectangular clarifiers. For more information, please contact your local sales representative or the original equipment manufacturer:

Polychem Systems

500 Spring Ridge Drive

Reading, Pennsylvania 19610 USA

Telephone: (610) 374-5109

Domestic and international references are located on the installations tab of the Polychem Systems website. If additional information is required, please contact Polychem Systems.

Website: www.brentwood-ind.com/plc/index.html

1.2 Description of Equipment and How it Functions

Polychem's drag flight conveyor is a straight-line chain and flight (scraper) sludge collection system. This collector mechanism consists of a motor and gear reduction unit transmitting torque through drive chain and sprockets to the head shaft of the collector mechanism. The collector chain and flights rotate around a series of sprockets to convey settled solids to one end of a structure (tank) and floating scum to the other end (if applicable) so that the material can be removed by a down-stream process.

The cross collector (if applicable) is similar in design to the main collector, and conveys accumulated sludge from the main collector (or multiple collectors) to a sludge sump for removal by a down-stream process.

1.3 Safety Precautions

A number of safety precautions are listed in this manual. Study them carefully and follow them. Insist that those working with you do the same. Nearly all employers are now subject to federal and/or regional regulations governing safety and the prevention of work related accidents. It is the owner's and user's responsibility to determine the suitability of a product for a particular use. Any applicable industry, trade association, federal, state and local regulations should be reviewed. Remember that an uninformed or careless operator can make the operation of any equipment dangerous.

General Safety Guidelines

1. Safety Glasses – Always wear safety glasses when working with this equipment.
2. Know your Equipment – Read all instruction manuals carefully. Learn the product's application and limitation, as well as potential hazards.
3. Guard Against Electrical Shock.
4. Guards and Guarding – Keep guards in place at all times. Remove a guard only when the equipment is de-energized and all energy sources are disabled. Keep gates and safety chain in place and in working order.
5. Keep Work Area Clean – Wipe up and properly dispose of any oils or greases.
6. Avoid Dangerous Environments – Sewer, carbon monoxide, and chlorine gases can be lethal in unventilated areas. Refer to federal and/or regional regulations governing the safety for entering and working in Confined Spaces.
7. Unauthorized Personnel – Keep all unauthorized personnel away from the equipment.
8. Equipment Design – Do not operate or use any piece of equipment other than that for which it was designed.
9. Wear Proper Apparel – Loose clothing or jewelry should not be worn around moving parts, these items can get caught. Rubber gloves and footwear are recommended when performing maintenance on the equipment. Long hair should be contained.

10. Don't Overreach – Keep proper footing and balance at all times.
11. Maintain Equipment – Follow instructions for lubricating for the best and safest performance.
12. Power Lockout – The equipment must be de-energized and all power must be locked out before performing any maintenance work, including lubrication and the removal of guards.
13. Remove all Tools/Wrenches – Develop a habit of checking to see that tools and service equipment are removed from machinery before energizing the equipment.
14. Hands, Feet and Head – Keep away from operating machinery. Do not reach in, on top, or underneath while any machinery is in operation. Do not attempt to remove foreign materials when the machinery is in operation.
15. Heat Strips, Portable Heaters, and Torches – These items are not to be used to thaw frozen equipment unless authorized by Polychem.
16. Handles/Levers – Keep all handles and levers free of oil, grease or ice.
17. Stay Alert – When equipment is in operation, watch what you are doing and use common sense.
18. Check for Damaged Parts – Before further operation of equipment, a guard or other parts that are damaged, should be carefully checked to determine that it will operate properly and perform its intended function. Check for alignment, binding mounting or breakage of moving parts, and any other condition that may affect its operation. A guard or other part that is damaged should be properly repaired or replaced.
19. Drugs, Alcohol, Medication – Do not operate or perform any work on equipment while under the influence of drugs, alcohol or any medication.
20. Flootation Devices – If machinery is in, on, or around a liquid filled pit, channel, or tank; precautions should be made to have flotation devices, rope, or a ladder in close proximity to this equipment.
21. Climbing – Never use machinery or its accessories to climb or stand unless machinery is so equipped with a ladder and/or work platform/bridge.
22. Ladders, Lift Platforms, Maintenance Lifts – Use only regulation conforming ladders or lifts to work on equipment.
23. Firm Footing – Never place a ladder or lift platform on unstable footing, i.e. frozen sludge or oil soaked concrete.
24. Emergency Stops – Operators should familiarize themselves with all controls and learn to stop the equipment quickly in case of emergency.
25. Teach Safety – Teach all safety rules and operating procedures to all personnel operating or performing work on the equipment.
26. Torque Overloads – Do not change any torque overloads, mechanical or electrical, or in any way change the speed settings of drives unless authorized by Polychem.
27. Familiarity – Do not allow familiarity (gained from frequent use) to become commonplace. Always remember that a careless fraction of a second is sufficient to inflict serious injury.
28. Vents – Do not plug or cover air vents on motors, reducers and guards. Vents must be kept clean and open to keep units cool.
29. Safety Signs – Eliminate hazards wherever possible. If hazards cannot be eliminated, the workers should be informed by signs posted to alert them to the hazard.
 - a. A safety sign must never replace the use of guarding.
 - b. Locate safety signs and labels as near to the hazardous area as possible, where the sign is readily observed and maintained by personnel associated with the equipment.
 - c. Signs and labels should be visible at all times when work is being performed and shall be removed or covered when those hazards no longer exist. Illuminate all signs that are required to be seen at night.

30. Fire and Explosion Prevention

- a. Post signs warning against smoking and open flames so that they can be easily seen in areas where fire or explosion hazards may exist.
- b. It is good practice to see that fire extinguishers or equivalent protection are located near the equipment or system. Fire extinguishers or equivalent protection should be suitable to the conditions and hazards involved (i.e. rooms containing electrical equipment must have an extinguisher rated for electrical fires).

31. Inspections – A good practice by the operator(s), before operating the equipment each day, is to make a visual inspection of the equipment and immediate area to determine that actuation will cause no hazard to personnel or damage to the equipment. The inspection should include walking the entire system to be sure it is clear of any foreign objects and the examination of at least the following: feed and discharge points, guards in place and switches operative, and any other parts of the equipment (system) exposed to personnel.

32. Safety Devices – Make inspections at regular intervals to insure that the safety devices are in proper working condition. Do not remove, bypass, or disengage any overload or safety device from the equipment.

33. Lubrication – Do not lubricate equipment while in operation, unless the equipment is furnished with extended fittings or cups located so that they can be reached without danger to the worker.

34. Inspection Doors – Secure inspection doors against opening or removal resulting from machine vibration. Except for openings that are specifically constructed for inspection while the equipment is operating, all doors, covers, and guards must be secured in place before starting the equipment.

35. Aisles and Passageways – Keep aisles and passageways clear and in good repair with no obstructions across or in aisles. Maintain access to all work areas.

36. Special Maintenance Conditions

a. Jammed Equipment and/or Overload

- i. Any machine which will not start, or has stopped unexpectedly, must be assumed to have stored energy and subject to sudden release.
- ii. Maintenance work and corrective measures must be approached with extreme caution to the potential danger for sudden release of stored energy.
- iii. Turn off and lock out all power sources to the stopped machine.
- iv. Wherever possible, release or neutralize the stored energy in a controlled manner.
- v. When working with tools, maintain a position such that sudden motion will not cause the tool to injure the person or force the person into contact with moving parts.

b. Electrical Controls

- i. Do not tamper with mechanical interlocks on doors of safety switches, control panels, motor control centers, or other electrical enclosures.
- ii. Do not tamper with control interlocking of dead man controls.
- iii. Obtain Polychem's approval before changing or adding to any control or electrical system, for the components furnished.
- iv. All electrical equipment must be properly grounded.

c. Repair of Machinery and Structures Below Water Level

- i. Lock out all power to the equipment.
- ii. Before attempting maintenance, dewater the well, tank or channel.

- d. When Inspection or Repair Must be Performed Submerged by Divers:
 - i. All water flow must be stopped where the divers will work.
 - ii. Shut down and lock out any equipment such to eliminate water currents in the diving area.
 - iii. Divers must, as a minimum, adhere to the procedures and requirements of any regulatory commission.
- 37. Electrical Equipment – Electrical equipment conforming to the requirements of any regulatory code or regulation should be considered for the following functions:
 - a. Safety shut-off switch with power lock out provisions at the equipment.
 - b. Emergency stop switches readily accessible wherever required.
 - c. Signal devices to warn personnel of imminent start-up of equipment, especially if started from a remote location.
- 38. Noise – Take appropriate safety precautions, in accordance with any federal and/or regional regulations to avoid exposure to equipment with high noise levels.

1.4 Pre-Start Checklist

Prior to starting the collector, the following steps are recommended to prevent damage to the system:

1. Check that all hardware is installed and correctly tightened.
2. Check the location and proper alignment of all sprockets and flights.
3. Check that all collector chain pins and retaining clips are properly seated.
4. Check that there is an identical number of chain links between flights on each strand of chain.
5. Check clearance between the return shoe lugs and that they are inboard of the return rail wear strip.
6. Check the tank(s) for any items that may interfere with collector system motion (ladders, buckets, tools etc.). Remove any items if found.
7. Do not start the collector if any sludge is left in the tank. Tanks should be hose-rinsed, so that any residual sludge is removed.
8. Check that reduction units and any other lubricated equipment are properly greased and oils are at the correct level.

1.5 Starting and Stopping the Collector

System Start

Polychem provides technical service at the time of initial start-up. A factory trained field service technician inspects all equipment before and during the initial start-up. For system start-ups after the initial, Polychem recommends that Sections 1.3, 1.4 and the following process are observed.

1. Energize the collector drive unit.
2. Visually verify that the flight travel is smooth and unobstructed.
3. Visually inspect the drive and collector chains for proper chain tension.
4. Visually inspect that the sprockets exhibit smooth rotation.
5. Audibly inspect for noises. The system should run quietly.
6. Address all discrepancies upon discovery. Drain the tank if necessary.
7. The collector system should be monitored for a minimum of one (1) complete rotation.
8. Fill the tank slowly, allowing only restricted flow from influent gates/valves, until the water level is above the influent gates/valves. Once this elevation is reached then the gates/valves can be completely opened.

System Shutdown

Occasional shut down of the collector may be required during the course of normal operation. Care must be exercised to prevent sludge buildup in the event that the collector is shutdown or operation is interrupted for any length of time. Damage or torque overload may occur if the collector is started with any sludge accumulation in the tank. To shutdown the system (non-emergency) the following process should be observed.

1. Close the influent gates/valves, and begin to drain the tank. Continue to run the collector until the flights are no longer submerged.
2. Hose-rinse all sprockets and shafting, continue rinsing until all residual sludge is removed from the tanks.
3. Start the system using the process outlined in this section.

Emergency Shutdown

In the event of a torque overload or in case of an emergency the collector system may be shut down by disrupting the power to the gear reduction unit(s). **Polychem's collector system requires electricity as the only utility for operation.** In either event it is necessary that the tank be drained, cleaned and inspected for damage, as outlined in this section.

1.6 Extended Shutdown of Chain and Flight Collector Mechanism

In cases where collector systems are installed and are not in continuous operation, Polychem Systems requires that these assembled components be maintained in the following manner during the warranty period:

1. The collector tank shall be dewatered.
2. The tank and collector equipment shall be cleaned, and all residual sludge shall be completely removed.
3. All metallic components shall be inspected for oxidation. If there is oxidation, it shall be removed using a hand tool and the affected parts shall be coated with a rust-inhibiting compound (Sprayon LU 777 Outdoor Metal Protectant or equal) or a petroleum-based water-resistant heavy grease. For fresh water applications a suitable Food Grade rust-inhibiting compound or heavy grease shall be used.
4. The collector system shall be rotated 180° (1/2 revolution) every thirty (30) days to prevent flattening of the bearings (Brinelling) and bowing of the scraper flights.
 - a. If it is not possible to rotate the entire system, the chain and flights shall be removed and stored appropriately. Please refer to section 1.7, "Receiving, Handling and Storage of Equipment" for proper requirements.
 - b. If 4.a is performed, the head shaft, idler sprockets/shafts and gear motors shall be rotated 1/2 revolution every ninety (90) days to prevent flattening of the bearings (Brinelling).
5. Any snow or ice accumulation on the collector equipment and tank floor shall be removed prior to operating the collector. *Failure to remove the snow or ice may result in damage to collector components.*
6. At no time shall the collector components be allowed to become frozen in ice.
7. Heaters in gear motors, actuators and/or control panels (if included) shall remain activated and be monitored regularly if conditions should dictate.
8. Lubricants for selected temperature ranges shall be in accordance with the component manufacturer's recommendations.
9. The procedure for starting and stopping the collector mechanism shall be followed as outlined in the Polychem Systems Operation and Maintenance Manual.

Failure to comply with these requirements during the warranty period will void the equipment warranty. Polychem Systems shall not be responsible for component damage if these procedures are not followed.

Special Operational Note:

Cases may exist when the influent flow does not require that all tanks be in operation. In such cases Polychem Systems' recommends that a rotation plan be followed such that any one (1) tank is not down indefinitely, rather each tank is equally rotated into and out of service. This will allow each collector system to operate equally over the lifetime of the equipment. Polychem Systems' recommends that the rotation schedule not exceed a ninety (90) day period. During each rotation out of service the extended shutdown procedure, as previously described, should be followed to ensure the life of the equipment and minimize the potential for component damage.

1.7 Receiving, Handling and Storage of the Equipment**Receiving**

It is the responsibility of the purchasing party (Installing Contractor, End User, etc.) to check quantities and conditions of all materials immediately upon receipt at the job or storage site. Particular attention is to be directed to the inspection of material finishes. All shipments must be inspected before unloading, with particular attention to the collector flights. Polychem Systems' Customer Service is to be notified of any damage as a result of shipment immediately and must be notified of any shortages within thirty (30) days after receipt of a shipment.

Handling

Extreme care must be observed when unloading the material. Polychem Systems recommends that weight appropriate equipment be used to unload and transport the system components. Additionally, follow any labeled instruction that is shown on the packaging to prevent damage. Polychem Systems cannot be responsible for damage resulting from careless handling.

Storage

Brentwood requires, upon delivery, that the equipment be stored in following manner during the warranty period:

1. All supplied components must be stored in a manner to protect their manufactured quality.
 - a. Indoors (Recommended): Cool, dry environment.
 - b. Outdoors: Elevated off the ground (pallets), under a heavy tarp, with adequate protection from the elements. Area shall not be subject to flooding.
2. All non-metallic components must be stored in such a way to protect them from ultra-violet (UV) radiation, i.e. sunlight.
3. All metallic components shall be inspected for oxidation. If there is any oxidation, it shall be removed using a hand tool. Metallic components shall be coated with a rust-inhibiting compound (Sprayon LU 777 Outdoor Metal Protectant or equal) or be covered in petroleum-based water-resistant heavy grease. For fresh water applications a suitable Food Grade rust-inhibiting compound or heavy grease shall be used.
4. All electrical components must be stored indoors (cool, dry environment), with adequate protection against vibration.
5. Due to special conditions and limited product shelf life, please refer to the storage instructions of the supplied adhesive anchoring system located within the product packaging.
6. It is recommended that the reduction unit output shaft be rotated 1/2 revolution every ninety (90) days to prevent flattening of the bearings (Brinelling). Extended storage shall be in accordance with the component manufacturer's requirements.
7. While in storage, quarterly inspections of all supplied equipment shall be performed to check for damage and/or oxidation.

1.8 Cold Weather Precautions

The operator must be vigilant to prevent snow and ice buildup. At no time shall the collector components be allowed to become covered, frozen or encased in snow or ice.

Ice formation or snow build up on the water surface or tank surfaces may result in damage to the collector.

Ice formation or snow build up on system components will result in damage to the collector.

The use of an insulated chain guard, drive enclosure or heater within the chain guard or enclosure does not guarantee the prevention of Ice formation or snow build up on drive components or tank surfaces.

Brentwood Industries shall not be responsible for damage or performance issues caused by snow or ice formation.

1.9 System Operation

Polychem Systems sludge collector mechanisms are designed for continuous 24 hours/day, 7 days/week operation. Intermittent operation is not recommended because damage to the system could occur due to excessive sludge build up. Any damage to the collector system, as a result of intermittent operation, is not the responsibility of Polychem Systems and is not covered under the Warranty listed in this manual.

1.10 Operation of the System In Reverse

Under no circumstances shall the collector system be run in reverse. In rare cases where stored energy must be released from the collector system it may be "Jog Reversed." A "Jog Reverse" is the momentary operation in increments of 90° (1/4 revolution) of the drive shaft. Any damage to the collector system, as a result of reverse operation, is not the responsibility of Polychem Systems and is not covered under the Warranty listed in this manual.

Section 008:

Filters

AquaDISK Tertiary Filtration - Design Summary

DESIGN INFLUENT CONDITIONS

Pre-Filter Treatment: Secondary
 Avg. Design Flow = 0.31 MGD = 217.01 gpm = 1182.94 m³/day
 Max Design Flow = 0.63 MGD = 434.03 gpm = 2365.88 m³/day

<u>DESIGN PARAMETERS</u>	Influent	mg/l	Effluent			
			Required	<= mg/l	Anticipated	<= mg/l
Avg. Total Suspended Solids:	TSSa	10	TSSa	5	TSSa	5
Max. Total Suspended Solids:	TSSm	15	--	--	--	--
*Turbidity:	--	--	NTU	2	NTU	2

*Note: Turbidity represented in Nephelometric Turbidity Units (NTU's) in lieu of mg/l.

AquaDISK FILTER RECOMMENDATION

Qty Of Filter Units Recommended = 2
 Number Of Disks Per Unit = 2
 Total Number Of Disks Recommended = 4
 Total Filter Area Provided = 215.2 ft² = (19.99 m²)
 Filter Model Recommended = AquaDisk Package: Model ADFSP-54 x 2E-PC
 Filter Media Cloth Type = OptiFiber PA2-13

AquaDISK FILTER CALCULATIONS

Filter Type:

Vertically Mounted Cloth Media Disks featuring automatically operated vacuum backwash . Tank shall include a rounded bottom and solids removal system.

Average Flow Conditions:

Average Hydraulic Loading = Avg. Design Flow (gpm) / Recommended Filter Area (ft²)
 = 217 / 215.2 ft²
 = 1.01 gpm/ft² (2.47 m/hr) at Avg. Flow

Maximum Flow Conditions:

Maximum Hydraulic Loading = Max. Design Flow (gpm) / Recommended Filter Area (ft²)
 = 434 / 215.2 ft²
 = 2.02 gpm/ft² (4.93 m/hr) at Max. Flow

Solids Loading:

Solids Loading Rate = (lbs TSS/day at max flow and max TSS loading) / Recommended Filter Area (ft²)
 = 78.2 lbs/day / 215.2 ft²
 = 0.36 lbs. TSS /day/ft² (1.77 kg. TSS/day/m²)

The above recommendation is based upon the provision to maintain a satisfactory hydraulic surface loading with (1) unit out of service. The resultant hydraulic loading rate at the Maximum Design Flow is: 4 gpm / ft² = (9.9 m/hr)

AquaDisk® Filter Control Strategy



**AQUA-AEROBIC
SYSTEMS, INC.**

A Metawater Company

AquaDisk® Cloth Media Filter ADFSP-54X2E-PC

**Sussex Regional Recharge Facility
Sussex County, DE
ID # 114194B**

Revision Date	By	Comments
2019-09-12	BQ	Submittal Issue DRAFT

AquaDisk® Filter Control Strategy

Table of Contents

1.0	INTRODUCTION	3
1.1	OVERVIEW	3
1.2	PRIMARY COMPONENTS.....	3
2.0	PLC / HMI EQUIPMENT	5
2.1	DESCRIPTION.....	5
2.2	MAIN COMPONENTS	5
3.0	AUTOMATIC OPERATION.....	6
3.1	SYSTEM STARTUP	6
3.2	SYSTEM SHUTDOWN	6
4.0	MANUAL OVERRIDE.....	7
5.0	HUMAN-MACHINE INTERFACE (HMI).....	7
5.1	HMI SCREEN LIST	8
5.2	HMI SCREEN TREE.....	9
5.3	HMI SECURITY LEVELS.....	10
5.4	HMI CONTROL AND DATA ENTRY	10
5.5	HMI ALARM STATUS	10
6.0	ALARM HANDLING	11
6.1	ALARM RESET	11
6.2	ALARM MESSAGES	11
6.3	ALARM HELP	12
7.0	OPERATION SUMMARY	13
7.1	FILTRATION	13
7.2	BACKWASH.....	14
7.3	SOLIDS WASTING	15
8.0	FILTER MODE DESCRIPTIONS	16
8.1	OFFLINE MODE.....	16
8.2	FILTERING MODE	16
8.3	BACKWASH MODE	16
8.4	EXTENDED BACKWASH MODE.....	17
8.5	SOLIDS WASTE MODE	17
8.6	CLEANING MODE.....	18
	APPENDIX - SYSTEM SETPOINTS.....	19

AquaDisk® Filter Control Strategy

1.0 INTRODUCTION

1.1 OVERVIEW

The AquaDisk® Cloth Media Filter is a complete system for continuously removing particulates from a flow stream. The system's operational strategy consists of three modes: Filtration, Backwash, and Solids Waste. A programmable logic controller (PLC) based control system provides for automatic operation of all process modes.

1.2 PRIMARY COMPONENTS

The primary components and their respective functions are as follows:

Influent Valve

The influent valve allows isolation of the filter for maintenance.

Filter Basin

The filter basin allows influent to distribute to each individual pile cloth media/filter frame section and allows heavy particulates to settle to the bottom of the tank for discharge by the solids waste system.

Pile Cloth Media

Pile cloth media covers the filter frames and removes particulates from the water.

Filter Frame

Supports the pile cloth media and channels filtrate to the centertube.

Centertube

The centertube collects filtrate from each individual pile cloth media/filter frame section and routes it to the effluent chamber.

Drive Motor

The drive motor rotates the centertube during the backwash mode through the stationary backwash shoes such that the entire pile cloth media area is cleaned by the backwash system.

Level Sensor

The level sensor measures the liquid level in the filter tank. Verifies sufficient level for backwash/waste pump(s) and triggers specific modes based on water level. An alarm will be shown on the HMI when water level is outside normal operating ranges.

AquaDisk® Filter Control Strategy

Backwash System

The backwash assembly consists of backwash shoes, associated plumbing, and backwash/waste pump(s). The stationary backwash shoes draw water at high velocity from the clean water side of the pile cloth media. The drive motor rotates the centertube such that the entire pile cloth media area passes under the backwash shoes. The backwash/waste pump(s) provides the necessary suction and discharges the flow to the designated location.

Solids Waste System

The solids wasting system uses a backwash/waste pump to remove settled solids via a connection to a perforated manifold.

Control Panel

The control panel contains the programmable logic controller and associated electronics to control the filter.

Human-Machine Interface

The human-machine interface (AKA operator interface) displays information about the status of the filter, alarm information, and allows user input to control filter operation.

AquaDisk® Filter Control Strategy

2.0 PLC / HMI EQUIPMENT

2.1 DESCRIPTION

The filter has one main control panel. The Programmable Logic Controller (PLC) is located in this control panel. The PLC interfaces with the real world using the following I/O (Input/Output) module types:

Discrete input module:	120VAC
Discrete output module:	120VAC
Analog input module:	4-20mA and 0-10VDC
Analog output module:	4-20mA and 0-10VDC

If the filter was online when a power loss occurred, it will index back into filtration mode once power is restored. If the filter was in the middle of a cleaning mode (e.g., backwash or solids waste) when the power loss occurred, that cleaning mode will be aborted and the filter will index into filtration mode.

The filter has a touch screen Human-Machine Interface (HMI) which communicates directly with the PLC. The HMI is the user interface which displays the filter status, alarm information, and short term historical trending. The HMI unit also provides the operator with the ability to change filter setpoints and other parameters.

2.2 MAIN COMPONENTS

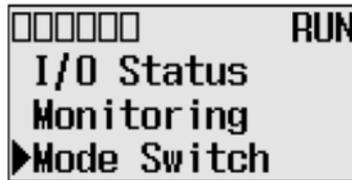
PLC	Allen-Bradley	MicroLogix 1400
HMI	Allen-Bradley	PanelView Plus 700

AquaDisk® Filter Control Strategy

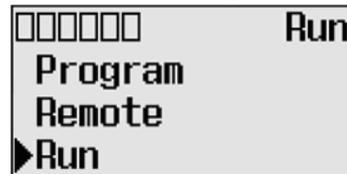
3.0 AUTOMATIC OPERATION

3.1 SYSTEM STARTUP

- Verify the disconnect switch on the control panel is in the “ON” position.
- Verify all motor controls are set to “AUTO”.
- Verify all valve controls are set to “AUTO”.
- Verify the PLC is in the “RUN” mode by checking the status on the PLC Main Menu screen. Note: This is not the HMI, but is a small LCD screen on the PLC itself.
- If the PLC is not in the “RUN” mode, follow these steps:
 1. On the Main Menu screen, select “Mode Switch” by using the arrow keys on the LCD keypad. Then press the “OK” key.



2. The Mode Switch screen is displayed, as shown below. The arrow indicates current Mode Switch position (not the current mode).



3. When the Up or Down key is pressed, the mode indicated by the arrow starts to blink if the mode is different from the current mode of controller. Press OK key to set the controller to the Run mode indicated by the arrow.
 4. If you have finished changing mode switch position, press the ESC key to return to the Main Menu screen, as shown in step 1.
- Acknowledge any new alarms displaying on the HMI.
 - Review the Filter Setup screens to make sure the setpoints are at the desired values.
 - [Open the manual influent valve \(if applicable\).](#)
 - Press the “Go ONLINE” button (located on the “Filter Control” screen) to begin filtration.
 - Acknowledge any new alarms that may occur. Go to the Alarm Summary screen and check for any active alarms. If there are active alarms indicated, reset the alarms.

3.2 SYSTEM SHUTDOWN

- Press the “Go OFFLINE” button (located on the “Filter Control” screen) to stop filtration.

AquaDisk® Filter Control Strategy

- Close the manual influent valve (if applicable).
- If required, set all motor controls to “OFF”.
- If required, set the valve controls to “CLOSE”.
- If required, turn off the disconnect switch on the control panel.

4.0 MANUAL OVERRIDE

Setting the respective Hand-Off-Auto controls (for motors) or Open-Close-Auto controls (for valves) in any position other than “Auto” will operate the respective components independent from PLC interlocks.

WARNING

Manually controlling the equipment bypasses safety interlocks. Caution must be used when operating equipment manually. Manually operated equipment should never be left unattended.

5.0 HUMAN-MACHINE INTERFACE (HMI)

The HMI screens are organized by different levels. There are screens which provide the operator with system status and alarm information. There are also screens which allow the user to modify system setpoints and parameters. All screens include touch cells to navigate to additional screens.

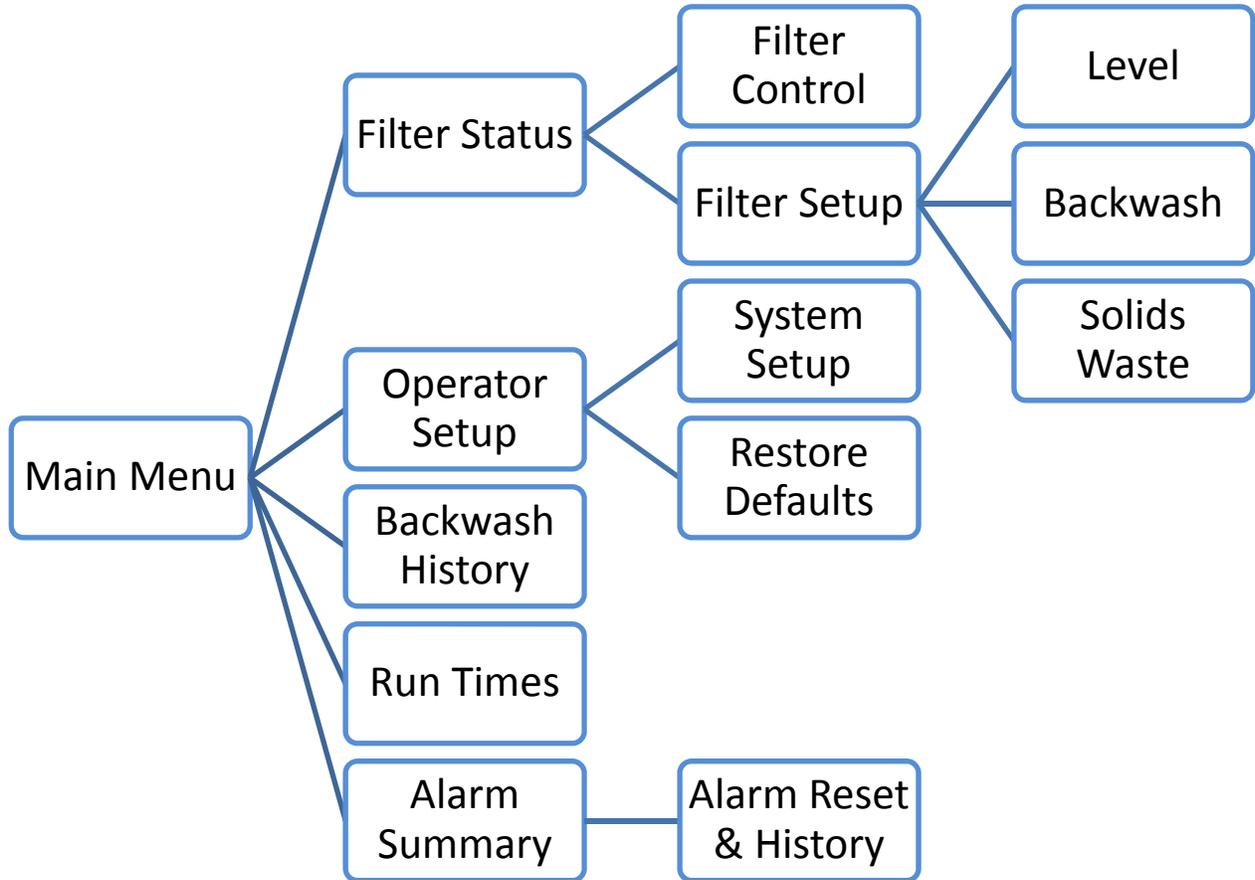
AquaDisk® Filter Control Strategy

5.1 HMI SCREEN LIST

Screen Name	Screen Description
Main Menu	This screen contains the name and project number. There is access to security login/logout.
Filter Status	This screen contains operating data about the filter including the current mode, time since the most recent backwash and solids wasting cycles, and the tank level.
Filter Control	This screen contains pushbutton controls for the filter modes, including online or offline.
Level Setup	This screen contains the tank level setpoints applicable to all modes. The differential level setpoints are also on this screen.
Backwash Setup	These screens contain setpoints applicable to all of the backwash modes, such as time interval and flow.
Solids Waste Setup	This screen contains the setpoints applicable to the Solids Waste and Draw Down modes.
Backwash History	These screens display a history of the past forty backwash cycles. The frequency of backwash provides an indication of filter loading and filter performance. The operator can reset this history.
Run Times	This screen contains process meters for the backwash, solids wasting, and scum removal cycles. Total minutes as well as cycle counts are listed. The screen also contains hour meters for each motor.
Alarm Summary	This screen displays the current active alarms for the filter. Active alarms must be reset after the alarm condition has been corrected.
Alarm History	This screen displays a recent history of alarms for the filter. Alarms remain on this list until bumped from the list by a newer alarm.
Operator Setup	This screen allows the user to set the real time clock in the PLC. There is access for the restore defaults and system setup screens.
System Setup	These screens contain setup information about the filter. This includes which valves and instruments exist, as well as the analog scaling parameters are for all instrumentation.

AquaDisk® Filter Control Strategy

5.2 HMI SCREEN TREE



AquaDisk® Filter Control Strategy

5.3 HMI SECURITY LEVELS

The HMI has security levels built in to protect the system operation, setpoint parameters, and the system configuration. There are five security accounts, or user levels: “Guest” (or Default), “Operator”, “Supervisor”, “Engineer”, and “AASI”. The “Guest” account has view access only. The “Operator” account provides protection to parameters that may need to be adjusted as part of normal operation. The “Supervisor” account includes operator functionality plus additional setpoint access. The “Engineer” account has full access to the system. The “AASI” account also has full access to the system, but this account is intended for use by Aqua-Aerobic Systems personnel only. For further security reasons, the system will automatically logout after a preset time period.

The system default values are identified in the Appendix. This appendix also identifies the security level required to modify a specific parameter.

The current security login (account name) is displayed on the Main Menu screen. There is also a button on that screen to access the login/logout functions. To login as a different account on the HMI, perform the following:

1. Press the “Login” button to bring up the Login window.
2. Press the “User” button to bring up the software keyboard. Type the desired account name, then press the enter button.
3. Press the “Password” button to bring up the software keyboard. Type the password, then press the enter button.
4. Press the enter button on the Login window.

5.4 HMI CONTROL AND DATA ENTRY

The user has the ability to modify system setpoints and other parameters via the HMI. The user selects the desired parameter to modify by pressing the respective point on the HMI touch screen. A numeric keypad will appear which allows the user to enter a new value. This new value is tied to the parameter that was selected. After entering the new value via the numeric keypad, the user then presses the Enter key to store the new value.

Software buttons and discrete (digital) parameters do not use the numeric keypad. These are activated directly by the user pressing the respective location on the touch screen.

5.5 HMI ALARM STATUS

When a new alarm is detected, the HMI will automatically change to the alarm summary screen. The alarm summary will indicate the description of the alarm condition, and the time and date at which the alarm occurred. There will also be a button for the user to acknowledge the current alarm shown.

Note: On the HMI, the alarm message will be prefixed with an alarm number. This is a reference number assigned by Aqua-Aerobic Systems and is not related to an equipment tag number.

AquaDisk® Filter Control Strategy

6.0 ALARM HANDLING

6.1 ALARM RESET

If a new (unacknowledged) alarm is present, the alarm will be indicated on the HMI alarm banner. If an alarm is present but is acknowledged, the alarm banner will not be displayed, but the alarm will be listed on the Alarm Summary screen. The alarms may be reset by pressing the alarm reset pushbutton on the HMI. Once all alarms have been reset, the Alarm Summary screen will be empty.

6.2 ALARM MESSAGES

The alarm messages for this system are indicated on the following pages.

Alarm #501 PLC Battery LOW

Alarm #502 PLC Output Power FAIL

Alarm #503 PLC Detected POWER LOSS

Alarm #504 PLC Input Power FAIL

Alarm #506 PLC-SCADA Communication LOSS

Alarm #101 Basin Level HIGH

Alarm #102 Basin Level too LOW for Backwash

Alarm #103 Basin Level too LOW for Solids Waste

Alarm #104 Basin Level Tank Level Transmitter vs.
High Level Switch Mismatch

Alarm #105 Basin Level OUT-OF-RANGE

Alarm #110 Backwash/Waste Pump Vacuum HIGH

Alarm #111 Backwash/Waste Pump Vacuum OUT-
OF-RANGE

Alarm #133 Drive Motor #1 FAILED TO RUN

Alarm #136 Backwash/Waste Pump #1 FAILED TO
RUN

Alarm #141 H-O-A Controls NOT IN AUTO for
Backwash

Alarm #145 Backwash Valve #1 FAILED TO OPEN

Alarm #146 Backwash Valve #1 FAILED TO CLOSE

Alarm #157 Solids Waste Valve #1 FAILED TO
OPEN

Alarm #158 Solids Waste Valve #1 FAILED TO
CLOSE

AquaDisk® Filter Control Strategy

6.3 ALARM HELP

This section explains the purpose of some of the alarm messages which may not be intuitive.

Input Power FAIL and Output Power FAIL alarms

These alarms indicate power was lost for the respective PLC I/O. This typically means one of the circuit breakers supplying power to the I/O has tripped.

PLC Detected POWER LOSS alarm

This alarm indicates power was lost to the main control panel. The alarm can be reset once power is restored.

Level Transmitter vs. High Level Switch MISMATCH alarm

This alarm indicates a mismatch between the level transmitter (transducer) and the high level switch. The high level should be triggered from the level transmitter first. If the high level is triggered by the level switch first, this alarm is annunciated. To correct this issue, raise the mounting of the high level switch.

MCP TRIP alarm

These alarms indicate the Motor Circuit Protector (i.e., circuit breaker) has tripped for the respective motor. This indicates a high current or short circuit event was detected by the MCP, and it tripped to protect the motor. This alarm may indicate a locked rotor condition (jam) or a loose wire.

Flow DEVIATION from Setpoint alarms

These alarms are used where the PLC is controlling the flow rate by adjusting the pump speed. Typically, a flow PID loop is used for this purpose. If the actual flow deviates from the setpoint (i.e., goes too far below or too far above the setpoint), this alarm is annunciated. This alarm may indicate the pump is having trouble sustaining flow; from an air gap in the line or from dirty cloth media causing a high suction vacuum.

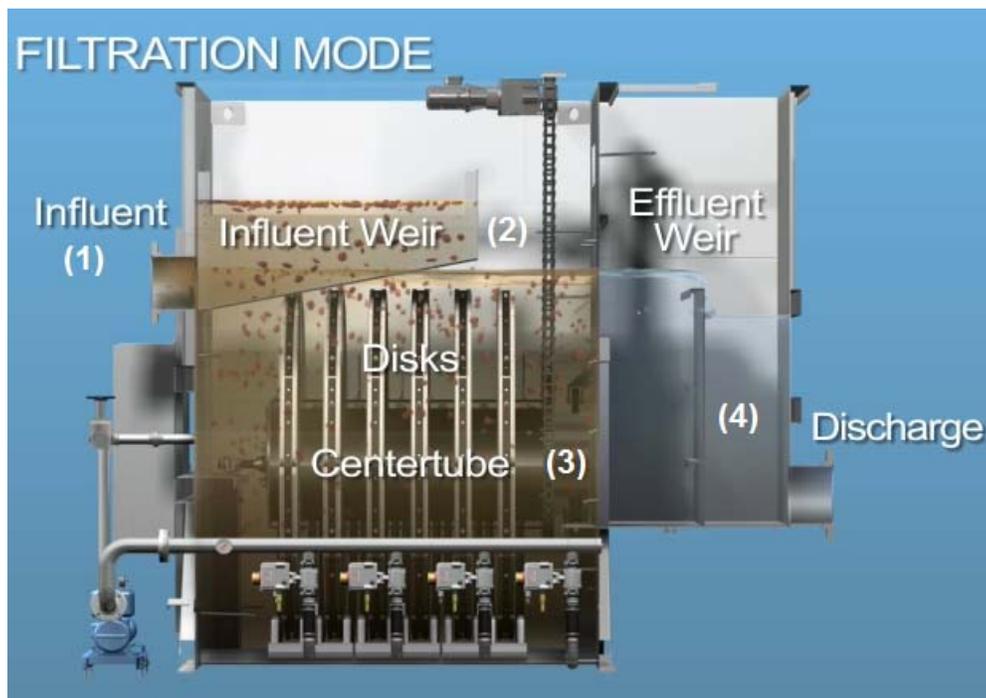
AquaDisk® Filter Control Strategy

7.0 OPERATION SUMMARY

The AquaDisk® Cloth Media Filter is a complete system for continuously removing particulates from a flow stream. The system's operational strategy consists of three modes: Filtration, Backwash, and Solids Wasting. A programmable logic controller (PLC) based control system provides for automatic operation of all process modes.

7.1 FILTRATION

The influent pipe (1) routes flow to the filter basin (2), where filtration occurs. The filter basin contains a series of circular disks covered with a unique pile cloth media. As water passes through the media via an outside-in flow path, some particulates are removed and stored within the pile cloth media while others are deposited on the pile cloth media surface. Filtered water, or filtrate, is collected in a centertube (3) and flows, via gravity, over the effluent weir and into the effluent chamber (4) prior to discharge. It is important to note that during filtration, the disks do not rotate.



Normal Operation

As more particulates are deposited on and within the pile cloth media, the pressure required to drive water through the pile cloth media (headloss) increases. This results in a rise in the water level within the filter basin and increased differential pressure on the pile cloth media. Upon reaching a specific basin water level set point, the PLC automatically initiates the backwash mode to clean the pile cloth media.

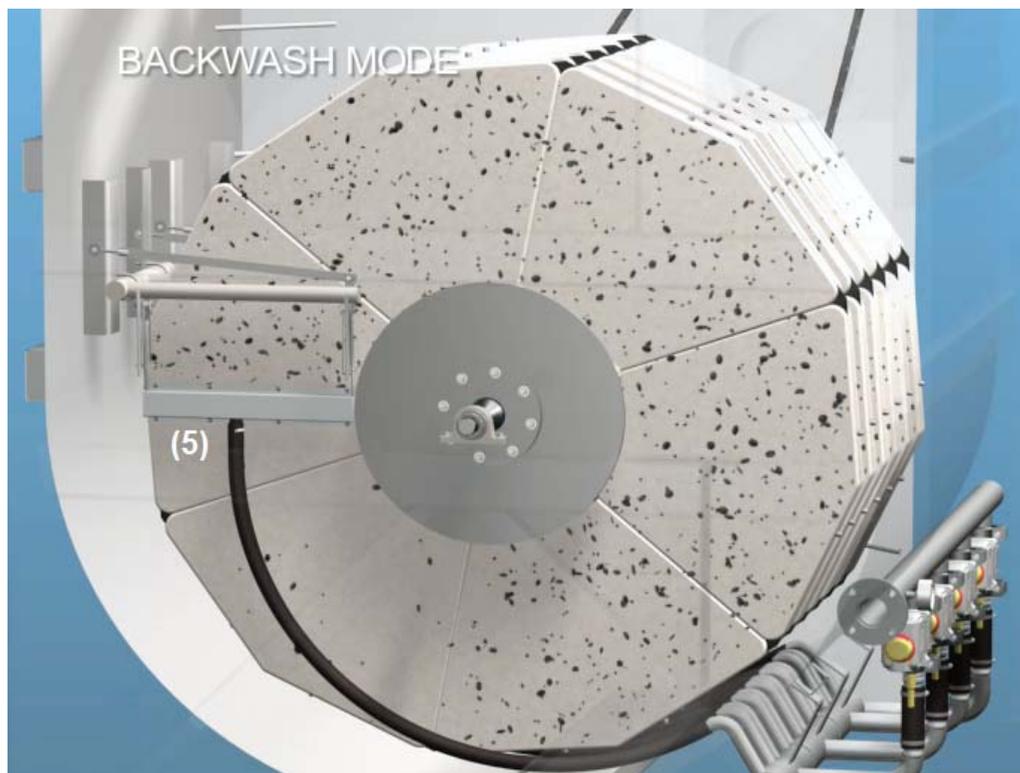
AquaDisk® Filter Control Strategy

7.2 BACKWASH

As the amount of particulates on and within the pile cloth media increases, the static pressure required to pass water through the pile cloth media increases. This results in an increased water level within the filter basin and increased differential pressure on the pile cloth media. Upon reaching a specific basin level or elapsed time period, the backwash mode will be automatically initiated to clean the pile cloth media.

Solids are backwashed from the pile cloth media surface by liquid suction through backwash shoes (5) positioned on both sides of each disk. These spring loaded backwash shoes contact the pile cloth media to provide the necessary suction for optimum cleaning efficiency. During backwash, disks are cleaned in multiples of two, unless the filter has only one disk. The disks rotate slowly while a backwash/waste pump (not shown) draws filtered water from the centertube through the pile cloth media on an inside-to-outside, or reversed, flow path. This provides effective cleaning of the pile cloth media over the entire disk. By the end of the backwash cycle, the basin water level returns to its normal operating level. Backwash water is typically directed to the headworks.

Filtration continues while the filter is in backwash mode. This feature allows continuous filtration while maintaining efficient filter performance.



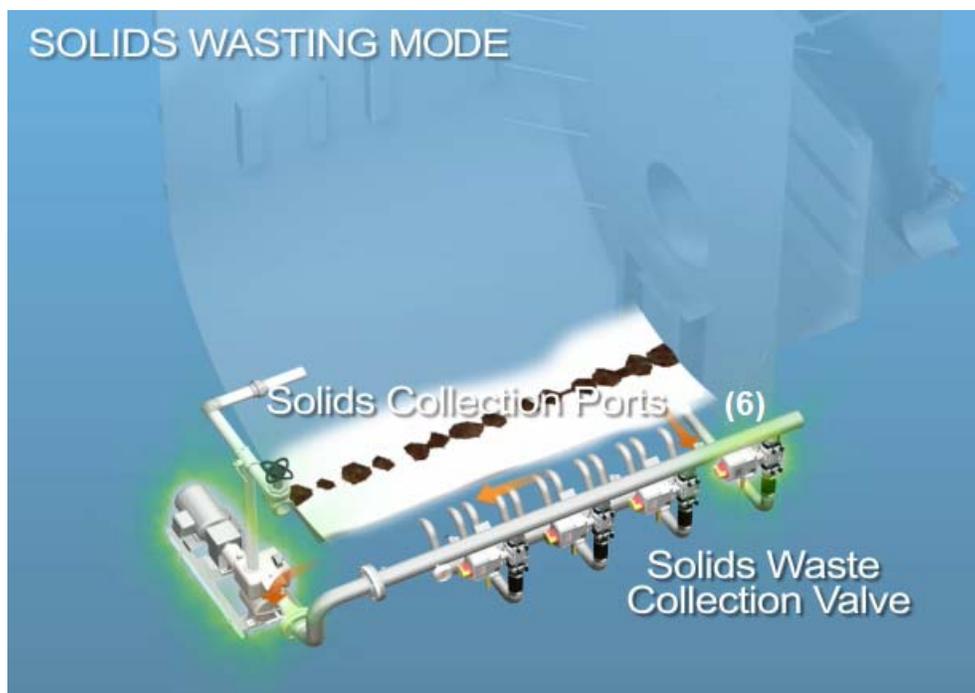
Backwash Shoes Clean Media

AquaDisk® Filter Control Strategy

7.3 SOLIDS WASTING

A quiescent environment during filtration, combined with the outside-in filtration flow path, allows heavier particulates to settle to the bottom of the filter basin. Upon reaching a specific number of backwash cycles performed, or an elapsed time, the solids waste mode will be automatically initiated. The solids waste mode utilizes the backwash/waste pump to provide suction of the settled solids through a perforated solids collection manifold (6). Since solids wasting occurs immediately after a backwash cycle is completed, the backwash/waste pump remains on during the backwash-to-solids waste mode transition. The solids are pumped on an intermittent basis, typically to the headworks.

Filtration continues while the filter is in solids waste mode. This feature allows continuous filtration while maintaining efficient filter performance.



Settled Solids Removal

AquaDisk® Filter Control Strategy

8.0 FILTER MODE DESCRIPTIONS

There are two main cleaning modes the filter may activate during typical operation. These cleaning modes are backwash mode and solids waste mode.

8.1 OFFLINE MODE

The filter is out of service and not filtering any influent. If there are automated influent valves, these are closed by the PLC. The filter is not allowed to enter backwash or solids waste modes.

8.2 FILTERING MODE

The filter is in service and water is flowing through the unit. The disks are stationary, so no pile cloth media cleaning (backwash) is currently taking place. This is the typical mode of operation for the filter.

8.3 BACKWASH MODE

The backwash mode draws water from the filtered-side of the pile cloth media. This reverse flow dislodges particulates embedded in the pile cloth media and restores it to a clean condition.

Each filter disk has two backwash shoes in contact with its disk faces. The backwash shoes connect via flexible hose to a collection manifold. For each pair of disks, there is one automatic backwash valve which isolates the collection manifold from the backwash/waste pump.

At the start of the cycle, there is a delay to allow the first automatic backwash valve to open fully before starting the backwash/waste pump. Once the automatic backwash valve is open, the drive motor turns and the backwash/waste pump runs for the operator specified duration. When the specified duration has elapsed, the first automatic backwash valve closes and the next one opens (if applicable). This sequence continues until each automatic backwash valve has been open for the specified duration.

The (normal) Backwash mode may be triggered by one of the following events:

1. The basin level is above the Backwash Start setpoint.
2. The length of time between backwashes has exceeded the setpoint.
3. A request occurs via user command.
4. High level float switch is triggered.

For installations with multiple backwash/waste pumps, the system can operate: 1) with all pumps operating simultaneously, or 2) with the pumps operating sequentially so that only one pump can be running at a time.

AquaDisk® Filter Control Strategy

The minimum permissible backwash duration per collection manifold is ten seconds. In approximately 53 seconds the drive motor rotates the disks through one complete revolution. The default cycle duration is 55 seconds. This allows the disks to stop at a position slightly different than where they started so that the backwash shoes aren't always parked on the same section of pile cloth media.

A level sensor in the filter tank will prevent the backwash mode from initiating if the water level is too low. If the basin level drops to the minimum backwash level in the midst of a backwash cycle, the backwash/waste pump and drive motor will stop, all automatic backwash valves will close, and an alarm will display. Once the water exceeds the minimum backwash level, the backwash mode will initiate based on the conditions outlined above even if the alarm has not been reset.

8.4 EXTENDED BACKWASH MODE

An Extended Backwash is used to provide extra backwash cycles to further clean the pile cloth media on regular intervals. This mode uses the same backwash cycle setpoints as a normal backwash, but the trigger interval is different and the operator has the option to set the time of day when this extended backwash will occur.

8.5 SOLIDS WASTE MODE

During normal filter operation, some particulates will settle to the bottom of the filter tank. On a periodic basis, they must be removed. A perforated manifold at the bottom of the basin is connected to the backwash/waste pump. An automatic solids waste valve on the suction side of the backwash/waste pump prevents free flow when the solids waste mode is inactive. When the solids waste mode activates, the automatic solids waste valve opens, connecting the perforated manifold to the backwash/waste pump. After a short delay to allow the automatic solids waste valve to open fully, the backwash/waste pump runs for an operator selected duration. When the selected duration completes, the backwash/waste pump shuts off and the automatic solids waste valve closes.

Backwash frequency correlates to the solids loading rate. The number of backwashes provides an indication of how quickly solids accumulate within the filter basin. Scheduling the solids waste mode based on backwash frequency automatically ties the solids waste cycle frequency to the solids loading rate. The time-based solids waste cycle interval ensures that periodic solids removal occurs regardless of solids loading rate. When the specified number of backwash cycles have completed, the solids waste cycle will begin immediately following the backwash. This reduces stop/start cycles on the backwash/waste pump.

The Solids Waste mode may be initiated by one of the following events:

1. The number of backwashes since the last solids waste cycle has exceeded the setpoint.
2. The length of time between solids waste cycles has exceeded the setpoint.
3. A request occurs via user command.

AquaDisk® Filter Control Strategy

A level sensor in the filter tank will prevent the solids waste mode from initiating if the water level is too low. If the basin level drops to the minimum solids waste level in the midst of a solids waste cycle, the backwash/waste pump will stop, the automatic solids waste valve will close, and an alarm will display. Once the water exceeds the minimum solids waste level, the solids waste mode will initiate based on the conditions outlined above even if the alarm has not been reset.

8.6 CLEANING MODE

A Cleaning Mode is used to provide extra backwash and cloth soaking cycles to further clean the pile cloth media if needed. The cleaning mode must be requested by the operator as it will not automatically start. The filter will perform the # of backwashes requested, then stop the backwashing and soak. When the soaking time is done, the cycle repeats with the filter backwashing again. This mode uses the same backwash cycle setpoints as a normal backwash. The flow will automatically recirculate back into the filter tank if an automatic recirculation valve exists. Otherwise, the manual valves must be set accordingly to provide the recirculation path.

AquaDisk® Filter Control Strategy

APPENDIX - SYSTEM SETPOINTS

Description	Default	Units	Min	Max	Security
Level Setup					
High Basin Level	9.34	Feet	4.00	13.00	Supervisor
Start Backwash Level	8.70	Feet	3.50	12.50	Supervisor
Minimum Level for Backwash	4.83	Feet	1.50	7.00	Supervisor
Minimum Level for Solids Waste	2.50	Feet	0.25	3.00	Supervisor
Backwash Setup					
Backwash Time Interval	60	Minutes	10	360	Operator
Backwash Duration (per valve)	55	Seconds	15	135	Operator
Backwash Setup (continued)					
Extended Backwash Interval	24	Hours	0	999	Supervisor
Extended Backwash Duration	5	Cycles	1	99	Supervisor
Extended Backwash Start Time - Hour	1	--	0	23	Supervisor
Extended Backwash Start Time - Minute	00	--	00	59	Supervisor
Solids Waste Setup					
Solids Waste Time Interval	180	Minutes	30	1440	Operator
Solids Waste Duration	15	Seconds	5	180	Operator
Solids Waste Flow	130.0	gpm	15.0	500.0	Supervisor
# of Backwashes Between Solids Waste	5	--	1	50	Operator
Description	Default	Units	Min	Max	Security
Cleaning Mode Setup					
Cleaning Mode Duration	4.0	Hours	0.5	24.0	Engineer
# of Backwashes per Cycle	5	--	1	250	Engineer
Soak Time per Cycle	1.0	Hours	0.1	24.0	Engineer
Description	Default	Units	Min	Max	Security
System Setup – Valves & Pumps					
Waste Pump Operation – Simultaneous or Sequentially?	Simultaneous	--	--	--	Engineer
Influent Valve (Discrete) Feedback?	No	--	--	--	Engineer
Valve Stroke Time	120	Seconds	5	300	Engineer
Backwash Valve #1 Feedback?	Yes	--	--	--	Engineer
Valve Stroke Time ★	15	Seconds	2	100	Engineer
Solids Waste Valve #1 Feedback?	Yes	--	--	--	Engineer
Valve Stroke Time ★	15	Seconds	2	100	Engineer

★ Similar valves have the same stroke time.

AquaDisk® Filter Control Strategy

Description	Default	Units	Min	Max	Security
System Setup - Analog Scaling					
Basin Level Enabled?	Yes	--	--	--	Engineer
Offset	2.00	Feet	0.00	5.00	Engineer
Span	8.33	Feet	2.00	24.00	Engineer
Backwash/Waste Pump Vacuum Enabled?	Yes	--	--	--	Engineer
Offset	0.0	Inches Hg	-5.0	5.0	Engineer
Span	30.5	Inches Hg	1.0	40.0	Engineer

Section 009:

UV

3. Plant Design

Your UV system has been designed on a set of parameters. These parameters are described below and are based on the entire plant operating properly. Ensure that pre-processes are providing good effluent that meets the design parameters. If you have concerns, please test the effluent's UV transmission (UVT%) and compare it to the design parameters.

1. Peak instant:	1.5 MGD
2. Average flow:	TBD
3. Minimum flow:	0
4. UV Transmittance at 254 nm:	65%
5. Dosage:	10 mJ
6. Total Suspended Solids:	10 mg/l
7. Effluent temperature range:	33 to 85 F

Effluent standard to be achieved < effluent limit of 20 fecal/100 ml based on a 30-day geometric mean of daily samples and sampling location immediately downstream of the UV reactor. Dosage > 90 mJ (90,000 uWs/cm²)

4. Environmental Issues Relating to UV Lamps

UV lamps need to be recycled like fluorescent lamps because they contain mercury. Please follow your local recycling laws. Please visit www.lamprecycle.org to find a recycler in your area. In the event that you are unable to find a disposal location, please contact GLASCO.

5. Receiving UV Equipment and Spare Parts

It is important to compare the shipment's contents to the actual packing list. Any deviations must be brought to the factory's attention. Additionally, lamps and quartz sleeves need to be inspected for damage. If shipment or parts are damaged,

Immediately contact factory and hold broken contents and their containers for inspection by shipping company.

6. Electrical Configuration and Maintenance

The UV disinfection system uses sophisticated electronics and specialty lamps. Unlike other equipment in the wastewater plant, the UV system's electronics require clean power. The system has been designed to use a certain specified voltage. UV equipment must be protected from surges. If the plant is susceptible to brown outs, please contact factory. If factory is using a back up generator, ensure that the UV system is isolated during the start up and operation.

III. Components, Assembly and Operation

A. Components

The UV disinfection system will come with a number of components. The following list highlights the main ones.

Two (2) modular support stainless steel bracketing systems

Stainless Steel Level Control System with drain

Ballast Control Center (BCC) – houses electronics, controls, displays

PLC – Allen Bradley

UV Modules

Ultraviolet lamps

Quartz sleeves

UV monitoring probe

Automatic cleaning system

Spare parts

Safety and cleaning supplies

Warranty information

Section 010: Pump Stations



SECTION 3 - SPECIFICATIONS

3.1 GENERAL

3.1.1 MATERIAL TESTING SPECIFICATIONS

1. Tests of all materials specified will be made in accordance with the industry best practices.
2. When ASTM, AASHTO, ASA, AWWA, or Federal Specification, Standard Specifications and serial numbers are stipulated, the reference shall be construed to be the latest effective specification.
3. If material previously certified is subsequently declared substandard or unfit for the intended use by the certifying agency, Artesian may declare the unused materials unsatisfactorily or unfit for use.

4. Abbreviations:

HMI	Human Machine Interface
I/O	Input / Output
OIT	Operator Interface Terminal
PLC	Programmable Logic Controller
SCADA	Supervisory Control and Data Acquisition
UL	Underwriters Laboratory
UPS	Uninterruptible Power Supply
PCP	Pump Control Panel

3.2 PUMP STATION

3.2.1 SUBMITTAL REQUIREMENTS

1. Shop drawings shall be furnished for review and approval as four (4) hard copy complete sets or one complete electronic set to the Design Engineer with subsequent review and approval by Artesian for any components that deviate from those specified by Artesian in these standards and specifications.

3.2.2 PUMP CONTROL PANEL

1. Description:
 - a) The contractor shall provide all materials, equipment and labor necessary to install, test and place into service a complete and functional Pump Control Panel. The general electrical provisions shall apply to all work specified under this section.
2. Scope:
 - a) The Contractor shall provide a Systems Integrator, experienced in integrating PLC systems for pump control and future SCADA.
 - b) Artesian Wastewater Management, Inc. reserves the right to accept or reject the Integrator provided.



- c) The Artesian Wastewater Management Department's standard Pump Control Panel (PCP) shall be manufactured by:
- TRIJAY SYSTEMS, INC.
10 Maple Avenue
P.O. Box 109
Line Lexington, Pa 18932
Phone: (215) 997-5833
3. Description of Work:
- a) It shall be the Systems Integrator's responsibility to furnish a complete, functioning, Integrated Pump Control Panel with future SCADA capability and space allowed for a future radio.
- b) The Systems Integrator shall be responsible for the detailed design, installation and the proper functioning and performance of the Pump Control Panel, the operating interface, the preparation of the required submittal data, conducting all test, calibrations and operational demonstrations. The Pump Control Panel Manufacturer shall be responsible for providing technical supervision for the installation and the connections to external, field installed equipment.
4. Bill of Material:
- a) The PCP Manufacturer shall provide the following Bill of Materials
- i. **Enclosure NEMA 12, 36.00"H x 36.00"W x 16.00"D.** Mfgr. SAGINAW Part No. SCE-36EL3616LP
 - ii. **Sub Panel 33.00"H x 27.00"W.** Mfgr. SAGINAW Part No. SCE-36P36
 - iii. **Mounting Foot Kit.** Mfgr. SAGINAW Part No. SCE-ELMFK4
 - iv. **Louver Plate Kit.** Mfgr. SAGINAW Part No. SCE-AVK34
 - v. **Modicon Momentum 24 VDC I/O Module Base (16 D.I./16 D.O.).** Mfgr. MODICON Part No. 170 ADM 350 10
 - vi. **Remote RTU PLC, Combination I/O Base.** Mfgr. MODICON Part No. 170 AMM 090 00
 - vii. **Remote RTU PLC, Terminal Blocks (3 per Package).** Mfgr. MODICON Part No. 170 XTS 001 00
 - viii. **I/O Bus Communication Adapter.** Mfgr. MODICON Part No. 170 INT 110 00
 - ix. **Unity Top Hat for Momentum.** Mfgr. MODICON Part No. 171CBU98090
 - x. **Remote Bus cable 4.5'.** Mfgr. MODICON Part No. 170 MCI 007 00
 - xi. **Color Touch Screen OIT, 5.7", 24VDC.** Mfgr. SCHNEIDER ELECTRIC Part No. HMIGTO2310
 - xii. **5 Port Ethernet Switch 10/100 Mbps.** Mfgr. PHOENIX CONTACT Part No. 2891001
 - xiii. **2-Position Selector Switch.** Mfgr. Square D Part No. 9001SKS11BH2
 - xiv. **3-Position Selector Switch.** Mfgr. Square D Part No. 9001SKS43BH2



- xv. **1 N.O./1 N.C. Contact Block.** Mfgr. Square D Part No. 9001KA1
- xvi. **Push Button, 1 N.O./ 1 N.C. Contact.** Mfgr. Square D Part No.9001SKR1BH13
- xvii. **Pilot Light, NEMA 4X, 120VAC, Amber.** Mfgr. Square D Part No. 9001SKP1A31
- xviii. **Pilot Light, NEMA 4X, 120VAC, Red.** Mfgr. Square D Part No. 9001SKP1R31
- xix. **Custom Engraved Nameplate, “VFD/AUX”.** Mfgr. Square D Part No. 9001KN100WP
- xx. **Custom Engraved Nameplate, “HAND-OFF-AUTO”.** Mfgr. Square D Part No. 9001KN100WP
- xxi. **Custom Engraved Nameplate, “P1 SELECTED P2”.** Mfgr. Square D Part No. 9001KN100WP
- xxii. **Custom Engraved Nameplate, “MASTER ALARM RESET”.** Mfgr. Square D Part No. 9001KN100WP
- xxiii. **Custom Engraved Nameplate, “SYSTEM FAULT”.** Mfgr. Square D Part No. 9001KN100WP
- xxiv. **Custom Engraved Nameplate, “RUN”.** Mfgr. Square D Part No. 9001KN100WP
- xxv. **Resistor Potentiometer w/ Dial plate 1K OHM.** Mfgr. Square D Part No. 9001K2105
- xxvi. **Surge Protection Device, 120VAC.** Mfgr. PHOENIX CONTACT Part No. 2856812
- xxvii. **Fuse Holder 120VAC w/ Blown Fuse Indicator.** Mfgr. PHOENIX CONTACT Part No. 3046100
- xxviii. **Fuse Holder 24VDC w/ Blown Fuse Indicator.** Mfgr. PHOENIX CONTACT Part No. 3046090
- xxix. **Single Level Terminal (Gray).** Mfgr. PHOENIX CONTACT Part No. 3044102
- xxx. **Single Level Ground Terminal (Green).** Mfgr. PHOENIX CONTACT Part No. 3044128
- xxxi. **Single Level Terminal End Cover (Gray).** Mfgr. PHOENIX CONTACT Part No. 3047028
- xxxii. **Double Level Terminal (Gray).** Mfgr. PHOENIX CONTACT Part No. 3044814
- xxxiii. **Double Level Terminal End Cover (Gray).** Mfgr. PHOENIX CONTACT Part No. 3047293
- xxxiv. **End Stop.** Mfgr. PHOENIX CONTACT Part No. 0800886
- xxxv. **24VDC Power Supply, Step-PS, 2.5A.** Mfgr. PHOENIX CONTACT Part No. 2868651
- xxxvi. **Fuse, 1.0A.** Mfgr. LITTLE FUSE Part No. LF-0217-WF-520F/1
- xxxvii. **Fuse, 2.0A.** Mfgr. LITTLE FUSE Part No. LF-0217-WF-520F/2
- xxxviii. **Fuse, 3.15A.** Mfgr. LITTLE FUSE Part No. LF-0217-WF-520F/3.15
- xxxix. **Circuit Breaker 20A, 120VAC.** Mfgr. WOERTZ Part No. WCB-1P-2-20



- xl. **Flanged Nylon Feed-Thru Receptacle.** Mfgr. HUBBELL Part No. HBL5279C
- xli. **DPDT Relay, 120VAC Coil, 2 Form “C” Contacts.** Mfgr. WEIDMULLER Part No. 8530661001
- xl.ii. **DPDT Relay, 24VDC Coil, 2 Form “C” Contacts.** Mfgr. WEIDMULLER Part No. 8530631001
- xl.iii. **Intrinsically Safe Switch.** Mfgr. PR ELECTRONICS Part No. 9202B2A
- xl.iiii. **Isolated Converter.** Mfgr. PR ELECTRONICS Part No. 3104
- xl.v. **Uninterruptible Power Supply, 500VA.** Mfgr. APC Part No. BE550G
- xl.vi. **Ground Bar.** Mfgr. ILSCO Part No. D167-6
- xl.vii. **Motor Protection Relay.** Mfgr. FLYGT Part No. 14-407129
- xl.viii. **11 Pin Relay Base Use w/ Motor Protection Relay.** Mfgr. IDEC Part No. SR3P-05
- xl.ix. **15A Din Rail Mounted Single Receptacle.** Mfgr. ELECTROTECH Part No. ESG-15OB-SIMPLEX-ASI
- l. **Surge Protector.** Mfgr. BOURNS Part No. 1820-28-A3
- li. **Digital Panel Recorder.** Mfgr. YOKOGAWA Part No. FX1012-4-2/AI/C7/M1
- lii. **Submersible Level Transmitters.** Mfgr. MERCOID Part No. PBLT2-15-60
- lii.iii. **Type S Control Floats.** Mfgr. ANCHOR SCIENTIFIC Part No. S60NO
- li.iiii. **MAG 5100W Flow Meter.** Mfgr. SIEMENS Part No. MAG 5100W
- li.v. **MAG 5000 Display.** Mfgr. SIEMENS Part No. 7ME6910-1AA10-1AA0
- li.vi. **MAG Remote Mounting Unit.** Mfgr. SIEMENS Part No. FDK-085U1053
- li.vii. **MAG Potting Kit.** Mfgr. SIEMENS Part No. FDK-085U0220
- li.viii. **MAG Cable Glands (4 Typ.).** Mfgr. SIEMENS Part No. A5E00822501
- li.lix. **MAG Cable for Electrode & Coil, Shielded PVC.** Mfgr. SIEMENS Part No. FDK-083F0210
- li.x. **Auto Dialer.** Mfgr. SENSAPHONE Part No. FGD-0800 8-Channel
- li.xi. **H2S Sensors (2 Required).** Mfgr. RKI INSTRUMENTS Part No. 65-2615RK-05

5. Submittals:

- a) Submittals for approval of the Pump Control Panel shall include, but not be limited to the following:
 - i. Manufacturer’s descriptive literature and data sheets indicating relevant features, certificates, capabilities, identification numbers, Operator Interface (OIT) Screens, OIT software, PLC’s, UPS, surge protection devices, IS Barriers, panel devices, such as Paper less recorders, auto dialer and H2s Sensors.



- ii. Drawings showing dimensions, mounting, and external connection details for the RTU's. Provide legend of custom engravings for control panel nameplates on submittal drawings.
 - iii. Wiring schematics for connections between PLC's and other devices and RTU hardware. Include wiring schematics for control power distribution, fuses, circuit breaker and other relevant information.
 - iv. Written description of the attributes of programming developed for the installation of the pump controls and future SCADA system, including procedures for modifications, downloading, and programmer operation.
 - v. Provide a hard and soft copy of the PLC program documentation including ladder logic, cross reference, memory usage, symbols and descriptions.
6. Warranty:
- a) The warranty shall provide a minimum of next-day, on-site service for any failures deemed an emergency, and replacement of the defective components within one week.
 - b) A five-day response time for on-site service is required for non-critical failures.
 - c) The warranty shall cover a period of one year from the date of final acceptance of the project.
 - d) Artesian Wastewater Management, Inc., shall be the sole determiner of the severity of a failure and whether the failure is an emergency or a non-critical failure.
7. Spare Parts:
- a) Spare parts shall be provided and available on-site prior to the pump station start-up. The System Integrator shall provide, as a minimum the following set of spare parts per pumping station.
 - i. Ethernet Hub.
 - ii. PLC power supply with battery backup.
 - iii. Submersible pressure transducer with bellows.
 - iv. Relay module (One (1) of each type provided).
 - v. Fuses (Five (5) of each type and rating used in the Pump Control Panel).
 - vi. Three (3) Spare LED Lamps.
 - vii. One (1) Spare VFD rated for the pumps being used (If VFD's are being used).

3.2.3 PUMP MOTOR CONTROLLERS

1. Variable Frequency Drive:
 - a) Pump stations with Non-Clog pumps shall utilize Square D, Altivar 61, Variable Torque, Variable Frequency Drives (VFD). All VFDs shall be supplied with a Type 1 conduit entry kit and a Remote LCD Display Keypad plugged into the front of the VFD unit.



- b) Pump stations with Grinder pumps shall utilize Square D, Altivar 71, Constant Torque, Variable Frequency Drives (VFD). All VFDs shall be supplied with a Type 1 conduit entry kit and a Remote LCD Display Keypad plugged into the front of the VFD unit.
2. Line Reactors:
 - a) Line Reactors, rated at 5% impedance shall be provided on the line side of each VFD. Each line reactor shall be installed in a NEMA 1 Type enclosure.
3. Load reactor:
 - a) Load Reactors, rated at 5% impedance shall be provided on the load side of each VFD if the distance between the VFD and the pump motor is 100 ft. or greater.
 - b) Each load reactor shall be installed in a NEMA 1 Type enclosure.
4. Pump Controller Circuit Breakers:
 - a) Circuit breakers shall be Square D, Thermal Magnetic, CSA/UL Certified as Current Limiting, standard 80% continuous duty. Circuit breakers shall be sized 200 % greater than the Full Load Amperage (FLA) listed on the pump nameplate.
 - b) All circuit breakers shall be within sight of the VFD controller.

3.2.4 DISCONNECT SWITCHES

1. Manufacturers: Square D, Heavy Duty Safety Switches
2. General:
 - a) Safety switches shall be equipped with a cover interlock to prevent operation with cover open. All switches shall be designed to permit padlocking in the off or open position.
 - b) Safety switches located where they are affected by outdoor weather, or in damp locations, shall be NEMA 4 and shall have stainless steel enclosures.
 - c) Safety switches shall be UL listed, and shall bear the UL label.
 - d) Safety switches shall be fused or unfused types, as indicated on the design drawings and shall be enclosed in NEMA 4 stainless steel enclosures, unless otherwise indicated. Safety switches, regardless of voltage, shall be heavy-duty. All safety switches shall be the front operated type, cover interlocked with switch.
 - e) All switches shall be visible blade, externally operated with all current carrying parts silver or tin plated. All switches shall have provisions for not less than two external padlocks and capable of accepting copper or aluminum conductors.

3.2.5 TRANSIENT VOLTAGE SURGE SUPPRESSION

1. Manufacturers:
 - a) Square D “SurgeLogic” Surge Protective Devices
 - b) Advanced Protection Technologies, Inc.
2. Service Entrance Suppressors:



- a) Surge Protection Device Description: Individual phase modular design with field-replaceable individual phase modules, sine-wave-tracking type with the following features and accessories:
 - i. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 - ii. LED indicator lights for power and protection status.
 - iii. Audible alarm, with silencing switch, to indicate when protection has failed.
 - iv. One set of dry contacts rated 5 A and 250 VAC, for remote monitoring of protection status. Coordinate with building power monitoring and control system.
 - v. Surge-event operations counter.
 - b) Peak Single-Impulse Surge Current Rating: 160 kA
 - c) Connection Means: Permanently wired to separately mounted NEMA 1 enclosure w/ circuit breaker.
3. Field Quality Control:
- a) Testing: Perform the following field quality-control testing:
 - i. After installing surge protective devices, but before the electrical circuitry has been energized, test for compliance with requirements.
 - ii. Complete startup checks according to manufacturer's written instructions.
 - iii. Perform each visual and mechanical inspection and electrical test started in NETA ATS, Section 7.19. Certify compliance with test parameters.
 - iv. Repair or replace malfunctioning units. Restart after repairs or replacements are made.

3.2.6 LIGHTING FIXTURES

1. General:
 - a) All exterior lighting shall be provided with stainless steel screws, nuts, washers and anchors if applicable.
 - b) All fixtures shall be prewired and tested at the factory and bear the UL Listed label.
 - c) Provide all support material and associated items necessary to provide a structural sound fixture support system.
2. Interior Lights:
 - a) All interior lights located within the large two and three door enclosures shall be Vapor Proof, Wet Location, 2 lamp fixtures.
 - b) Lamps shall be fluorescent, energy saving, T8 lamps, 4 feet in length, 32 Watts.
 - c) All interior lights shall be on a separate 120 VAC circuit and shall be controlled by a single pole light switch housed in a PVC gang box with a rain tight, toggle type, PVC cover.
 - d) Provide one, two lamp, fluorescent, T8, 32W, Vapor Proof fixture for the Control Side and one for the Power Side of the electrical enclosure.



3. Exterior Lights:
 - a) All exterior lights shall be mounted on a fourteen-foot aluminum pole and have the ability to alumininate downward. All exterior light fixtures and poles shall be a bronze or brown color.
 - b) Exterior light fixtures shall be the LED Street/Flood light type, 150 W, outdoor with a pole mount slip fitter.
 - c) All exterior lights shall be on a separate 120 VAC circuit and shall be controlled by a single pole light switch housed in a PVC gang box with a rain tight, toggle type, PVC cover.

3.2.7 GROUNDING SYSTEMS

1. General:
 - a) Provide all labor, materials, electric gear and services necessary for the installation of a complete ground system.
 - b) The ground system shall consist of all required rods and copper conductors, including all necessary connections to control centers, panels, and equipment mounting cabinet steel, etc.
2. Scope:
 - a) Provide a ground for the service neutral, neutrals of each separately derived system (SDS), metallic structures, enclosures and devices. All bonding and grounding electrode conductors shall be in accordance with the National Electric Code (NEC), and as shown and required.
 - b) The neutrals of each separately derived power system shall be connected to ground at one point only. The service ground shall extend from this single point of connection to the principle ground point.
3. Installation:
 - a) Provide bare copper wire and connections to ground all transformer secondary neutral terminals as required by the National Electric Code (NEC). Wire shall be sized as required by the NEC, but shall not be sized smaller than #6 AWG copper conductor.
 - b) The electrical continuity of all metal raceways shall be insured by means of properly installing locknuts, bonding straps or other approved means.
 - c) Panels with oversized knockout, concentric, eccentric, or reducing washers shall be bonded around that opening. Use a bonding-type locknut, not a standard locknut.
 - d) Provide an external intersystem bonding terminal for connecting communications systems bonding and grounding electrode conductors. Separate ground systems between communications systems and the electric service shall not be acceptable. The resulting termination must:
 - i. Be accessible for connection and inspection.
 - ii. Consist of a set of terminals with the capacity for connecting at least three intersystem bonding conductors.
 - iii. Not interfere with opening the enclosure for a service, building/structure disconnecting means, or metering equipment.



- iv. Be securely mounted and electrically connected to service equipment, the meter enclosure, or exposed nonflexible metallic service raceway, or it must be mounted at one of the enclosures and connected to the enclosure or grounding electrode. Use at least a #6 AWG copper conductor.
- v. Be securely mounted to the structure disconnecting means, or it must be mounted at the disconnecting means and connected to the enclosure or grounding electrode conductor. Use at least a #6 AWG copper conductor.
- vi. Use terminals listed as grounding and bonding equipment.
- vii. Equipment bonding jumpers shall be copper.

3.2.8 UNDERGROUND CONDUITS

- 1. General:
 - a) All polyvinylchloride (PVC) underground conduits for the power utility service shall be heavy wall, Sch. 80 PVC conforming to NEMA TC-6, NEMA TC-8, and ASTM Standard F-512 for utility duct. PVC conduits shall be suitable for direct burial underground applications.
 - b) All underground PVC conduits for power feed conductors to motors, power feed conductors to controls and signal conductors shall be heavy wall, Sch. 80 PVC conduit.
- 2. Execution:
 - a) Conduits for Power wiring shall not be closer than six (6) inches from conduits for signal wiring.
 - b) Provide a minimum of 3/16 inch, 3-strand polypropylene pull cord having not less than 800 pound test strength in all empty spare conduits. Provide a minimum of two (2) feet of slack pull cord at each end of the raceway.
 - c) All underground conduits shall be installed a minimum of 24 inches below finish grade or paving at any point, unless otherwise noted. Conduits entering a wet well shall be laid on a downhill slope to allow any water to drain back into the wet well.
 - d) Conduits shall be thoroughly cleaned before installing any conductors and spare conduits shall be plugged to keep the interior clean.

3.2.9 EMERGENCY STANDBY POWER GENERATION & ATS

- 1. References:
 - a) The completed installation shall comply with the requirements of the latest issue of NFPA 37 – COMBUSTION ENGINES.
 - b) The electrical generating systems shall meet all requirements of NFPA 110 including design specifications, prototype tests, one-step full load pickup, and installation acceptance.
 - c) The engine generator sets shall meet all the applicable local and state requirements of the Delaware State Department of the Environmental Air Quality Standards.



- d) Engine generator sets shall be built and listed to meet Underwriters Laboratories UL 2200.
- e) Acceptable generator manufacturers are MTU, Cummins and Kohler.
- 2. System Description:
 - a) Upon the loss of power on any phase, or reduction of normal power voltage by 5 percent for 15 seconds, the engine will automatically start and the loads will be transferred from the normal bus to the emergency bus.
 - b) When the power is restored within 5 percent of the normal voltage, the following shall occur:
 - i. The automatic transfer switch (ATS) shall transfer the load back to the normal bus after 15 minutes of operation.
 - ii. The generator shall run for a cool down period without load as recommended by the engine manufacturer.
 - c) The automatic transfer switch shall have the capacity to automatically exercise the generator with and without load on a regularly scheduled weekly or biweekly basis through local or remote operation.
- 3. Generator:
 - a) Generator sets shall have a standby rated output of not less than that indicated on the drawings at 0.8 power factor at 1000 feet altitude with an ambient temperature of 122 degrees F. The generator controls shall be arranged for automatic starting and transfer of the load upon loss of any phase of the normal power source, and automatic re-transfer and shut down upon restoration of the normal power source.
 - b) Generators shall be provided with a weather shielded, aluminum, sound attenuation enclosures which shall reduce the noise level so that it shall not exceed 55 dB at all points on the property line or 72 dB at 23 feet from connector.
 - c) The generator set shall be provided with a weather shielded sound attenuated ALUMINUM ENCLOSURE, Level 3 with air exhaust scoop, which shall reduce average noise level to 72 dB @ 23 feet.
- 4. Engines:
 - a) Engines shall be 4 cycle, naturally aspirated or turbo charged, radiator cooled type, having all necessary horsepower to deliver the rated output at 1800 RPM. Engines shall be equipped with the following:
 - i. Pressure type fuel injection system
 - ii. Fuel oil pump
 - iii. Replaceable element type fuel filters
 - iv. Electronic solenoid fuel shut off valve
 - v. Electronic isochronous governor, steady-state regulation +/- .25 percent Barber Colman Model DYNC or equivalent by Woodward suitable
 - vi. Lube oil pump
 - vii. Lube oil pressure relief
 - viii. Lube oil cooler
 - ix. Lube oil level indicator/dip stick



- x. Full flow replaceable lube oil filter
 - xi. Replaceable dry combustion air filter
 - xii. All contacts, sensors and other miscellaneous elements to provide all pre-failure alarms and failure alarms and all shutdown functions required.
 - xiii. Axial cooling for engine driver
 - xiv. Set mounted radiator with a duct mounted flange
 - xv. Heavy-duty 12-volt electric starter motor
 - xvi. Engine mounted thermostatically controlled jacket water heater that shall be disconnected whenever the engine starts. Heater shall be 1500 watts, 120 volts, single phase, 60 Hz.
 - xvii. Thermostats to maintain proper operating temperatures.
 - xviii. 50 % ethylene-glycol/50 % water coolant mixture ant-freeze protection to minus 10 degrees F
 - xix. Coolant corrosion resistor with replaceable element
 - xx. Flexible fuel oil lines (supply and return)
 - xxi. Self-sealing, pre-lubricated coolant pump
5. Generation Unit:
- a) The generation unit shall be a single pre-lubricated bearing, self-aligning, four-pole, synchronous type, revolving field, with amortisseur windings, direct drive centrifugal blower for proper cooling and minimum noise, temperature compensated solid-state voltage regulator, with brushless rotating exciter system. The generation unit shall have separately excited permanent magnet generator system. The generation unit shall be directly connected to the engine flywheel housing and driven through a flexible coupling to insure a permanent alignment; gear driven generators are not acceptable. Insulation shall meet NEMA MG1 for Class F. The maximum temperature rise shall not exceed 105-degree C at 40-degree C ambient. The generator design shall prevent potentially damaging shaft currents.
 - b) Voltage regulation shall be solid-state design and shall function by controlling the exciter magnetic field between stator and rotor to provide no load regulation of rated voltage within +/- 2 percent during steady-state conditions. The engine-generator set and regulator shall be able to sustain at least 90 percent of no load voltage for 10 seconds with 250 percent of rated load at near zero power factor connected to its terminals. The voltage regulator shall be insensitive to severe load induced wave shape distortion from SCR or thyristor circuits such as those used in battery charging and motor speed control equipment.
 - c) Exciter shall be three-phase, full wave, rectified, with heavy-duty silicon diodes mounted on the common rotor shaft and sized for maximum motor starting loads. Systems using three-wire, solid-state control elements (such as transistors or SCR's) rotating on the rotor shall not be acceptable.
 - d) The generator shall meet or exceed the NEMA "Standards for Motors and Generators".



- e) Generators shall also meet or exceed ANSI and IEEE Standards. Provide generator with interference suppression for MGI-22.43. Stator winding: 2/3 pitch.
- 6. Generator Control Panel:
 - a) The generator manufacturer shall provide a lighted, unit mounted NEMA 12 control module enclosure that is factory built, wired, tested, and shock-mounted by the manufacturer. Engine-generator set control shall include the following:
 - i. Current and potential transformers as required.
 - ii. Remote, two-wire controls with start-stop terminals.
 - iii. Molded case line circuit breaker equipped with instantaneous magnetic trips and longtime thermal trips. The instantaneous trips should be set in a range of 500 percent to 700 percent of the full load current of the alternator. The thermal trips shall operate in 15 to 45 minutes when load current is 120 percent of the rated alternator current.
 - iv. Control circuit protection.
 - v. Manual selector switch: RUN-STOP-REMOTE.
 - vi. Automatic engine shutdown for the following fault conditions:
 - 1. Over crank
 - 2. Over speed
 - 3. Low oil pressure
 - 4. High engine (coolant) temperature
 - 5. Operation of a remote manual stop station
 - vii. Indicator lamps shall be provided to signal the following functions:
 - 1. RUN – indicates start system disconnect (green)
 - 2. OVER CRANK – indicates the starter has been locked out because cranking time was excessive (red)
 - 3. OVER SPEED – indicates engine has shut down because of excessive rpm (red)
 - 4. HIGH COOLANT TEMPERATURE – indicates engine has shut down because of critically high temperature (red)
 - 5. LOW OIL PRESSURE – indicates engine has shut down because of critically low oil pressure (red)
 - 6. PRE HIGH COOLANT TEMPERATURE – indicates engine temperature is marginally high (yellow)
 - 7. PRE LOW OIL PRESSURE – indicates oil pressure is marginally low (yellow)
 - 8. LOW COOLANT TEMPERATURE – indicates inoperative coolant heater
 - 9. SWITCH OFF – indicates control switch is in the “STOP” position (flashing red)
 - 10. LOW FUEL – indicates fuel supply is marginally low (yellow)
 - 11. Provide two SPARE fault condition lamps to be designated later (red)
 - viii. A fault reset switch shall be provided to clear fault indications and allow restarting of the engine after shutdown faults. The control design



shall be such that the fault indication shall remain until reset. The fault indicator memory shall not be dependent on the presence of either ac or dc voltage and shall retain the fault status memory even through complete removal and replacement of the starting batteries. The fault reset function shall operate only when the RUN-STOP-REMOTE switch is in the STOP position. Provide a test switch for indicating lights.

1. Manual reset exciter field circuit breaker.
 2. A locking screwdriver type potentiometer shall be provided to adjust the voltage +/- 5 percent from rated value.
 3. Voltmeter, AC – 2 percent accuracy with three phase selector switch with positions for reading phase-to-phase voltages, phase-to-neutral voltages and off (7 positions total).
 4. Ammeter, AC – 2 percent accuracy with three phase selector switch with positions for reading phase currents and off (4 positions total).
 5. Frequency meter, 45-65 Hz (direct reading dial type).
 6. Running time meter (hours - +/- 0.6 Hz accuracy).
 7. Oil engine pressure gauge.
 8. Coolant temperature gauge.
 9. Remote stop switch contacts.
 10. Voltage regulator.
 11. Cranking cyler to provide three – 15 second cycles with provisions for re-crank in the event of a false start.
 12. Speed adjustment control switch.
 13. Provisions for low voltage shutdown.
 14. Lube oil temperature gauge.
 15. Kilowatt meter.
- ix. Provide dry contacts for the following:
1. Generator fail.
 2. Generator run status.
 3. Low fuel level.
 4. Fuel tank leak.
7. Batteries:
- a) Provide a proper sized set of batteries, for engine starting and control power. Provide 12V DC engine start batteries sized to provide a minimum of 90 seconds of cranking. Batteries shall be lead acid. Batteries shall be equipped with explosion proof vents.
 - b) Provide a floor mounted, welded steel battery rack in the generator housing for batteries with bottom pan and an acid resistant molded plastic liner. Angles shall be arranged to support batteries on all sides. Grind smooth and thoroughly clean all welds. Paint with a rust resistant prime coat and an acid resistant finish coat.
 - c) Provide a hydrometer and mounting for hydrometer storage for checking batteries.
 - d) Provide heavy-duty battery cables and all necessary accessories required to interconnect the batteries and engine generator set.



8. Battery Charger:
 - a) Provide a fully automatic current limiting, self-protecting battery charger to automatically recharge the batteries. The charger shall be sized to fully charge the batteries within a minimum of 12 hours. The charger shall maintain 12V DC output voltage with 120 VAC line voltage fluctuations of +/- 10 percent. Provide the following:
 - i. Two ranges – float and equalize for lead acid batteries.
 - ii. Automatic AC line compensation.
 - iii. DC cranking disconnect relay to disconnect battery during engine cranking.
 - iv. Automatic surge suppressors.
 - v. Ammeter and voltmeter, DC.
 - vi. Fused AC input and DC output.
 - vii. Selector switch to transfer from float charge to high rate equalize charge.
 - viii. Low battery voltage sensor and red light.
 - ix. High battery voltage sensor and red light.
 - x. Charging current failure (loss of AC power) sensor and red light and alarm.
 - xi. Power on green light.
 - b) Provide contacts for remote annunciation of the following:
 - i. Low battery voltage.
 - ii. High battery voltage.
 - iii. Charging current failure (loss of AC power).
 - iv. Battery rectifier failure.
9. Fuel Tank:
 - a) Provide a dual wall sub-base fuel storage tank with a minimum capacity for 24 hours' full load operation. The tank shall be constructed of corrosion resistant steel and shall be UL 142 listed. The equipment, as installed, shall meet all local and regional requirements for above ground tanks. It shall include low fuel, high fuel, and liquid in rupture basin leak alarms and have all required vents. The fill shall be a 2 inch NPT connection and both the inner and outer pressure relief vents shall be 4 inch NPT and furnished by the manufacturer of the tank.
 - b) All fuel tanks shall be elevated above the designed concrete slab using the necessary spring isolators required to support the fuel tank, fuel and the generator weight.
 - c) Alarm devices shall be of the float type. A NEMA 4 panel with high, low and leak detection alarm indications shall be provided. The panel shall be suitable for a 120 VAC, 1 phase service.
 - d) A Direct Mechanical Level Gauge shall be furnished as follows:
 - i. The direct mechanical level gauge shall be the floating arm level mechanism type with thermometer style indicator. The float-operated mechanism shall be non-corrosive and have brass rivets secure float arm to gauge indicator arm with no gears, cams, magnets or tapes to wear.



- ii. The thermometer type indicator shall stand out boldly against the calibration chart. The gauge shall feature a zinc based, two-piece die-cast assembly, calibration chart between heavy plastic domes, non-corrosive rivets, and a coated float impervious to fuel oils. The complete unit shall be capable to withstand air pressure in excess of 70 psi.
 - iii. The float arm assembly shall be adjusted according to the tank dimensions. The direct mechanical level gauge shall be Therma-Gauge, manufactured by Kreger Sentry Gauge Co., “or equal”.
10. Exhaust System:
- a) Provide a critical type, or hospital grade exhaust silencer, with flanged inlet and outlet connections mounted so that its weight is not supported by the engine. Provide a flanged flexible stainless steel exhaust pipe, gas proof, 18 inches long minimum connection between the engine exhaust manifold and the silencer.
 - b) Exhaust piping and muffler shall be sized so that the total back pressure shall not exceed the maximum allowable engine back pressure. Piping shall be Schedule 40 black steel.
 - c) Exhaust system shall be mounted so that a Level 3, Aluminum (Level 2 enclosure with air exhaust scoop) Sound Attenuated Enclosure can be provided.
11. Automatic Transfer Switch:
- a) Furnish and install automatic transfer switches (ATS) with number of poles, amperage, voltage, and withstand current ratings as shown on the plans. Each automatic transfer shall consist of an inherently double throw power transfer switch unit and a microprocessor controller, interconnected to provide complete automatic operation. All transfer switches and control panels shall be the product of the same manufacturer.
 - b) Automatic transfer switches shall be ASCO Series 300.
 - c) The automatic transfer switches and accessories shall conform to the requirements of:
 - i. UL 1008 - Standard for Automatic Transfer Switches
 - ii. NFPA 70 - National Electrical Code
 - iii. NFPA 110 - Emergency and Standby Power Systems
 - iv. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
 - v. NEMA Standard ICS10-1993 (formerly ICS2-447) - AC Automatic Transfer Switches
 - vi. NEC Articles 700, 701, 702
 - vii. International Standards Organization ISO 9001: 2000
 - d) The transfer switch unit shall be electrically operated and mechanically held. The electrical operator shall be a single-solenoid mechanism, momentarily energized. Main operators which include overcurrent disconnect devices will not be accepted. The switch shall be mechanically interlocked to ensure only one of two possible positions, normal or emergency.
 - i. The switch shall be positively locked and unaffected by momentary outages so that contact pressure is maintained at a constant value and



temperature rise at the contacts is minimized for maximum reliability and operating life.

- ii. All main contacts shall be silver composition. Switches rated 600 amperes and above shall have segmented, blow-on construction for high withstand current capability and be protected by separate arcing contacts.
- iii. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. A manual operating handle shall be provided for maintenance purposes. The handle shall permit the operator to manually stop the contacts at any point throughout their entire travel to inspect and service the contacts when required.
- iv. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.
- v. Where neutral conductors must be switched, the ATS shall be provided with fully-rated neutral transfer contacts.
- vi. Where neutral conductors are to be solidly connected, a neutral terminal plate with fully-rated AL-CU pressure connectors shall be provided.

12. Microprocessor Controller with Membrane Interface Panel:

- a) The controller shall direct the operation of the transfer switch. The controller's sensing and logic shall be controlled by a built-in microprocessor for maximum reliability, minimum maintenance, and inherent serial communications capability. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance.
- b) The controller shall be enclosed with a protective cover and be mounted separate from the transfer switch unit for safety and ease of maintenance. Sensing and control logic shall be provided on printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers.
- c) The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:
 - i. ANSI C37.90A/IEEE 472 Voltage Surge Test
 - ii. NEMA ICS – 109.21 Impulse Withstand Test
 - iii. IEC801-2 Electrostatic discharge (ESD) immunity
 - iv. ENV50140 and IEC 801 – 3 Radiated electromagnetic field immunity
 - v. IEC 801 – 4 Electrical fast transient (EFT) immunity
 - vi. ENV50142 Surge transient immunity
 - vii. ENV50141: Conducted radio-frequency field immunity
 - viii. EN55011: Group 1, Class A conducted and radiated emissions
 - ix. EN61000 –4 – 11 Voltage dips and interruptions immunity

13. Enclosure:



- a) The ATS shall be furnished in a NEMA type 1 enclosure unless otherwise shown on the plans.
 - b) Provide strip heater with thermostat for Type 3R enclosure requirements.
 - c) Controller shall be flush-mounted display with LED indicators for switch position and source acceptability. It shall also include test and time delay bypass switches.
14. Voltage and Frequency Sensing:
- a) The voltage of each phase of the normal source shall be monitored, with pickup adjustable to 95% of nominal and dropout adjustable from 70% to 90% of pickup setting.
 - b) Single-phase voltage and frequency sensing of the emergency source shall be provided.
15. Time Delays:
- a) An adjustable time delay shall be provided to override momentary normal source outages and delay all transfer and engine starting signals.
 - b) An adjustable time delay shall be provided on transfer to emergency, adjustable from 0 to 5 minutes for controlled timing of transfer of loads to emergency.
 - c) A generator stabilization time delay shall be provided after transfer to emergency.
 - d) An adjustable time delay shall be provided on retransfer to normal, adjustable to 30 minutes. Time delay shall be automatically bypassed if emergency source fails and normal source is acceptable.
 - e) A 5-minute cool down time delay shall be provided on shutdown of engine generator.
 - f) All adjustable time delays shall be field adjustable without the use of special tools.
16. Additional Features:
- a) A set of contacts rated 5 amps, 32 VDC shall be provided for a low-voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output, and run for the duration of the cool down setting, regardless of whether the normal source restores before the load is transferred.
 - b) A push-button type test switch shall be provided to simulate a normal source failure.
 - c) A push-button type switch to bypass the time delay on transfer to emergency, the engine exerciser period on the retransfer to normal time delay whichever delay is active at the time the push-button is activated.
 - d) Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal.
 - e) Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of one contact, closed when the ATS is connected to the normal source and one contact, closed, when the ATS is connected to the emergency source.
 - f) Indicating lights shall be provided, one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to



- the emergency source (red). Also provide indicating lights for both normal and emergency source availability.
- g) Terminals shall be provided to indicate actual availability of the normal and emergency sources, as determined by the voltage sensing pickup and dropout settings for each source.
 - h) Engine Exerciser - An engine generator exercising timer shall be provided, including a selector switch to select exercise with or without load transfer.
 - i) Inphase Monitor - An Inphase monitor shall be inherently built into the controls. The monitor shall control transfer so that motor load inrush currents do not exceed normal starting currents, and shall not require external control of power sources. The inphase monitor shall be specifically designed for and be the product of the ATS manufacturer.
 - j) Selective Load Disconnect - A double throw contact shall be provided to operate after a time delay, adjustable to 20 seconds prior to transfer and reset 0 to 20 seconds after transfer. This contact can be used to selectively disconnect specific load(s) when the transfer switch is transferred. Output contacts shall be rated 6 amps at 28 VDC or 120 VAC.
17. Optional Accessories (Specify if Required):
- a) Communications Interface - Serial Module (5110) to allow local or remote communications with ASCO PowerQuest ® or SiteWeb™ communication products. The module shall be used to connect the Series 300, and ASCO ATS Annunciators to the serial network via an RS-485 interface. The module shall have two port connectors used for ATS & Standalone Power Manager connectivity. (Accessory 72A).
 - b) Communications Interface – Connectivity Module (5150) to allow several different serial devices that communicate at different baud rates and with different protocols to a common Ethernet media. The module shall be used to connect Series 300 and ASCO ATS Annunciators to the standard Ethernet TCP/IP network with standard 10 Base-T (RJ-45) connector. The module shall be designed to communicate with up to 8 clients such as Web applications (web pages) or PowerQuest® communication products simultaneously over an Ethernet connection. (Accessory 72E).
 - c) Programmable Engine Exerciser - A seven or fourteen-day programmable engine exerciser with digital readout display. Shall include one form C contact for availability of normal and emergency sources. Include “with or without” load control switch for exerciser period. The exerciser shall be backed up by a permanent battery. (Accessory 11BG).
 - d) Enclosure Heater - A 125-watt enclosure heater with transformer and thermostat (adjustable from 30-degrees to 140-degrees F) (Accessory 44 G).
18. Power Monitoring and Control:
- a) A PowerQuest® PC based Automatic Transfer Switch (ATS) remote monitoring and control system designed to communicate with other ATSS located in remote locations shall be provided. System shall utilize serial communications capability inherent with the ATS microprocessor based control panel offering. Refer to separate Suggested Specification.



- b) A SiteWeb™ remote monitoring and control system that is accessible from any network connected pc. It shall be an internet browser based system that can be configured to remotely monitor and control from a pc connected to the internet. Refer to separate Suggested Specification.
19. Withstand and Closing Ratings:
- a) The ATS shall be rated to close on and withstand the available rms symmetrical short circuit current at the ATS terminals with the type of overcurrent protection shown on the plans. WCR ATS ratings as be as follows when used with specific circuit breakers:

ATS Size	Withstand & Closing Rating MCCB	W/CLF
30	22,000A	100,000
70 - 200	22,000A	200,000
230	22,000A	100,000
260 – 400	42,000A	200,000
600 – 1200	65,000A	200,000
1600 – 2000	85,000A	200,000
2600 – 3000	100,000A	200,000

20. Tests and Certification:
- a) The complete ATS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.
 - b) Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.
 - c) The ATS manufacturer shall be certified to ISO 9001: 2000 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001: 2000.
21. Service Representation:
- a) The ATS manufacturer shall maintain a national service organization of company-employed personnel located throughout the contiguous United States. The service center's personnel must be factory trained and must be on call 24 hours a day, 365 days a year.
 - b) The manufacturer shall maintain records of each switch, by serial number, for a minimum of 20 years.



- c) For ease of maintenance, the transfer switch nameplate shall include drawing numbers and serviceable part numbers.

3.2.10 CONDUCTORS, SPLICES & TERMINATIONS (600V OR LESS)

1. General:
 - a) Contractor shall submit detailed sheets on proposed materials, splicing and terminating methods. Manufacturer's data shall include specifications and installation instructions. Include data substantiating that proposed materials comply with specified requirements.
2. Single Conductor Cables:
 - a) Secondary conductors in electrical enclosures mounted within the equipment mounting cabinet shall be soft drawn stranded copper 98% conductivity, 600 volt insulation, and shall be manufactured in accordance with requirements of the NEC, UL, ASA, NEMA, and IPCEA.
 - b) Conductor insulation shall be NEC type "THHN", "THWN", or "XHHW". All conductors shall be color coded for identification, unless otherwise indicated. Conductor size shall be as defined by standard American Wire Gauge (AWG) numbers or circular mils where indicated.
 - c) The minimum size for power and lighting circuits shall be #12 AWG copper, stranded.
 - d) All conductors shall be copper, stranded, no solid wire shall be installed. No aluminum conductors shall be used.
3. Splicing & Terminations:
 - a) Splicing and Termination connections shall be the solderless type and designed for use with stranded wire and shall be circular compression type fittings. Thomas and Betts, Burndy, Square D, or equivalent.
 - b) Splices for branch circuits and control wiring # 10 gauge or smaller shall be made with spring wire nuts, Ideal "Wirenuts" or equivalent.
4. Pump Cables:
 - a) Pump cables entering an electrical enclosure shall incorporate an aluminum strain relief, mesh grip sized appropriately for the cable diameter. Strain reliefs shall prevent the cable from pulling out and provide a dust-tight seal. Strain reliefs shall be manufactured by Hubbell, or equal.
 - b) Pump cables entering an electrical enclosure shall incorporate an aluminum strain relief, mesh grip sized appropriately for the cable diameter. Strain reliefs shall prevent the cable from pulling out and provide a dust-tight seal. Strain reliefs shall be manufactured by Hubbell, or equal.
5. Float & Transducer Cables:
 - a) Float and Transducer cables entering an electrical enclosure shall incorporate an aluminum strain relief, mesh grip sized appropriately for the cable diameter. Strain reliefs shall prevent the cable from pulling out and provide a dust-tight seal. Strain reliefs shall be manufactured by Hubbell, or equal.
 - b) Float and Transducer cables entering an electrical enclosure shall incorporate an aluminum strain relief, mesh grip sized appropriately for the cable diameter.



Strain reliefs shall prevent the cable from pulling out and provide a dust-tight seal. Strain reliefs shall be manufactured by Hubbell, or equal.

6. Conductor Color Coding:

- a) Phase wires shall be color coded. Phase wires #10 AWG or smaller shall be color coded throughout the entire length. Phase wires larger than #10 AWG may be color coded using tape at each splice and termination point. Color coded tape shall be within two (2) inches of the wire termination and marked a minimum of every three (3) feet within a wireway. Color coding shall be as follows:

480Y/277 Volt, 3-Phase, 4 Wire + Ground

PHASE A – BROWN
PHASE B – ORANGE
PHASE C – YELLOW
NEUTRAL – GRAY
GROUND – GREEN

240/120 Volt, 3-Phase, 4 Wire + Ground, High-Leg Delta

PHASE A – BLUE
PHASE B – ORANGE
PHASE C – BLACK
NEUTRAL – WHITE
GROUND – GREEN

120/240 Volt, 1-Phase, 3 Wire + Ground

PHASE A – BLUE
PHASE B – BLACK
NEUTRAL – WHITE
GROUND – GREEN

- b) Green colored insulated equipment grounding shall be provided for feeders and for branch circuits. Green grounding conductors shall be run with each respective feeder and branch circuit conductor group and with each multiwire branch circuit conductor group.

7. Wire Identification:

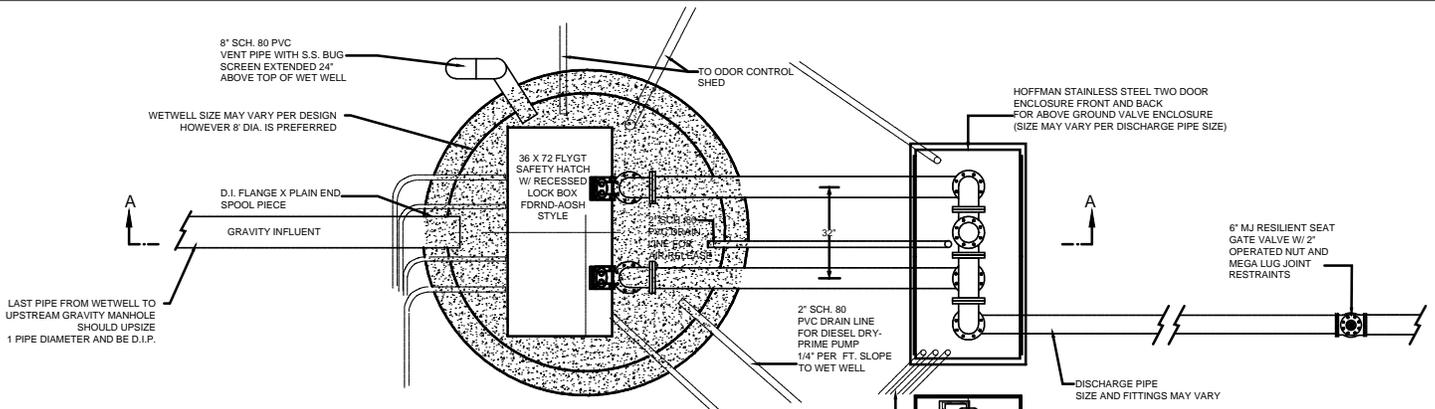
- a) Provide wire identification for all control wires. Control wires originating from the Pump Control Panel (PCP) shall be identified, matching the numbering system used on the PCP terminals and carried out on both terminating ends. Identification tags shall be within two (2) inches of the termination.

3.2.11 POWER/CONTROL ENCLOSURE CABINET FOR PUMP STATIONS

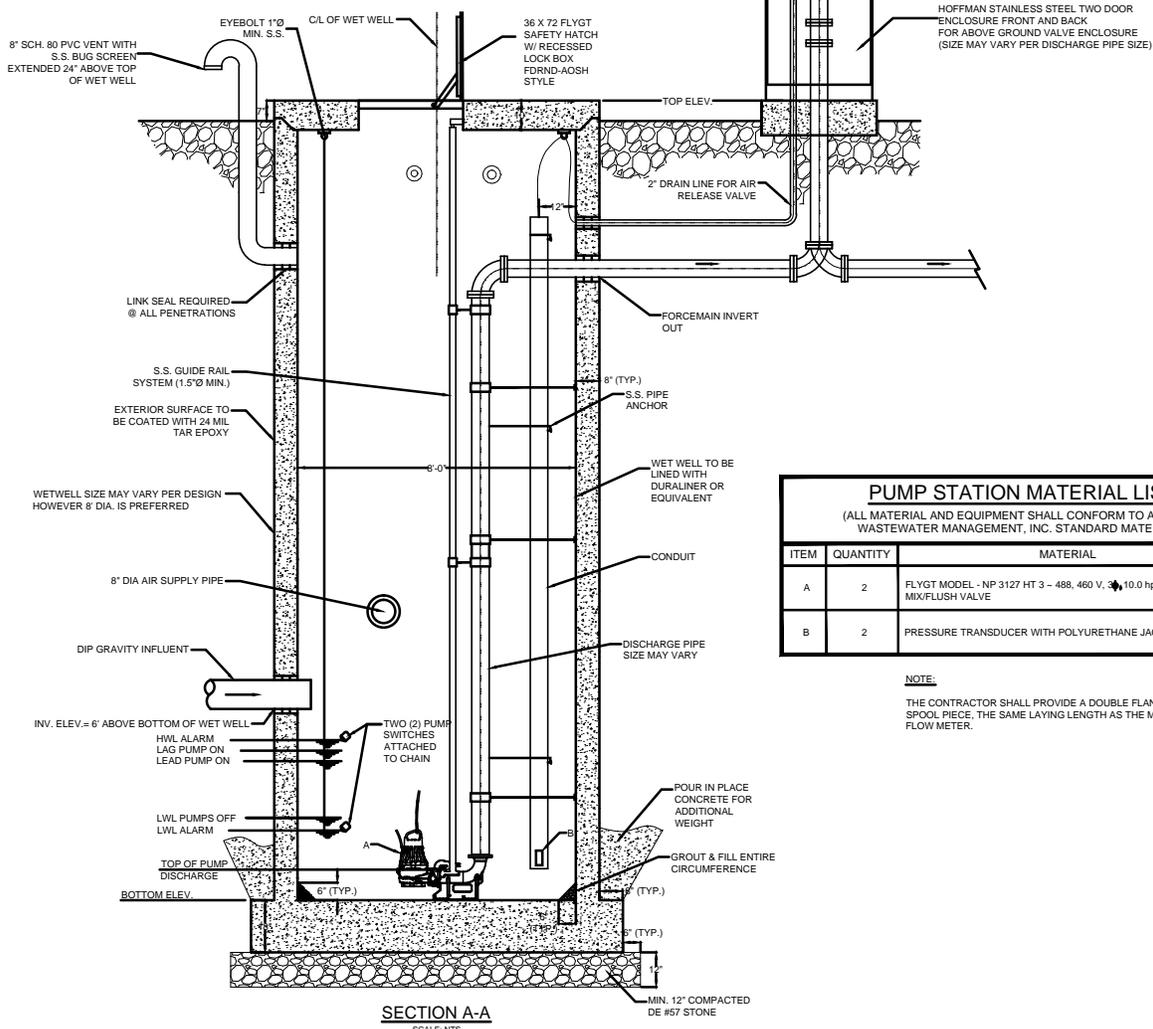
1. General:



- a) All Pump Stations shall have an electrical enclosure cabinet consisting of three (3) doors, front and back with the following dimensions:
 - LENGTH – 112 INCHES
 - HEIGHT – 90 INCHES
 - WIDTH – 48 INCHES
 - b) Lift Stations shall use a smaller enclosure cabinet (see section Power/Control Enclosure Cabinet for Lift Stations).
 - c) Electrical enclosure cabinets shall be used for pump stations designed for 35 hp. pumps, or smaller. Pump stations designed for larger than 35 hp. shall have all electric controls and VFDs in a concrete, or masonry building, large enough to provide access and meet all local, state and national codes.
 - d) One side of the electrical enclosure cabinet shall represent the Control Side and the other shall be the Power Side. The Control Side shall always face the wet well with control disconnects within sight of the wet well access hatch.
2. Electrical Enclosure Cabinets:
- a) Electrical enclosure cabinets for Pump Stations shall be Model No. 182TQ A27003 Assembly, manufactured by Hoffman with the following features:
 - i. 3 – doors front and back.
 - ii. Custom “C” size enclosure.
 - iii. Holes &/ or cutouts in body.
 - iv. Enclosure to have door stop studs installed in top of all doors.
 - v. Stainless steel channel base installed.
 - vi. Custom dual access – (3X) rear doors required.
 - vii. Omit all interlocking.
 - viii. Open bottom with 6-inch flange.
 - ix. Enclosure has modified lift angles.
 - x. Fab the following:
 1. (8X) 182TQM 1 – Custom CPS.
 2. (8X) 182TQM 2 – CPS Supports.
 3. (2X) 29980 – 34 X 78 Panel.
 4. (2X) 29990 – 70 X 78 Panel.
 5. (2X) Std. C Post SA.
 6. (1X) RD1, RD2 & RD3.
 7. Install SS C Channel around bottom toed-up.
 8. Install Dripshield and Unistrut.
 9. Install Dripshield on front and rear w/ std. fixture.
3. Electrical Enclosure Cabinet Paint:
- a) The electrical enclosure cabinet and all sub-panels shall be painted by the manufacturer with a zinc rich epoxy in and out. The paint color shall be Hoffman A1, standard white.
4. Assembly:
- a) The electrical enclosure cabinet shall have the following assembly components:
 - i. UL Type 3R Label required.
 - ii. Install doors with stainless steel hinge pins.



PLAN
N.T.S.



SECTION A-A
SCALE: N.T.S.

PUMP STATION MATERIAL LIST		
(ALL MATERIAL AND EQUIPMENT SHALL CONFORM TO ARTESIAN WASTEWATER MANAGEMENT, INC. STANDARD MATERIALS)		
ITEM	QUANTITY	MATERIAL
A	2	FLYGT MODEL - NP 3127 HT 3 - 488, 460 V, 10.0 hp, 1745 rpm WITH MIX/FLUSH VALVE
B	2	PRESSURE TRANSDUCER WITH POLYURETHANE JACKETED CABLE

NOTE:
THE CONTRACTOR SHALL PROVIDE A DOUBLE FLANGED SPOOL PIECE, THE SAME LAYING LENGTH AS THE MAGNETIC FLOW METER.

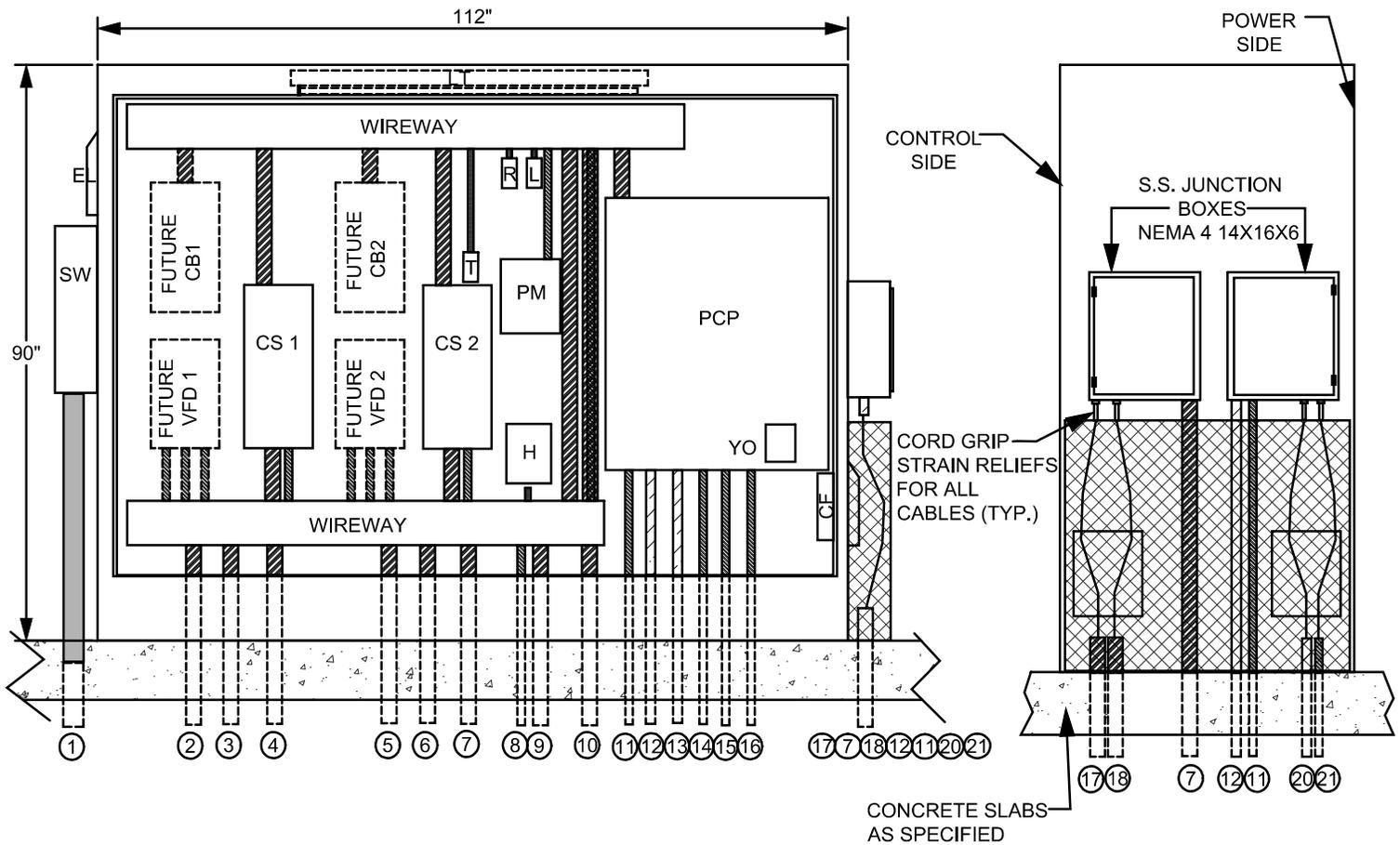
STANDARD DETAILS

DUPLEX SUBMERSIBLE PUMP STATION WITH ABOVE GROUND VALVE ENCLOSURE



664 Churchmans Road
Newark, Delaware 19702
P.O. Box 15004, Wilmington, Delaware 19850
Phone: (302) 453-6900 Fax: (302) 453-5800

ISSUED: FEBRUARY 20, 2014	SCALE: NOT TO SCALE
REVISED: OCTOBER 8, 2014	
REVISED: SEPTEMBER 1, 2015	PLATE: PS-01



ELECTRICAL CONDUIT DESIGN LEGEND

- | | |
|---|--|
| <ul style="list-style-type: none"> 3 IN. SCH. 80 PVC CONDUIT 2 IN. SCH. 80 PVC CONDUIT 1 1/4 IN. SCH. 80 PVC CONDUIT 1 IN. SCH. 80 PVC CONDUIT 3/4 IN. SCH. 8-PVC CONDUIT | <ul style="list-style-type: none"> T - CABINET COOLING THERMOSTAT EL - EXHAUST LOUVER PCP -SCADA CONTROL PANEL PM -PHASE MONITOR H -400 WATT CABINET HEATER CF -CABINET COOLING FAN SW -200 AMP., SQUARE D, NEMA 3R, 3 PH. NON-FUSIBLE SAFETY SWITCH R -RECEPTACLE L -LIGHT SWITCH LT -CABINET LIGHT CS1 - SQUARE D COMBINATION STARTER W/ THERMAL MAGNETIC BREAKER, 120 V. COIL, W/O CONTROL TRANSFORMER CS2 - SQUARE D COMBINATION STARTER W/ THERMAL MAGNETIC BREAKER, 120 V. COIL W/O CONTROL TRANSFORMER YO - YOKAGAWA |
|---|--|

- ① 3 IN. SCH. 80 PVC TO SERVICE TRANSFORMER.
- ② 2 IN. SCH. 80 PVC FEED TO LINE REACTOR NO.1 (FOR FUTURE USE).
- ③ 2 IN. SCH. 80 PVC FEED FROM LINE REACTOR NO.1 (FOR FUTURE USE).
- ④ 2 IN. SCH. 80 PVC TO FUTURE ODOR CONTROL
- ⑤ 2 IN. SCH. 80 PVC FEED TO LINE REACTOR NO.2 (FOR FUTURE USE).
- ⑥ 2 IN. SCH. 80 PVC FEED FROM LINE REACTOR NO.2 (FOR FUTURE USE).
- ⑦ 2 IN. SCH. 80 PVC TO STAINLESS STEEL JUNCTION BOX (PUMP NO. 1 & 2).
- ⑧ 1 IN. SCH. 80 PVC TO POWER SIDE.
- ⑨ 2 IN. SCH. 80 PVC TO POWER SIDE (240/120 V.FEED IN)..
- ⑩ 2 IN. SCH. 80 PVC TO POWER SIDE (480 V. FEED IN FOR CS1 & CS2)..
- ⑪ 1 IN. SCH. 80 PVC TO STAINLESS STEEL JUNCTION BOX (TRANSDUCER).
- ⑫ 1 1/4 IN. SCH. 80 PVC TO STAINLESS STEEL JUNCTION BOX (REDUNDANT ON/OFF FLOATS).
- ⑬ 1 1/4 IN. SCH. 80 PVC TO ANTENNA POLE.
- ⑭ 1 IN. TO FUTURE ATS ON POWER SIDE.
- ⑮ 1 IN. TO BLOWER.
- ⑯ 1 IN. TO FLOW METER ELECTRONICS ON POWER SIDE.
- ⑰ 2 IN. SCH. 80 PVC CONDUIT TO WET WELL (PUMP NO. 1).
- ⑱ 2 IN. SCH. 80 PVC CONDUIT TO WET WELL (PUMP NO. 2).
- ⑲ 2 IN. SCH. 80 PVC CONDUIT (CONDUIT NO. 7 CONTROL SIDE TERMINATES AT NO. 7 UNDER STAINLESS STEEL JUNCTION BOX, FEED IN TO OUTSIDE S.S. JUNCTION BOX FROM EACH COMBINATION STARTER).
- ⑳ 1 1/4 IN. SCH. 80 PVC CONDUIT TO WET WELL (REDUNDANT ON/OFF FLOATS).
- ㉑ 1 IN. SCH. 80 PVC CONDUIT TO WET WELL (TRANSDUCER).

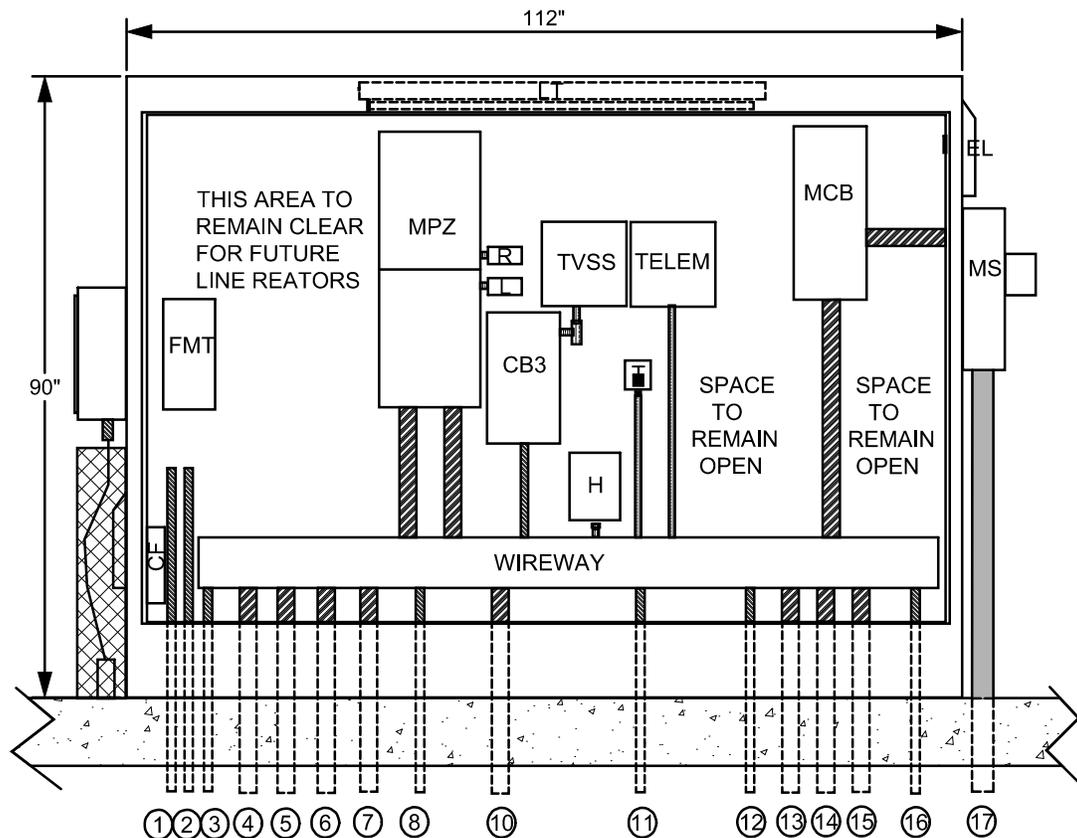
STANDARD DETAILS

**277/480 VOLT, 3 PHASE, 4 WIRE
FRONT VIEW, CONTROL SIDE**

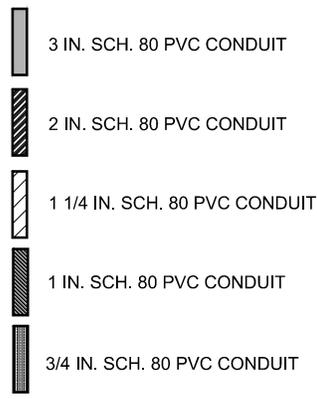


664 Churchmans Road
Newark, Delaware 19702
P.O. Box 15004, Wilmington, Delaware 19850
Phone: (302) 453-6900 Fax: (302) 453-5800

ISSUED: FEBRUARY 20, 2014	SCALE: NOT TO SCALE
REVISED:	
REVISED:	PLATE: PS-05



ELECTRICAL CONDUIT DESIGN LEGEND



- T - CABINET COOLING THERMOSTAT
- EL - EXHAUST LOUVER
- H - 400 WATT CABINET HEATER
- CF - CABINET COOLING FAN
- MCB - SQUARE D, 200 AMP, 480/ 277 V., MAIN CIRCUIT BREAKER SIZED FOR FAULT CURRENT AVAILABILITY, CONTACT SERVICE PROVIDER
- MPZ - MINI POWER ZONE (15 KVA)
- TVSS- TRANSIENT VOLTAGE SURGE SUPPRESSOR, 480/277 V., 3 PH., 4 WIRE. SQUARE D EMA SERIES, 160 KA
- MS - METER SOCKET-480/277 V., 3 PH. 200 AMP., 4 WIRE.
- R - RECEPTACLE
- L - LIGHT SWITCH
- LT - CABINET LIGHT
- CB3 - SQUARE D, 30 AMP CIRCUIT BREAKER, 480/277 V., 3 PH.
- FMT - FLOW METER TOTALIZER ELECTRONICS.
- TELEM - TELEMETRY UNIT.

- ① 1 IN. SCH. 80 PVC TO FLOW METER.
- ② 1 IN. SCH. 80 PVC TO PCP.
- ③ 1 IN. SCH. 80 PVC TO FLOW METER.
- ④ 2 IN. SCH. 80 PVC TO LINE REACTOR NO.1 (FOR FUTURE USE).
- ⑤ 2 IN. SCH. 80 PVC FEED TO VFD NO.1 (FOR FUTURE USE).
- ⑥ 2 IN. SCH. 80 PVC TO LINE REACTOR NO.2. (FOR FUTURE USE).
- ⑦ 2 IN. SCH. 80 PVC FEED TO VFD NO.2 (FOR FUTURE USE).
- ⑧ 1 IN. SCH. 80 PVC TO YARD LIGHT.
- ⑩ 2 IN. SCH. 80 PVC TO CONTROL SIDE (240/120 V.FEED OUT).
- ⑪ 1 IN. SCH. 80 PVC TO CONTROL SIDE.
- ⑫ 1 IN. SCH. 80 PVC TO FUTURE ODOR CONTROL.
- ⑬ 2 IN. SCH. 80 PVC TO FUTURE ODOR CONTROL AREA.
- ⑭ 2 IN. SCH. 80 PVC TO FUTURE ODOR CONTROL AREA.
- ⑮ 2 IN. SCH. 80 PVC TO CONTROL SIDE (480 V. FEED OUT TO CS1 & CS2).
- ⑯ 1 IN. SCH. 80 PVC TO PCP.
- ⑰ 3 IN. SCH. 40 PVC TO TRANSFORMER, SCH. 80 PVC ABOVE CONCRETE SLAB.

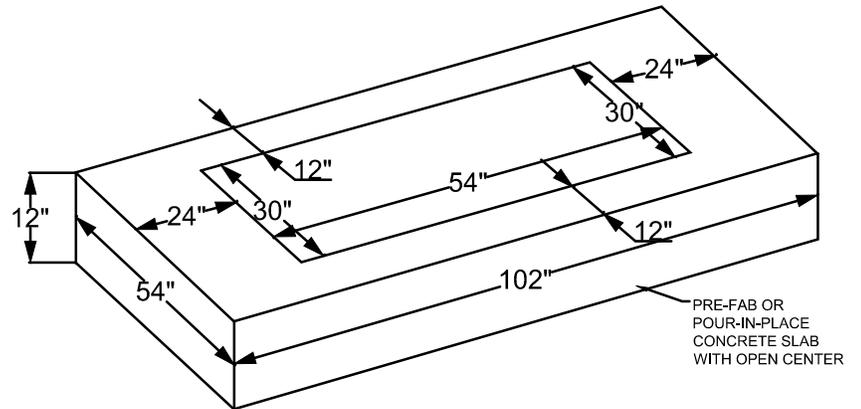
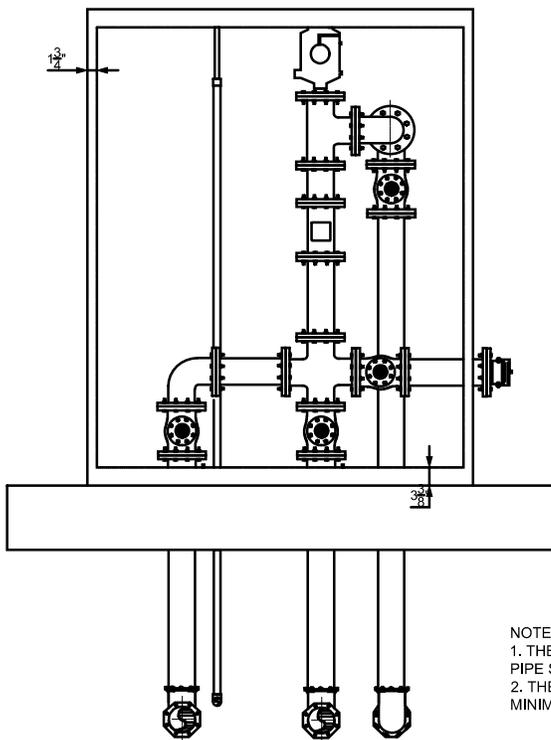
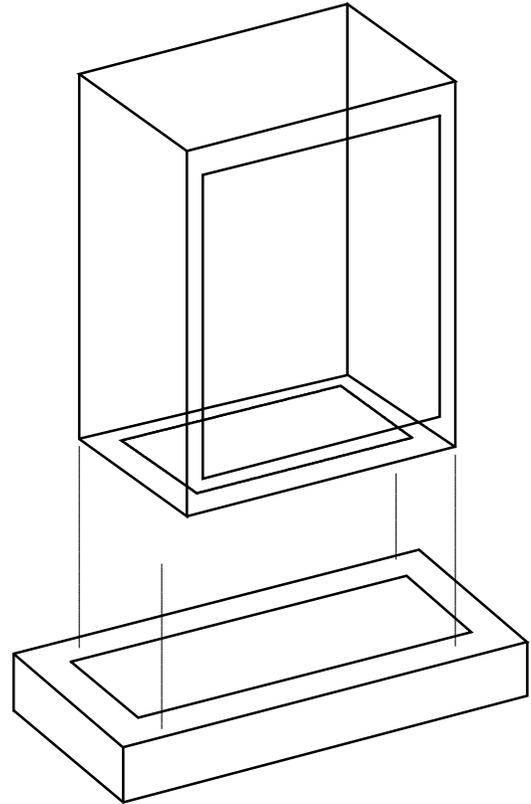
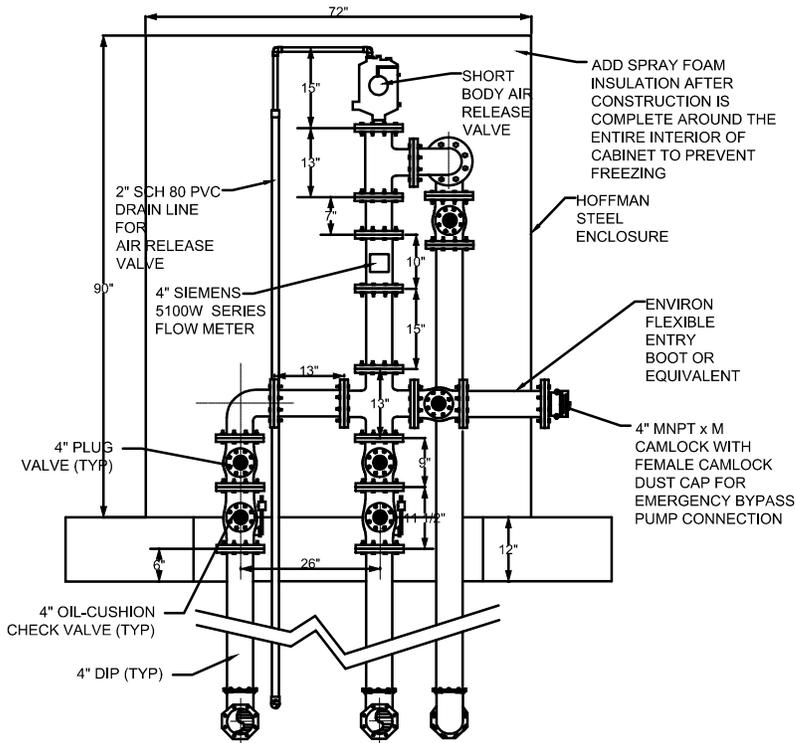
STANDARD DETAILS

277/480 VOLT, 3 PHASE, 4 WIRE
FRONT VIEW, POWER SIDE



664 Churchmans Road
Newark, Delaware 19702
P.O. Box 15004, Wilmington, Delaware 19850
Phone: (302) 453-6900 Fax: (302) 453-5800

ISSUED: FEBRUARY 20, 2014	SCALE: NOT TO SCALE
REVISED: SEPTEMBER 1, 2015	
REVISED:	PLATE: PS-06



NOTES:
 1. THE CABINET AND DISCHARGE PIPE SIZES MAY VARY.
 2. THE 4" PIPE SIZE IS THE MINIMUM.

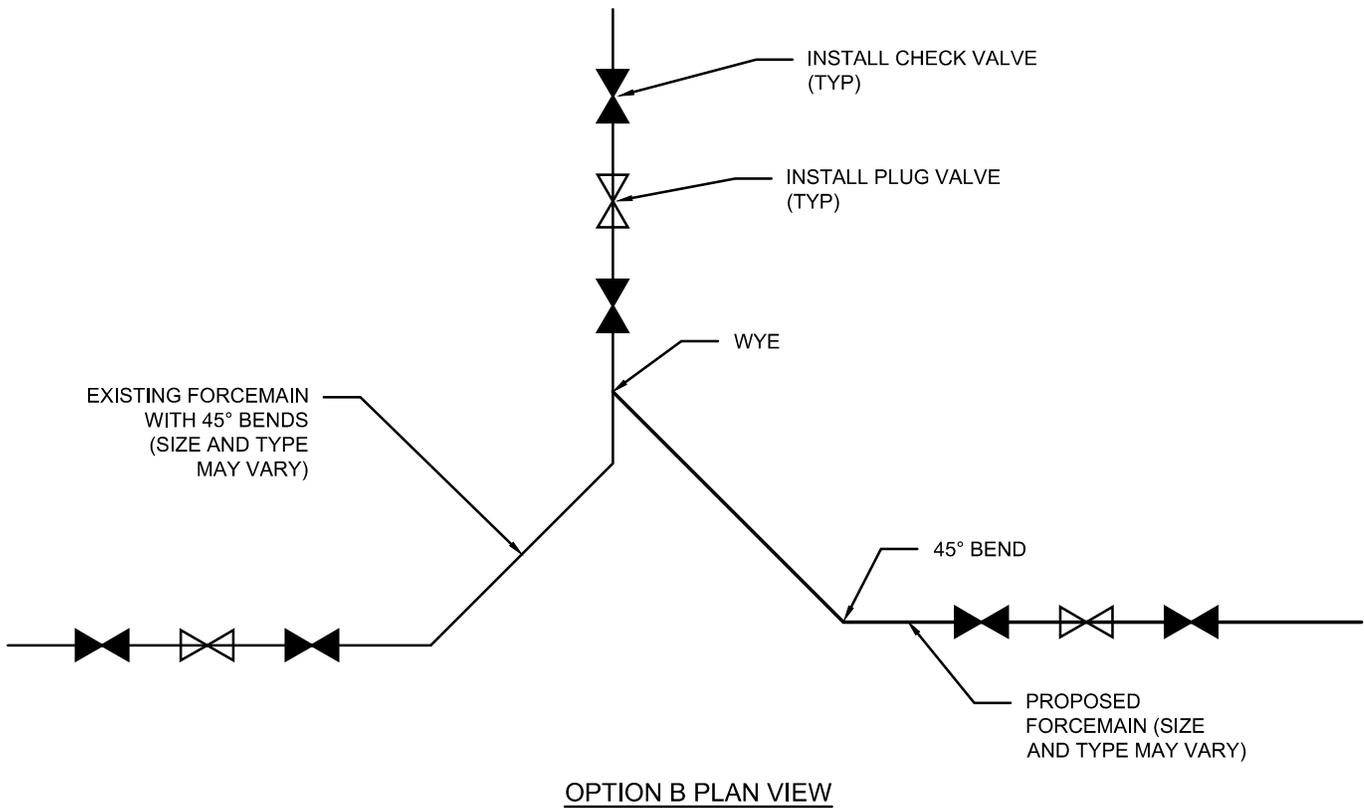
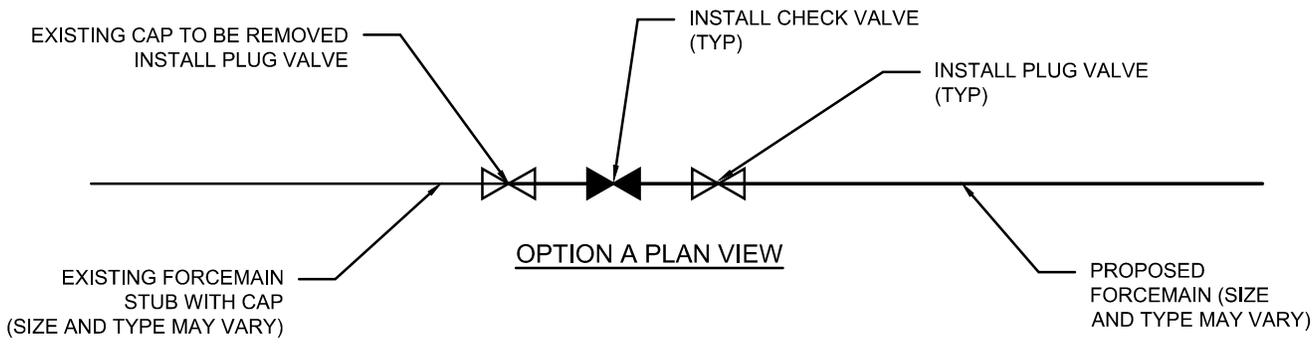
STANDARD DETAILS

4-INCH ABOVE GRADE VALVE ENCLOSURE WITH BYPASS



664 Churchmans Road
 Newark, Delaware 19702
 P.O. Box 15004, Wilmington, Delaware 19850
 Phone: (302) 453-6900 Fax: (302) 453-5800

ISSUED: JANUARY 31, 2019	SCALE: NOT TO SCALE
REVISED:	
REVISED:	PLATE: PS-07



STANDARD DETAILS

TYPICAL FORCEMAIN
TIE-IN



664 Churchmans Road
Newark, Delaware 19702
P.O. Box 15004, Wilmington, Delaware 19850
Phone: (302) 453-6900 Fax: (302) 453-5800

ISSUED: MARCH 5, 2014 SCALE: NOT TO SCALE

REVISED:

REVISED: PLATE: FM-01

Section 011: Site Clearing

SPECIFICATIONS

SECTION 011 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Protecting existing trees, shrubs, ground covers, plants and grass to remain.
2. Removing existing trees, shrubs, ground covers, plants and grass.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Temporary erosion and sedimentation control measures.

B. Related Sections include the following:

1. Division 1 Section 01500 "Temporary Facilities and Controls" for temporary utilities, temporary construction and support facilities, temporary security and protection facilities, and temporary erosion and sedimentation control procedures.
2. Division 1 Section 01700 "Execution Requirements" for verifying utility locations and for recording field measurements.
3. Division 2 Section 02300 "Earthwork" for soil materials, excavating, backfilling, and site grading.
4. Division 2 Section 02920 "Lawns and Grasses" for finish grading including preparing and placing planting soil mixes and testing of topsoil material.

1.2 DEFINITIONS

- A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches (50 mm) in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.
- B. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

1.3 MATERIAL OWNERSHIP

- A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.4 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

SPECIFICATIONS

- C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- D. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 2 Section 02300 "Earthwork."
- B. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly flag trees and vegetation to remain or to be relocated.
- C. Protect existing site improvements to remain from damage during construction.
- D. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. The Contractor shall, in accordance with the Delaware Erosion and Sediment Control Handbook, plan and implement all necessary requirements under the Delaware Sediment and Storm Water Regulations. The Contractor shall minimize erosion of the disturbed construction areas and shall prevent sediment from entering water courses or areas beyond the project site. The Contractor shall comply with all applicable Federal, State, and local regulations pertaining to sediment and erosion control.
- B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- C. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE PROTECTION

- A. Erect and maintain temporary fencing around tree protection zones before starting site clearing. Remove fence when construction is complete.
 - 1. Do not store construction materials, debris, or excavated material within fenced area.
 - 2. Do not permit vehicles, equipment, or foot traffic within fenced area.
 - 3. Maintain fenced area free of weeds and trash.
- B. Do not excavate within tree protection zones, unless otherwise indicated.
- C. Where excavation for new construction is required within tree protection zones, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.
 - 1. Cover exposed roots with burlap and water regularly.

SPECIFICATIONS

2. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
 3. Coat cut faces of roots more than 1-1/2 inches (38 mm) in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
 4. Backfill with soil as soon as possible.
- D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Engineer.
1. Employ an arborist, licensed in jurisdiction where Project is located, to submit details of proposed repairs and to repair damage to trees and shrubs.
 2. Replace trees that cannot be repaired and restored to full-growth status, as determined by Engineer.

3.4 TRANSPLANTING

- A. Transplant small trees and shrubs located either within construction lines or which may be damaged during construction to a new location on the same property.
1. New locations for transplanting shall be determined in the field by the Engineer.
 2. Perform the necessary excavation to remove and transplant the various designated small trees and bushes as shown and required by the Contract Documents.
- B. Take all precautions customary in good trade practice in preparing plants for transplanting. Plants transplanted with workmanship that fail to meet the highest standards will be rejected. All plants shall have firm, natural balls of earth of ample proportions and diameter not less than as specified in the "USA Standard for Nursery Stock". Plants with cracked, broken, or crushed balls which occur either before or during planting operations, will be rejected and shall be removed from the site immediately. Bare root plants shall be dug with sufficient spread and depth of roots as to insure full and prompt recovery and development of the plants. All plants shall be handled so that roots are adequately protected and moist at all times. Material that cannot be planted immediately after delivery shall be adequately protected by covering with canvas, wet straw, burlap, moss, or other suitable material and kept covered until ready to be planted. Trees shall not be planted with frozen earth balls.
- C. Where specified the plants shall be located as indicated on the Drawings, but may be shifted to avoid utilities subject to the approval of the Engineer. In all mass plant areas, the plants shall be evenly spaced to give uniform cover in the planting bed area. No excavation shall commence until all locations are approved.
- D. Plant all trees and shrubs in pits excavated with vertical sides as detailed on the Drawings. They shall be of such a depth that when planted and settled, the crown of the plant shall bear the same relation to finished grade as it did to soil surface in its place of growth. All backfill topsoil shall be covered with waterproof material after mixing. Pits shall be backfilled with specified soil mix and compacted firmly, especially under ball of roots to establish a firm foundation. Plants shall be set in the center of pits in a vertical position so that the crown of the plant is level with the finished grade after allowing for watering and settling of soil. The soil mixture shall be carefully and firmly worked and tamped under and around the base of the ball to fill all voids. When partially backfilled and compacted, the burlap shall be removed from the sides and tops of the balls and cut away to prevent air pockets, but no burlap shall be pulled from under the balls. A ring of earth shall be formed around the plant to produce a dish for watering. All plants shall be thoroughly watered immediately after planting. This shall mean complete saturation of all backfill in the pits and beds during the same day of planting. Care shall be taken during all planting operations to insure that no excavated material is dumped on any grassed area unless a suitable type of matting or protective underlay is used. The Contractor will be responsible for all damage to any grassed, planted, or other landscape area caused by these operations and shall repair any damage so caused in a manner satisfactory to the Engineer at the Contractor's own expense.

SPECIFICATIONS

3.5 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction. Blasting shall not be permitted as a method of removal. Backfill the excavated area with select granular material specified in Section 02300.
 - 1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
 - 2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
 - 3. Grind stumps and remove roots, obstructions, and debris extending to a depth of 18 inches (450 mm) below exposed subgrade.
 - 4. Use only hand methods for grubbing within tree protection zone.
 - 5. Chip removed tree branches and dispose of off-site.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
 - 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches (200 mm), and compact each layer to a density equal to adjacent original ground.

3.5 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
 - 1. Remove subsoil and non-soil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 1. Limit height of topsoil stockpiles to 72 inches (1800 mm).
 - 2. Do not stockpile topsoil within tree protection zones.
 - 3. Dispose of excess topsoil as specified for waste material disposal.
 - 4. Stockpile surplus topsoil to allow for re-spreading deeper topsoil.

3.7 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
 - 1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.
 - 2. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

3.8 DISPOSAL

- A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
 - 1. Separate recyclable materials produced during site clearing from other non-recyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

Section 012:

Dewatering

SPECIFICATIONS

SECTION 012 - DEWATERING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes construction dewatering.
- B. Related Sections include the following:
 - 1. Division 1 Section 01500 "Temporary Facilities and Controls" for temporary utilities and support facilities.
 - 2. Division 2 Section 02300 "Earthwork" for excavating, backfilling, site grading and for site utilities.

1.2 PERFORMANCE REQUIREMENTS

- A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control ground-water flow into excavations and permit construction to proceed on dry, stable subgrades.
 - 1. Maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
 - 2. Prevent surface water from entering excavations by grading, dikes, or other means.
 - 3. Accomplish dewatering without damaging existing buildings adjacent to excavation.
 - 4. Remove dewatering system if no longer needed.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with installer licensing, permitting, construction, and water disposal requirements of authorities having jurisdiction.

1.4 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by and then only after arranging to provide temporary utility services according to requirements indicated.
- B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner and Engineer will not be responsible for interpretations or conclusions drawn from this data.
 - 1. Make additional test borings and conduct other exploratory operations necessary for dewatering.
- C. Survey adjacent structures and improvements, employing a qualified professional engineer or land surveyor, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
 - 1. During dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

DEWATERING

SPECIFICATIONS

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
 - 1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
 - 2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.
- B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

3.2 INSTALLATION

- A. Prepare and submit permit applications in accordance with applicable state regulations.
- B. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
- C. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed, or until dewatering is no longer required.
- D. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
- E. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
 - 1. Maintain piezometric water level a minimum of 24 inches below surface of excavation.
- F. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.
- G. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.
 - 1. Remove dewatering system from Project site on completion of dewatering in accordance with applicable state regulations.
- H. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

Section 013:

Cast-In-Place Concrete

SPECIFICATIONS

SECTION 013 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
 - 1. Footings.
 - 2. Foundation walls.
 - 3. Slabs-on-grade.
 - 4. Buttresses

1.2 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
- D. Material Certificates: For each of the following, signed by manufacturers:
 - 1. Cementitious materials.
 - 2. Admixtures.
 - 3. Steel reinforcement and accessories.
 - 4. Waterstops.
 - 5. Curing compounds.
 - 6. Bonding agents.
 - 7. Vapor retarders.
 - 8. Semirigid joint filler.
 - 9. Joint-filler strips.
- E. Field quality-control test and inspection reports.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

SPECIFICATIONS

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- C. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.
- D. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."
- E. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 1. ACI 301, "Specification for Structural Concrete," Sections 1 through 5.
 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials"
 - ACI 318, "Specifications for Building Code Requirements for Structural Concrete"

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.
- B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

- A. Form lumber in contact with exposed concrete: New except as allowed for re-use of forms by these Contract Documents.
 1. Concrete Exposed to View: Use plywood with DFPA stamp of "B-B Plyform". Plyform shall be 5/8" thick for supports 12" on center maximum or 3/4" thick for supports 16" on center maximum. Use in as large sheets as practical to keep joints to a minimum.
 2. Concrete Not Exposed to View: Use clean, straight lumber, plywood, or metal.
- B. Form Oil: Colorless, non-staining, Sinclair No. 1 form oil, or equivalent.
- C. Form Sealers: First quality of their respective kinds and subject to review of the Engineer.
- D. Form Ties: Factory-fabricated, snap-off metal or glass-fiber-reinforced plastic form ties designed to resist form deflection and to prevent spalling of concrete on removal.
 1. Furnish units that will leave no corrodible metal closer than 1-1/2 inch to the plane of exposed concrete surface.
 2. Furnish ties that, when removed, will leave holes no smaller than 1/2 inch or larger than 1 inch in diameter in concrete surface.
 3. Furnish ties adjustable in length so as to permit complete tightening of forms.
 4. Form ties used for exposed concrete surfaces shall have a minimum working strength when fully assembled of at least 3,000 pounds.
 5. Form Snap Ties: Incorporate waterstops and manufacture by Dayton Sure Grip, Type 42, or equal with 1-1/2" set back from the face of the wall as detailed in ACI 347.

2.2 STEEL REINFORCEMENT

SPECIFICATIONS

- A. Reinforcing Bars: ASTM A 615, Grade 60, Deformed, billet steel bars for concrete reinforcement. Free of loose scale, rust, or other coatings that will reduce bond.
- B. Steel Bar Mats: ASTM A 185 intermediate grade, deformed bars. Conform to dimensional requirements as shown on the drawings.
- C. Welded Wire Reinforcement: ASTM A 185 and ASTM A82, plain, fabricated from No. 10 gauge wire into flat sheets. Individual wires on 6-inch centers in each direction as required by the drawings.
- D. Welded Wire Reinforcement for concrete pavement construction: ASTM A 185 and ASTM A 82, fabricated from cold drawn steel wire into flat sheets. Furnish with dimensions, spacing and wire sizes as specified.

2.3 REINFORCEMENT ACCESSORIES

- A. Accessories include all spacers, chairs, bolsters, ties, other devices necessary for properly placing, spacing, supporting and fastening reinforcement in place. Conform to requirements of The Concrete Reinforcing Steel Institute "Manual of Standard Practice of Reinforced Concrete Construction".
 - 1. Metal Accessories: Galvanized after fabrication or plastic protected where legs will be exposed in finished concrete surfaces.

2.4 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
 - 1. Portland Cement: ASTM C 150, Type I or Type IA, gray. Use only one brand of any one type for exposed surfaces.
 - a. Cement for all concrete in direct contact with sewage (even if coated): C₃ A content shall be less than 8 percent. Portland blast furnace slag cement (ASTM C 595), Type IS (MS) or IS-A (MS) also may be used as well as Portland Pozzolan Cement (ASTM C 595). Types IP or IPA, with pozzolan content not exceeding 25 percent by weight.
- B. Normal-Weight Aggregates: ASTM C 33 coarse aggregate or better, graded. Provide aggregates from a single source.
 - 1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Lightweight Aggregate: ASTM C 330, 3/8-inch nominal maximum aggregate size.
- D. Water: Reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substance injurious to the finished product. Comply with ASTM C 94.
 - 1. Water known to be of potable quality may be used without test.
 - 2. pH: 4.5 to 8.5.

2.5 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.
 - 1. Products:

SPECIFICATIONS

- a. Sika Corporation; Sika AER
 - b. Master Builders; MBOR
- B. Chemical Admixtures: ASTM C 494. Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
1. Water-Reducing Admixture: Type A.
 2. Retarding Admixture: Type B.
 3. Water-Reducing and Retarding Admixture: Type D.
 4. Accelerating Admixtures: Type C.
 5. Water Reducing and Accelerating Admixtures: Type E
- C. Water Reducing Admixtures: ASTM C 494
1. Products:
 - a. Sika Corporation: Plastiment
 - b. Master Builders: Masterpozzolith

2.6 WATERSTOPS

- A. Flexible PVC Waterstops: for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes. Compound as necessary to meet the manufacturer's requirements. Do not incorporate reclaimed PVC from any source in the compounding.
1. Manufacturers:
 - a. Sika Greenstreak.
 2. Profile: Flat, dumbbell with center bulb.
 3. Extruded material: Dense, homogeneous, and free from porosity or other imperfections which could affect its durability of performance.

2.7 VAPOR BARRIERS

- A. Plastic Vapor Barrier: Polyethylene sheet not less than 10 mils thick. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.

2.8 CURING MATERIALS

- A. Moisture-Retaining Cover: AASHTO M 171 for Polyethylene Film and Waterproof Paper.
1. Waterproof Paper: The name of the manufacturer shall be marked or imprinted clearly on the paper for proper identification and it shall retain 90% of the mix water.
- B. Curing Compound: ASTM C 309. Compatible with subsequent finish or completely removed.
1. Available Products:
 - a. Sonneborne-Contech; Hydrocide Curing Compound.
 2. Liquid Membrane Curing Compounds: AASHTO M 148 for Type 2, Class A or B, White Pigmented. Acceptance for continued use will be based upon satisfactory field performance.

2.9 RELATED MATERIALS

SPECIFICATIONS

- A. Non-bituminous Expansion Joint Filler: AASHTO M 153, Type I or Type III, unless otherwise specified on the Drawings or in the special provisions.
 - 1. Types I Joint Filler: Preformed strips of a durable elastic, sponge rubber compound. Unless otherwise specified, the sponge rubber shall have a cement-gray color to blend with concrete in appearance.
 - 2. Type III Joint Filler: Preformed strips of clean, granulated cork particles securely bound together by a synthetic resin of an insoluble nature.
- B. Bituminous Expansion Joint Filler: AASHTO M 33, consisting of a bituminous mastic composition formed and encased between two (2) layers of bituminous impregnated felt.
- C. Dovetail Anchor Slots: Type 24-gauge galvanized steel sheet, minimum, with fillers. Standard types to engage anchors supplied.
- D. Rubber Joint Sealant: The sealant shall be a multi-part chemically curing polyurethane sealant which meets or exceeds the curing requirements of Federal Specification TT-S-00227E (3) and TT-S-00230C (2) Nonsag type, Class A, compounds resistant to 50 percent total joint movement. The color shall be gray to match concrete. A primer shall be used as recommended by the sealant manufacturer. A bond breaker such as masking tape, polyethylene film, or backing rod as supplied by the manufacturer shall be used at the bottom of the joint.
 - 1. Manufacturer: Fox Industries, FX-570/571.

2.10 CONCRETE MIXTURES, GENERAL

- A. General:
 - 1. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
 - a. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
 - 2. Admixtures: Use admixtures according to manufacturer's written instructions.
 - a. Use water-reducing, high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
 - b. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 - c. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
- B. Mix Compositions: The composition of the mix and strength requirements as established by ASTM C94 shall conform to the following:

Class of Concrete	A	B	C
Minimum 28 Day Compressive Strength (PSI)	4,500	4,000	3,000
Cement Content:			
Minimum Sacks/CY	7-1/2	7	6
Minimum Pounds/CY	705	658	564
Water Cement Ratio	0.45	0.45	0.45
Percent Entrained Air	5-7	4-7	4-7
Slump (Inches)	2-4	2-4	2-4

- 1. All concrete exposed to weather and interior slabs on grade shall contain 4% to 6% entrained air as indicated in Chapter 3, ACI 301. Use an air entraining admixture and normal Portland cement or an air entraining Portland cement. Measure air content at point of discharge at job site.

SPECIFICATIONS

2. Concrete exposed to weather shall be made with not more than 6 gallons of water per bag of cement, including the free moisture in the aggregate.

C. Selection:

1. Concrete not in direct contact with potable water or sewage shall be Class C in accordance with the mix compositions in this section, unless otherwise shown or noted.
2. Concrete in direct contact with potable water or sewage shall be Class B unless otherwise shown or noted.

2.11 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to ACI 315.

2.12 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94 and furnish batch ticket information to engineer before unloading at the site.
 1. Batch delivery ticket: Indicate the producer's name, delivery date, time of loading, time delivered, truck number, quantities of each material in the batch, and information necessary to calculate the total mixing water added by the producer. Total mixing water includes free water on aggregates, water and ice batched at the plant, and water added by the truck operator.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94 Chapter 7 ACI 301. Mix concrete materials in appropriate drum-type batch machine mixer. Furnish batch ticket for each batch discharged and used in the work.
- C. Volumetrically Batched Concrete: Conform to ASTM C 685.
 1. Adhere to aggregate sizes, slumps, concrete strengths, and air contents as specified herein.
 2. Proportions of the concrete: Determined by Alternate 2, with the request stipulated in Paragraph 5.3.2 of ASTM C 685 being carried out.
 3. The supplier will be required to have one (1) person at the job site to operate the mixers. It shall be the responsibility of this person to set, record, and maintain surveillance of all gauges on the mixers at the job. No other personnel will be allowed to perform this function.

2.13 GROUT

- A. Non-shrink, non-metallic grout in accordance with ASTM C-1107 (Grade C).
- B. Products:
 - a. Sika Corporation: SikaGrout 212, high performance, cementitious grout

PART 3 - EXECUTION

3.1 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301.

SPECIFICATIONS

- B. Lay out forms for all required cast-in-place concrete to the shapes, sizes, lines and dimensions indicated on the Drawings. Exercise particular care in the layout of forms to avoid necessity for cutting of concrete after it is in place.
- C. Construct forms to be straight, true, plumb, and square within a tolerance horizontally of one in 200 and a tolerance vertically of one in 500.
- D. Nail Plywood Panels directly to studs and apply in a manner to minimize the number of joints.
 - 1. Panel joints: Tight butt joints with all edges true and square.
- E. Construct footing forms of wood unless otherwise specifically approved by the Engineer.
 - 1. Upon approval by the Engineer, side forms for footings may be of earth provided the soil will stand without caving and the sides of the bank are made with a neat cut to the minimum dimensions indicated on the Drawings. Make all necessary provisions to prevent cave-ins during placement of concrete.
- F. Set all required steel frames, angles, grills, bolts, inserts, and other such items required to be anchored in the concrete before the concrete is placed.
- G. Provide openings, chases, offsets, recesses, anchorage, blocking, and other features as shown or required in the work. Perform all forming required for work of other trades and do all cutting and repairing of forms required to permit such installation. Consult with other trades as required relative to provision for openings, chases, and other items in the forms.
- H. Brace and tie forms together so as to maintain position and shape and to ensure safety to personnel.
 - 1. Construct bracing, supporting members, and centering of ample size and strength to safely carry, without excessive deflection, all dead and live loads to which they may be subjected.
 - 2. Properly space the forms apart and securely tie them together, using metal spreader ties that give positive tying and accurate spreading.

3.2 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete according to ACI 301.
 - 1. Slots: Install in face of all concrete against which masonry will be installed. Space at 2'-0" on centers horizontally or as required by details and/or job conditions. Also install slots where masonry will abut concrete.

3.3 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of beams, walls, columns, and similar parts of the work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg. F for 48 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
 - 1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved at least 75 percent of its 28-day design compressive strength.
 - 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

SPECIFICATIONS

- B. Reuse of forms shall be subject to advance approval of the Engineer. Reuse of forms shall in no way delay or change the schedule for placement of concrete from the schedule obtainable if all forms were new. Reuse of forms shall in no way impart less structural stability to the forms nor less acceptable finish to the concrete.

3.4 VAPOR BARRIERS

- A. Plastic Vapor Barriers: Place, protect, and repair vapor barriers according to ASTM E 1643 and manufacturer's written instructions.
 - 1. Lap joints 2 feet and seal with manufacturer's recommended tape or mastic. Turn up on walls approximately 4-inches, stretch and weight edges and laps to maintain their positions until concrete is placed.
 - 2. Provide wood runways for wheeled equipment for transporting concrete. Do not displace film.
 - 3. Repair all holes in vapor barrier prior to placement of concrete.

3.5 STEEL REINFORCEMENT

- A. General: Comply with ACI 301.
 - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Fabricate all reinforcement in strict accordance with shop drawings which have been reviewed by the Engineer. Do not use bars with kinks or bends not shown on the Drawings or on the reviewed shop drawings.
- C. Do not bend or straighten reinforcement bars in a manner that will injure the material. Bond all bars cold.
 - 1. Stirrups and Ties: Bend around a pin having a diameter not less than two (2) times the minimum thickness of the bar.
 - 2. Other bars and hooks: Bend around a pin having a diameter not less than six (6) times the minimum of the bar.
- D. Before the start of concrete placement, accurately position, support and secure reinforcement against displacement using concrete blocks, metal chairs or spacers or by metal hangers. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
 - 1. Clear space between bars: Not less than 1-1/2 times the normal diameter of round bars.
 - 2. In no case shall the clear distance be less than 1-1/2 inches nor less than 1-1/3 times the maximum size of aggregate.
 - 3. Minimum concrete covering the reinforcement:
 - a. Concrete below ground deposited against forms: Two (2) Inches
 - b. Concrete deposited against earth: Three (3) Inches
 - c. Concrete elsewhere: As indicated on the Drawings or otherwise approved by the Engineer.
- E. Splicing:
 - 1. Horizontal bars:
 - a. Place bars in horizontal members with minimum laps at splices sufficient to develop the strength of the bars.

SPECIFICATIONS

- b. Bars may be wired together at laps except at point of support of the member, at which point preserve the clear space described above.
 - c. Whenever possible, stagger the splices of adjacent bars.
 - d. Splice 36 bar diameters minimum.
2. Wire fabric: Make all splices in wire fabric at least 1-1/2 meshes wide.
 3. Other splices: Make only those other splices that are indicated on the shop drawings which have been reviewed by the Engineer.
- F. Anchor all steel dowels into position before the concrete is placed.
- G. In the event conduits, piping, inserts, sleeves, or any other items interfere with placing reinforcement as indicated on the Drawings or as otherwise required, immediately consult the Engineer to determine a new procedure before placing concrete.

3.6 JOINTS

- A. General: Construct joints in accordance with Chapter 6, ACI 301.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations as approved by Engineer prior to starting concrete placement.
1. At construction joints, erect a temporary wood bulkhead so that the jointing will follow a vertical plane perpendicular to the direction of the main reinforcement. To this bulkhead fasten a wood strip 2" thick and of width equal to one-third the depth of the concrete slab to form a tongue and grooved joint.
 2. Key and waterstop construction joints below liquid levels.
 3. Space vertical joints in walls at thirty (30) feet, maximum. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
- C. Contraction Joints in Slab-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

3.7 WATERSTOPS

- A. Waterstops: Install continuous and weld at butt joints and intersections in strict accordance with manufacturer's written instructions.

3.8 CONCRETE PLACEMENT

- A. Place concrete in accordance with ACI 301 and ACI 304. Do not place concrete until forms and reinforcement are inspected by the Engineer. Notify Engineer of all concrete pours at least 24 hours prior to pouring concrete.

SPECIFICATIONS

- B. Transmit-mix all concrete in accordance with ASTM C-94 unless otherwise specifically permitted by Engineer.
- C. Place concrete as dry as possible consistent with good workmanship, never exceeding the maximum specified slump.
- D. Deposit and consolidate concrete in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
 - 1. Do not use retempered concrete or concrete that has been contaminated by foreign materials.
 - 2. Do not pour a greater area at one time than can be properly finished without checking. In any case, a slab length pour greater than 60 feet shall not be placed without construction joints.
 - 3. Tamp slabs with a jitterbug to depress the rock, and then pushfloat with a bullfloat as necessary.
 - 4. Screed slab surfaces with a straightedge and strike off to correct elevations.
 - 5. Slab depressions as required for the finishes indicated on the Drawings.
 - 6. Plane floor slabs to a Class A tolerance, that is, true planes within 1/8" in 10 feet, as determined by a 10 foot straightedge placed anywhere on the slab in any direction.
 - 7. Slope surfaces uniformly to drains where required.
- E. Do not use concrete with a placing temperature that will cause difficulty from loss of slump, flash set, or cold joints. Do not allow concrete temperature to exceed 90 degrees F during placement and use all means necessary to avoid drying concrete prior to finishing operations. Provide and use all required windbreaks, sunshades, fog sprays, and other devices to protect the concrete.
- F. Chuting, Pumping, and Pneumatically Conveying Concrete: Use only equipment of such size and design as to ensure a practically continuous flow of concrete at the delivery end without loss or separation of materials.
- G. Cold-Weather Placement: Comply with ACI 306.
 - 1. Cover and insulate concrete to protect concrete and the ground underneath slabs and footings from freezing.
- H. Hot-Weather Placement: Comply with ACI 305.
 - 1. Provide extra protection against moisture loss by keeping all exposed concrete surfaces constantly wet as specified and by keeping the forms continuously wet for the entire curing period.

3.9 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: Comply with Chapter 10, ACI 301.
 - 1. Apply to concrete surfaces not exposed to public view.
- B. Smooth-Rubbed Finish: Comply with Chapter 10, ACI 301.
 - 1. Apply to concrete surfaces exposed to public view or in contact with contained liquids even if to be coated.

3.10 FINISHING FLOORS AND SLABS

- A. General: Comply with Chapter 11 of ACI 301.

SPECIFICATIONS

1. Monolithically finish all concrete slabs. Do not sprinkle dry cement or mixtures of dry cement and sand on the surface of the wearing course to absorb moisture or to stiffen the mix.
 2. Keep the floor moist during the first 48 hours after placing.
- B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
1. Apply float finish to surfaces of all interior slabs.
- C. Clean exposed concrete. Remove blemishes, form oil stain, and other discolorations. Clean surfaces by brushing with a mild detergent and water.
- D. Cut off flush all nails, tie wires, and form ties. Leave all surfaces smooth and clean. Remove metal spreader ties on exposed concrete by removing or snapping off inside the wall surfaces and pointing up and rubbing the resulting pockets to match the surrounding areas.
- E. Flush all holes resulting from the use of spreader rods and sleeve nuts using water, and then solidly pack throughout the wall thickness with cement grout applied under pressure by means of a grouting gun.
1. Grout: One (1) part Portland cement to 2-1/2 parts sand. Apply immediately after removing forms.
- F. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance with a smooth, dense and plane surface.
1. Apply a trowel finish to surfaces of all interior slabs.
 2. Apply a curing and sealing compound compatible with finish.
 3. Steel trowel finish after sheen has disappeared from the surface.
- G. Trowel and Fine-Broom Finish: Apply a first Trowel Finish to surfaces of exterior stairs, exterior slabs subject to foot traffic, and entrance slabs. After three (3) trowelings, while concrete is still plastic, slightly scarify surface with a fine broom.
1. Provide stairs and slabs with sufficient pitch to shed water.

3.11 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

3.12 CONCRETE PROTECTING AND CURING

SPECIFICATIONS

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- B. Interior Slab Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, and other surfaces. Cure by fog mist until a curing membrane has been installed.
 - 1. Apply a fog mist above the finished concrete surface, using fog nozzles to keep the air humid and to prevent loss of moisture from the concrete surface. The fog shall produce an appearance of wet sheen on the concrete but in no case shall allow a concentration of water in one place. Continue fogging until a membrane has been installed.
 - 2. Curing Membrane:
 - a. As soon as possible after finishing interior slabs, install the specified curing membrane. Lap all joints six (6) inches and securely join together. Weight down the covering to prevent damage from the wind. Construct so as to achieve a completely sealed membrane over the entire slab.
 - b. Unless otherwise directed by the Engineer keep the curing membrane in place and intact for at least ten (10) days after placement of concrete. Make all inspections and repairs necessary to ensure proper curing.

3.13 CONCRETE SURFACE REPAIRS

- A.. Defective Concrete: Repair and patch defective areas in accordance with Chapter 9, ACI 301.
- B. Immediately after forms and curing membrane have been removed, inspect all concrete surfaces and patch all pour joints, voids, rock pockets, form tie holes, and other imperfections before the concrete is thoroughly dry. Do not notch concrete until it has been inspected by the Engineer.
- C. Patching Mortar: One part cement to three parts water, to a consistency as dry as possible within the requirements of handling. Install by ramming it into place.
- D. Repairing Formed Surfaces: Chip away concrete to a depth of about one inch, leaving edges perpendicular to the surface. Wet the area to be patched along with a space of at least six (6) inches wide around it to prevent water from being absorbed out of the mortar. Coat the area to be patched with a cement wash consisting of neat cement and solution of one part "Konsesit", or equal, to four parts of water. Apply patching mortar immediately. Screed off the patch so as to leave the patch slightly higher than surrounding surface. Leave undisturbed for a period of one or two hours to permit initial shrinkage, and then final finish by matching the patch to adjacent surfaces and keep it wet for at least seven (7) days. Provide protective covering.
- E. Repairing Major Surface Defects: If the defects are serious or affect the strength of the structure, or if patching does not satisfactorily restore the quality and appearance of the surface, the Engineer may require "cement gun concrete" to be used or the concrete to be removed and replaced complete in accordance with the provisions of this Division, all at no cost to the Owner.

3.14 FIELD QUALITY CONTROL

- A. Notify Engineer when all the provisions of this section are met and the Contractor is ready to place concrete.
 - 1. No concrete shall be deposited before the Engineer has reviewed the reinforcing and given permission to proceed. Such inspection and permission to proceed shall in no way release the Contractor of the responsibility for proper placement of reinforcing and placement of concrete, and the responsibility for adherence to the requirements of the Contract Documents.
 - 2. Notify the Engineer at least 24 hours in advance of all concrete pours.

SPECIFICATIONS

- B. Testing and Inspecting: The Contractor shall engage a qualified, independent testing and inspecting agency at Contractor's expense to perform tests and inspections and to submit reports. Upon receipt, Contractor shall furnish test results to the Owner.
- C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
1. Testing Frequency: Obtain six (6) composite specimens from the first batch. Obtain at least six (6) composite specimens for each 25 cu. yd. or fraction thereof of each concrete mixture placed each day. Samples shall be taken in accordance with ASTM C172 and cylinders molded in accordance with ASTM C31.
 2. Slump: ASTM C 143; one test at point of placement for each composite sample. Perform additional tests when concrete consistency appears to change.
 - a. Slump Limit: 2 inches minimum and 4 inches maximum, unless otherwise noted.
 - b. For slabs the maximum slump shall be 3-1/2 inches.
 3. Air Content: ASTM C 231 and ASTM C 138.
 4. Compression Test Specimens: ASTM C 31.
 - a. Cast and cure one set of six (6) standard 4-inch x 8-inch cylinder specimens for each composite sample.
 5. Compressive-Strength Tests: ASTM C 39; test one set of three cured specimens at 7 days and one set of three specimens at 28 days.
 - a. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
 - b. Specimens made to check the adequacy of the design for strength of concrete or as a basis for acceptance of concrete will be made and laboratory cured in accordance with ASTM C31.
 6. Strength of each concrete mixture will be satisfactory if every average of any five consecutive compressive-strength tests equals or exceeds specified compressive strength and not more than one in ten shall have an average value less than 90% of the specified value.
 7. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 - a. When the average of compressive tests for 5 consecutive cylinders falls below the specified strength, the design mix and water content shall be adjusted to produce the specified strength for concrete that is subsequently placed.
 - b. The Engineer may order additional curing for that portion of the structure where the questionable concrete has been placed. In the event that such additional curing does not give the strength required as determined by load tests made in accordance with ACI 318 or cored cylinder tests, the Engineer may order defective parts removed and replaced, or reinforced, all at no additional expense to the Owner.
 8. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

Section 014:

Basic Mechanical Materials &
Methods

SPECIFICATIONS

SECTION 014 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Mechanical sleeve seals.
3. Sleeves.
4. Grout.
5. Equipment installation requirements common to equipment sections.
6. Concrete bases.
7. Supports and anchorages.

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.3 SUBMITTALS

- A. Furnish shop drawings and descriptive data, complete with required project designation for all products.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 15 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

- A. Refer to individual Division 15 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

SPECIFICATIONS

- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12.
- G. Solvent Cements for Joining Plastic Piping:
 - 1. ABS Piping: ASTM D 2235.
 - 2. CPVC Piping: ASTM F 493.
 - 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 - 4. PVC to ABS Piping Transition: ASTM D 3138.

2.3 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 - 1. Available Product: Link-Seal, by Thunderline Corporation
- B. Sealing Elements: EPDM, nitrile, silicone interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
- C. Pressure Plates: Carbon steel composite, Include two for each sealing element.
- D. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating or stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.4 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.
- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.5 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
 - 1. Finish: Chromium plated with a suitable pattern.

2.6 GROUT

SPECIFICATIONS

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 15 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors.
- M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- N. Wall and floor sleeves for pipes smaller than four (4) inches shall be galvanized steel. Sleeves passing through floors shall extend approximately $\frac{1}{2}$ inch above the finished floor. Escutcheon plates shall be installed to conceal ends of all exposed pipe sleeves above the floors of finished rooms. Sleeves shall be of ample size to permit passage of pipe and insulation (where required) and allow for expansion. Space between pipe and sleeves shall be sealed with mastic or mechanical sleeve seal.
- O. Generally, except where otherwise noted on the Drawings for pipes four (4) inches and larger passing through walls, all wall castings and sleeves shall be cast iron special type for concrete pipes with waterstop flanges. Generally, wall casting shall be used. Sleeves shall be used where noted.

SPECIFICATIONS

- P. Generally, except where otherwise noted on the Drawings for pipes four (4) inches and larger passing through floors, all sleeves shall be standard-weight galvanized steel. Space between pipes and sleeves shall be sealed as specified in Paragraph N. above.
- Q. Generally, the diameter of sleeves for non-insulated pipe shall be on pipe size larger than the pipe passing through the sleeve. The diameter of sleeves for insulated pipe shall be of suitable size and allow the insulation to be continuous and of full thickness. Sleeves for flanged pipe shall be of a diameter to pass the flanges, if cast-on flanges are used. Space between pipe and sleeve shall be sealed as specified in Paragraph N. above.
- R. The Contractor will not be allowed to box out the concrete for installation of any wall castings or sleeves except with the Engineer's permission for each specific location involved. Castings shall be securely fastened in place so that pouring of concrete will not disturb their position in any manner. The Contractor shall correlate with all trades to assure that all wall castings and wall floor sleeves are properly set.
- S. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.
- T. Verify final equipment locations for roughing-in.
- U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402, for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
 - 3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

SPECIFICATIONS

4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 5. PVC Nonpressure Piping: Join according to ASTM D 2855.
 6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
- L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
1. Plain-End Pipe and Fittings: Use butt fusion.
 2. Plain-End Pipe and Socket Fittings: Use socket fusion.
- M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.3 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.5 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions.
1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 7. Use 4000 psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."

SPECIFICATIONS

3.6 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 5 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.7 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor mechanical materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.8 GROUTING

- A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.