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Academic Interface at the New University of Florida Water Reclamation Facility

Master of Engineering Project

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Introduction

Recent planning studies at the University of Florida have shown substantial changes in the wastewater treatment facilities are required to meet current environmental water quality standards. The age of the existing wastewater treatment plant and the maintenance problems inherent with a 40 year old process facility mandated the construction of a new wastewater treatment facility. The existing wastewater treatment plant consists of a contact stabilization activated sludge process and trickling filter treatment system operated in parallel. There is a long standing relationship between the University's wastewater treatment plant and the students and faculty at the University. Many of the features of the existing plant were implemented at the suggestion of University faculty members. Additionally, two courses in the Department of Environmental Engineering Sciences require students to be involved with operations or obtain experimental samples from the wastewater treatment plant. Consequently, the existing plant provides students with the opportunity to gain "hands on" experience in the field of wastewater treatment and understand the various treatment processes used. It is therefore desirable to keep the academic perspective in mind as the University of Florida's Physical Plant Division develops the plans for the new wastewater reclamation facility. The University formed and selected a Wastewater Task Force to be an integral part of the design process for the new wastewater reclamation facility to ensure the academic and research potential of facility is met. This project describes how the academic interface with the new wastewater reclamation facility was maintained.

Academic Interface Requirements

The Task Force has identified two major areas of necessary features in the new plant. They are:

1. Facilities
2. Process Design Consideration and Flexibility.

The existing wastewater treatment plant does not provide for on-site laboratory facilities for students and research. The proposed plant is to have a microbiology lab, chemistry lab, pilot testing room and electronic monitoring and control room in the plant operations building. Equally as important, the implemented treatment process should provide for completely separate treatment trains. While wastewater treatment plants are designed with operational redundancy, it is desirable to keep all processes in the redundant trains completely separate. This will allow modification to the process configuration and operational settings for research and experimental purposes. Additionally, automated control and measurement systems in the plant should be reported to an academic workstation for data collection and analysis.

These considerations were incorporated into the design of the new wastewater reclamation facility currently at the 50% stage of design. The University of Florida's Physical Plant Division has requested the designer of record to prepare two designs for contractor bidding. The primary design will control nitrogen discharge in the final effluent and classify the plant as advanced secondary treatment. A second or additive bid design will add biological treatment units (anaerobic, anoxic and oxic tanks) to achieve additional nutrient control and upgrade the plant to advanced wastewater treatment (AWT) standards. Both designs use on an activated sludge treatment process known as the "Kruger Bio-Denitro System". This process uses a special oxidation ditch system called "Phased Isolation Ditch Technology". The phased isolation ditches are continuous flow, activated sludge systems with phased or intermittent operations. Using hydraulic controls, it is possible to operate the ditch with special treatment objectives while maintaining a continuous flow through the plant. Each process train consists of two oxidation ditches interconnected to allow flow between the ditches. Brush type surface aerators are operated intermittently to provide oxic and anoxic conditions for nitrification and denitrification, respectively. The operational phases in a ditch are short relative to the hydraulic residence time and the amount of wastewater entering a ditch is small compared to the total volume of the ditch. An operational schematic of the 4 phases of complete Kruger cycle is presented in Figure 1. Each ditch will discharge to its own secondary clarifier for sedimentation. Return and waste activated sludges remain separate through the digestion and solids handling facilities. Tertiary effluent filtration is provided, again keeping the two trains separate, by continuous upflow wastewater filters. The plant flow process is shown in Figure 2. Figure 2 differentiates the two parts of the design by using dashed lines to represent the additive bid item. The University has also obtained an additional pilot scale filter for research needs. The layout and operation of this pilot scale filter is described later in this report.

The proposed operations building provides 1,500 square feet of floor space for the microbiology lab, chemistry lab, pilot testing room and electronic monitoring and

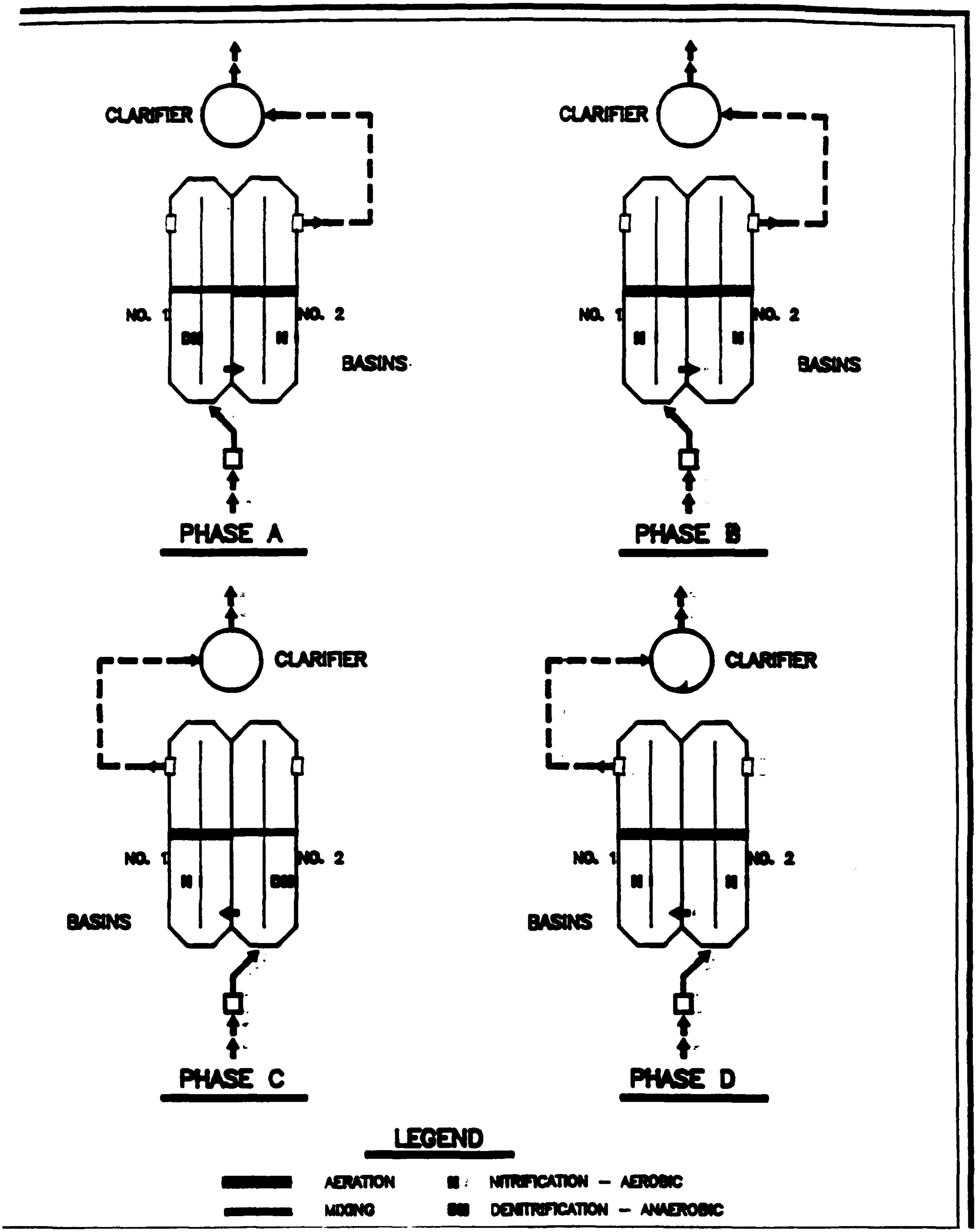


Figure 1
Kruger Bio–Denitro Process Schematic

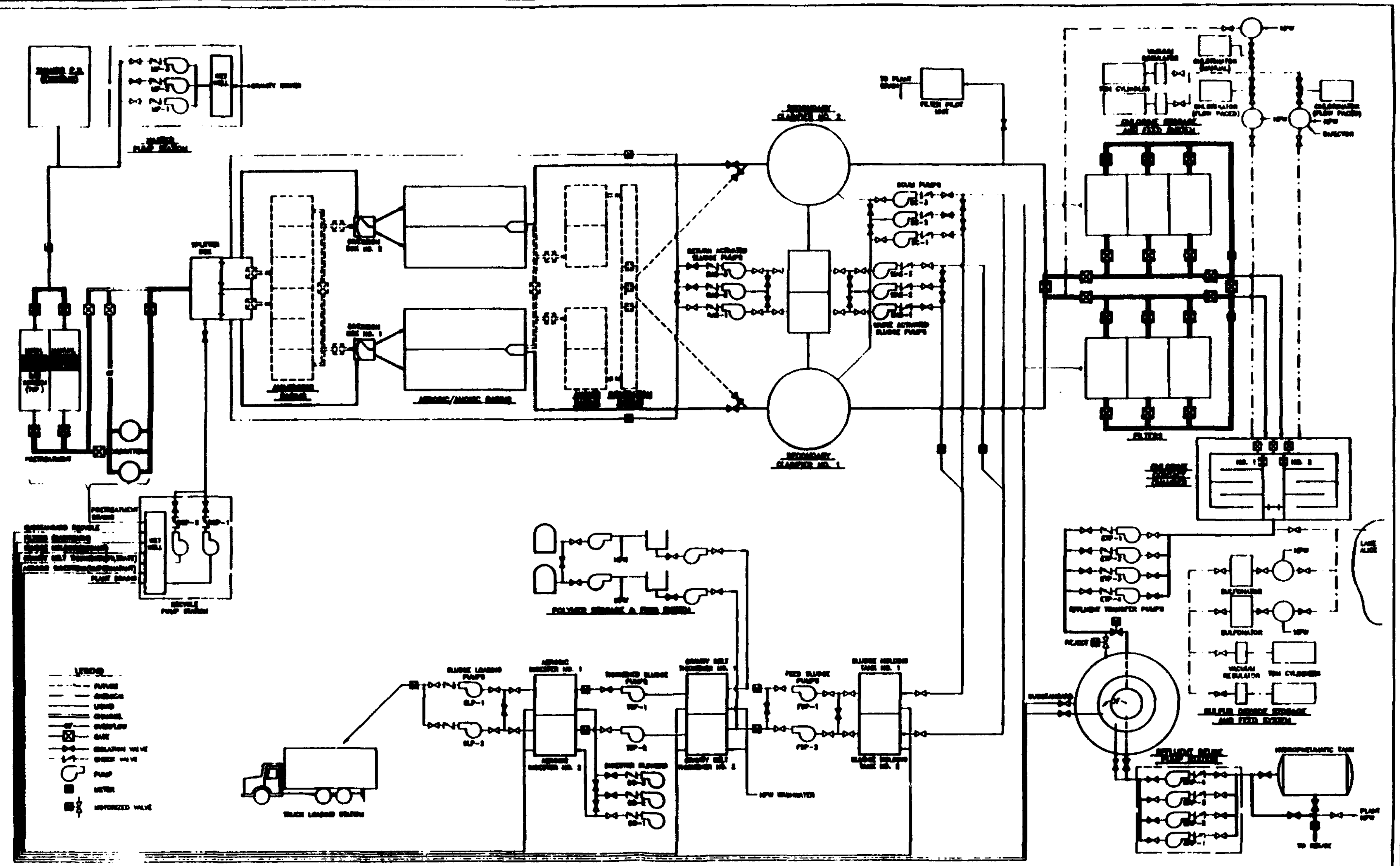


Figure 2
Plant Process Flow Diagram

control room. The control room will allow real time data analysis and collection from the plant's supervisory control and data acquisition (SCADA) unit. The pilot testing room will have sufficient floor clearance to allow modelling of the plant's secondary clarifiers. Additionally, the pilot testing room will be climate controlled to observe temperature effects on experiments and pilot processes. The proposed floor plan and layout of the academic facilities is shown in Figure 3. Price quotations for some equipment shown in Figure 3 is included in Appendix A.

Involvement in the Design Process

Since the beginning of the design process by the designer of record, Dyer, Riddle, Mills and Precourt of Orlando, Florida in June of 1991, I have participated in the meetings and development of the wastewater treatment planning and design. My primary assignments have been to lay out the academic facilities and the pilot scale effluent filter. The experience of observing the development of the project through the design stage has been interesting. The limiting budgetary allotment for the project has affected the academic interface substantially from the conceptual design. The original plan for the operations building was a two-story structure with the academic portion on the lower floor and plant operations on the upper floor. However, during the course of design, funding had to be allocated for the demolition of the existing wastewater treatment plant site which had not been considered in the conceptual design. Keeping within the budget limits for the project, funding had to be transferred to the demolition from other portions of the project. The operations building was targeted for down scaling. This radically altered the concept for the building and it was decided to construct a one-story building with 1,500 square feet allocated for the academic area and 2,000 square feet for the plant operations and administrative functions. Several floor plans have been considered to this point, In fact, the floor plan of the operations building was not included in the 50% submittal by the designer as mutually agreed upon. The final built in features of the academic facilities will not be known until additional project cost estimates are complete.

The real time acquisition of data and operating conditions in the plant has been a major point of concern to the Task Force. As previously mentioned, the Bio-Denitro process can be configured to meet specific treatment objectives rather easily. Considering this process is only used at one other location in the United States at this

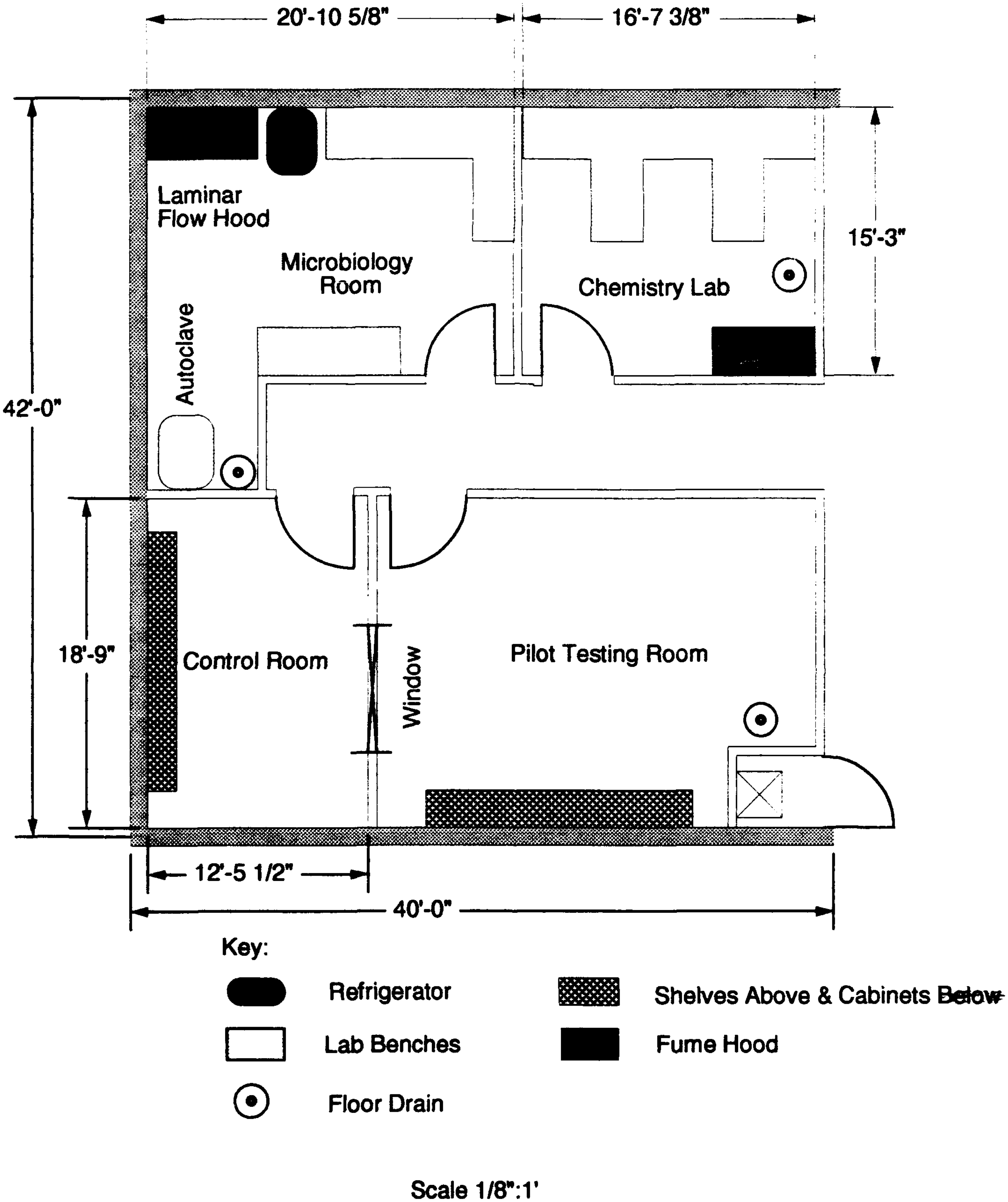


Figure 3
Proposed Academic Floor Plan @ UF Water Reclamation Facility

time, there is little documentation of what operating parameters can optimize attainment of treatment objectives. This will provide the University with an excellent opportunity to lead the way in researching this type of process. Since the facility will use an advanced computer based SCADA system to record and monitor operating parameters such as pH, dissolved oxygen, turbidity and flow rates, it is desirable to collect and analyze the data for academic and research purposes. It is extremely important to have the data available in a format compatible with the micro–computer based local area network at the University's College of Engineering. This will allow students and researchers to quickly collect vast amounts of data normally requiring significantly less manpower for data collection. Existing SCADA systems at wastewater treatment facilities such as Gainesville's Main Street plant do a good job recording and monitoring the operational parameters but generally archive data on a mini-computer in formats requiring extensive and sometimes complicated translation to a compatible micro–computer based operating system and data format. Ideally, researchers need to be able to analyze plant operating data using popular micro–computer based applications such as Lotus 1-2-3® or Microsoft Excel ®. The need for a software patch to the SCADA system is a fairly unusual requirement for a typical wastewater treatment facility, but the unique nature of the treatment process and needs of the academic community at the University mandates its implementation.

Data Acquisition and Control Systems

The use of computers in the area of wastewater treatment has expanded significantly during the past five years. By programming plant operational logic into a supervisory computer, the computer may be able to operate the plant as a human operator would by energizing pumps, opening and closing valves, etc. However, the more popular application of computers is data collection and reporting operational status of plant equipment to a central location so operators can make better plant operation decisions. The SCADA system at the new UF plant will be essentially a data collector and presentation device. Prior to understanding the function of the SCADA system as proposed, some background on the constituent parts of the system should be discussed.

The SCADA system consists of several essential parts. They are:

–Sensors

–Input / Output Devices (I/O)

–Connectivity Media

–Programmable Logic Controllers (PLC) and Master Computer

–Display, Recording and Reporting Equipment.

The sensors are field instruments which record the operational parameters of either the plant equipment or plant conditions. Operating condition sensors are typically temperature, pH, turbidity, dissolved oxygen (DO) and flow meters. The electrical output from these sensors is called an analog signal. The strength of the signal is directly related to the quantity its measuring. Equipment sensors are generally in–line electrical sensors which generate an electrical signal when a motor is energized. This output is called discrete because it is either on or off. Output from both types of sensors are connected to a larger I/O device. The I/O device contains a multiple conversion boards. The conversion boards use integrated circuitry to convert the analog and discrete electrical signals into digital signals. The digital signal consists of the sensor data (in digital form) and a "tag". The tag is a digital code which permits the PLC to identify which sensor is providing the data. The digital signal is then transmitted from the I/O device to the PLC by the connectivity media. In cases where there is long distances between the I/O device and the PLC, radio telemetry may be used to transmit the signals. Generally, a fiber optical cable or simple shielded cable is used for short distances. The PLC collects and assimilates the input from the I/O devices. The PLC contains a section for data input (from the field) and data output (to the master computer or alarm generator) and is programmable so when certain user specified conditions are encountered, an alarm or other report will be generated. The PLC can also be configured to energize pumps and open or close valves. The master computer continually scans the PLC output table for status changes and incoming operational data. The master computer will display, log and print the information for the operator's use. The master computer should also convert the digital tag into an identifier which is familiar to plant operators. Depending on the size and complexity of the plant, several I/O devices and PLCs may be needed.

The proposed SCADA system for the UF plant will be contain the following SCADA equipment:

–3 I/O devices physically located near the major motor controller centers.

–1 Programmable Logic Controller (Allen Bradley Series 5151).

–2 Digital Equipment Corporation Master Computers (DEC Series 3100).

The master computers will be storing data in ASCII format and connected to the

University of Florida College of Engineering Ethernet© network. This will allow any microcomputer connected to the network access to the plant data from anywhere on the network. The SCADA system will be set up in a "star" configuration as shown in Figure 4. The "star" configuration means the I/O devices will be connected individually to the PLC. It should be noted that the Kruger activated sludge treatment process will provide a separate PLC to control its operation. The Kruger PLC controls the phasing of the oxidation ditches to meet established treatment objectives. The Kruger PLC essentially uses elapsed time for each phase and the dissolved oxygen concentration to cycle the ditches between oxic and anoxic phases. However, the Kruger PLC will not be connected directly to the plant PLC. Instead, the plant PLC will monitor and display all the data collected by the Kruger sensors. As requested by the Task Force, the Kruger PLC may be disengaged manually allowing process control parameters to be modified for experimentation.

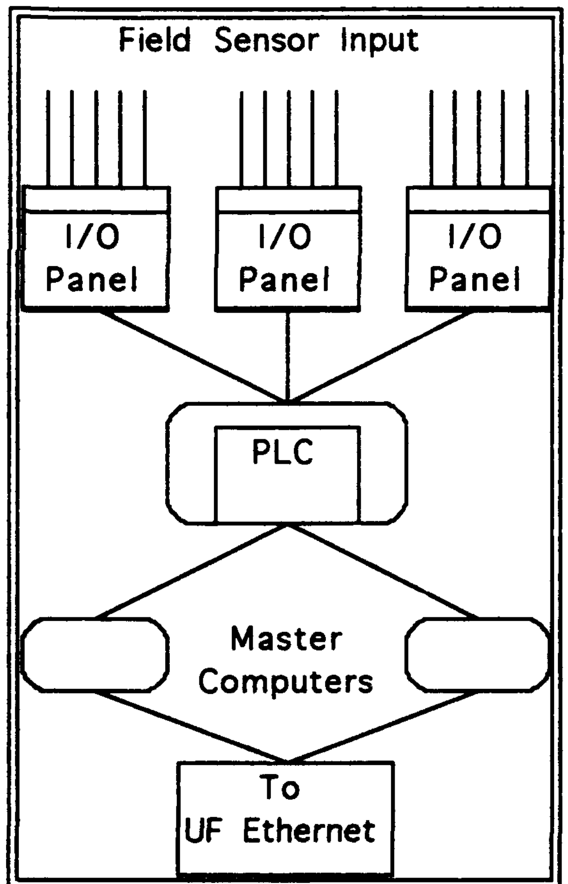


Figure 4
SCADA System Configuration

The proposed SCADA system will be set up to collect and record data except for two specific processed where the SCADA system will actually control the treatment. Generally, the treatment processes are controlled by individual control panels either provided with the equipment or engineered for their specific task. However, the two processes which will be controlled by the SCADA system are:

–Chlorination disinfection system.

–Aeration conditions in the reaeration tanks in the AWT configuration.

The chlorination system will use a residual chlorine analyzer to detect the chlorine concentration in the final effluent. Depending on the desired concentration (programmed by plant operators), the SCADA will operate a valve and regulate the amount of chlorine dispensed into the chlorine contact chamber. In the AWT configuration, oxic conditions in the final aeration tank will be provided by a mechanical blower. The operator will set a desired dissolved oxygen concentration for the aeration tank and the SCADA will operate a plug valve in the air supply line to regulate the volumetric flow of air into the tank.

Figure 2 provides a flow process schematic for the new plant. However, it does not include an equipment schedule and control summary. Understanding what data are available from the SCADA system requires knowing what data are being acquired and from what piece of equipment. The following equipment schedule is provided for this purpose:

Treatment	**Equipment**	**Control Information**
Pretreatment	Parshall Flume	–Instantaneous and totalizing flow meter data.
	Overflow Sump	–High level alarm for grit chamber by–pass.
	Flow Splitter Box	–High level alarm.
Activated Sludge Secondary Treatment	Distribution Weir	–Elapsed time for phasing.
	Oxidation Ditches (4)	–Dissolved oxygen, turbidity and elapsed time for phasing.
	Submerged Mixers (8)	–Elapsed time for phasing. –On/Off status.
	Surface Aerators (8)	–Elapsed time for phasing. –On/Off status.
	Effluent Weir	–Elapsed time for phasing.
	Clarifier Drive Unit	–On/Off status.

Treatment Process	Equipment	Control Information
Activated Sludge Secondary Treatment	Clarifier Sludge Blanket	–Level indicator.
	Activated Sludge Pit	–Low level alarm.
	Return Activated Sludge Pumps (Variable Frequency Drive) (3)	–Elapsed time of operation. –Magnetic flow meter. –On/Off status. –Flow pacing from secondary effluent flow meter.
Solids Handling	Clarifier Scum Pump (2)	–Elapsed time of operation. –On/Off status.
	Waste Activated Sludge Pumps (3)	–Magnetic flow meter. –Elapsed time of operation. –On/Off status.
	Sludge Holding Tank	–High and low level alarms.
	Pre–thickened Sludge Feed Pumps (Variable Frequency Drive)(2)	–Discharge side magnetic flow meter (instantaneous and totalizing) for flow pacing. –On/Off status.

Treatment Process	Equipment	Control Information
Solids Handling	Thickened Sludge Pumps (Variable Frequency Drive) (2)	–Discharge side magnetic flow meter (instantaneous and totalizing) for flow pacing. –On/Off status.
	Aerobic Digester	–Level indicator.
	Digester Blowers (3)	–On/Off status.
	Sludge Loading Pumps (2)	–Magnetic flow meter (instantaneous and totalizing). –On/Off status.
Effluent Treatment and Handling	Tertiary Filters	–Upstream measuring weir. –Downstream turbidity meter.
	Chlorine Contact Chamber	–Chlorine residual analyzer.
	Effluent Transfer Pumps (4)	–High and low level controls. –On/Off status.
	Effluent Reuse Pumps (4)	–High and low level controls. –On/Off status. –Magnetic flow meter (instantaneous and totalizing).
Plant Underdrain and Recycle Flow	Recycle Pumps (2).	–High and low level controls. –On/Off status.

Metering Plan

Flow meters assist the plant operators in ensuring treatment goals are met and processes are operated within their design parameters. Flow data are also important tools in the study of plant operations. The primary operational parameter in activated sludge biological treatment systems is the recycle ratio or the flow rate of return activated sludge compared to the wastewater influent (or plant) flow rate. Flow meters allow operators to set and adjust the return activated sludge flow rate to keep a desired recycle ratio. Flow meters are also required by regulatory agencies to accurately record the wastewater influent flow rate to ensure the plant is operating within its design capacity. However, flow meters can also be used to pace the operation of pumps and other hydraulic control equipment via special control circuits. Both measuring and flow pacing are used in the UF Water Reclamation Facility design.

Flows are measured and reported in two modes. The first mode is an instantaneous flow measurement. The second mode is a totalized flow based on a set time interval such as an hour, day or week. The plant SCADA system will record both measurements. The totalized flow will be computed from the instantaneous flow measurements over a specified sampling time interval. The SCADA system will use an intergrating algorithm to determine the totalized flow.

Flow pacing uses flow measurement data and converts it into a hydraulic control signal. As an example, the measuring weir at the head of the tertiary filters will send a control signal to the variable frequency drive return activated sludge pumps which will control the return sludge flow rate. Consequently, the return sludge rate will be flow paced based on the secondary effluent flow rate. Flow pacing can result in energy savings by cutting pumping power requirements during low flow periods. In other cases, such as the pre-thickened and thickened sludge flows, flow pacing using flow meters keep the variable frequency drive pre-thickened and thickened sludge pumps from overloading the gravity belt thickener and spilling sludge on the ground. The following metering plan is provided to show metering points and process interface:

Meter Location	Meter Type	Function
Upstream of Pretreatment	Parshall Flume	Influent wastewater flow
Upstream of Tertiary Filters	Sharp Crested Weir	Flow pace return sludge
Upstream of Chlorine Contact Basin	Sharp Crested Weir	Flow pace chlorine flow
Discharge of Effluent Reuse Pumps	Magnetic/Ultrasonic	Measure reuse flow
Discharge of Return Sludge Pump	Magnetic/Ultrasonic	Measure return sludge flow

Discharge of Waste Sludge Pump	Magnetic/Ultrasonic	Measure waste sludge flow
Discharge of Thickener Feed Pump	Magnetic/Ultrasonic	Flow pace thickener feed
Discharge of Thickened Sludge Pump	Magnetic/Ultrasonic	Flow pace thickened sludge
Sludge Loading Station	Magnetic/Ultrasonic	Disposal amount
		Spill control

Pilot Filter Layout Summary

A continuous upflow pilot scale wastewater filter is to be installed at the University of Florida as part of a complete wastewater treatment plant renovation. The DynaSand® filter (Model DS-392) is to be provided by the Parkson Corporation and installed adjacent to an operational bank of DynaSand® filters for wastewater treatment. The purpose of the pilot filter is to meet the research needs of the University and acquaint students with the operation of a increasingly popular technology for enhanced solids removal and nutrient control in wastewater treatment. The pilot filter will also enable plant operators and engineers to modify operational parameters on a pilot scale to observe results without endangering the effluent quality of the wastewater. As the DynaSand® filter is a proprietary item, many of the design parameters have been furnished by the Parkson Corporation and been based on observation of the filter in many operational conditions. These general parameters were adapted for the installation at the University of Florida.

Pilot Filter Process Description

The DynaSand® filter is a continuous upward flow, granular medium filter. The filter has many applications in areas of water treatment such as drinking water production, industrial water treatment and domestic wastewater treatment. Generally, chemical addition rather than physical alterations adapt the DynaSand® to the intended application. This feature makes it very desirable for process engineers to "take it off the shelf" and install it onsite with only piping modifications required. The primary design concern in selecting the appropriate filter is flow capacity. Influent is introduced into the bottom of the filter (shown in Figure 5) and flows upward through the sand bed. Filtrate is removed over a weir and sent for additional treatment or reuse as appropriate. Influent may be pumped or gravity fed to the filter depending on the installation site configuration and the availability of adequate elevation head. The sand bed moves slowly downward through the filter (counter-current flow to the influent)

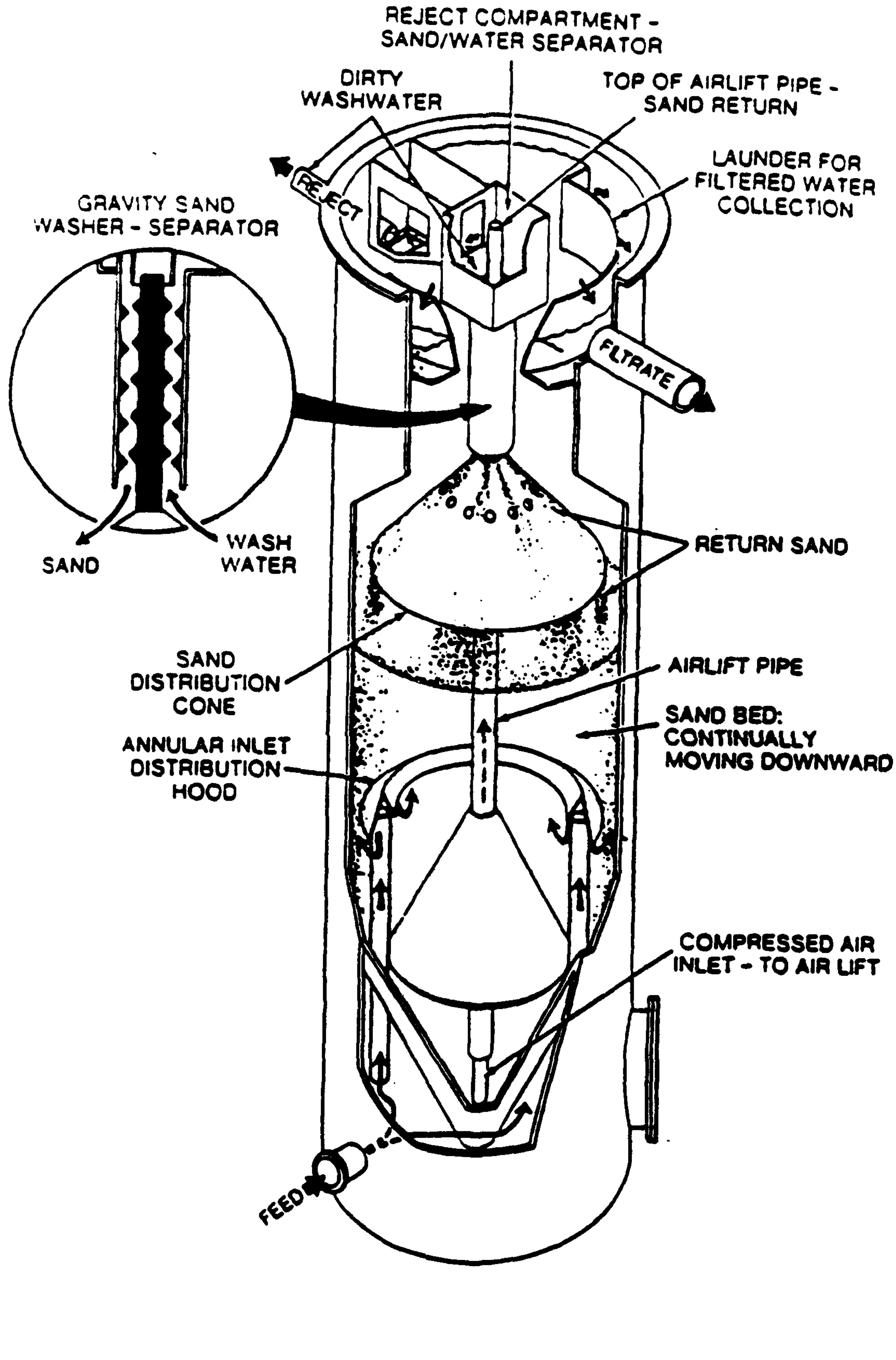


Figure 3
Parkson Filter Unit

as a result of the air lift tube inserted into the bottom of the sand bed. Compressed air is injected into the sand–water mixture and lowers the density of the mixture. The mixture rises up through the air lift tube where entrapped solids are removed by agitation from compressed air bubbles. Most of the influent suspended solids are quickly removed in the bottom of the sand bed. The solids entrapped in the sand–water mixture are evacuated from the sand bed in the air lift tube. The aforementioned mechanical agitation separates the solids from the sand media. As the sand–water mixture reaches the top of the filter, it splashes over the end of the air lift tube into an annular chamber within the center of the filter. The annular chamber contains a baffle and a splash hood which prevents sand from leaving the filter in the reject water. Reject water containing suspended solids flows under the baffle, over a weir and out of the filter for additional treatment. The dense sand falls quickly through a zig–zag section, called the sand washer, outside of the air lift tube. By setting the weir level of the reject water lower than the filtrate level, adequate head is provided to drive clean water up through the sand washer enhancing the removal of the solids from the sand. This small flow of water through the sand washer enters the annular chamber at the top of the filter and ultimately flows out with the reject water. The clean sand falls over a cone in the filter and is uniformly distributed throughout the cross sectional area of the filter. It should be noted that the pilot scale filter does not contain this upper sand distribution cone.

The physical process of the DynaSand® filter of adsorbing suspended solids onto a granular medium is not different than conventional granular medium bed filters. However, there are substantial differences in the operation of each filter. The DynaSand® filter requires a source of compressed air. Pumps and accessories are also generally needed for the influent feed. The compressed air and influent pumps operate continuously. A typical downward flow granular medium bed filter generally does not require additional pumping nor compressed air for proper operation. The major constraints on a conventional filter are the rapid development of solids on the top layer of the media. As with the DynaSand® filter, most of the solids are removed upon initial contact with the media. However, solids are not continuously removed, which results in plugging and unacceptable head loss through the media. The vast majority of the filter's depth is not providing substantial treatment. Filter backwashing is essential to keep plugging and excessive head loss from occurring. Backwashing requires removing the filter from service and agitating it to remove entrapped suspended solids. Backwash pumps and piping are needed for this procedure. Since the filter is off line during the backwashing period, additional filters are needed to keep up with the continuous treatment requirement of domestic wastewater treatment systems. This increases the capital investment and land area required in treatment plant construction. The DynaSand® filter eliminates the need for backwashing with its additional capital construction and operational requirements. Additionally, the operation of the DynaSand® can be modified to optimize treatment and cost benefits. Conventional filters do not provide such operational flexibility.

Operation control of the DynaSand® filter is relatively simple. As with most physical treatment units, surface hydraulic loading rates are important in the efficient operation of the filter. The filter is normally designed for hydraulic loading up to 9 gpm/ft^2 . In normal situations, hydraulic loading can be controlled by throttling a valve downstream of the influent feed pump. However, for this pilot filter, a more precise variable speed pump will be provided. The DynaSand® filter differs from other physical treatment units because while solids loading on the filter can not truly be controlled, solids withdrawal can be. The rate of solids withdrawal is directly related to the amount of compressed air introduced into the filter. As more air is injected, more sand–water mixture is withdrawn along with the suspended solids trapped in the interstices. The movement of the sand through the filter can be quantified as the sand bed turnover rate. Of course, if the sand bed moves too quickly through the filter, the flocculation conditions will be negatively impacted and flocs may shear away from the sand particles. Additionally, more compressed air will increase operational costs of the filter which may be undesirable. The filter lends itself very well to experimentation and determination of optimum control settings for various operating conditions.

Design Procedures

The dynamic nature of the DynaSand® filter make the design approach somewhat different from standard granular medium filter design. Standard filter capacity and size must be designed for peak solids and hydraulic loading conditions. Head loss may be estimated using accepted methods such as Carmen-Kozeny, Fair-Hatch, etc [Metcalf & Eddy, 1991]. Physical dimensions are designed for reasonable backwashing periods. However, the DynaSand® design is by nature limited due to the proprietary nature of the filter and its design. The designer must rely on information from the manufacturer in choosing the correct filter. Manufacturer's generally maintain operational observations of the filter's performance in differing conditions. Since their reputation and financial position is somewhat related to the filter's performance for the client, the manufacturer's data is normally accurate and most acceptable. Academic and pilot studies are also helpful in determining the filter's full potential. As the technology is relatively new in this country and research has been limited to the past six years, the proposed pilot filter for the University of Florida should provide additional and needed research. The design of the pilot filter for research purposes is again different from an operational filter designed to treat domestic wastewater. The operational filter is an essential part of the wastewater treatment plant's overall regulatory compliance strategy. These filters cannot fail under operating conditions. However, many operating parameters of the filter do not need to be observed if it is operating satisfactorily. Research of a pilot scale filter requires understanding of why the filter is operating properly (or improperly) and what is occurring in the treatment process. Pilot filters require sampling ports, additional pressure and elevation gauges, precise operational controls and taps for chemical and polymer addition. It is important to understand the research requirements as well as the normal operational requirements of the filter in the design process.

The design of the DynaSand® filter installation was broken into segments for ease of report presentation. The segments are filter characteristics, hydraulic appurtenances and accessory equipment. A layout schematic is shown in Figure 6.

DynaSand® Filter Characteristics

DynaSand Model DS-392

Cross Sectional Area: 11 ft^2.

Height: 12 feet.

Filter Weight (with sand and water): 16,000 lbs.

Maximum Compressed Air Requirement: 2 ft^3 per minute at 25 psi.

Hydraulic Flow Rate Range: 2–10 gpm/ft^2.

Headloss Through the Filter: 12 inches.

Compressed Air Usage: 40–70 ft^3/hr.

Sand Characteristics:

  Diameter: ≈1.5 mm.

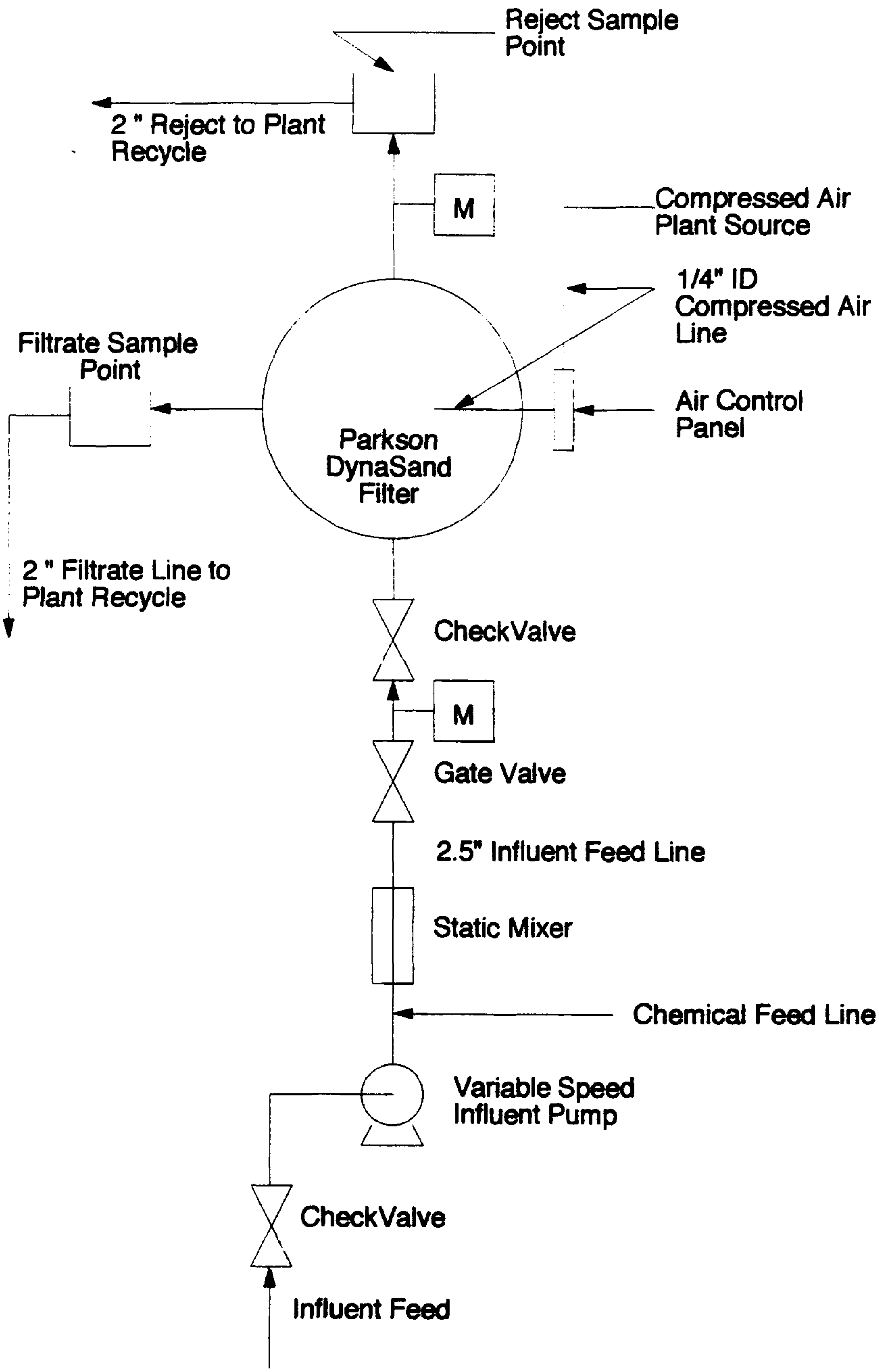


Figure 6
Pilot Filter Layout Schematic

Uniformity Coefficient: 1.5.

Filter Bed Depth: 2 meters (6.56 ft).

The filter shall be transported by flat bed truck from Parkson Corp. to the construction site. The filter shall be carefully off loaded using a ten ton crane and placed on the reinforced concrete pad shown in the supplemental and project drawings. Approximate cost of the transporation and off loading is $1,000 based on crane rental with operator and transportation costs from Ft. Lauderdale, Florida (estimated from Means Construction Cost Data, 1992). The filter frame shall be bolted to the pad using the 1" diameter anchor bolts showed in the anchoring plan shown in Figure 7.

Hydraulic Appurtenances

Refer to Figure 8 for pipe venting and meter installation.

Influent Feed Line:

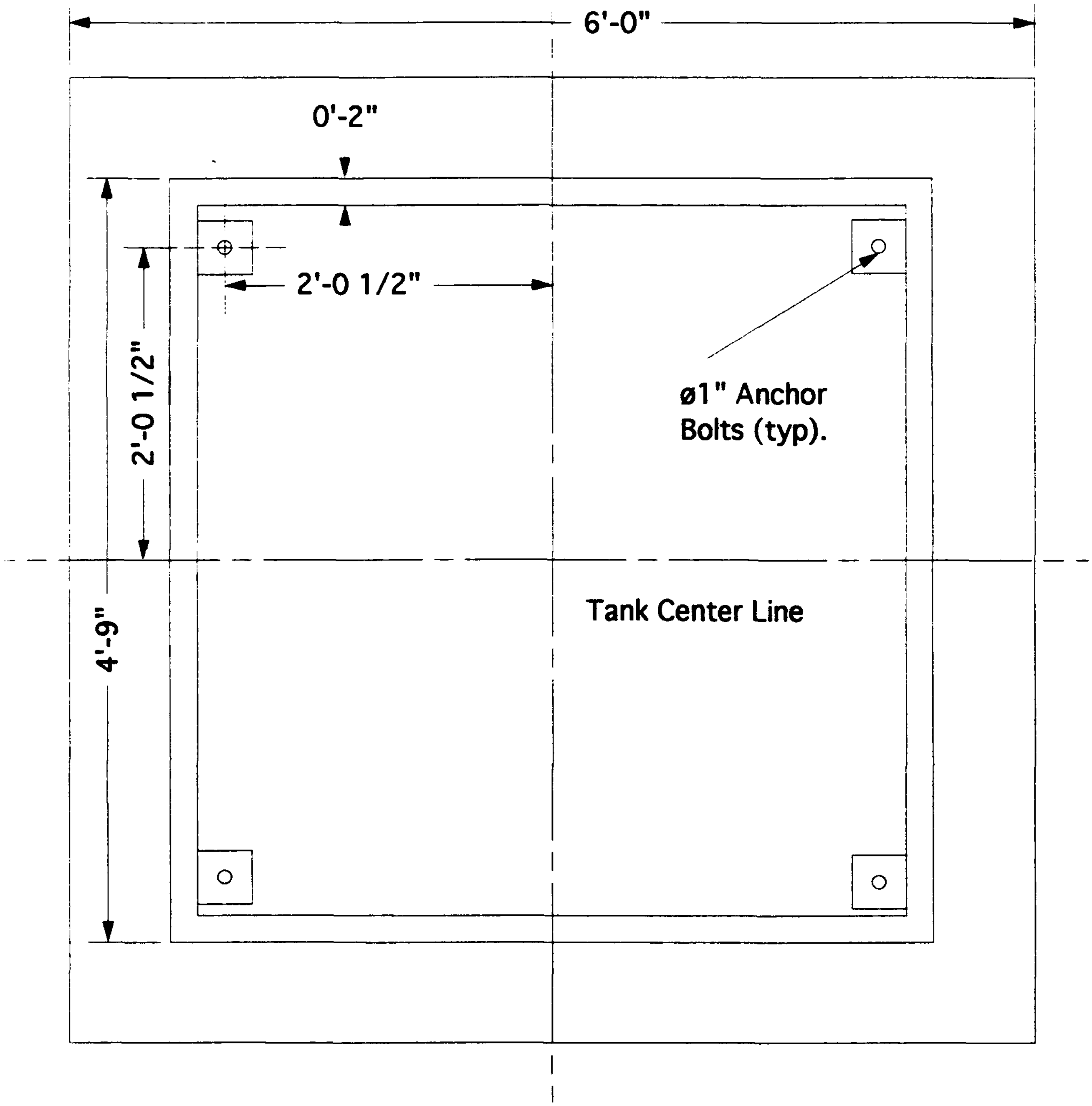
- -Material: PVC Schedule 80.
- -Diameter: 2.5 inches.
- -Blind flanges provided for polymer/chemical addition and methanol addition.
- -Static mixer (with pressure gauges up and down stream of the mixer) in line and downstream of chemical addition points.
- -Check valve and gate valve assembly before inlet to filter.
- -Relief (Overflow) Standpipe 30 inches above filtrate weir level.

Filtrate Line:

- -Material: PVC Schedule 80.
- -Diameter: 2 inches.
- -Discharge to treatment plant recycle pump station.
- -Sampling port or handhole provided for grab samples.
- -Relief (Overflow) Standpipe 30 inches above filtrate weir level.

Reject Line:

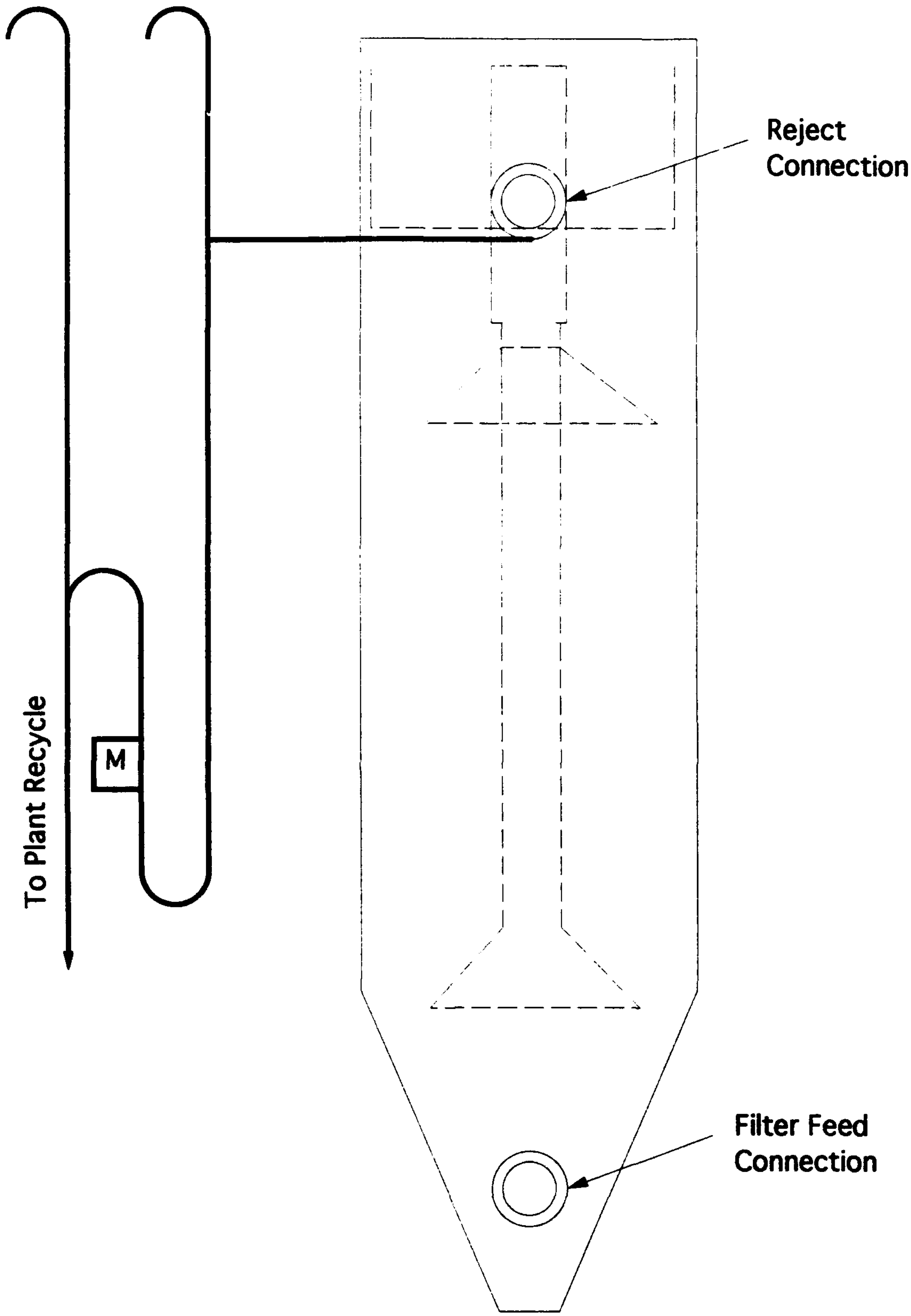
- -Material: PVC Schedule 80.
- -Diameter: 2 inches.
- -Discharge to treatment plant recycle pump station.
- -Sampling port or handhole provided for grab samples.
- -Relief (Overflow) Standpipe 30 inches above filtrate weir level.



Drawing Scale 1":1'

Concrete Pad is 6' x 6'
Filter Frame is 4'-9" x 4'-9"

Figure 7
Pilot Filter Pad and Anchoring Plan



Note:
1. Vent Piping is to be 30" above filtrate weir elevation

Figure 8
Reject Line and Metering Elevation

Influent Feed Pump:

-Pump: Gorman-Rupp; Centrifugal Model 12B9-B; 2 inch inlet and outlet. Base Plate - L182T. Capacity 90 gpm @ 20 feet of head, or equal.

-Pump Motor: Reliance Electric P18G3337, TEFC, 2 hp; 230/3/60,Wood Flexible Coupling, or equal.

-Variable Speed Controller: T. B. Woods AC Invertor, AFC-2003-0C2, NEMA4/12, 2 hp, 230/3/60, or equal.

-Provide a check valve on the suction side of the pump to ensure sand and water does not backflow through the pump.

Metering Equipment:

-Reject and influent feed meters shall be rotor type, invasive sensors. Sensors shall be provided with appropriate saddle or tee fittings. Sensor output signal shall be 1 V peak to peak with a flow range of 1-30 feet per second. Sensors shall be capable of withstanding pressures of 200 psi at 80° F. Flow meters shall be battery operated with a 0.7" high, four digit LCD display. Flow meters shall also be capable of totalizing flow measurements. Meters shall be Sigma, Surfilco or equal.

pH and Temperature Controller and Sensor:

-Sensor shall be in-line type and installed in the filter feed line downstream of chemical feed addition. Temperature and pH controller shall be microprocessor controlled with output range of 4-20 mA. Controller shall have a LCD display with automatic temperature compensation. Provide a NEMA 4X weather proof enclosure for the controller. pH shall be accurate to 0.02 units over the full range of the controller. Controller shall have programmable alarms with a selectable (pH, temperature or ORP) readouts.

Accessory Equipment

Chemical Feed Systems:

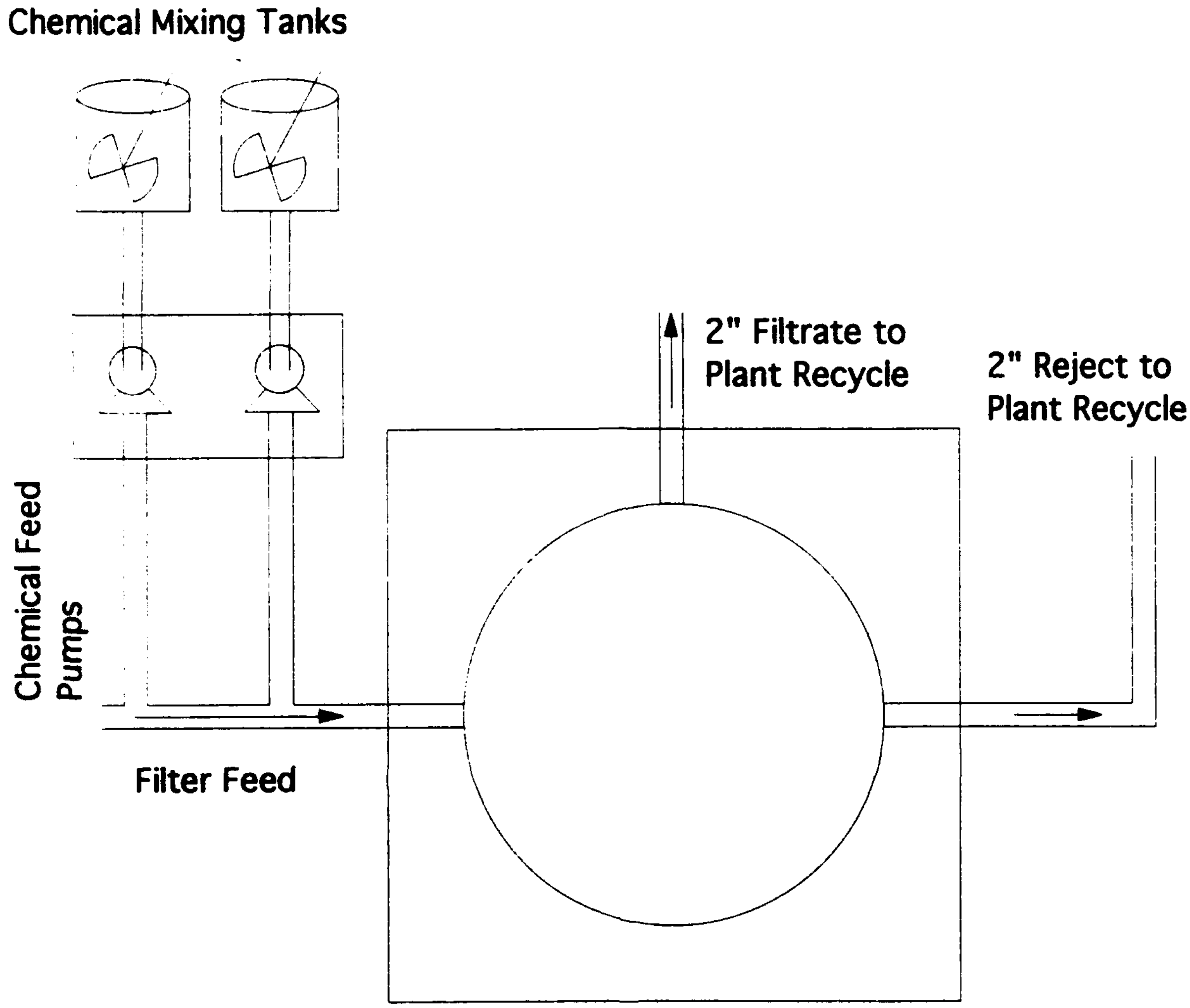
-Chemical Feed Pumps: Two chemical metering pumps shall be provided to pump a solution of methanol. The chemical metering pump shall operate with a 115/230 V, single phase, 60 Hz AC constant speed motor. The single head pump shall be a positive–displacement mechanically actuated diaphragm type with a Kynar head. the head shall contain a 3 inch diaphragm for a total capacity of 500 gallons per day per head at 65 strokes per minute. The stroke length of the hypalon reinforced diaphragm shall be controlled by a manual crank located on top of the pump housing. The stroke length shall be indicated on a slide–rule type scale with digital indicator. The crank locks in position to prevent feed rate changes while the pump is running. A four-step pulley shall be provided to give four individual capacity ranges of 500, 290, 170, or 92 GPD. Each range shall have a 10:1 turn down adjustment. This range can be extended to 50 to 1 by shifting the belt o V–groove pulleys. The pump housing shall be constructed of cast aluminum with a fiberglass base. The pump drive shall be lubricated by an internal gear pump that move oil onto the eccentric–push rod assembly for lubrication. Each pump shall contain suction and discharge valves suitable for pumping a solution of methanol. The pump shall be Model 44-113 as manufactured by Wallace& Tiernan, or equal. Provide strainers, unions, drain plugs and pressure relief valves as required.

-Chemical Mixing Tanks: Tanks shall transparent and not less than 3 gallons in capacity. Mixers shall be constructed of 316 stainless steel and meet explosion proof, Class I, Group D standards. Mixer motor shall be at least 1 hp at 3450 rpm. Mixer impeller shall be 3 1/2" with shroud. Mixer shall be supplied with a motor mount clamp and other necessary devices to secure the mixer to the side of the mixing tanks. Mixer shall operate at 120V/ 1 phase/ 60 Hz. TEFC motors shall be overload protected and supplied with a molded plug.

-Chemical feed system schematic is shown in Figure 9. Typical chemical feed equipment, meters and pumps are included in Appendix B of this report. Price quotations for selected equipment are included in Appendix A.

Air Compressor:

-Compressed air supply from operational units should be adequate. If not, use Ingersoll-Rand T-30 compressor package with motor starter.



Note:
1. Chemical Feed Pumps may be used to supply alum, methanol or polymers, as required

Scale:
1":2'

Figure 9
Pilot Filter Chemical Feed System

Air Supply Line:

-Material: ABS Plastic.

-Diameter: 1/4 inch I.D.

-Provide a solenoid valve on the supply line. The solenoid valve control shall be interlocked with the power supply to the influent feed pump. Under no circumstances (unless manually by-passed) should the solenoid valve be opened if the influent feed pump is not operating.

Air Supply Control Panel:

-Provided with DynaSand® filter.

Experiments and Operational Procedures

The DynaSand® filter requires little maintenance and can be operated with minimal operator attention. Filter set up can be provided by the manufacturer to ensure proper operation and warranty conditions are not voided. Set up consists of ensuring all controls are operating properly and piping connections are tight. The filter should be partially filled with water before charging it with sand. If sand is not provided by the manufacturer, use a high silica sand with the aforementioned effective size and uniformity coefficient. The filter should be operated for several hours with minimal flow purging the filter to wash the colloidal clays off the sand. After this period, the filter should be ready for operation. It is most advantageous to operate the filter continuously to control solids deposition in the piping and control microbial growth in the sand bed. However, conditions may arise where the filter must be shut down for an extended period of time. If this occurs, purging similar to the set up procedure should be used. Again, compressed air should not be introduced into the filter until the filter is at least half full of water and the influent feed pump is operational. It may be necessary to add a disinfectant to remove excessive microbial growth. Powdered chlorine is satisfactory for this procedure. During the start up of the filter, head loss through the filter will build rapidly during the first hour of operation and then stabilize. Approximately three filter volumes of water are needed until stabilization is achieved. Compressed air pressure should be a minimum of 15 psi. Higher operating pressures will tend to stabilize the lifting of the sand–water mixture but result in increased operational costs. Experimental procedures should not be attempted until the filter is stabilized.

The pilot scale filter is designed for research and academic instruction. As a physical treatment unit, its primary purpose is to remove residual suspended solids from the influent and provide a cleaner filtrate. The filter can be operated with and without chemical addition to achieve acceptable solids removal efficiencies. If the filter is operated without chemical addition, operating conditions can be varied by changing one or all of the following conditions:

1. Hydraulic Loading Rate.
2. Solids Loading Rate.
3. Solids Withdrawal Rate (Reject Flow or Sand Bed Turnover Rates)

The hydraulic loading rate can be adjusted by the variable speed pump. Solids loading can be changed by adding suspended solids into the influent feed at a controlled rate. Small amounts of mixed liquor can be used for this purpose. Finally, solids withdrawal can be modified by adjusting the flow of compressed air into the filter bed. The use of the quantifying term "Sand Bed Turnover Rate" [Anderson et. al., 1990] is helpful to understand the dynamics of filter. The Sand Bed Turnover Rate can be simply measured using a steel rod with a plate on the end. The rod is lowered into the filter and marked to a reference point. The air flow rate is kept constant and the rod will move through the filter bed as it moves downward. After a specific period of time, the distance the rod has dropped is measured and a linear velocity of the sand bed (similar to a Darcy velocity) is calculated. Knowing the cross sectional area of the filter (and thereby knowing the volume of sand in the 2 meter bed) , a volumetric flow rate of sand can be computed and quantified as a number of sand beds per unit time. Suspended solids removal efficiency can be compared by varying any or all of these control parameters.

The addition of chemicals adds another variable to the experimental scenario. Depending on the type of chemical added, solid removal efficiency, turbidity removal or nutrient removal can be affected. If alum is added, chemical precipitation will occur and solids removal efficiency will be increased. Additionally, free aluminum ions will combine with available phosphates and precipitate out of the wastewater. Thiswill reduce the total phosphorus in the discharge filtrate which may be beneficial in some cases. By varying the amount of alum added and assigning costs to each control parameter, optimized operating conditions may be determined. If an external carbon source (i.e. methanol) is added to the influent feed, the anaerobic conditions in the filter bed can create a suitable environment for denitrifying bacteria to exist. These denitrifying bacteria can assimilate available nitrate in the influent feed and biotransform it into nitrogen gas, thereby reducing the total nitrogen content of the filtrate. Filtrate turbidity can also be reduced if a polymer such as Percol 776 is added. In cases where filtrate turbidity can be a problem, adequate polymer dosages can be developed and minimize cost to the plant operation.

Conclusions

The DynaSand® pilot filter can provide many interesting research and experimental opportunities. However, for applications where chemical addition is not required, it must be realized the DynaSand® filter's primary advantage over conventional deep bed and filters is cost. Without chemical addition, the DynaSand® filter produces a filtrate which is indistinguishable from conventional deep bed filters provided a high quality influent feed is available [Weinschrott and Tchobanoglous, 1986]. The DynaSand® filter can be more cost efficient to construct by eliminating the land requirement for conventional filters where land cost is a premium. If chemical addition is needed for turbidity, nutrient control or advance solids removal, the DynaSand® may present significant capital and operational savings as well as providing treatment capabilities not available in conventional filters.

Acknowledgements

I would like to acknowledge the support and cooperation of the following individuals to allow the completion of this project:

Dr. Ben Koopman of the University of Florida Department of Environmental Engineering and Sciences.

Mr. Ron Port of the Parkson Corporation.

Messrs. Ron Ferland, James Broome and Rick Wilson of Dyer, Riddle, Mills and Precourt, Inc.

Mr. Pete Hoanshelt of EMI Consulting Specialties, Inc.

References

Anderson, Robert J., Pierce, Christopher N. and Tchobanoglous, George, *Evaluation of the DynaSand® Continuous-Backwash Upflow Filter for Water Supply Applications*, University of California, Davis, Davis, CA, 1990.

Koopman, B., Stevens, C. & Wonderlick, C., *Denitrification in a Moving Bed, Upflow Sand Filter*, presented at the 62nd Annual Conference, Water Pollution Control Federation, San Francisco, CA 1989.

Larsson, Hans F., Continuous Contact Filtration, Axel Johnson Engineering AB, Nynashamn, Sweden.

Metcalf & Eddy, Inc, Wastewater Engineering, Treatment, Disposal and Reuse, Third Edition, McGraw-Hill, Inc., New York, NY, 1991

Weinschrott, R. and Tchobangolous, G., *Evaluation of the Parkson DynaSand® Filter for Wastewater Reclamation in California*, University of California, Davis, Davis, CA, 1986.

Appendix A

Equipment Price Estimates

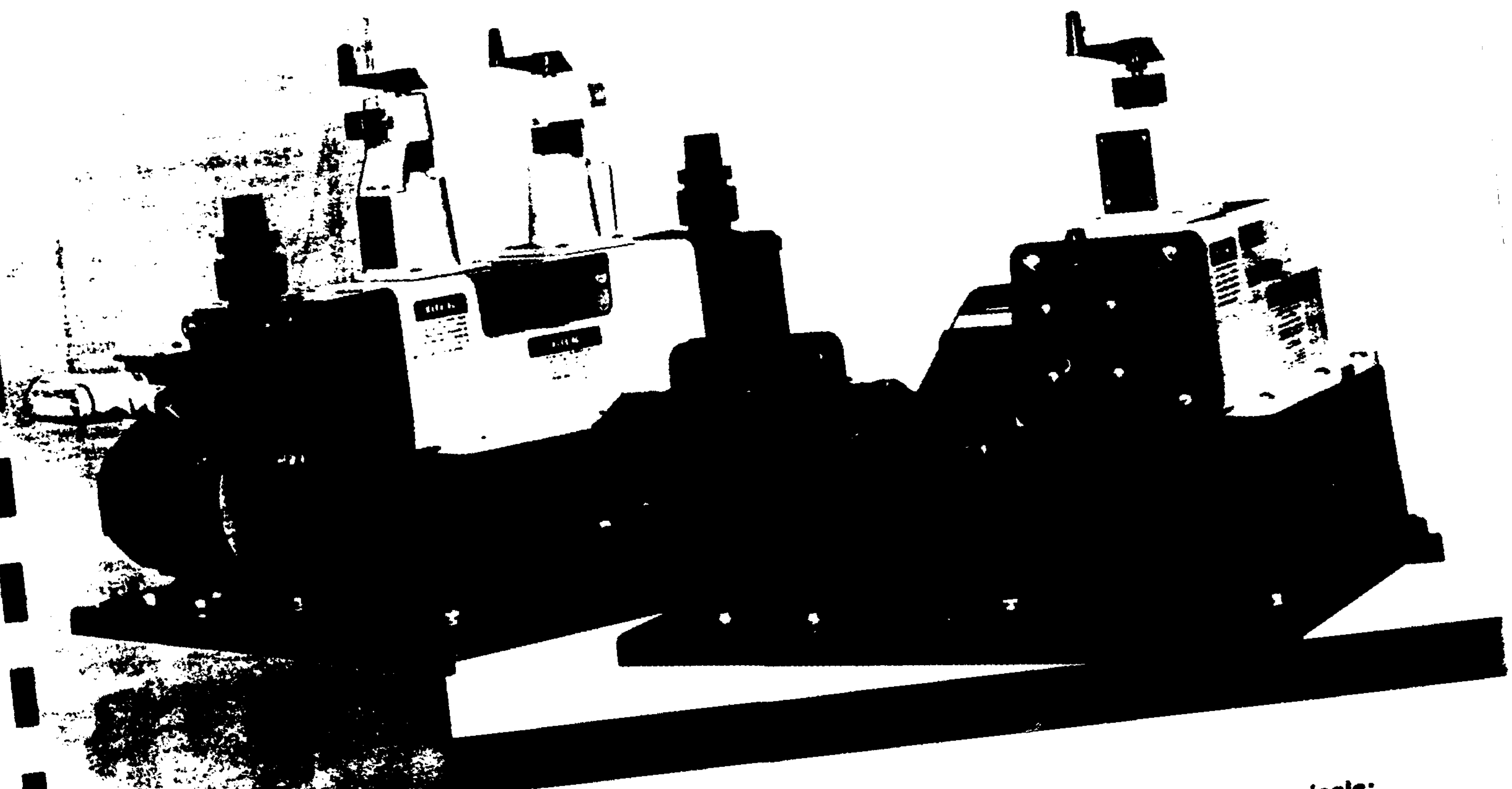
Equipment	Description	Price
Autoclave	Barnstead benchtop sterilizer (10"). Cole–Parmer catalog #L-10750-00	$4,363
Flow Meters	Paddle-wheel type. Cole–Parmer catalog #L-06518-11	$210
Fume Hood	59" Fiberglass. Cole–Parmer catalog #L-09031-XX	$5,250
Chemical Feed Systems	Wallace & Tiernan WT–44 Series chemical feed pumps and valves (equipment only). 1 day system check out by service representative. Price quote is prorated from a written proposal from Heyward, Inc., Orange Park, Florida	$6,100

Appendix B

44 SERIES

DIAPHRAGM METERING PUMPS

and chemical metering systems



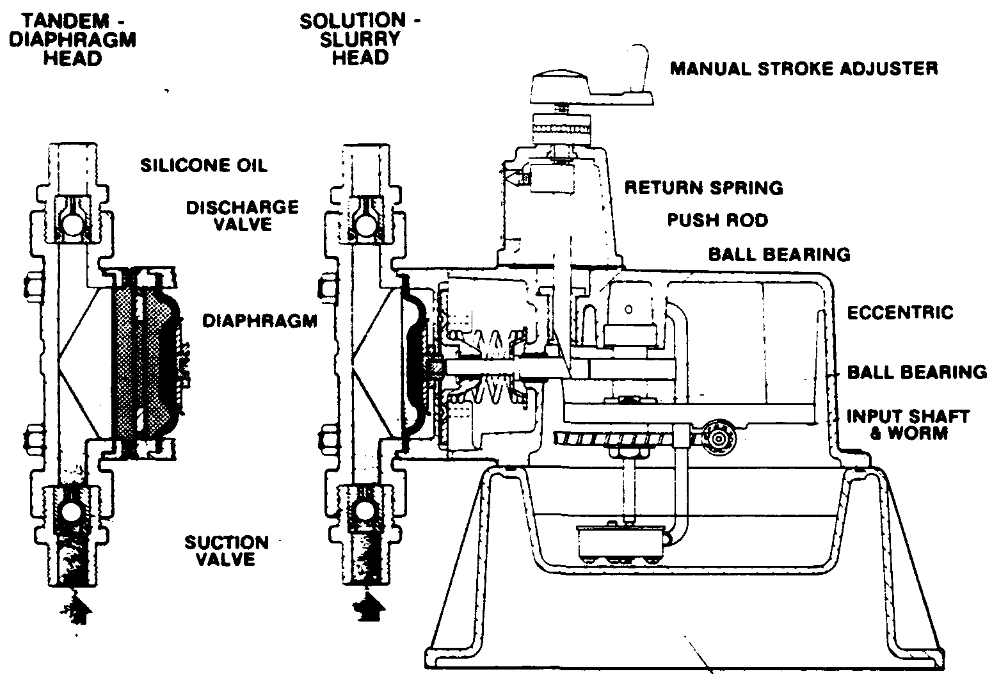
USE: Series 44-100, pumping heads for mild chemicals;
Series 44-200, pumping heads for aggressive chemicals;
Series 44-300, pumping heads for slurries.

CAPACITIES: 0.34 to 208 gph (8-5000 gpd).

PRESSURE: To 150 psig (125 psig for slurries).

CONTROL: Manual; remote-manual; start-stop; automatic by SCR variable-speed control and/or electronic stroke-length control.

FEATURES



Optional sight flow indicator available to permit visual check of pumping activity.

DOUBLE-HEAD MODELS:

For high capacities; two-chemical metering; or one standby head.

RUGGED INDUSTRIAL CONSTRUCTION:

Enclosed, gear-pump-lubricated drive; liberal use of heavy-duty parts and load-absorbing ball bearing; eccentric-type drive.

MANY CHOICES:

PUMPING HEADS for mild chemicals, aggressive chemicals, and slurries; each has 12 CAPACITIES between 1.8 and 208 gph; FEED RATES easily adjustable from 0.34 to 208 gph. 8 manual and automatic CONTROL MODES.

ACCURATE FEED RATE CONTROL:

With manual crank and scale; vernier or digital-stroke-length indicator for very precise, repeatable feed rate settings.

LONG LIFE WITH AGGRESSIVE CHEMICALS:

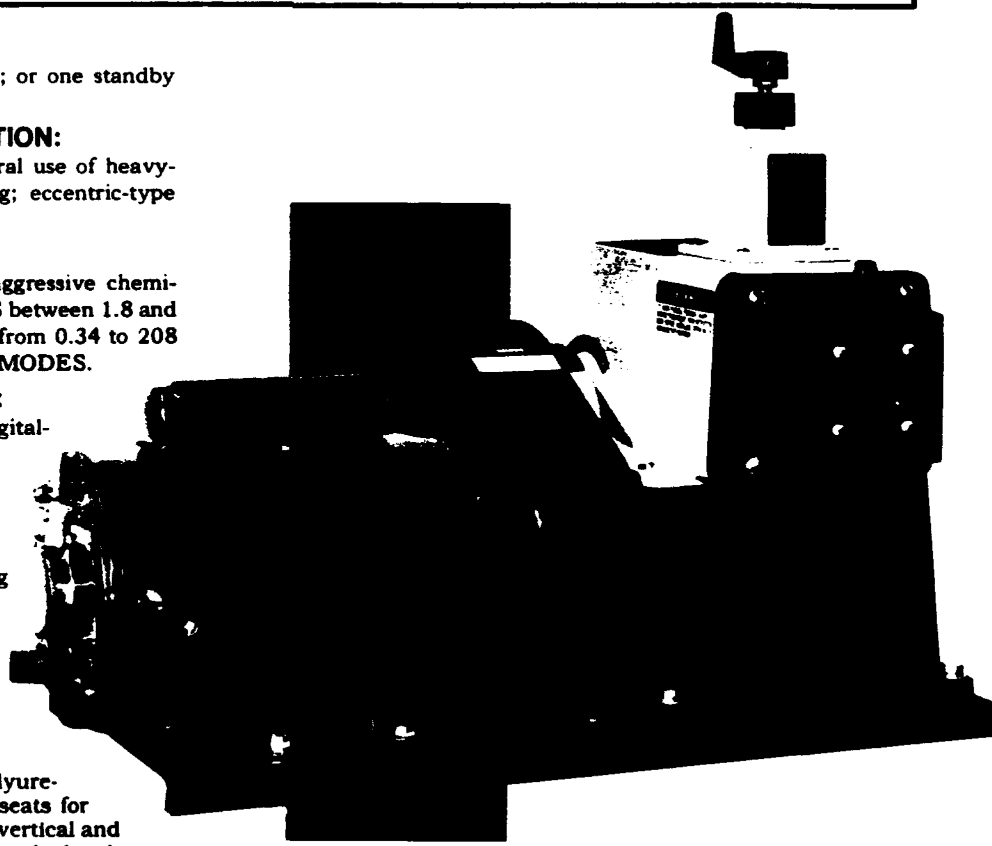
Unique two-diaphragm head has its driving diaphragm hydraulically linked to a TFE pumping diaphragm. The latter carries no pumping load, remains intact almost indefinitely. And the TFE stands up to aggressive chemicals.

LONG LIFE WITH SLURRIES:

The slurry-head pump features resilient polyurethane valve balls and ceramic or 316 SS seats for strong resistance to abrasion. Flow path is vertical and straight through, there are no obstructions in the head.

ADD-ON AUTOMATIC CONTROL:

SCR variable-speed control and electronic-stroke-length control added in minutes.



LOW COST CHEMICAL METERING SYSTEMS:

Stock components, designed around 44 Series Pumps, means custom metering systems from standard tanks, mixers, controls, etc.

DESIGN AND OPERATION

A smooth-running eccentric mechanism converts rotary motor input to reciprocating push-rod motion. A standard induction or variable-speed motor drives an input shaft via 4-step V-groove pulleys. A worm on this shaft engages a worm gear on an eccentric shaft to rotate the eccentric. A ring, driven by the eccentric, drives the diaphragm push rod. Forward motion produces the discharge stroke. A heavy spring returns the push rod for the suction stroke. An adjustable return-stroke stop varies stroke length.

The drive is enclosed by an aluminum housing; lubricated by a gear pump; has an oil dipstick. Electric motors adjust easily for belt tension. A steel base with corrosion-resistant finish supports the pump and motor. A belt guard conforms to OSHA standards (OSHA sec. 1910.212 and .219 Machine Guarding).

A manual crank for each head sets stroke length with the pump running. The stroke-adjusting mechanism stops the return stroke of the push rod for positive control of volume pumped. The eccentric-push rod assembly is supported by load-distributing bearings in the housing. A knurled nut locks the crank. It cannot creep to change feed rate while the pump is running. Stroke length is adjustable from zero flow to maximum.

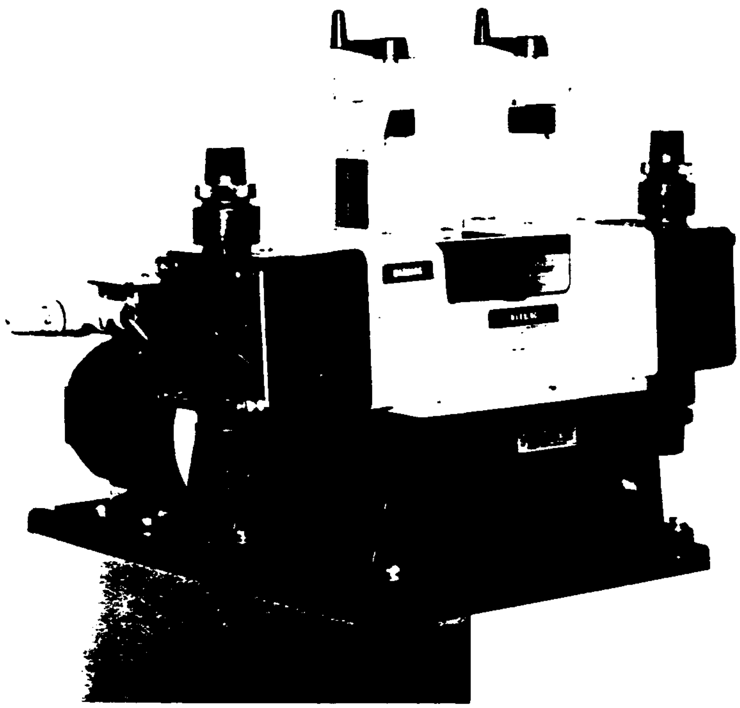
Two 4-step pulleys on the motor and input shaft give convenient stroking-speed adjustment over a 5:1 range with induction motors. An optional 20:1 range SCR variable-speed motor is available. By combining the 4-step pulleys and stroke-length adjustment, feed rates of 50:1 can be achieved. With the manual-stroke-length crank, the 4-step pulleys, and optional SCR variable-speed motor, range is 1000:1 for water-like solutions.

Pumping heads have reinforcing ribs for extra strength. Standard heads are PVC: KYNAR vinylidene fluoride resin is optional for high temperatures and pressures. Valves are easily removed and broken down for cleaning. They thread directly into the head and are sealed by Viton. Hypalon or TFE O-rings. As in pumps costing much more, the valve balls (or poppets) are guided to seat quickly and securely for efficient pumping. Standard valve balls are made of chemically-inert, non-elastomeric PTFE. They can handle wide range of chemicals with virtually no possibility of becoming misshaped. Some pump models have anti-syphon springs in the discharge: for the higher capacity models, external anti-syphon valves are optional.

For long life, pumping diaphragms are nylon-reinforced Hypalon. They also have short stroking lengths and a TFE disk where the push rod connects—the point of mechanical failure for ordinary diaphragms. A corrosion-resistant steel backing plate used with these diaphragms adds strength, helps make delivery reliable at high pressures.

Polymer Heads

The Kynar 3- and 4-inch pumping heads are available with spring-loaded valves designed for polymer solutions. They allow reliable metering of polymer solutions at viscosities up to 5500 cps at 195 spm, or to 10,000 cps at 114 spm, or less. (Viscosities measured with Brookfield Viscometer with #2 spindle at 3 rpm.)



CHEMICALS

44 Series mild chemical pumps gives excellent service metering such water and waste treatment chemicals:

alum	soda ash
calcium hypochlorite	sodium aluminate
copper sulfate	sodium bicarbonate
ferric chloride	sodium bisulfate
ferric sulfate	sodium flouride
ferrous sulfate	sodium hypochlorite
fluosilicic acid	sodium metabisulfite
potassium permanganate	sodium silicofluoride
	sodium sulfite
	sodium thiosulfate

and with industrial chemicals such as:

barium chloride	magnesium sulfate
boric acid	potassium carbonate
citric acid	sodium phosphate
ethylene glycol	sodium sulfate
glycerine	zinc sulfate

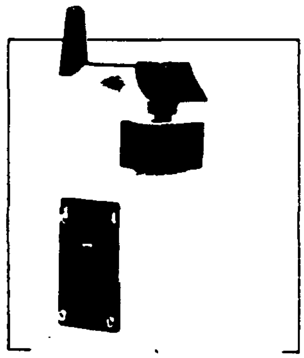
44 Series pumps for aggressive chemicals give excellent service handling such corrosives as:

Acids: acetic, chromic, hydrochloric, nitric, phosphoric, sulfuric, fluosilicic acid.
Algicides: hypochlorites, metallic biocides, organic biocides.
Oxidizing agents: chromates, permanganates.
Reducing agents: ferrous sulfate, sulfites.
Also: caustic soda, ferric chloride, fluorides.

44 Series slurry pumps handle slurries with up to the following concentrations:
hydrated lime, 3.8 lb per gallon of water; activated carbon, 1.1 lb per gallon of water; diatomaceous earth, 1.7 lb per gallon of water.

CONTROL MODES

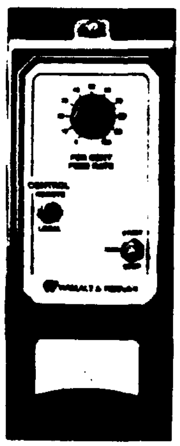
A manual crank gives continuous feedrate adjustment over a 10:1 range. A percent scale and vernier read out the stroke-length setting to 1 part in 400. Each revolution of the crank changes stroke length by 2%. Stroke length is adjustable to zero. Optional digital stroke-length indicator permits precise, repeatable feedrate settings.



44 Series Pumps are easily wired into the circuit of a transfer pump, switch, timer, or controller.

A remote-mounted Wallace & Tiernan Automatic Controller, in the manual mode, has a switch which increases or decreases pump feedrate by adjusting stroke length. It also has a highly visible LED bar graph which reads out 0-100% of maximum feedrate (stroke length) in 5% increments. When changing feedrate, this bar graph also confirms the direction in which the stroke length is moving. A NEMA 12 enclosure (dustlight) is used to house the control electronics. An actuator, in a NEMA 4X enclosure (corrosion-resistant and watertight), is mounted on the pump. For convenience, a percent stroke-length indicator and a manual stroke-length adjustment are included with the actuator.

[illegible]RIABLE-SPEED CONTROL



Control unit for variable-speed drive with optional speed readout meter.

For precise and accurate feedrate control (via stroking speed), a Wallace & Tiernan SCR Control Unit varies the speed of a dc pump-drive motor. Stroking speed can be regulated manually by potentiometer setting or can be controlled automatically by a 4-20 mA process variable input signal (option). The feedrate (stroking speed) can be continuously adjusted over a 20:1 range. Closed-loop speed regulation provides feedrate control accurate to 1% of full scale. The SCR Control Unit converts 115 volts ac to dc power for the drive motor. An optional readout meter mounted below the control unit and calibrated 0-100% of maximum feedrate, reads out motor speed from a tachometer generator. The front panel has two toggle-type selector switches: motor start-stop-run, and either local-remote or run-jog, depending on arrangement. The control unit and readout meter are housed in NEMA 4 enclosures.

[illegible] STROKE-[illegible]TH CONTROL

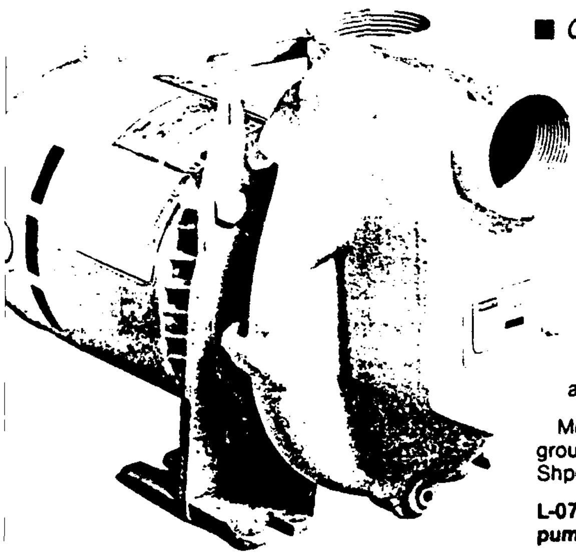
The Wallace & Tiernan Electronic Controller is designed specifically for metering-pump control. It features a high-resolution LED bar graph with switch-selectable, percent readout of the flow (or other) input or the pump stroke length (feedrate). It controls a NEMA 4X actuator which adjusts the pump's stroke-length mechanism. The controller is available in three arrangements:

Auto-Proportional Control. This economical arrangement gives automatic control according to one process input. It has the bar graph described above, a dosage adjustment which scales the input 0-200%, and mechanical manual override. Zero and span adjustments are included.

Auto/Manual Proportional Control. Gives automatic control in accordance with one process variable. It has the bar graph described above, a dosage adjustment which scales the flow input 0-200%, electronic and mechanical manual overrides with electronic indication, and independent zero and span adjustments to the flow input.

Compound-loop Control. This dual-signal, information-feedback system gives pump feedrate control according to two variables, the water's flow and chlorine demand. The controller accepts flow-proproportional and residual signals and translates them into a hypochlorite feedrate. The controller has the flow input-stroke length bar graph described above. In addition it has a tri-color LED bar graph which shows residual deviation from the setpoint, a measured residual-residual setpoint readout, no-flow alarm, high- and low-residual alarms, dosage adjustment, electronic and mechanical manual overrides with electronic indication.

Versatile utility pump primes itself



Self-priming utility pump

■ *Convenient carrying handle*

Use this versatile, self-priming centrifugal pump for continuous duty or emergency draining of basements, pools, or sumps.

Pump lifts from a depth of 12 feet, once the priming reservoir is filled. Pumps up to 76 gpm, generates up to 51 feet of head (22 psi).

Motor is ½ hp, 115 VAC, 60 Hz, 3450 rpm. Inlet and outlet ports are 1½" NPT(F). Seal is carbon/ceramic with Buna N elastomers. Other wetted parts are cast iron and Buna N.

Measures 17"L x 6½"W x 10"H. Includes 8 ft grounded cord for 115 VAC, 60 Hz operation. Shpg wt 34 lbs (15.4 kg).

L-07080-50 Self-priming utility pump **$175.00**

Accessories

L-06450-84 Inlet/outlet fitting, polypropylene; 1½" NPT(M) x 1½" hose barb. Pack of 10 . . . . **$19.60/pk**

L-06401-08 Tubing, reinforced PVC; 1½"ID. Pack of 25 ft **$79.05/pk**

L-06403-60 Hose clamps, stainless steel; 1" x 2". Pack of 10 . . . . **$7.50/pk**

Specifications

Flow rate: up to 76 gpm

Maximum pressure: 51 feet of head

Maximum temperature: 180°F (82°C)

Self-priming centrifugal pumps

■ *Available in 3 materials*

Use for continuous transfer of liquids from tanks and sumps, in chemical process and batching lines, in wastewater treatment, or in agriculture. Pumps move out any air in the inlet line—ideal for liquids with entrained gases. Can lift water from 12 feet below the inlet level, without priming.

Self-cleaning, semi-open impeller permits handling solids up to ⅜" in diameter and liquids with viscosities up to 100 SSU. Install your own cord and plug for 115 or 230 VAC (60 Hz) operation. All pumps are rated for continuous duty.

Cast-iron pumps are equipped with cast-iron body and impeller, Buna N O-rings, and a carbon/ceramic face seal with Buna N elastomers. Maximum fluid temperature is 180°F. Motors are open drip-proof, single phase, and run at 3450 rpm.

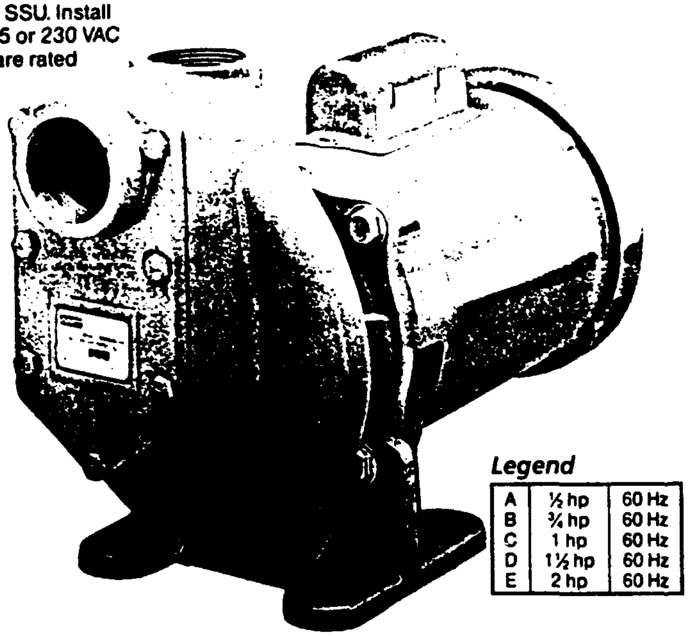
Bronze pumps handle a wide range of solvents. Equipped with bronze body and impeller, Viton® O-rings, and carbon/ceramic face seal with Viton elastomers. Maximum fluid temperature is 250°F. Motors are totally enclosed, fan-cooled, single-phase, and run at 3450 rpm.

Stainless steel pumps handle acids, caustics, solvents, trichloroethylene, and photographic chemicals. Equipped with cast 316 stainless steel body and impeller, Teflon® O-ring, and carbon/ceramic face seal with Teflon wedges. Maximum fluid temperature is 350°F. Same motors as on bronze pumps.

Optional TEFC, explosion-proof, three-phase, or air motors are available on any of these pumps. For accessories, order the same as for the 07080-50 pump model—listed above.

For information on the chemical compatibility of these pumps, see the chemical resistance charts on pages 1183-1191.

See our compact filtration system, including centrifugal pump, on page 328.



Specifications

Flow rate: up to 145 gpm

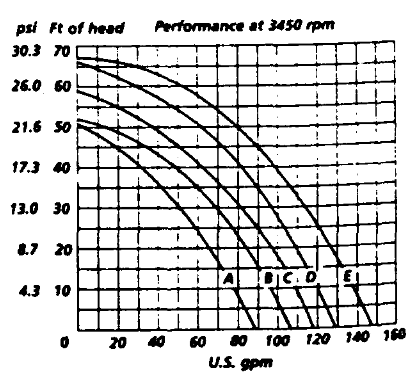
Maximum pressure: 67 feet of head

Maximum temperature: up to 350°F (176°C)

Inlet/outlet ports: 1½" NPT(F)

Legend

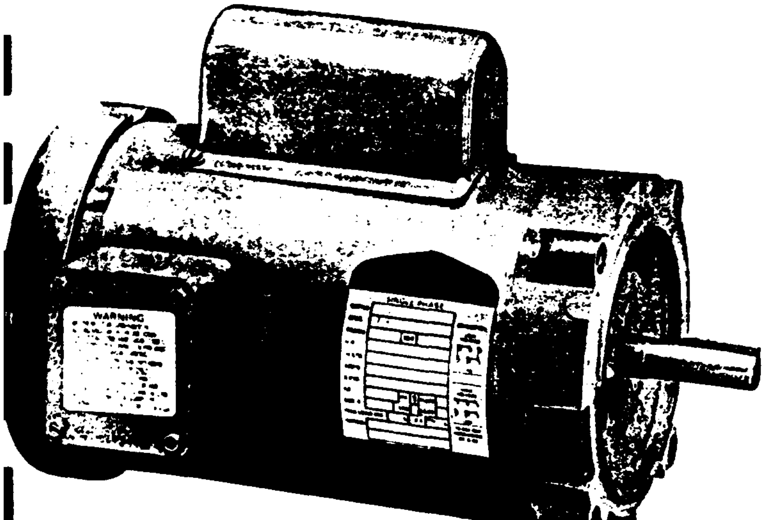
A	½ hp	60 Hz
B	¾ hp	60 Hz
C	1 hp	60 Hz
D	1½ hp	60 Hz
E	2 hp	60 Hz



hp	Max head	Max flow	Dimensions L x W x H	Shpg wt lbs (kg)	Cast iron		Bronze		Stainless steel	
					Cat. no.	Price	Cat. no.	Price	Cat. no.	Price
½	51 ft	89 gpm	18⅛" x 6½" x 10"	36 (16.3)	L-07112-00	$273.00	L-07112-25	$355.00	L-07112-50	$728.00
¾	52 ft	107 gpm	19¼" x 6½" x 10"	54 (24.5)	L-07112-05	290.00	L-07112-30	373.00	L-07112-55	746.00
1	59 ft	119 gpm	21¼" x 6½" x 10"	57 (25.9)	L-07112-10	309.00	L-07112-35	398.00	L-07112-60	770.00
1½	66 ft	125 gpm	21¼" x 6½" x 10"	63 (28.6)	L-07112-15	360.00	L-07112-40	456.00	L-07112-65	828.00
2	67 ft	145 gpm	22⅛" x 6½" x 10"	65 (29.5)	L-07112-20	426.00	L-07112-45	515.00	L-07112-70	887.00

Viton, Teflon—Reg TM E. I. du Pont de Nemours & Co.

NEMA Type C-face electric motors (AC)


07129-20

Use these motors with pumps listed throughout the "Pump" section. TEFC motors and WDD motors have UL approval and are CSA certified. XPRF motors are UL approved and CSA certified for Class 1, Group D only. Motors supplied without cord and plug.

Totally enclosed fan-cooled motors

Catalog number	NEMA frame	hp	rpm	VAC	Phase	Shpg wt lbs (kg)	Price
L-07129-05	56 C	¼	1725	115-208/230	1	23 (10.4)	$166.00
L-07129-10*	56 C	⅓	1725	115-208/230	1	29 (13.2)	185.00
L-07129-48*	56 C	⅓	1725	230/460	3	18 (8.2)	181.00
L-07129-16	56 C	⅓	3450	115/230	1	20 (9.1)	143.00
L-07129-58	56 C	⅓	3450	230/460	3	18 (8.2)	150.00
L-07129-20*	56 C	½	1725	115-208/230	1	34 (15.5)	223.00
L-07129-21*	56 C	½	3450	115-208/230	1	24 (10.9)	170.00
L-07129-30*	56 C	¾	1725	115-208/230	1	41 (18.6)	267.00
L-07129-49*	56 C	¾	1725	230/460	3	24 (10.9)	247.00
L-07129-31*	56 C	¾	3450	115/230	1	37 (16.8)	191.00
L-07129-59*	56 C	¾	3450	230/460	3	22 (10.0)	209.00
L-07129-40*	56 C	1	1725	115-208/230	1	44 (20.0)	303.00
L-07129-42*	56 C	1	3450	115-208/230	1	41 (18.6)	219.00
L-07129-50*	56 C	1½	1725	208-230/460	3	36 (16.3)	245.00
L-07129-54	56 C	2	1725	230/460	3	44 (20.0)	255.00
L-07129-56*	182TC	3	1725	230/460	3	66 (29.9)	366.00

Explosion proof motors

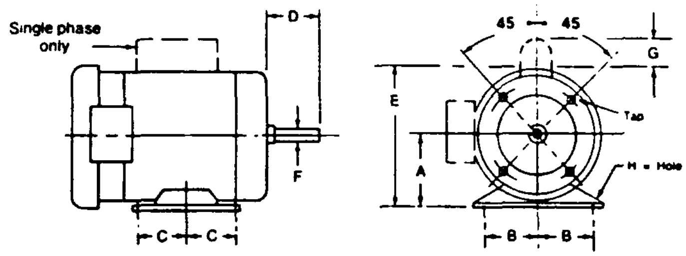
Catalog number	NEMA frame	hp	rpm	VAC	Phase	Shpg wt lbs (kg)	Price
L-07129-15	56 C	⅓	1725	115/230	1	42 (19.1)	$335.00
L-07129-18*	56 C	⅓	3450	115/230	1	47 (21.4)	337.00
L-07129-25*	56 C	½	1725	115/230	1	49 (22.3)	373.00
L-07129-26	56 C	½	3450	115/230	1	47 (21.4)	323.00
L-07129-35*	56 C	¾	1725	115/230	1	54 (24.5)	415.00
L-07129-45*	56 C	1	1725	115/230	1	60 (27.3)	470.00
L-07129-47	56 C	1	3450	115/230	1	57 (25.9)	371.00
L-07129-55	56 C	1½	1725	208-230/460	3	74 (33.6)	484.00
L-07129-67	145TC	2	3450	230/460	3	56 (25.4)	545.00
L-07129-66*	56 C	3	1725	230/460	3	42 (19.1)	522.00

Wash down duty motors

Catalog number	NEMA frame	hp	rpm	VAC	Phase	Shpg wt lbs (kg)	Price
L-07129-80*	56 C	½	1725	115/208-230	1	31 (14.1)	$273.00
L-07129-82*	56 C	¾	1725	115/208-230	1	38 (17.3)	312.00
L-07129-84*	56 C	1	1725	115/208-230	1	38 (17.3)	357.00
L-07129-86*	56 C	1½	1725	115/208-230	1	52 (23.6)	457.00

*Includes base.

Standard motor dimensions (in inches)

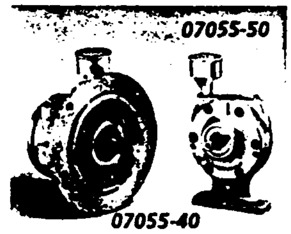


NEMA frame	A	B	C	D	E	F	G	H	Tap
56 C	3½	2 7/16	1½	1⅞	6⅜	⅝	2¼	11/32	⅜-16
145TC	3½	2¾	2½	2¼	6⅞	⅞	2¼	13/32	⅜-16
182TC	4½	3¾	2¼	2¾	9	1⅛	2¼	11/32	½-13

Air motors

Choose from two models. Maximum pressure is 100 psi. Model 07055-40 features reversible shaft rotation.

Cat. no.	L-07055-50	L-07055-40
hp	¾	1½
rpm	50-3000	300-3000
Shpg wt	6 lbs (2.7 kg)	19 lbs (8.6 kg)
Price	$98.50	$165.00



Motor accessories

A) Coupling and spider hardware smooths power transfer, absorb vibration, and compensate for minor misalignment. For complete coupling, order two couplings (at right) and one spider (07127-69).

L-07127-69 Spider **$4.80**

Catalog number	Max hp	Bore dia	Price/ea
L-07127-56	7.2	⅜"	$6.50
L-07127-57	7.2	½"	6.60
L-07127-59	7.2	⅝	6.60
L-07127-61	7.2	¾"	5.30
L-07127-63	7.2	⅞"	5.75
L-07127-65	10	1"	8.10
L-07127-67	10	1⅛"	8.85

B) Coupling guard covers a spider coupling to ensure safety.
L-07127-52 Coupling guard, 6". Aluminum **$29.00**

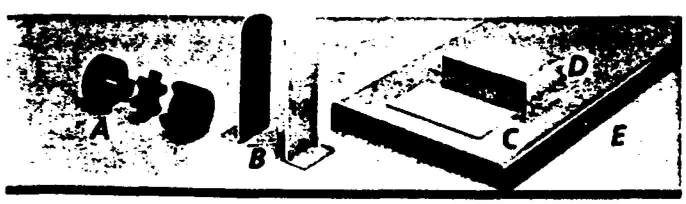
C) Shims correct minor vertical offset between motor and pump.
L-07000-28 Shim, 0.062". Aluminum **$8.50**
L-07000-30 Shim, 0.125". Aluminum **$10.00**

D) Risers adjust vertical alignment between motor and pump, mount on base plate (sold below). Choose height from table.

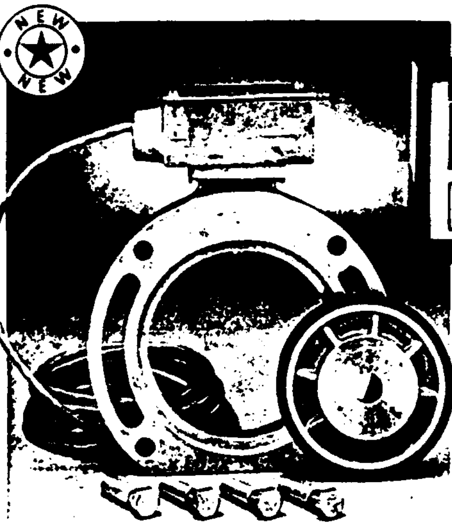
Cat. no.	Height	Price	Cat. no.	Height	Price
L-07000-12	⅛"	$11.00	L-07000-20	1"	$11.00
L-07000-14	¼"	11.00	L-07000-22	1½"	11.00
L-07000-16	½"	11.00	L-07000-24	2"	11.00
L-07000-18	¾"	11.00	L-07000-26	3"	11.00

E) Motor base plate is of steel construction. Two sizes are available.
L-07130-35 Motor base plate, 18"L x 9½"W x 1¼"H **$32.00**
L-07130-37 Motor base plate, 24"L x 9½"W x 1¼"H **$34.00**

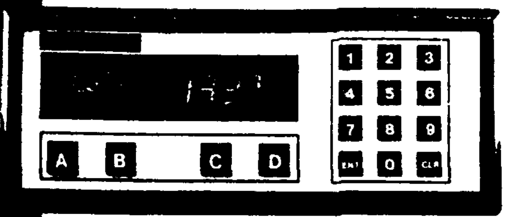
Motor foot bracket (not shown) acts as a base for 56 C-face motors.
L-07127-80 Motor foot bracket, 6"L x 5¾"W x 3"H **$8.58**



New motor tachometer system



70000-00



Monitor and/or control motor rpm with our new motor tachometer system. Start with our new magnetic wheel sensor. Add either our new signal conditioner to provide an analog output, or our new panel-mount monitor/controller for use in a feedback control system.

Magnetic wheel sensor

- Fits NEMA Type 56 C-face motors

This new sensor generates a 0-20 kHz digital pulse train (60 pulses per revolution) that you can input to meters, counters, or computer interfaces.

Simple two-piece construction—attach magnet wheel to the ⅝" dia shaft of your motor; then attach ring sensor to the motor face. Magnet wheel is only 9/16" in width so you can couple pumps, pulleys, or other equipment to your motor.

Magnetic wheel sensor comes complete with magnet wheel, ring sensor, mounting hardware, and a 10 ft. three-conductor connecting cable. See pages 879-880 for our complete selection of NEMA Type 56 C-face motors.

L-70000-00 Magnetic wheel sensor.
Shpt wt 15 lbs (6.8 kg) **$165.00**

Signal conditioner

- Converts pulse train output to 4 to 20 mA and 0 to 10 VDC

Our new signal conditioner (not pictured) accepts frequency input from the magnetic wheel sensor and provides dual analog outputs proportional to motor rpm. Use analog outputs to drive chart recorders and analog or digital meters. Install magnetic wheel sensor up to 1500 feet away from the signal conditioner. Signal conditioner comes in a NEMA Type 4 enclosure.

L-70001-00 Signal conditioner. Shpg wt 3 lbs (1.4 kg) **$405.00**

Panel-mount monitor/controller

08614-70

- Ideal for batch control

Use with magnetic wheel sensor to create a feedback control system. Monitor/controller accepts sensor frequency output signal directly without requiring a signal conditioner. Scale display to read out directly in engineering units. Easily program rpm, flow units (gpm, ml/min), or accumulated flow.

Two SPDT relays (rated for 10 A each) allow on/off control of pumps, valves, or other devices. Monitor/controller also produces a 4-20 mA output signal—use for proportional control or as a recorder output.

Meter provides 12 VDC output to power magnetic wheel sensor. Panel-mount meter fits into a 7.365" x 2.495" cutout.

Cat. no.	VAC	Shpg wt	Price
L-08614-70	115	4 lbs	$509.00
L-08614-75	230	(1.8 kg)	509.00

Specifications

For magnetic wheel sensor 70000-00

Input power: 6 to 24 VDC; 10 mA
Output: 0 to 20 kHz, NPN open collector
Operating temperature
Sensor: −20 to 60°C
Magnetic wheel: −65 to 150°C
Maximum operating speed: 10,000 rpm
Conduit entrance: ½" NPT(F)

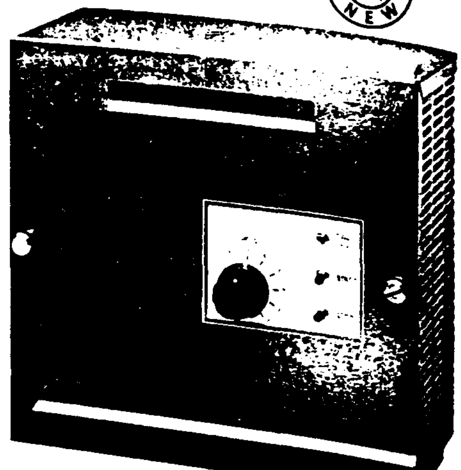
For signal conditioner 70001-00

Signal input: 4.8 Hz to 20 kHz
Excitation output (for magnetic wheel sensor): 13.6 VDC; 50 mA maximum
Signal outputs: 4 to 20 mA and 0 to 10 VDC
Operating temperature: 0 to 70°C
Input power: 115 VAC; 50/60 Hz
Dimensions: 8"L x 6"W x 3½"H

For monitor/controllers 08614-70 and -75

Signal input: up to 20 kHz
Excitation output (for ring sensor): 12 VDC; 100 mA maximum
Signal outputs: two SPDT relays rated for 10 A at 115 VAC
Recorder output: 4 to 20 mA
Display: 8 digit LED
Operating temperature: 0 to 54°C
Dimensions: 7⅜"W x 3 5/16"H x 6½"D

New AC motor speed controller



70050 05

- Controls three-phase motors
- Local or remote control

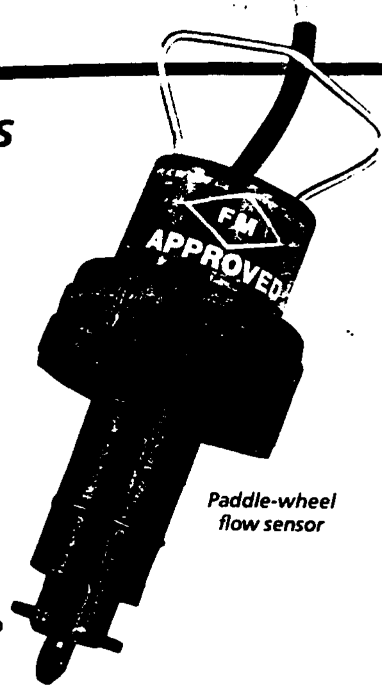
Use these speed controllers with an AC motor to get maintenance free, variable speed operation. Controllers convert single-phase AC voltage into a variable three-phase voltage supply for your three-phase motor (not for use with single-phase motors). Output signal is a high-quality sine wave, generated by a custom pulse-width modulation integrated circuit. Select horsepower via internal jumpers.

Control speed, direction, and start/stop from the front-panel controls. Controller can also accept 0-10 VDC input for remote control of speed; has contact closures for remote start/stop and reversing. Use the auxiliary output (proportional to speed) to connect controller to a display, PLC, or computer interface. Controller inputs and outputs are isolated to minimize electrical noise problems.

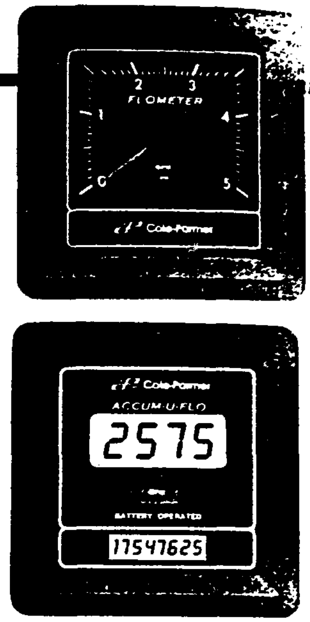
Cat. no.	L-70050-05	L-70050-15
Motor hp/ full load amps	½ hp/2.0 A ¾ hp/2.8 A	¾ hp/3 A 1 hp/4 A 1½ hp/5 A 2 hp/ 7 A
Controller output	0 to 230 VAC (three-phase), 2 to 440 Hz	0 to 230 VAC (three-phase), 2 to 120 Hz
Auxiliary output	0 to 5 VDC	0 to 3600 Hz
Input requirements	230 VAC (single-phase), 50/60 Hz	230 VAC (single-phase), 50/60 Hz
Dimensions (W x H x D)	9¾" x 9" x 4½"	9¾" x 16" x 6"
Shpg wt	7 lbs (3.2 kg)	14 lbs (7.2 kg)
Price	$602.00	$1102.00

Electronic flowmeter systems

- *Simple, accurate liquid flow monitoring—only three primary components*
- *Sensors can be fitted to almost any size pipe*
- *Mix and match components to build your own high-performance system*
- *Optional accessories let you maximize your flow control options*
- *Easy to install—easy to maintain*
- *Interface flow systems with other control instruments to expand system capabilities*



Paddle-wheel flow sensor



Meters available with analog or digital display

Sensors, meters, flow controllers, signal conditioners, installation fittings—the next six pages feature the components you need to customize a flow monitoring or controlling system that will work for you. No matter how complex your requirements, we can help you design a system to fit your application.

How to order your flowmeter system

Each flowmeter system must include:

1) A flow sensor
2) A meter or controller appropriate for your application
3) A pipe fitting.

What you should know before you order:

We calibrate systems to meet the exact requirements of your application. To ensure that we provide you with the correct flowmeter system for your application, please provide us with the following information when ordering.

1. Flow rate in gallons/minute or liters/minute. Minimum, maximum, and average rates are helpful.
2. Type of fluid to be monitored.
3. Percentage of solids in the fluid.
4. Anticipated maximum fluid temperature and system pressure.
5. Pipe size and material.

Selecting the right components

1. Flow sensors. Choose our ROTOR-X™ paddle-wheel flow sensor when flow velocities range from 1 to 30 ft/sec and fluid is relatively free of particulate matter (up to 1%). The heavy-duty METALEX™ 316 stainless steel paddle-wheel flow sensors withstand high temperatures, high pressures, and corrosive fluids. These sensors handle up to 10% particulate matter, over a flow range of 1.5 to 30 ft/sec. Use a MIGHTY-MAG™ magnetic flow sensor for electrically conductive fluids and slurries containing up to 30% particulate matter (minimum 10 μmhos conductivity) where flow velocities range from 0.5 to 30 ft/sec. Sensors are listed on pages 385-386.

2. Meters, accumulators, and controllers. See pages 387-389.

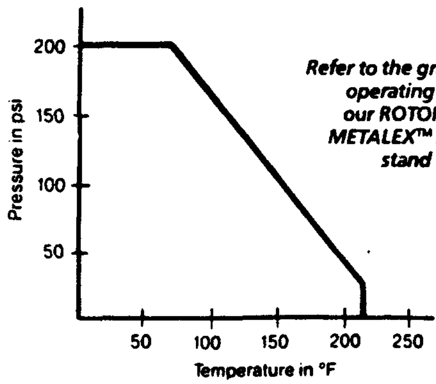
3. Installation fittings. Fittings are precision crafted to ensure proper insertion depth of the sensor and proper flow response. Paddle-wheel and magnetic sensor fittings are sold on page 391. METALEX sensor fittings are sold on page 385.

4. Calibration and scale ranges. Decide what volumetric units you need on your meters, then consult the table below (1 gpm = 3.78 lpm).

5. Temperature and pressure. METALEX sensors withstand up to 300°F (149°C) and 1500 psi when used with minitap fittings; for ROTOR-X capabilities, see graph below left.

6. Accessories. See page 390 for such components as signal converters, testers, and flow limit detectors. Order a dust- and moisture-resistant NEMA Type 4X housing to protect your equipment.

Maximum temperature and pressure



Refer to the graph at left for operating conditions of our ROTOR-X™ sensors. METALEX™ sensors withstand temperatures to 300°F and pressures to 1500 psi.

Scale ranges

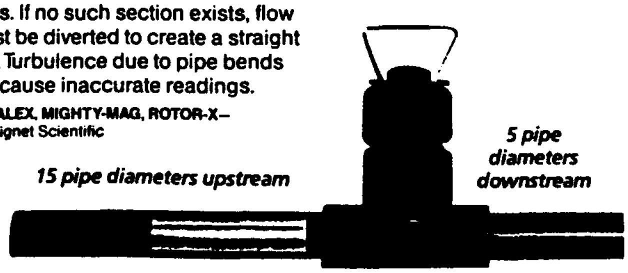
Pipe ID	Minimum monitored flow (gpm)			Scale range #1 (gpm)	Scale range #2 (gpm)	Scale range #3* (gpm)
	Paddle-wheel	METALEX™	Magnetic			
½"	1	1.5	0.5	0-18	0-12	0-8
¾"	1.5	2.5	0.7	0-30	0-18	0-12
1"	2.7	4.1	1.3	0-50	0-30	0-18
1¼"	4.5	7.0	2.2	0-80	0-50	0-30
1½"	6.2	9.6	3.1	0-120	0-80	0-50
2"	10.5	16	5.2	0-180	0-120	0-80
2½"	15	23	7.5	0-300	0-180	0-120
3"	23	35	11.5	0-500	0-300	0-180
4"	39	60	19.5	0-800	0-500	0-300
5"	61	95	30.5	0-1200	0-800	0-500
6"	88	135	44	0-1800	0-1200	0-800
8"	154	235	77	0-3000	0-1800	0-1200
10"	240	370	120	0-5000	0-3000	0-1800
12"	346	530	173	0-8000	0-5000	0-3000

*Model 05621-30 sensor cannot be calibrated for scale range #3.

Installing the flow sensor

Paddle-wheel and magnetic sensors must be installed in a full-flowing, straight section of pipe. Allow a straight run of pipe at least 15 pipe diameters before the sensor and 5 pipe diameters following the sensor after any bends, valves, or flow restrictions. If no such section exists, flow must be diverted to create a straight run. Turbulence due to pipe bends will cause inaccurate readings.

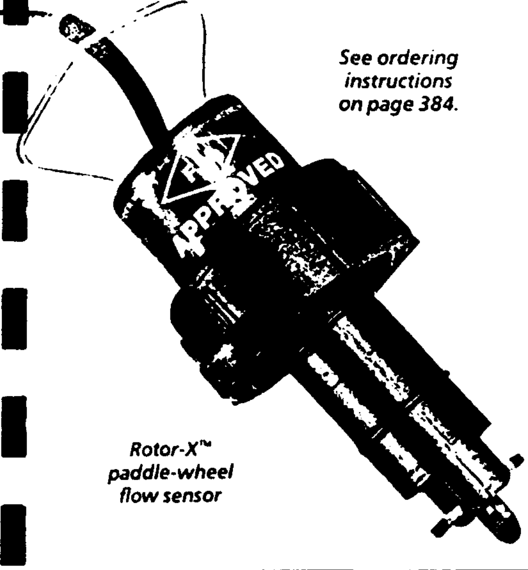
METALEX, MIGHTY-MAG, ROTOR-X–TM Signet Scientific



Flow sensors

Rotor-X™ paddle-wheel flow sensors

■ *Open-core design ensures accurate, linear output to ±1%*



See ordering instructions on page 384.

Rotor-X™ paddle-wheel flow sensor

Sensors contain an open-core rotor with a small magnet in each of the four paddles. As they rotate, the magnets pass a coil in the sensor. The transducer generates a linear frequency output that is proportional to the flow velocity. This signal travels up to 200 feet without amplification. The minimum flow velocity to produce a linear signal is 1 ft/sec.

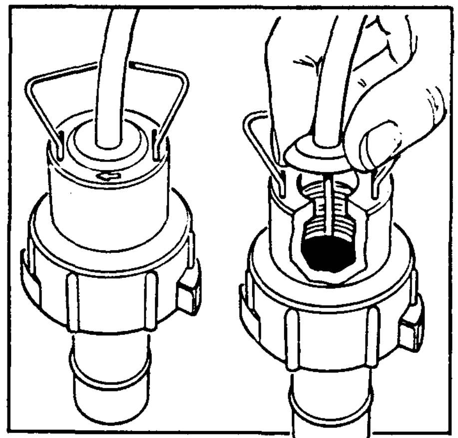
The patented open-core design eliminates cavitation at flow velocities up to 30 ft/sec. Closed or solid paddle-wheel designs create air bubbles at these velocities causing a nonlinear and nonrepeatable signal.

The sensor materials are inert to most chemicals. Rotor is polyvinylidene fluoride (PVDF). Choose glass-filled polypropylene body with titanium paddle shaft or PVDF body with Hastelloy C* shaft.

Use with relatively clear fluids, low to medium viscosity. Mount in any type of pipe. See our wide range of pipe fittings on page 391.

Catalog number	Body material	Shaft material	Pipe size	Sensor length	Minimum flow	Price
L-05618-10	Polypropylene	Titanium	½" to 4"	3½"	1 ft/sec	$195.00
L-05618-11	Polypropylene	Titanium	5" to 8"	5"	1 ft/sec	210.00
L-05618-12	Polypropylene	Titanium	10" and up	7¾"	1 ft/sec	230.00
L-05618-13	PVDF	Hastelloy C*	½" to 4"	3½"	1 ft/sec	385.00
L-05618-14	PVDF	Hastelloy C*	5" to 8"	5"	1 ft/sec	400.00
L-05618-15	PVDF	Hastelloy C*	10" and up	7¾"	1 ft/sec	430.00

*Hastelloy C–Reg TM Cabot Corporation



Use paddle-wheel flow sensors with leads exposed or installed in ½" conduit *Pry up the rubber cap to expose ½" NPT(F) conduit threads*

Specifications

Signal: 1 volt peak-to-peak per ft/sec; 8 kΩ source impedance with frequency of 5 to 6 Hz per ft/sec
Flow range: 1 to 30 ft/sec
Linearity: ±1% full scale
Repeatability: ±0.5% full scale
Max temp at 25 psi: 220°F (104°C)
Max pressure at 77°F (25°C): 200 psi
Max % solids: 1% of fluid volume
Standard cable: 25 ft long, supplied
Sensor diameter: 1¾"

Brass sensors for flows down to 0.7 ft/sec available on request. Call us for information.

Metalex™ paddle-wheel flow sensors

■ *Stainless steel body withstands high pressures and high temperatures*

Use these rugged sensors to monitor the flow of liquid ammonia, turbine steam condensate, and more—wherever strength and chemical resistance are required.

Open-core rotor is cavitation free up to 30 ft/sec, and is ideal for liquids containing up to 10% particulates. Easy maintenance—replaceable in minutes.

Sensors are compatible with all of our line- and battery-powered flowmeters, accumulators, and controllers on pages 387-389. The sine wave output signal is compatible with computers, data loggers, etc.

METALEX™ sensors feature CD4MCU rotors; Fluoroloy B rotor bearings; 316 SS bodies, rotor shafts, and shaft retainers. Choose from minitap and saddle fitting models.

Catalog number	Pipe size	Use with fitting type	Price
L-05618-60	½" to 1"	Minitap	$310.00
L-05618-64	1¼" to 12"	Minitap	310.00
L-05618-80	2" to 12"	Saddle	310.00

Specifications

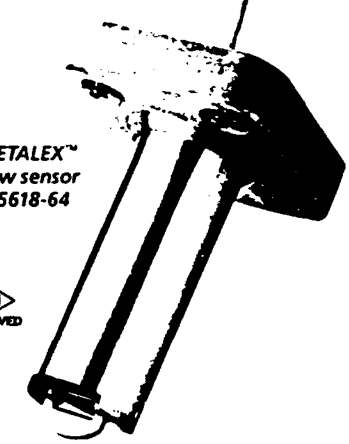
Signal: sine wave, at approximately 10 to 14 Hz per ft/sec; 10 kΩ source impedance
Flow range: 1.5 to 30 ft/sec
Linearity: ±1% of full scale
Repeatability: ±0.5% of full scale
Max temperature: 300°F (150°F for saddle fitting)
Max pressure: 1500 psi (300 psi in saddle fitting)

Rotor-X, Metalex–TM Signet Scientific

Fittings for Metalex™ sensors

Catalog number	Pipe size	Fitting type	Use with sensor	Price
L-05618-61	½"	Minitap	05618-60	$189.00
L-05618-62	¾"	Minitap	05618-60	189.00
L-05618-63	1"	Minitap	05618-60	189.00
L-05618-65	1¼"	Minitap	05618-64	189.00
L-05618-66	1½"	Minitap	05618-64	189.00
L-05618-70	2"	Minitap	05618-64	189.00
L-05618-71	2½"	Minitap	05618-64	189.00
L-05618-72	3"	Minitap	05618-64	189.00
L-05618-73	4"	Minitap	05618-64	189.00
L-05618-74	5"	Minitap	05618-64	189.00
L-05618-75	6"	Minitap	05618-64	189.00
L-05618-76	8"	Minitap	05618-64	189.00
L-05618-77	10"	Minitap	05618-64	189.00
L-05618-78	12"	Minitap	05618-64	189.00
L-05618-81	2"	Saddle*	05618-80	210.00
L-05618-84	4"	Saddle*	05618-80	231.00

*Saddle fittings for 5-12" pipe available on request.



METALEX™ flow sensor 05618-64

Minitap fitting 05618-70