FINAL **SCHEMATIC DESIGN REPORT**

Bend Water Reclamation Facility Secondary Expansion Project

OCTOBER 2011

PREPARED BY **CH2MHILL**

IN ASSOCIATION WITH **WHPacific**

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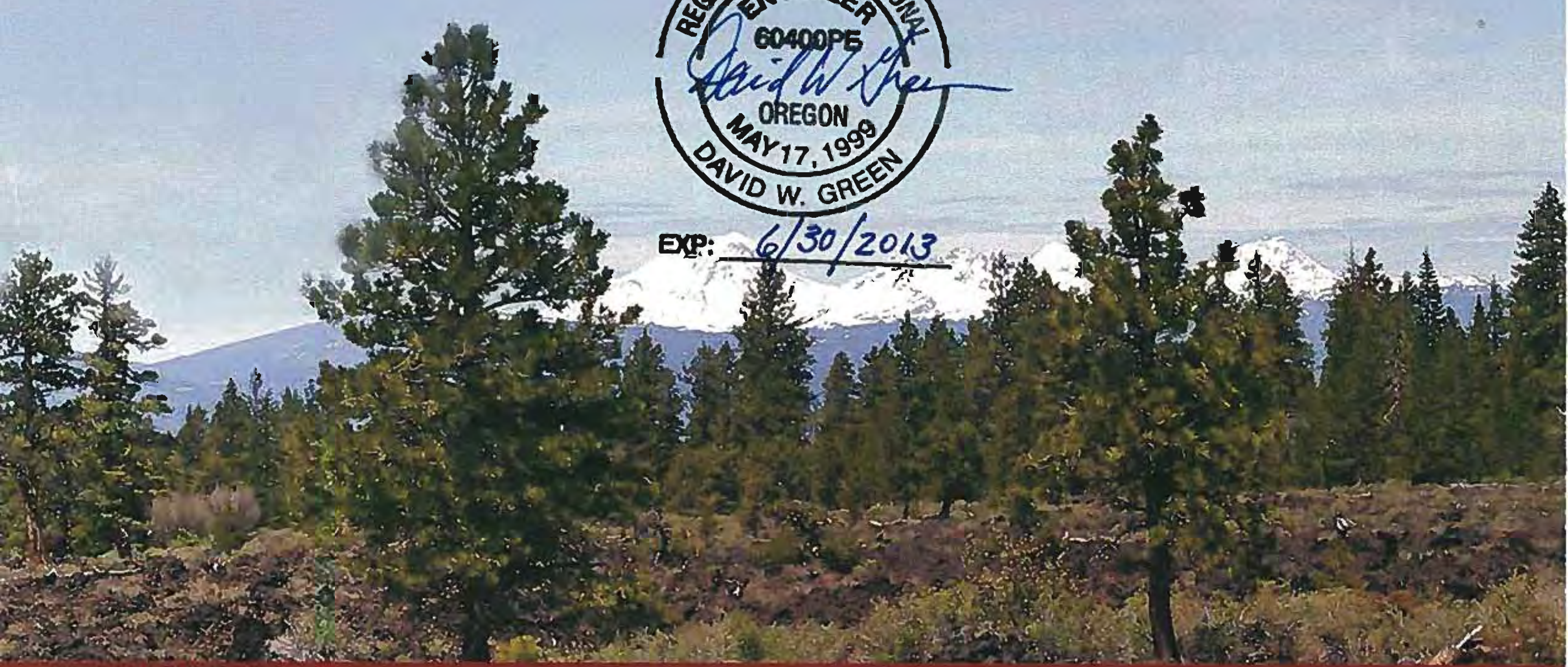

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Appendixes

Drawings

Bound separately.

TM 1—Project Background, Criteria, and Objectives

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DATE: October 3, 2011

PROJECT: Schematic Design Report
Bend Water Reclamation Facility Secondary Expansion

Introduction

The purpose of this technical memorandum is to define and document the project background, design criteria and project objectives that influence the Bend Water Reclamation Facility (WRF) secondary expansion predesign project. This memorandum also documents the goals and success criteria of the project.

The following information is summarized in this memorandum:

- Predesign goals and success criteria
- Overview of the design process
- Key regulatory requirements
- Projected flows and loads

For reference, the following information is already documented in the Project Definition Report (CH2M HILL, February 2011) and not repeated in this Schematic Design Report:

- City of Bend standards and preferences
- Standards, code requirements, and design criteria for:
  - Site and civil design
  - Structural design
  - Architectural design
  - Process mechanical design
  - Building services design
  - Electrical design criteria
  - Instrumentation and control (I&C) design

Predesign Goals and Objectives

The predesign team has endeavored to ensure the project satisfies the following goals and objectives:

- Incorporate community values and concerns

- Maximize community acceptance of the facility
- Maximize the value of Bend investment in facilities
- Minimize Bend customer rate impacts
- Consider and balance both short-term and long-term facility concerns and investment
- Meet state, Federal, and local regulatory requirements
- Maximize the facilities' ability to meet future regulatory requirements
- Provide reliable and efficient technology recommendations
- Provide for continued operation of the existing facility during construction
- Balance capital expense with operation and maintenance expense
- Provide operable, maintainable, reliable, sustainable, and flexible facilities
- Provide an orderly and systematic progression of facility renovation, replacement, and enhancement through detailed design and construction
- Provide guidance for future facility expansion
- Recommend and document technical criteria, decisions, and recommendations for facilities
- Establish budget-level cost estimates for facilities
- Establish an implementation schedule for design and construction of facilities
- Recommend effective implementation of delivery process for construction of facilities
- Satisfy Oregon Department of Environmental Quality (DEQ) criteria and interaction needs during predesign
- Address corrosion resistance in materials used, provide adequate ventilation and be suitable for implementation of future odor control
- Provide accurate flow measurement and sampling
- Provide a quality design, minimizing unforeseen issues
- Implement predesign phase document tracking and handling in EADOC

Overview of the Design Process

The predesign phase incorporates the first two phases of CH2M HILL's four-phase design process. For a typical design-bid-build approach, the four-phase design process includes the following:

- Phase 1: Project Definition
- Phase 2: Schematic Design
- Phase 3: Design Development
- Phase 4: Construction Document Preparation

The purpose of the overall predesign process is to take the Bend WRF secondary expansion project to an approximate 30 percent complete level through two design phases: Project Definition and Schematic Design. The Phase 1 Project Definition Report, which was completed and accepted by the City of Bend in February 2011, defined the overall project requirements and provided a clear picture of the entire, upgraded facility. The objective of the Project Definition phase was to select and finalize significant project components and site layout such that Phase 2: Schematic Design can proceed efficiently.

This Schematic Design report builds on the results of the Phase 1 Project Definition work as well as the work captured in previous reports, in particular the Preliminary Process Evaluation Summary (CH2M HILL, September 2010), the Value Engineering Report (CH2M HILL, June 2009), and the Bend WRF Facilities Plan (Carollo, April 2008).

The purpose of schematic design and this report is to further develop and refine the design concepts developed during the project definition phase. In addition, this schematic design report updates the construction cost estimate for the proposed project. This report also summarizes the steps and processes involved in developing and finalizing the recommendations for the schematic design phase, including workshops and the development of technical memorandums that form the foundation for the predesign.

The design approach for the schematic design phase included three additional interactive workshops meant to facilitate information transfer from the project team to the City of Bend and to engage the City in important project decisions. The results of these workshops are documented in meeting minutes and workshop slides, which can be found in Appendix A to this Schematic Design Report. The draft deliverables and the material presented in the workshop slides document the progress of the design and culminated in the fact sheets and technical memorandums found in this schematic design report.

Background

The *City of Bend Water Reclamation Facilities Plan* (Carollo, April 2008) recommended improvements to meet the current and future treatment needs of the Bend WRF. The facilities plan recommended filtrate reaeration, with the existing MLE basins, as the treatment approach for capacity expansion. Prior to embarking on the secondary expansion predesign project based on this selected treatment alternative, the City of Bend chose to conduct a value planning effort to validate the facilities plan recommendation and identify alternative solutions that may provide more value or improved performance with reduced capital and lifecycle costs.

The value planning process involved two steps. A value engineering workshop was held, in which process experts from CH2M HILL identified a number of alternatives for capacity expansion and process optimization at the Bend WRF. The *Value Engineering Report* (CH2M HILL, June 2009) summarizes the identified alternatives. A process refinement study was then conducted to select the most appropriate treatment alternative to carry forward into the secondary expansion predesign project. The process refinement study compared the facilities plan alternative to others identified during the value engineering workshop and considered capital and operating costs, treatment reliability, operational complexity, construction constraints, technology application and experience, ability to meet future more stringent effluent limits, and ease of future capacity expansion. The results of the process refinement study can be found in the *Preliminary Process Evaluation Summary* (CH2M HILL, September 2010).

The value planning process resulted in a shift in the secondary treatment approach from the recommended facilities plan alternative of filtrate reaeration to an integrated fixed-film activated sludge (IFAS) process. IFAS incorporates biofilm carrier media into the activated sludge process. The biofilms that develop on the carrier media allow the biological treatment process to maintain full nitrification at a reduced aerobic solids retention time (SRT), which provides an increase in treatment capacity with the same reactor volume.

Based on the design criteria, the *Project Definition Report* (CH2M HILL, February 2011) defined the number, location and type of process elements moving forward (expanded primary clarification, secondary treatment utilizing the IFAS process, a new blower building utilizing turbo blowers, disinfection using sodium hypochlorite, and in-vessel ultraviolet disinfection for reuse water). In addition, the solids processing upgrades were defined, as well as plant utility (compressed air, plant water, etc.) requirements.

This Schematic Design Report documents the continued development and evolution of the design, including better definition of support utilities and discipline design elements (structural, electrical, etc.). Key design criteria are presented in this technical memorandum, and project recommendations are summarized in *TM 2 – Process and Facilities Overview*. Each of the individual unit process areas and discipline design elements are described in detail in the attached technical memoranda and presented in the attached drawing package.

Influent Flows and Loads

The recent economic downturn resulted in a decrease in population growth in the City of Bend, which also decreased the rise of wastewater flows and loads requiring treatment. Therefore, the flows currently reaching the treatment facility are lower than the projections made during the facility planning effort. It is not clear when growth will start again and whether it will resume at a rate consistent with the previous growth rate. Therefore, the long-term implementation schedule needs to be flexible enough to accommodate variations in future population growth and future flows and loads. As a result, one of the goals of this predesign work is to develop solutions that can be phased in quickly, accommodating the resurgence of flow and load growth, when it does begin to occur.

There are three critical design capacities for the Bend WRF secondary expansion project. *Technical Memorandum 6 – Process Design Criteria* (*Project Definition Report* [CH2M HILL, February 2011]) provides additional information on these three design capacities.

Required Near-Term Capacity. The City of Bend has authorized development on properties with a substantial number of equivalent dwelling units (EDUs) that have not yet connected to the City sewer system. Hydraulic modeling has been performed by the City to estimate the required near-term treatment capacity if all authorized EDUs connect to the City sewer system. The minimum required near-term process capacity is set at 8.5 million gallons per day (mgd) on an average day maximum month (ADMM) basis based on the results of these preliminary estimates. *TM 6 – Process Design Criteria* (*Project Definition Report* [CH2M HILL, February 2011]) provides more information on the next steps to confirm this critical design value.

2030 Facilities Plan Capacity. *Technical Memorandum No. 1 Flow and Waste Load Projections* (Carollo, 2008) developed the flow and load projections through the 2030 planning horizon which provide the basis for this project. Table 1 summarizes the 2030 Facilities Plan flow and load projections.

TABLE 1
2030 Facilities Plan Projected Flows and Loads*
City of Bend WRF Secondary Expansion Project

Flow Condition (mgd)	**2030**
Average Annual Flow	10.9
Average Day Maximum Month Flow	11.9
Peak Day Flow	13.6
Peak Dry Weather Flow	21.4
Peak Wet Weather Flow	29.1
Biochemical Oxygen Demand Loading (ppd)	
Average Annual	33,090
Average Day Maximum Month	38,800
Total Suspended Solids Loading (ppd)	
Average Annual	36,453
Average Day Maximum Month	42,600
Total Kjeldahl Nitrogen Loading (ppd)	
Average Annual	4,818
Average Day Maximum Month	5,900
NH_3-N Loading (ppd)	
Average Annual	2,545
Average Day Maximum Month	3,600

**Source: City of Bend Water Reclamation Facilities Plan Technical Memorandum No. 1 Flow and Waste Load Projections* (Carollo, 2008).

ppd = pounds per day.

Collection System Buildout Peak Wet Weather Capacity. The Collection System Master Plan InfoSWMM model was originally prepared by MWH with subsequent modifications by Murray Smith and Associates (MSA) and is being used on current projects by CH2M HILL. The model reflects all changes and updates to the buildout collection system model performed by MSA as documented in the current CSMP Addendum #2. The City provided the most recent buildout model to CH2M HILL in support of the Parallel Plant Interceptor study. The collection system model was run by the City's consultant design team in December 2010 to confirm the buildout peak wet weather flow rate, which was found to be approximately 50 mgd. Buildout requirements include improvements to the plant and improvements to the collection system such as the crossing over the nearby irrigation canal (currently, the crossing limits influent flow to approximately 30 mgd).

Regulatory Requirements

Current WPCF Permit

The Bend WRF operates under Water Pollution Control Facilities (WPCF) permit number OR-101572, issued by DEQ, and which expires on November 30, 2015. The WRF discharges treated effluent either to evaporation/seepage ponds, or as recycled water. The facility produces Class A recycled water, which is discharged for irrigation via Outfall 004. However, the facility is also permitted to produce Class B and Class C recycled water through Outfalls 002 and 003, respectively. The WPCF effluent limits for the Bend WRF are shown in Table 2.

TABLE 2
Current WPCF Discharge Requirements
City of Bend WRF Secondary Expansion Project

	30-Day Average		**7-Day Average**		**Daily Maximum**
Biochemical oxygen demand (BOD)	20 mg/L	1,000 mg/L	30 mg/L	1,500 ppd	2,000 ppd
Total suspended solids (TSS)	20 mg/L	1,000 mg/L	30 mg/L	1,500 ppd	2,000 ppd
E. Coli bacteria	126 organisms/100 mL		406 organisms/100 mL		
Total nitrogen	Annual monthly average effluent concentration of 10 mg/L				
pH	Shall be within the range 5.5 and 9.0				
Class A recycled water	(1) Total coliform shall not exceed a 7-day median of 2.2 organisms/100 mL, and no single sample to 23 organisms/100 mL (2) Turbidity shall not exceed a 24-hour mean of 2 NTU, and shall not exceed 5 NTU for more than 5% of the time during a 24-hour period				

mg/L = milligrams per liter; NTU = nephelometric turbidity unit; ppd = pounds per day.

Future Regulatory Requirements for Recycled (Reclaimed) Water

The standards for effluent reuse in Oregon are established by DEQ through Oregon Administrative Rule Chapter 340 Division 55 (OAR 340-55). This rule was updated in 2008, changing the definitions of reclaimed water. Under the revised rule, Oregon defines four levels of recycled treatment, Classes A through D plus a fifth category, oxidized and not disinfected. Class A is oxidized, filtered, and disinfected. Classes B, C, and D are oxidized and disinfected and vary by allowable bacterial count. When the WPCF permit for the Bend WRF was renewed, the recycle classification changed to be consistent with the terms of the new rule. With these new rules, the water currently produced by Bend WRF is reclassified as Class A. *TM 11 – Energy Efficiency and Sustainability Opportunities* (Project Definition Report, CH2M HILL, 2011) provides additional information on the changes to the recycled water regulations in the State of Oregon.

Potential Future Regulatory Requirements for Total Nitrogen

Because the effluent from the Bend WRF is discharged through evaporation/seepage ponds, the WRF must monitor groundwater wells as part of its WPCF permit requirements to ensure that the wastewater discharge to the groundwater is not detrimental to groundwater quality. The *Bend WRF Facilities Plan* (Carollo, April 2008) evaluated lower effluent total nitrogen limits of 6 milligrams per liter (mg/L) and 3 mg/L to account for potentially more stringent WPCF permit requirements in the future for groundwater protection. DEQ reviewed the *Bend WRF Facilities Plan* (Carollo, April 2008) and responded with a memorandum on February 27, 2009. The facilities plan recommended an expansion of the evaporation/seepage ponds to accommodate buildout future flows. DEQ approved the proposed expanded discharge in the facilities plan with no further nitrogen removal based on the following conditions:

- The facility will be required to continue its groundwater protection program.
- The facility will be required to reevaluate its groundwater monitoring network to verify adequate coverage is being achieved with the expanded seepage ponds.
- The facility will be required to closely monitor the concentrations of down-gradient monitoring wells.
- In the event down-gradient monitoring well nitrate concentrations reach 5 mg/L, the facility will be required to upgrade the current treatment process to achieve lower effluent nitrogen levels.
- An upgrade of the facilities groundwater monitoring plan will be required to evaluate the effectiveness of the monitoring well network as well as the analyte list to determine if additional metals must be added to the list.

Construction Permits

Permits will be required before initiation of construction activities including building permits, land use permits, and permits for erosion control/stormwater discharge. The project team will continue to identify necessary permits to ensure obtaining these permits does not hinder construction.

Plant Reliability Criteria

The U.S. Environmental Protection Agency (EPA) requires that wastewater facilities meet the requirements for reliability and redundancy in their treatment components and associated equipment. The reliability and redundancy standards establish minimum levels of reliability for three classes of wastewater works. Oregon DEQ has classified wastewater facilities in Oregon and applied these EPA Reliability Criteria, governing the reliability of mechanical, electrical, and fluid systems used in wastewater systems. The standards are intended to protect the environment, particularly receiving waters, against unacceptable degradation resulting from power failure, flood, peak loads, equipment failure, and maintenance shutdowns. The standards are divided into three, decreasingly stringent classes of reliability: I, II, and III.

The EPA Reliability classification of the Bend WRF was discussed at a meeting with Oregon DEQ, CH2M HILL, and the City of Bend on October 28, 2010. Because the Bend WRF does not discharge to a surface water with human contact, the Bend WRF was determined to be a Class II facility at the October 28, 2010, meeting.

Table 3 provides the Class II component reliability standards as they relate to the City of Bend WRF. For the purposes of the work at the City of Bend WRF, the reliability criteria for chlorine contact basins have been applied to the ultraviolet disinfection basins proposed in this Schematic Design Report.

Excerpts from the EPA technical bulletins *Design Criteria for Mechanical, Electrical, and Fluid System and Component Reliability* (EPA-430-99-74-001) and *Construction Grants CG-85* (EPA-430-9-84-004) are attached for reference.

TABLE 3
Class II Component Reliability Standards
City of Bend WRF Secondary Expansion Project

Component	Reliability Criteria
Mechanical screens	Backup screen required for peak flow
Primary clarifiers	Multiple basins; with largest unit of our service, remaining basins have capacity for at least 50% design flow
Aeration basins	Minimum of two of equal volume; no backup required
Aeration blowers	Multiple units required; with the largest unit out of service, remaining units shall be able to maintain the design oxygen transfer efficiency. The backup unit may be uninstalled.
Air diffusers	Multiple sections; with largest unit out of service, oxygen transfer capability not measurably impaired
Secondary clarifiers	Multiple basins; with larges unit out of service, remaining basins have capacity for at least 50% design flow
Filters	Backup not required.
UV disinfection	Multiple channels; with larges unit out of service, remaining channels have capacity for at least 50% design flow
Anaerobic digesters	Minimum of two tanks
Sludge mixed equipment	Backup equipment or flexibility of system such that with one piece of equipment out of service, total mixing capability is not lost; backup equipment may be uninstalled.
Sludge pumping	Sufficient capacity to handle peak flow with one unit out of service. Backup may be uninstalled
Electrical power	Two separate and independent electric power sources for either two separate utility substations or one substation and one standby generator. The backup power source should have capacity of operate mechanical bar screens, main pumps, primary sedimentation, disinfection, and critical lighting and ventilation. For Class II facilities, treatment should be at least equivalent to primary sedimentation and disinfection.

Attachments

Attachment A—EPA Technical Bulletin Excerpts

- Excerpt from *Design Criteria for Mechanical, Electrical, and Fluid System and Component Reliability* (EPA-430-99-74-001)
- Excerpt from *Construction Grants CG-85* (EPA-430-9-84-004)

Attachment A—EPA Technical Bulletin Excerpts

ONSTRUCTION GRANTS PROGRAM

DESIGN CRITERIA FOR MECHANICAL, ELECTRIC, AND FLUID SYSTEM AND COMPONENT RELIABILITY

U.S. ENVIRONMENTAL PROTECTION AGENCY

criteria by giving examples of designs which are in conformance with the criteria.

- Consideration and Where Practicable - Used to specify criteria which shall be considered by the Grant Applicant, but which are not mandatory.

Reliability Classification

These requirements establish minimum standards of reliability for three classes of wastewater treatment works. Unless identified as applying to a particular class, all criteria contained in this document apply equally to all three classes. The reliability classification shall be selected and justified by the Grant Applicant, subject to the approval of the Regional Administrator, and shall be based on the consequences of degradation of the effluent quality on the receiving navigable waters. This document does not specify requirements for classifying works; however, suggested guidelines are:

Reliability Class I	Works which discharge into navigable waters that could be permanently or unacceptably damaged by effluent which was degraded in quality for only a few hours. Examples of Reliability Class I works might be those discharging near drinking water reservoirs, into shellfish waters, or in close proximity to areas used for water contact sports.

Reliability Class II	Works which discharge into navigable waters that would not be permanently or unacceptably damaged by short-term effluent quality degradations, but could be damaged by continued (on the order of several days) effluent quality degradation. An example of a Reliability Class II works might be one which discharges into recreational waters.
Reliability Class III	Works not otherwise classified as Reliability Class I or Class II.

Note: Pumping stations associated with, but physically removed from, the actual treatment works could have a different classification from the works itself.

Table 1 Wastewater Treatment System Rellability

WASTEWATER TREATMENT SYSTEM			
Features Common to Class I, II, III: Trash removal or comminution Grit removal - not applicable to treatment works which do not pump or dewater sludge (e.g., stabilization ponds) Provisions for removal of settled solids - applicable to channels, pump wells, and piping prior ro degritting or primary sedimentation Holding basin - applicable to Class I with adequate capacity for all flows Unit operation bypass - not applicable where two or more units are provided and operating unit can handle peak flow; applicable to comminution regardless of number of units			
Component Backup Features	**Class I**	**Class II**	**Class III**
Backup bar screen for mechanically cleaned screen or comminutor	yes	yes	yes
Backup pump	yes[a]	yes[a]	yes[a]
Primary sedimentation basins	Multiple basins[b]	Multiple basins[b]	minimum, two [b]
Trickling filters	Multiple filters[c]	Multiple filters [b]	No backup
Aeration basin	Minimum of two of equal volume	Minimum of two of equal volume	Single basin permissible
Aeration blowers or mechanical aerators	Multiple units [d]	Multiple units [d]	Minimum, two [d]
Air diffusers	Multiple sections [e]	Multiple sections [e]	Multiple sections [e]
Final sedimentation basins	Multiple basins [c]	Multiple basins [b]	minimum, two [b]
Chemical flash mixer	Minimum of two or backup [f]	No backup	No backup
Chemical sedimentation basins	Multiple basins [c]	No backup	No backup
Filters and activated carbon columns	Multiple units [c]	No backup	No backup
Flocculation basins	Minimum, two	No backup	No backup
Disinfection basins	Multiple basins [b]	Multiple basins [b]	Multiple basins [b]

[a] Sufficient capacity of remaining pump to handle peak flow with one pump out of service
[b] With largest unit out of service remaining units have capacity for at least 50 percent of design flow
[c] With largest unit out of service remaining units have capacity for at least 75 percent of design flow
[d] With largest unit out of service remaining units able to maintain design oxygen transfer; backup unit may be uninstalled
[e] With largest section out of service oxygen transfer capability not measurably impaired
[f] If only one basin, backup system provided with at least two mixing devices (one may be uninstalled)

Source: EPA Construction Grants 1985 (CG-85) [430/9-84-004]

Table 2 Sludge Handling and Disposal System Reliability

SLUDGE HANDLING AND DISPOSAL SYSTEM
Features Common to Class I, II, III: Alternate methods of sludge disposal and/or treatment - applicable to unit operations without backup capability Provisions for preventing contamination of treated wastewater
Component Backup Features Common to Class I, II, III: Sludge holding tanks - permissible as alternate to backup capability with adequate capacity for estimated time of repair Backup pump - sufficient capacity of remaining pumps to handle peak flow with one pump out of service; backup pump may be uninstalled Anaerobic sludge digestion Digestion tanks - at least two digestion tanks Sludge mixing equipment - backup equipment or flexibility of system such hat with one piece of equipment out of service total mixing capability is not lost; backup equipment may be uninstalled Aerobic sludge digester Aeration basin - backup not required Aeration blowers or mechanical aerators - at least two units; permissible for less than design oxygen transfer with one unit out of service; backup unit may be uninstalled Air diffusers - with largest section out of service oxygen transfer capability not measurably impaired Vacuum filter - multiple filters with capability to dewater design sludge flow with largest capacity filter out of service; each filter serviced by two vacuum pumps and two filtrate pumps Centrifuges - multiple centrifuges with capacity to dewater design sludge flow with largest capacity centrifuge out of service Incinerators - backup not required; backup required for critical auxiliary components (e.g., center shaft cooling fan)

Source: EPA Construction Grants 1985 (CG-85) [430/9-84-004]

Table 3 Electric Power System Reliability

ELECTRIC POWER SYSTEM			
Features Common to Class I, II, III: Power Source - two separate and independent electric power sources from either two separate utility substations or one substation and one standby generator			
Capacity of backup power source	**Class I**	**Class II [a]**	**Class III [a]**
Mechanical bar screen or comminutors	Yes	Yes	Yes
Main pumps	Yes	Yes	Yes
Degritting	Optional	No	No
Primary sedimentation	Yes	Yes	Yes
Secondary treatment	Yes	Optional	No
Final Sedimentation	Yes	Optional	No
Advanced waste treatment	Yes	Optional	No
Disinfection	Yes	Yes	Yes
Sludge handling and treatments	Optional	No	No
Critical lighting and ventilation	Yes	Yes	Yes

[a] At least treatment equivalent to sedimentation and disinfection

Source: EPA Construction Grants 1985 (CG-85) [430/9-84-004]

TM 2—Process and Facilities Overview and Recommendations

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DATE: October 3, 2011

PROJECT: Schematic Design Report
Bend Water Reclamation Facility Secondary Expansion

Objective

This technical memorandum summarizes the Bend Water Reclamation Facility (WRF) secondary expansion mass balance, design summary data, key equipment, and process and facility improvements for the recommended project at the end of Schematic Design.

Introduction

The secondary expansion project generally includes the addition of a third primary clarifier, a fourth aeration basin, a fourth secondary clarifier (by approximately 2025) with mixed liquor conveyance and flow splitting improvements, a new blower building, new disinfection facility, chemical building, plant water pump station and significant yard piping and hydraulic improvements. Drawings depicting these facilities are included in the Schematic Design submittal drawing set.

Mass Balance

The mass balances for startup (6 million gallons per day [mgd] average day maximum month [ADMM] flow) and year 2030 (11.9 mgd ADMM flow) are shown in Tables 1 and 2, respectively.

Design Summary Data

Design summary data for the secondary expansion are shown in Table 3.

Hydraulic Profile

The hydraulic profile for the proposed process changes is included in the Schematic Design submittal drawing set.

Equipment List

The equipment list associated with the proposed unit process upgrades is shown in Attachment A.

Pipe Schedule

The draft pipe schedule is shown in Attachment B.

Process Summary and Recommendations

Primary Treatment

A new primary clarifier will be constructed along with an associated primary sludge pump station. The existing primary sludge pump station will also be upgraded as part of the current project.

Existing Primary Clarifiers 1 and 2

A 30-inch influent pipe discharges to the existing primary splitter box. The splitter box splits flow to the two existing clarifiers and has the capability to connect a future third primary clarifier. Yard piping updates to increase the conveyance of primary influent from the headworks will use the existing connection in the primary influent splitter box to connect an additional 30-inch primary influent pipe. This will eliminate the ability to install future additional primary clarifiers using this existing infrastructure.

Flow is split to the primary clarifiers via fixed weirs and is then conveyed to each clarifier through a 24-inch pipe. The primary influent pipe feeds the bottom of the 65-foot diameter clarifier through the primary clarifier influent feed well. A conventional rake mechanism rotates along the bottom of the clarifier collecting settled sludge. A 6-inch primary sludge pipe from each clarifier is routed to the primary sludge pump station. The existing primary sludge pump station is attached to the existing primary influent splitter structure. Water overflows v-notched weirs and is discharged through a 24-inch primary effluent pipe.

As the rake mechanism rotates, a spray header and skimmer arm collect scum from the surface of each clarifier and direct scum into a scum box. The spray header is equipped with spray nozzles that drive the scum towards the scum box. The scum box in each clarifier has a 6-inch scum pipe that conveys primary scum to the primary sludge pump station.

Table 1
Mass Balance for 6.0-mgd Average Day Maximum Month Flow Conditions (Startup)
Bend Water Reclamation Facility Secondary Expansion Project

Constituent	Raw Waste-water (RW)	Main Recycle Influent (Recyl)	Main Recycled Stream (Recycle)	Main Combined Recycle Effluent (RecyE)	DB_LS Combined Discharge	Main Primary Influent (PI)	Main Primary Effluent (PE)	Main Bioreactor Influent (BI)	Main Secondary Clarifier Influent (SI)	Main Secondary Clarifier Effluent (SE)	Plant Effluent (PLE)	Main Primary Sludge (PSD)	Main WAS	GBT WAS Thickener Influent (TWASI)	GBT Thickened WAS (TWAS)	Sludge Combined Discharge	Meso Anaerobic Digester Influent (AnDI)	Meso Anaerobic Digester Effluent (AnDE)	BFP Dewatering Influent (DWI)	BFP Dewatered Sludge (DWE)	Biosolids to Disposal	GBT WAS Thickening Recycle (TWASR)	BFP Dewatering Recycle (DWR)	Recy Combined Discharge
Flow (gallons/day)	6,000,000	6,000,000	195,032	6,195,032	6,195,032	6,195,032	6,142,501	6,142,501	9,213,751	6,010,748	6,010,748	52,531	131,753	131,753	11,489	64,020	64,020	64,020	64,020	9,824	9,824	120,264	74,768	195,032
Carbonaceous BOD5 (lb/day)	19,717	19,717	471	20,188	20,188	20,188	11,776	11,776	78,766	185	185	8,412	3,232	3,232	2,831	11,243	11,243	2,077	2,077	1,921	1,921	315	156	471
Particulate	10,936	10,936	122	11,057	11,057	11,057	2,937	2,937	5,116	9	9	8,120	210	210	189	8,309	8,309	2,011	2,011	1,911	1,911	21	101	122
Heterotrophs	1	1	252	253	253	253	67	67	63,389	114	114	186	2,603	2,603	2,265	2,451	2,451	0	0	0	0	252	0	252
PAOs	0	0	42	42	42	42	11	11	10,171	18	18	31	418	418	376	407	407	0	0	0	0	42	0	42
PHA	0	0	0	0	0	0	0	0	23	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0
Filtrate	8,780	8,780	56	8,836	8,836	8,836	8,761	8,761	67	44	44	75	1	1	0	75	75	65	65	10	10	1	55	56
COD (lb/day)	41,706	41,706	2,012	43,717	43,717	43,717	23,762	23,762	233,228	1,996	1,996	19,955	9,512	9,512	8,532	28,487	28,487	13,796	13,796	12,764	12,764	979	1,032	2,012
Particulate Bio	17,758	17,758	172	17,930	17,930	17,930	4,762	4,762	8,308	15	15	13,168	341	341	307	13,475	13,475	2,755	2,755	2,617	2,617	34	138	172
Particulate Non-Bio	5,016	5,016	649	5,665	5,665	5,665	1,505	1,505	35,106	63	63	4,160	1,441	1,441	1,297	5,458	5,458	10,101	10,101	9,595	9,595	144	505	649
Decay Prod Aer/Anx	2,587	2,587	186	2,772	2,772	2,772	736	736	45,209	81	81	2,036	1,856	1,856	1,671	3,707	3,707	0	0	0	0	186	0	186
Decay Prod Anaerobic	0	0	26	26	26	26	7	7	0	0	0	19	0	0	0	19	19	511	511	486	486	0	26	26
Heterotrophs	2	2	424	426	426	426	113	113	103,289	185	185	313	4,241	4,241	3,817	4,130	4,130	0	0	0	0	424	0	424
Autotrophs	0	0	44	44	44	44	12	12	10,737	19	19	32	441	441	397	429	429	0	0	0	0	44	0	44
PAOs	0	0	115	115	115	115	31	31	28,097	50	50	85	1,154	1,154	1,038	1,123	1,123	0	0	0	0	115	0	115
PHA	0	0	0	0	0	0	0	0	58	0	0	0	2	2	2	2	2	0	0	0	0	0	0	0
Soluble Bio	5,988	5,988	9	5,997	5,997	5,997	5,946	5,946	108	71	71	51	2	2	0	51	51	9	9	1	1	1	7	9
VFA	2,566	2,566	39	2,605	2,605	2,605	2,583	2,583	1	1	1	22	0	0	0	22	22	46	46	7	7	0	39	39
Colloidal Bio	5,703	5,703	43	5,747	5,747	5,747	5,698	5,698	0	0	0	49	0	0	0	49	49	51	51	8	8	0	43	43
Soluble Non-Bio	1,251	1,251	304	1,556	1,556	1,556	1,542	1,542	2,313	1,509	1,509	13	33	33	3	16	16	324	324	50	50	30	274	304
Colloidal Non-Bio	834	834	0	834	834	834	827	827	2	2	2	7	0	0	0	7	7	0	0	0	0	0	0	0
TSS (lb/day)	21,519	21,519	1,586	23,105	23,105	23,105	6,007	6,007	207,569	373	373	17,098	8,523	8,523	7,671	24,768	24,768	14,671	14,671	13,937	13,937	852	734	1,586
Biodegradable	12,407	12,407	125	12,533	12,533	12,533	3,329	3,329	5,808	10	10	9,204	238	238	215	9,419	9,419	2,029	2,029	1,928	1,928	24	101	125
Non-Biodegradable	7,086	7,086	814	7,899	7,899	7,899	1,969	1,969	49,097	88	88	5,931	2,016	2,016	1,814	7,745	7,745	12,242	12,242	11,630	11,630	202	612	814
Decay Prod Aer/Anx	2,024	2,024	145	2,169	2,169	2,169	576	576	35,375	64	64	1,593	1,452	1,452	1,307	2,900	2,900	0	0	0	0	145	0	145
Decay Prod Anaerobic	0	0	20	20	20	20	5	5	0	0	0	15	0	0	0	15	15	400	400	380	380	0	20	20
Metal Hydroxide	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Metal Phosphate	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heterotrophs	2	2	332	334	334	334	89	89	80,820	145	145	245	3,319	3,319	2,987	3,232	3,232	0	0	0	0	332	0	332
Autotrophs	0	0	34	34	34	34	9	9	8,402	15	15	25	345	345	310	336	336	0	0	0	0	34	0	34
PAOs	0	0	90	90	90	90	24	24	21,985	39	39	66	903	903	812	879	879	0	0	0	0	90	0	90
PHA	0	0	0	0	0	0	0	0	35	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0
Poly-P	0	0	25	25	25	25	7	7	6,048	11	11	18	248	248	223	242	242	0	0	0	0	25	0	25
VSS (lb/day)	17,861	17,861	1,209	19,070	19,070	19,070	5,065	5,065	165,292	297	297	14,005	6,787	6,787	6,108	20,114	20,114	10,615	10,615	10,085	10,085	679	531	1,209
Biodegradable	11,787	11,787	113	11,900	11,900	11,900	3,161	3,161	5,227	9	9	8,739	215	215	193	8,933	8,933	1,826	1,826	1,735	1,735	21	91	113
Non-Biodegradable	4,251	4,251	537	4,787	4,787	4,787	1,271	1,271	28,107	50	50	3,516	1,154	1,154	1,039	4,555	4,555	8,429	8,429	8,008	8,008	115	421	537
Decay Prod Aer/Anx	1,822	1,822	131	1,952	1,952	1,952	519	519	31,837	57	57	1,434	1,307	1,307	1,177	2,610	2,610	0	0	0	0	131	0	131
Decay Prod Anaerobic	0	0	18	18	18	18	5	5	0	0	0	13	0	0	0	13	13	360	360	342	342	0	18	18
Metal Hydroxide	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heterotrophs	2	2	299	300	300	300	80	80	72,738	131	131	220	2,987	2,987	2,688	2,908	2,908	0	0	0	0	299	0	299
Autotrophs	0	0	31	31	31	31	8	8	7,561	14	14	23	310	310	279	302	302	0	0	0	0	31	0	31
PAOs	0	0	81	81	81	81	22	22	19,787	36	36	60	812	812	731	791	791	0	0	0	0	81	0	81
PHA	0	0	0	0	0	0	0	0	35	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0
TKN (lb/day)	2,952	2,952	559	3,511	3,511	3,511	2,924	2,924	12,676	115	115	587	517	517	463	1,050	1,050	1,050	1,050	545	545	53	505	559
NH3-N (lb-N/day)	1,902	1,902	470	2,371	2,371	2,371	2,351	2,351	22	15	15	20	0	0	0	20	20	554	554	85	85	0	469	470
Particulate Bio Org N	393	393	8	401	401	401	107	107	191	0	0	295	8	8	7	302	302	144	144	137	137	1	7	8
Non-Bio Part Org N	142	142	19	161	161	161	43	43	999	2	2	118	41	41	37	155	155	307	307	292	292	4	15	19
Decay Prod Aer/Anx	157	157	11	168	168	168	45	45	2,738	5	5	123	112	112	101	224	224	0	0	0	0	11	0	11
Decay Prod Anaerobic	0	0	2	2	2	2	0	0	0	0	0	1	0	0	0	1	1	31	31	29	29	0	2	2
Heterotrophs	0	0	26	26	26	26	7	7	6,256	11	11	19	257	257	231	250	250	0	0	0	0	26	0	26
Autotrophs	0	0	3	3	3	3	1	1	650	1	1	2	27	27	24	26	26	0	0	0	0	3	0	3
PAOs	0	0	7	7	7	7	2	2	1,702	3	3	5	70	70	63	68	68	0	0	0	0	7	0	7
Non-Bio Soluble Org. N	65	65	13	78	78	78	77	77	116	76	76	1	2	2	0	1	1	14	14	2	2	2	12	13
Non-Bio Colloidal Org. N	20	20	0	20	20	20	19	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Soluble Bio Org N	141	141	0	141	141	141	140	140	3	2	2	1	0	0	0	1	1	0	0	0	0	0	0	0
Colloidal Bio Org N	134	134	0	134	134	134	133	133	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0

Table 1
Mass Balance for 6.0-mgd Average Day Maximum Month Flow Conditions (Startup)
Bend Water Reclamation Facility Secondary Expansion Project

Constituent	Raw Waste-water (RW)	Main Recycle Influent (Recyl)	Main Recycled Stream (Recycle)	Main Combined Recycle Effluent (RecyE)	DB_LS Combined Discharge	Main Primary Influent (PI)	Main Primary Effluent (PE)	Main Bioreactor Influent (BI)	Main Secondary Clarifier Influent (SI)	Main Secondary Clarifier Effluent (SE)	Plant Effluent (PLE)	Main Primary Sludge (PSD)	Main WAS	GBT WAS Thickener Influent (TWASI)	GBT Thickened WAS (TWAS)	Sludge Combined Discharge	Meso Anaerobic Digester Influent (AnDI)	Meso Anaerobic Digester Effluent (AnDE)	BFP Dewatering Influent (DWI)	BFP Dewatered Sludge (DWE)	Biosolids to Disposal	GBT WAS Thickening Recycle (TWASR)	BFP Dewatering Recycle (DWR)	Recy Combined Discharge
NO3-N (lb-N/day)	0	0	5	5	5	5	5	5	350	228	228	0	5	5	0	0	0	0	0	0	0	5	0	5
TP (lb-P/day)	200	200	204	404	404	404	253	253	5,877	12	12	152	241	241	217	369	369	369	369	189	189	24	180	204
Bio Particulate	88	88	2	91	91	91	24	24	18	0	0	67	1	1	1	67	67	44	44	42	42	0	2	2
Non-Bio Particulate	32	32	7	38	38	38	10	10	238	0	0	28	10	10	9	37	37	112	112	106	106	1	6	7
Decay Prod Aer/Anx	52	52	4	55	55	55	15	15	904	2	2	41	37	37	33	74	74	0	0	0	0	4	0	4
Decay Prod Anaerobic	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	10	10	10	10	0	1	1
Metal Phosphate	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heterotrophs	0	0	8	9	9	9	2	2	2,066	4	4	6	85	85	76	83	83	0	0	0	0	8	0	8
Autotrophs	0	0	1	1	1	1	0	0	215	0	0	1	9	9	8	9	9	0	0	0	0	1	0	1
PAOs	0	0	2	2	2	2	1	1	562	1	1	2	23	23	21	22	22	0	0	0	0	2	0	2
Poly-P	0	0	8	8	8	8	2	2	1,872	3	3	6	77	77	69	75	75	0	0	0	0	8	0	8
Ortho-PO4	28	28	172	200	200	200	198	198	2	1	1	2	0	0	0	2	2	203	203	31	31	0	172	172
Alkalinity (lb/day as CaCO3)	20,016	20,016	2,249	22,265	22,265	22,265	22,076	22,076	22,944	14,968	14,968	189	328	328	29	217	217	2,303	2,303	353	353	299	1,949	2,249
H2S (lb/day)	300	300	23	323	323	323	320	320	0	0	0	3	0	0	0	3	3	27	27	4	4	0	23	23
Temperature (oC)	17	17	24	17	17	17	17	17	17	17	17	17	17	17	17	17	17	35	35	35	35	17	35	24
BOD5 (mg/L)	394	394	290	390	390	390	230	230	1,024	4	4	19,188	2,940	2,940	29,528	21,043	21,043	3,887	3,887	23,428	23,428	314	250	290
COD (mg/L)	833	833	1,236	846	846	846	464	464	3,033	40	40	45,518	8,650	8,650	88,987	53,319	53,319	25,823	25,823	155,690	155,690	976	1,654	1,236
TSS (mg/L)	430	430	974	447	447	447	117	117	2,699	7	7	39,000	7,751	7,751	80,000	46,358	46,358	27,459	27,459	170,000	170,000	849	1,176	974
VSS (mg/L)	357	357	743	369	369	369	99	99	2,150	6	6	31,947	6,173	6,173	63,706	37,646	37,646	19,869	19,869	123,008	123,008	676	851	743
TKN (mg-N/L)	58.96	59	343	68	68	68	57	57	165	2	2.28	1,338	470	470	4,833	1,966	1,966	1,966	1,966	6,646	6,646	53	810	343
NH3-N (mg-N/L)	37.97	38	289	46	46	46	46	46	0	0	0.29	46	0	0	0	38	38	1,038	1,038	1,038	1,038	0	752	289
NO3-N (mg-N/L)	0.00	0	3	0	0	0	0	0	5	5	4.55	0	5	5	5	1	1	0	0	0	0	5	0	3
TP (mg-P/L)	4.00	4	125	8	8	8	5	5	76	0	0.24	346	219	219	2,264	691	691	691	691	2,305	2,305	24	289	125
Alkalinity (mg/L as CaCO3)	400	400	1,382	431	431	431	431	431	298	298	298	431	298	298	298	407	407	4,310	4,310	4,310	4,310	298	3,124	1,382
H2S (mg/L)	6.00	6	14	6	6	6	6	6	0	0	0	6	0	0	0	5	5	50	50	50	50	0	36	14

Table 2
Mass Balance for 11.9-mgd Average Day Maximum Month Flow Conditions
Bend Water Reclamation Facility Secondary Expansion Project

Constituent	Raw Waste-water (RW)	Main Recycle Influent (RecyI)	Main Recycled Stream (Recycle)	Main Combined Recycle Effluent (RecyE)	DB_LS Combined Discharge	Main Primary Influent (PI)	Main Primary Effluent (PE)	Main Bioreactor Influent (BI)	Main Secondary Clarifier Influent (SI)	Main Secondary Clarifier Effluent (SE)	Plant Effluent (PLE)	Main Primary Sludge (PSD)	Main WAS	GBT WAS Thickener Influent (TWASI)	GBT Thickened WAS (TWAS)	Sludge Combined Discharge	Meso Anaerobic Digester Influent (AnDI)	Meso Anaerobic Digester Effluent (AnDE)	BFP Dewatering Influent (DWI)	BFP Dewatered Sludge (DWE)	Biosolids to Disposal	GBT WAS Thickening Recycle (TWASR)	BFP Dewatering Recycle (DWR)	Recy Combined Discharge
Flow (gallons/day)	11,900,000	11,900,000	351,465	12,251,463	12,251,463	12,251,463	12,146,521	12,146,521	18,219,782	11,900,025	11,900,025	104,941	246,497	246,497	26,218	131,160	131,160	131,160	131,160	20,544	20,544	220,278	131,187	351,465
Carbonaceous BOD5 (lb/day)	39,104	39,104	1,079	40,183	40,183	40,183	23,416	23,416	184,932	328	328	16,767	7,200	7,200	6,306	23,073	23,073	4,847	4,847	4,469	4,469	702	377	1,079
Particulate	21,689	21,689	287	21,976	21,976	21,976	5,836	5,836	13,728	20	20	16,140	535	535	481	16,621	16,621	4,677	4,677	4,443	4,443	53	234	287
Heterotrophs	1	1	565	566	566	566	150	150	149,927	222	222	416	5,839	5,839	5,082	5,498	5,498	0	0	0	0	565	0	565
PAOs	0	0	82	82	82	82	22	22	21,135	31	31	60	823	823	741	801	801	0	0	0	0	82	0	82
PHA	0	0	0	0	0	0	0	0	58	0	0	0	2	2	2	2	2	0	0	0	0	0	0	0
Filtrate	17,414	17,414	144	17,558	17,558	17,558	17,408	17,408	84	55	55	150	1	1	0	151	151	170	170	27	27	1	143	144
COD (lb/day)	82,714	82,714	4,221	86,935	86,935	86,935	47,233	47,233	516,120	3,857	3,857	39,703	19,980	19,980	17,931	57,634	57,634	28,522	28,522	26,350	26,350	2,049	2,172	4,221
Particulate Bio	35,220	35,220	411	35,631	35,631	35,631	9,462	9,462	22,292	33	33	26,168	868	868	781	26,950	26,950	6,482	6,482	6,158	6,158	87	324	411
Particulate Non-Bio	9,948	9,948	1,287	11,234	11,234	11,234	2,983	2,983	73,803	109	109	8,251	2,874	2,874	2,587	10,838	10,838	19,987	19,987	18,988	18,988	287	999	1,287
Decay Prod Aer/Anx	5,130	5,130	349	5,480	5,480	5,480	1,455	1,455	89,649	132	132	4,024	3,492	3,492	3,142	7,167	7,167	0	0	0	0	349	0	349
Decay Prod Anaerobic	0	0	56	56	56	56	15	15	0	0	0	41	0	0	0	41	41	1,113	1,113	1,057	1,057	0	56	56
Heterotrophs	2	2	951	954	954	954	253	253	244,297	361	361	700	9,515	9,515	8,563	9,263	9,263	0	0	0	0	951	0	951
Autotrophs	0	0	89	89	89	89	24	24	22,798	34	34	65	888	888	799	864	864	0	0	0	0	89	0	89
PAOs	0	0	227	227	227	227	60	60	58,385	86	86	167	2,274	2,274	2,046	2,213	2,213	0	0	0	0	227	0	227
PHA	0	0	1	1	1	1	0	0	148	0	0	0	6	6	5	6	6	0	0	0	0	1	0	1
Soluble Bio	11,877	11,877	20	11,897	11,897	11,897	11,795	11,795	136	89	89	102	2	2	0	102	102	22	22	3	3	2	18	20
VFA	5,090	5,090	100	5,190	5,190	5,190	5,146	5,146	1	1	1	44	0	0	0	44	44	119	119	19	19	0	100	100
Colloidal Bio	11,311	11,311	114	11,426	11,426	11,426	11,328	11,328	0	0	0	98	0	0	0	98	98	135	135	21	21	0	114	114
Soluble Non-Bio	2,481	2,481	616	3,098	3,098	3,098	3,071	3,071	4,606	3,008	3,008	27	62	62	7	33	33	665	665	104	104	56	561	616
Colloidal Non-Bio	1,654	1,654	0	1,654	1,654	1,654	1,640	1,640	5	3	3	14	0	0	0	14	14	0	0	0	0	0	0	0
TSS (lb/day)	42,678	42,678	3,479	46,156	46,156	46,156	12,001	12,001	499,389	738	738	34,156	19,449	19,449	17,504	51,660	51,660	30,681	30,681	29,147	29,147	1,945	1,534	3,479
Biodegradable	24,608	24,608	299	24,908	24,908	24,908	6,615	6,615	15,583	23	23	18,293	607	607	546	18,839	18,839	4,773	4,773	4,534	4,534	61	239	299
Non-Biodegradable	14,053	14,053	1,656	15,709	15,709	15,709	3,915	3,915	103,666	153	153	11,794	4,037	4,037	3,634	15,428	15,428	25,038	25,038	23,786	23,786	404	1,252	1,656
Decay Prod Aer/Anx	4,014	4,014	273	4,288	4,288	4,288	1,139	1,139	70,148	104	104	3,149	2,732	2,732	2,459	5,608	5,608	0	0	0	0	273	0	273
Decay Prod Anaerobic	0	0	44	44	44	44	12	12	0	0	0	32	0	0	0	32	32	871	871	827	827	0	44	44
Metal Hydroxide	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Metal Phosphate	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heterotrophs	2	2	744	746	746	746	198	198	191,156	282	282	548	7,445	7,445	6,700	7,248	7,248	0	0	0	0	744	0	744
Autotrophs	0	0	69	69	69	69	18	18	17,839	26	26	51	695	695	625	676	676	0	0	0	0	69	0	69
PAOs	0	0	178	178	178	178	47	47	45,684	68	68	131	1,779	1,779	1,601	1,732	1,732	0	0	0	0	178	0	178
PHA	0	0	0	0	0	0	0	0	89	0	0	0	3	3	3	3	3	0	0	0	0	0	0	0
Poly-P	0	0	215	215	215	215	57	57	55,223	82	82	158	2,151	2,151	1,936	2,094	2,094	0	0	0	0	215	0	215
VSS (lb/day)	35,422	35,422	2,512	37,934	37,934	37,934	10,074	10,074	365,547	540	540	27,860	14,237	14,237	12,813	40,673	40,673	21,758	21,758	20,670	20,670	1,424	1,088	2,512
Biodegradable	23,378	23,378	269	23,647	23,647	23,647	6,280	6,280	14,025	21	21	17,367	546	546	492	17,859	17,859	4,295	4,295	4,081	4,081	55	215	269
Non-Biodegradable	8,430	8,430	1,064	9,494	9,494	9,494	2,521	2,521	59,089	87	87	6,973	2,301	2,301	2,071	9,044	9,044	16,679	16,679	15,845	15,845	230	834	1,064
Decay Prod Aer/Anx	3,613	3,613	246	3,859	3,859	3,859	1,025	1,025	63,133	93	93	2,834	2,459	2,459	2,213	5,047	5,047	0	0	0	0	246	0	246
Decay Prod Anaerobic	0	0	39	39	39	39	10	10	0	0	0	29	0	0	0	29	29	784	784	744	744	0	39	39
Metal Hydroxide	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heterotrophs	2	2	670	672	672	672	178	178	172,040	254	254	493	6,700	6,700	6,030	6,524	6,524	0	0	0	0	670	0	670
Autotrophs	0	0	63	63	63	63	17	17	16,055	24	24	46	625	625	563	609	609	0	0	0	0	63	0	63
PAOs	0	0	160	160	160	160	43	43	41,116	61	61	118	1,601	1,601	1,441	1,559	1,559	0	0	0	0	160	0	160
PHA	0	0	0	0	0	0	0	0	89	0	0	0	3	3	3	3	3	0	0	0	0	0	0	0
TKN (lb/day)	5,856	5,856	1,056	6,912	6,912	6,912	5,739	5,739	28,098	248	248	1,173	1,086	1,086	974	2,147	2,147	2,147	2,147	1,203	1,203	112	944	1,056
NH3-N (lb-N/day)	3,771	3,771	866	4,638	4,638	4,638	4,598	4,598	82	53	53	40	1	1	0	40	40	1,026	1,026	161	161	1	865	866
Particulate Bio Org N	780	780	19	798	798	798	212	212	511	1	1	586	20	20	18	604	604	333	333	317	317	2	17	19
Non-Bio Part Org N	281	281	43	324	324	324	86	86	2,129	3	3	238	83	83	75	313	313	691	691	657	657	8	35	43
Decay Prod Aer/Anx	311	311	21	332	332	332	88	88	5,429	8	8	244	211	211	190	434	434	0	0	0	0	21	0	21
Decay Prod Anaerobic	0	0	3	3	3	3	1	1	0	0	0	2	0	0	0	2	2	67	67	64	64	0	3	3
Heterotrophs	0	0	58	58	58	58	15	15	14,795	22	22	42	576	576	519	561	561	0	0	0	0	58	0	58
Autotrophs	0	0	5	5	5	5	1	1	1,381	2	2	4	54	54	48	52	52	0	0	0	0	5	0	5
PAOs	0	0	14	14	14	14	4	4	3,536	5	5	10	138	138	124	134	134	0	0	0	0	14	0	14
Non-Bio Soluble Org. N	129	129	26	155	155	155	154	154	231	151	151	1	3	3	0	2	2	28	28	4	4	3	24	26
Non-Bio Colloidal Org. N	39	39	0	39	39	39	39	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Soluble Bio Org N	279	279	1	280	280	280	277	277	3	2	2	2	0	0	0	2	2	1	1	0	0	0	1	1
Colloidal Bio Org N	266	266	0	266	266	266	263	263	0	0	0	2	0	0	0	2	2	0	0	0	0	0	0	0

Table 2
Mass Balance for 11.9-mgd Average Day Maximum Month Flow Conditions
Bend Water Reclamation Facility Secondary Expansion Project

Constituent	Raw Waste-water (RW)	Main Recycle Influent (Recyl)	Main Recycled Stream (Recycle)	Main Combined Recycle Effluent (RecyE)	DB_LS Combined Discharge	Main Primary Influent (PI)	Main Primary Effluent (PE)	Main Bioreactor Influent (BI)	Main Secondary Clarifier Influent (SI)	Main Secondary Clarifier Effluent (SE)	Plant Effluent (PLE)
NO3-N (lb-N/day)	0	0	9	9	9	9	9	9	768	502	502
TP (lb-P/day)	764	764	749	1,514	1,514	1,514	1,160	1,160	26,175	146	146
Bio Particulate	175	175	5	181	181	181	48	48	48	0	0
Non-Bio Particulate	63	63	23	86	86	86	23	23	563	1	1
Decay Prod Aer/Anx	103	103	7	110	110	110	29	29	1,793	3	3
Decay Prod Anaerobic	0	0	1	1	1	1	0	0	0	0	0
Metal Phosphate	0	0	0	0	0	0	0	0	0	0	0
Heterotrophs	0	0	19	19	19	19	5	5	4,886	7	7
Autotrophs	0	0	2	2	2	2	0	0	456	1	1
PAOs	0	0	5	5	5	5	1	1	1,168	2	2
Poly-P	0	0	67	67	67	67	18	18	17,097	25	25
Ortho-PO4	423	423	622	1,045	1,045	1,045	1,036	1,036	164	107	107
Alkalinity (lb/day as CaCO3)	39,698	39,698	4,899	44,597	44,597	44,597	44,215	44,215	47,084	30,753	30,753
H2S (lb/day)	596	596	46	642	642	642	636	636	0	0	0
Temperature (oC)	17	17	24	17	17	17	17	17	17	17	17
BOD5 (mg/L)	394	394	368	393	393	393	231	231	1,216	3	3
COD (mg/L)	833	833	1,439	850	850	850	466	466	3,394	39	39
TSS (mg/L)	430	430	1,186	451	451	451	118	118	3,284	7	7
VSS (mg/L)	357	357	856	371	371	371	99	99	2,404	5	5
TKN (mg-N/L)	58.96	59	360	68	68	68	57	57	185	2	2.49
NH3-N (mg-N/L)	37.97	38	295	45	45	45	45	45	1	1	0.54
NO3-N (mg-N/L)	0.00	0	3	0	0	0	0	0	5	5	5.05
TP (mg-P/L)	7.70	8	256	15	15	15	11	11	172	1	1.47
Alkalinity (mg/L as CaCO3)	400	400	1,670	436	436	436	436	436	310	310	310
H2S (mg/L)	6.00	6	16	6	6	6	6	6	0	0	0

Constituent	Main Primary Sludge (PSD)	Main WAS	GBT WAS Thickener Influent (TWASI)	GBT Thickened WAS (TWAS)	Sludge Combined Discharge	Meso Anaerobic Digester Influent (AnDI)	Meso Anaerobic Digester Effluent (AnDE)	BFP Dewatering Influent (DWI)	BFP Dewatered Sludge (DWE)	Biosolids to Disposal	GBT WAS Thickening Recycle (TWASR)	BFP Dewatering Recycle (DWR)	Recy Combined Discharge
NO3-N (lb-N/day)	0	10	10	1	1	1	0	0	0	0	9	0	9
TP (lb-P/day)	353	1,015	1,015	912	1,265	1,265	1,265	1,265	619	619	103	646	749
Bio Particulate	133	2	2	2	134	134	102	102	97	97	0	5	5
Non-Bio Particulate	63	22	22	20	83	83	407	407	386	386	2	20	23
Decay Prod Aer/Anx	80	70	70	63	143	143	0	0	0	0	7	0	7
Decay Prod Anaerobic	1	0	0	0	1	1	22	22	21	21	0	1	1
Metal Phosphate	0	0	0	0	0	0	0	0	0	0	0	0	0
Heterotrophs	14	190	190	171	185	185	0	0	0	0	19	0	19
Autotrophs	1	18	18	16	17	17	0	0	0	0	2	0	2
PAOs	3	45	45	41	44	44	0	0	0	0	5	0	5
Poly-P	49	666	666	599	648	648	0	0	0	0	67	0	67
Ortho-PO4	9	2	2	0	9	9	735	735	115	115	2	620	622
Alkalinity (lb/day as CaCO3)	382	637	637	68	450	450	5,134	5,134	804	804	569	4,330	4,899
H2S (lb/day)	5	0	0	0	5	5	55	55	9	9	0	46	46
Temperature (oC)	17	17	17	17	17	17	35	35	35	35	17	35	24
BOD5 (mg/L)	19,145	3,500	3,500	28,822	21,079	21,079	4,428	4,428	26,068	26,068	382	344	368
COD (mg/L)	45,333	9,713	9,713	81,951	52,653	52,653	26,057	26,057	153,686	153,686	1,115	1,984	1,439
TSS (mg/L)	39,000	9,455	9,455	80,000	47,196	47,196	28,030	28,030	170,000	170,000	1,058	1,401	1,186
VSS (mg/L)	31,811	6,921	6,921	58,559	37,158	37,158	19,878	19,878	120,558	120,558	774	994	856
TKN (mg-N/L)	1,339	528	528	4,453	1,962	1,962	1,962	1,962	7,016	7,016	61	863	360
NH3-N (mg-N/L)	45	1	1	1	36	36	938	938	938	938	1	791	295
NO3-N (mg-N/L)	0	5	5	5	1	1	0	0	0	0	5	0	3
TP (mg-P/L)	404	494	494	4,168	1,156	1,156	1,156	1,156	3,612	3,612	56	590	256
Alkalinity (mg/L as CaCO3)	436	310	310	310	411	411	4,690	4,690	4,690	4,690	310	3,955	1,670
H2S (mg/L)	6	0	0	0	5	5	50	50	50	50	0	42	16

Table 3
Design Summary Data
Bend WRF Secondary Expansion

INFLUENT FLOWS AND LOADS	DESIGN VALUES
FLOWS, MGD	
AVERAGE ANNUAL	10.9
AVERAGE DAY MAXIMUM MONTH	11.9
MAXIMUM WEEK	12.4
MAXIMUM DAY	13.6
PEAK HOUR DRY WEATHER	21.4
PEAK HOUR WET WEATHER	29.1
BOD LOADINGS, LBS/DAY	
AVERAGE ANNUAL	33,090
AVERAGE DAY MAXIMUM MONTH	38,800
MAXIMUM WEEK	48,888
TSS LOADINGS, LBS/DAY	
AVERAGE ANNUAL	36,453
AVERAGE DAY MAXIMUM MONTH	42,600
MAXIMUM WEEK	53,676
TKN LOADINGS, LBS/DAY	
AVERAGE ANNUAL	4,818
AVERAGE DAY MAXIMUM MONTH	5,900
MAXIMUM WEEK	7,434
AMMONIA LOADINGS, LBS/DAY	
AVERAGE ANNUAL	2,545
MAXIMUM MONTH WET WEATHER	3,600
MAXIMUM WEEK	4,536
EFFLUENT REQUIREMENT	
EFFLUENT DISCHARGE	
BOD5, MONTHLY AVERAGE (MG/L)	20
BOD5, MONTHLY AVERAGE (LB/DAY)	1,150
BOD5, WEEKLY AVERAGE (MG/L)	30
BOD5, WEEKLY AVERAGE (LB/DAY)	1,700
BOD5, DAILY MAXIMUM (LBS)	2,300
TSS, MONTHLY AVERAGE (MG/L)	20
TSS, MONTHLY AVERAGE (LB/DAY)	1,150
TSS, WEEKLY AVERAGE (MG/L)	30
TSS, WEEKLY AVERAGE (LB/DAY)	1,700
TSS, DAILY MAXIMUM (LBS)	2,300
TN, ANNUAL MONTHLY AVERAGE (MG/L)	10
pH	5.5 to 9.0
E. COLI, GEO MEAN (ORG. PER 100 ML)	126
E. COLI, MAX (ORG. PER 100 ML)	406
LEVEL IV RECLAIMED WATER	
TOTAL COLIFORM, 7-DAY MEDIAN (#/mL)	< 2.2
TOTAL COLIFORM, MAXIMUM (#/mL)	< 23
TURBIDITY, 5% OF 24-HR PERIOD, NTU	5
TURBIDITY, 24-HR MEAN, NTU	2

LIQUIDS UNIT PROCESS CRITERIA	DESIGN VALUES
PLANT DRAIN PUMP STATION	
TYPE	Submersible, Pre-rotation
NUMBER OF UNITS	1
CAPACITY/UNIT, GPM	3,600
DISCHARGE PRESSURE (FT)	17
POWER (EACH), HP	30
DRIVE TYPE	Constant
PRIMARY CLARIFIERS	
UNITS	2 EXISTING, 1 NEW
TYPE	CIRCULAR
DIAMETER (EACH), FT	65
SIDEWATER DEPTH, FT	9
PEAK HOUR SURFACE OVERFLOW RATE, GPD/SF	3,000
PSD CONCENTRATION, %	2 % to 5 %
DESIGN FLOW, GAL/DAY	380,200 @ 2 %
	151,600 @ 5%
MINIMUM FLOW, GAL/DAY	40,000 @ 2%
	16,000 @ 5%
PRIMARY SLUDGE PUMPS	
TYPE	2-STAGE, PROGRESSING CAVITY
NUMBER OF UNITS	3
CAPACITY (EACH), GPM @ FT TDH	180 GPM @ 175 FT
POWER (EACH), HP	15
DRIVE TYPE	VARIABLE
PRIMARY SCUM PUMPS	
TYPE	2-STAGE, PROGRESSING CAVITY
NUMBER OF UNITS	2
CAPACITY (EACH), GPM @ FT TDH	180 GPM @ 181 FT
POWER (EACH), HP	15
DRIVE TYPE	VARIABLE
AERATION BASINS	
UNITS	3 EXISTING, 1 NEW
VOLUME, EA, GAL	1,010,000
LENGTH X WIDTH (EACH), FT	204 x 46
SIDEWATER DEPTH, FT	15
ANOXIC VOLUME, EA, GAL (W/ ANX SWING)	340,000 (490,000)
AEROBIC (NON IFAS) VOLUME, EA, GAL (W/ AER SWING)	210,000 (360,000)
IFAS VOLUME, GAL	310,000
DESIGN SRT, DAYS	5
DESIGN MLSS, MG/L	3,000
CARRIER MEDIA SYSTEM	
PROCESS DESIGN FLOW, ADMM MGD	8.5
CARRIER MEDIA, CUBIC YARDS	1,651
CARRIER MEDIA BULK SPECIFIC SURFACE AREA, M2/M3	500
NUMBER OF BASINS @ FILL RATIO	2 @ 55% BY VOLUME
SCREEN LENGTH, FT	12
SCREEN DIAMETER, INCHES	16
SCREENS, NO. per Basin	13
AERATION BASIN DIFFUSERS	
TYPE	COARSE BUBBLE
NUMBER OF UNITS, BASIN 1	TBD
NUMBER OF UNITS, BASIN 2	TBD
NUMBER OF UNITS, BASIN 3	TBD
ANOXIC ZONE MIXERS	
TYPE	FLOATING
CELL A, AB 4 (POWER AND NUMBER)	2 TOTAL, 3 HP
CELL A, AB 4 (POWER AND NUMBER)	1, 7.5 HP
CELL D, AB 1-4 (POWER AND NUMBER)	4 TOTAL, 7.5 HP
MIXED LIQUOR RECYCLE PUMPS	
TYPE	VERTICAL LINE-SHAFT
NUMBER OF UNITS PER BASIN	2
CAPACITY (EACH), GPM @ FT TDH	6,000 GPM @ 10 FT
POWER (EACH), HP	15
DRIVE TYPE	ADJUSTABLE

LIQUIDS UNIT PROCESS CRITERIA	DESIGN VALUES
AERATION BLOWERS	
LOCATION	NEW BLOWER BUILDING
UNITS	5 NEW
TYPE	HIGH SPEED TURBO
CAPACITY (EA), SCFM @ PSIG	300 HP - 5,500 scfm @ 8 PSIG
CAPACITY (EA), SCFM @ PSIG	100 HP - 1,500 scfm @ 8 PSIG
NUMBER @ POWER (EACH), HP	4 @ 300, 1 @ 100
TOTAL CAPCITY, SCFM	23,500
LOCATION	EXISTING BLOWER BUILDING
UNITS, SIZE	4 EXISTING
TYPE	MULTISTAGE CENTRIFUGAL
MAX CAPACITY (TOTAL), SCFM @ PSIG	14,000 @ 8
POWER (EACH), HP	250
SECONDARY CLARIFIERS	
UNITS	3 EXISTING
TYPE	CIRCULAR
DIAMETER (EACH), FT	80
SIDEWATER DEPTH, FT	2 UNITS @ 12, 1 UNITS @ 14
PEAK HOUR SURFACE OVERFLOW RATE, GPD/SF	1,890
MAX WEEK SOLIDS LOADING RATE, PPD/SF	37
RETURN ACTIVATED SLUDGE PUMPS	
TYPE	CENTRIFUGAL
NUMBER OF UNITS	3 EXISTING
CAPACITY (EACH), GPM @ FT TDH	2,100 @ 25
POWER (EACH), HP	22
DRIVE TYPE	
WASTE ACTIVATED SLUDGE / SCUM PUMPS	
TYPE	CENTRIFUGAL
NUMBER OF UNITS	2 EXISTING
CAPACITY (EACH), GPM @ FT TDH	200
POWER (EACH), HP	
DRIVE TYPE	
REUSE ULTRAVIOLET DISINFECTION	
TYPE	MPHO UV, IN-VESSEL
NUMBER OF TRAINS	2
NUMBER OF UNITS/TRAIN	2
CAPACITY, MGD	2.5 Design, 5.0 Peak
NUMBER OF LAMPS/UNIT	12
POWER (EACH TRAIN), KW	61
REUSE SODIUM HYPOCHLORITE DISINFECTION	
TYPE	DIAPHRAGM
UNITS	2
CAPACITY, GPH	2
PRESSURE, PSIG	20
SODIUM HYPOCHLORITE SYSTEM	
DESIGN WINTER STORAGE, DAYS	60
DESIGN SUMMER STORAGE, DAYS	15
REUSE RESIDUAL METERING PUMPS	
NUMBER OF PUMPS	2
TYPE	DIAPHRAGM
CAPACITY, GPH	2 GPH @ 20 PSIG
RAS FILAMENT CONTROL METERING PUMPS	
NUMBER OF PUMPS	1
TYPE	DIAPHRAGM
CAPACITY, GPH	10
SODIUM HYPOCHLORITE TRANSFER PUMP	
NUMBER OF PUMPS	1
TYPE	CENTRIFUGAL MAGNETIC DRIVE
CAPACITY, GPM	20
PLANT EFFLUENT DISINFECTION	
FLOW, MGD ADMM	11.9
TYPE	IN-CHANNEL, LPHO UV
UV TRANSMITTANCE, %	55
CHANNELS	3
OUTPUT, mJ/cm2	35

Table 3
Design Summary Data
Bend WRF Secondary Expansion

SOLIDS UNIT PROCESS CRITERIA	DESIGN VALUES
WASTE ACTIVATED SLUDGE	
SOLIDS LOAD, DESIGN, PPD	19,438
SOLIDS LOAD, MIN, PPD	8,166
TS CONCENTRATION, %	0.7 - 1.1
FLOW, DESIGN, GPD	246,376
FLOW, MIN, GPD	132,069
WASTE ACTIVATED SLUDGE THICKENING	
UNITS	1 EXISTING
TYPE	GRAVITY BELT
WIDTH (METER)	2
THICKENED SOLIDS, PERCENT DRY WEIGHT	8
SOLIDS CAPTURE, PERCENT	90
OPERATION (HRS/DAY, DAYS/WEEK)	24/7
MASS LOADING	660 LB/HR/M
HYDRAULIC LOADING	100 GPM/M
THICKENED WASTE SLUDGE FEED	
SOLIDS LOAD, DESIGN, PPD	218,725
SOLIDS LOAD, MIN, PPD	91,875
TS CONCENTRATION, %	8
FLOW, DESIGN, GPD	26,219
FLOW, MIN, GPD	11,013
DIGESTED SLUDGE / DEWATERING FEED	
SOLIDS LOAD, DESIGN, PPD	30,335
SOLIDS LOAD, MIN, PPD	12,708
TS CONCENTRATION, %	3
FLOW, DESIGN, GPD	108,042
FLOW, MIN, GPD	46,211

SOLIDS UNIT PROCESS CRITERIA	DESIGN VALUES
DEWATERING	
UNITS	2
TYPE	BELT FILTER PRESS
WIDTH (METER)	2
CAKE SOLIDS, PERCENT DRY WEIGHT	18
SOLIDS CAPTURE, PERCENT	90
OPERATION (HRS/DAY, DAYS/WEEK)	8/5
DEWATERED CAKE PUMP	
UNITS	2
SOLIDS LOAD, DESIGN, LBS/HR	4,060
SOLIDS LOAD, MIN, LBS/HR	2,153
TS CONCENTRATION, %	17
FLOW, DESIGN, GPM	30
FLOW, MIN, GPM	8
POLYMER SYSTEM (DEWATERING)	
GBT DOSE, LB/DT	13
BFP DOSE, LB/DT	12
TOTAL USAGE, LB/WEEK (DESIGN)	2,173
TOTAL USAGE, LB/WEEK (MIN)	912
MAXIMUM TOTAL DOSE (DESIGN), LB/HR	31
MAXIMUM TOTAL DOSE (MIN), LB/HR	16
DRY PO STORAGE, LB	4,950
MAKE-UP CONCENTRATION, %	0
PO MIX TANK VOL., GAL	600
PO FEED TANK VOL., GAL	900
PO FEED RATE (DESIGN), GPM	23
PO FEED RATE (MIN), GPM	2
DEWATERED CAKE CONVEYOR	
UNITS	1 EXISTING
TYPE	SCREW
DIAMETER, INCHES	12
POWER (EACH), HP	7.5
DEWATERING CAKE HOPPER	
UNITS	1 EXISTING
CAPACITY, CUBIC YARDS	36
WASHWATER BOOSTER PUMPS (DEWATERING)	
UNITS	1 EXISTING, 1 NEW
PUMP TYPE	TURBINE
CAPACITY (EACH), GPM @ PSI TDH	150
POWER (EACH), HP	5
DRIVE TYPE	CONSTANT

SUPPORT SYSTEM CRITERIA	
PLANT WATER SODIUM HYPOCHLORITE SYSTEM	
CONCENTRATION, PERCENT	12.6
METERING PUMPS, NUMBER	2
PUMP TYPE	DIAPHRAGM
CAPACITY (EACH), GPH @ PSI	2 @ 100
POWER (EACH), HP	NA
PLANT WATER PUMPS	
TYPE	VERTICAL TURBINE
NUMBER OF UNITS	4
CAPACITY, GPM @ FT TDH	375 GPM @ 231
POWER (EACH), HP	30
DRIVE TYPE	VARIABLE
AIR COMPRESSOR (INSTRUMENT AIR, ETC)	
UNITS	2 EXISTING, 2 NEW
COMPRESSOR TYPE	ROTARY SCREW
CAPACITY (EACH), SCFM	200
POWER (EACH), HP	50
DRIVE TYPE	CONSTANT
DISCHARGE PRESSURE, PSIG	100
HOT WATER LOOP	
UNITS	EXISTING
PUMP TYPE	BOILER, 3-PASS FIRE TUBE
CAPACITY (EACH), MBH	2069
UNITS	2 EXISTING
PUMP TYPE	HEATINGE WATER PUMPS
CAPACITY (EACH), GPM @ FT	170 @ 30
POWER (EACH), HP	2
ADDITIONAL CONNECTED LOAD, MBH	700
ADDITIONAL CONNECTED FLOW, GOM	70
SUPPLY TEMPERATURE, DEGREES F	160
RETURN TEMPERATURE, DEGREES F	140

Primary Clarifier 3

The new primary clarifier will be located to the west of the existing Primary Clarifiers 1 and 2. A new 30-inch primary influent pipe will discharge into a new primary influent splitter box. A second 30-inch connection will be provided for a future parallel primary influent line to serve future additional primary clarifiers. The new primary influent splitter box will have connections for two future primary clarifiers in addition to Primary Clarifier 3. Flow will be directed to Primary Clarifier 3 by flow over a fixed weir and conveyance through a 30-inch primary influent pipe. The new primary clarifier will be designed to match the existing primary clarifiers to ensure that all the units function as uniformly as possible. The primary effluent from Primary Clarifier 3 will be discharged through a 30-inch pipe to ensure the system has capacity to convey the design peak flow.

Existing Primary Sludge Pump Station

The primary sludge pump station is integral with the primary clarifier splitter box and primary scum pit. The 6-inch primary sludge pipe from each primary clarifier and the 6-inch primary scum pipe connect to the suction header. The header allows each of the three pumps (two primary sludge pumps, one primary scum pump) to draw from either clarifier or the scum pit if one of the pumps is out of service. The discharge from the primary sludge/scum pumps is combined in a header that discharges to either the digester feed wet well or directly to Anaerobic Digester 3.

New Primary Sludge Pump Station

The new primary sludge pump station will be adjacent to the new primary clarifier splitter box and primary scum pit, but will not be structurally connected. The 6-inch primary sludge pipe from Primary Clarifier 3 and the 6-inch primary scum pipe will connect to the suction header. The header allows the two pumps (one primary sludge pump, one primary scum pump) to draw from either the clarifier or the scum pit if one of the pumps is out of service. The discharge from the primary sludge/scum pumps is combined in a header that connects to the existing primary sludge line that discharges to either the digester feed wet well or directly to Anaerobic Digester 3. The new primary sludge pump station will have a separate electrical room for housing electrical gear and instrumentation and control equipment.

Secondary Treatment

The following sections present the key improvements proposed for the secondary treatment process at the Bend WRF. These build on the concepts presented in the Project Definition phase of the design. Three-dimensional models have been developed, detailing the Schematic Design improvements.

Primary Effluent Piping Gallery

Existing Aeration Basin 3 has a piping gallery attached to the south end. This piping gallery contains a 42-inch primary effluent (PE) header. Three 18-inch pipes and three 12-inch pipes are connected to the existing PE header. Each pipe is dedicated to a single aeration basin. The 18-inch pipes direct flow to the head of the basin (Cell A1) and the 12-inch pipes direct flow to the first aerobic, or integrated fixed-film activated sludge (IFAS), zone (Cell B). The existing piping gallery also contains an 18-inch return activated sludge (RAS) header. Three 10-inch RAS pipes are connected to the RAS header. Each pipe conveys RAS to one of the three existing aeration basins. Each of the PE and RAS pipes has a flow meter and control valve to monitor and control flow.

The existing primary effluent piping does not have the necessary capacity to convey the full design peak flow. Two 18-inch PE pipes and one 12-inch PE pipe are necessary to convey the peak design flow through each basin. This process and associated flow splits are described in *TM 9 – Plant Hydraulic Improvements and Yard Piping*.

The typical recommendation for positioning a flow meter is to provide a straight run of pipe for five pipe diameters upstream and three pipe diameters downstream of the flow meter. This ensures uniform flow through the meter, maximizing its accuracy. It is also desirable to install control valves within a straight pipe run to maximize performance. The installation of the existing flow meters and control valves does not meet these standard design approaches. The new primary effluent and RAS piping will be installed following these recommendations, and the existing piping will be removed and rearranged so the configurations are consistent. Having consistent piping configurations will minimize potential control issues that may arise due to differences. The existing flow meters and control valves will be reused to minimize project costs.

The existing piping gallery system will be expanded in the secondary expansion project to house the new PE piping, flow control valve, and flow meter assemblies. The existing gallery will be extended to the west to serve Aeration Basin 4. A new PE piping gallery will also be constructed for the control valves and meters serving Aeration Basins 1 and 2.

Existing Aeration Basin Improvements/Aeration Basin 4

Aeration Basin 4 will be designed to match the existing aeration basins, incorporating the same features. The aeration basins will be converted from the existing suspended-growth system to incorporate an IFAS system. The IFAS system will be incorporated into each aeration basin including: plastic biofilm carrier media, carrier media retention screens, and coarse-bubble aeration. Each aeration basin will include updated mixed-liquor recycle pumping, anoxic/swing zone mixing, allowances for scum removal, basin drainage, and IFAS carrier media transfer.

Mixed-Liquor Recycle Pumps

The mixed-liquor recycle (MLR) pumping system is required to return a nitrate-rich stream from the end of the bioreactor to the anoxic zones for denitrification. Process simulations indicate these MLR pumps will be located within Cell C, with flow being returned to Cell A—Anoxic Zone 1. The MLR pumping system is designed to provide a flow rate of 400 percent of the average day, maximum month flow.

The two MLR pumps will be controlled with adjustable frequency drives (AFDs). The speeds of these pumps will be based on the nitrate level leaving the anoxic environment, with this adjusted to optimize the denitrification process. A secondary control will be based on influent flow, allowing the operations staff to adjust the MLR flow when required to address wet-weather conditions or similar.

Two options have been evaluated for the MLR pumping system: (1) axial-flow type submersible pumps (similar to those existing) and (2) vertical-line shaft type pumps. Both of these systems provide the required MLR flow to meet the treatment goals.

A review of the MLR pumping system options determined that the vertical turbine pump is appropriate for this plant. The Schematic Design drawings have been developed showing the axial-flow type pump system, but this will be updated in the next phase of design.

Anoxic Zone/Swing Zone Mixers

The existing mixers within Cell A will be re-used in Aeration Basins 1, 2, and 3. New surface mixers, matching the existing mixers, will be installed in Cell A of Aeration Basin 4. New surface mixers will be installed in the swing zone (Cell D) for all aeration basins, matching those included in Cell A.

Secondary Scum Removal System

The general concept for scum removal is to allow this to pass through the aeration basins, along with the mixed-liquor that is conveyed to the secondary clarifiers. The scum will then be removed at the secondary clarifiers through the existing scum removal system. The following features are included in the aeration basin to help scum removal:

- Hydraulic profile that provides the appropriate headloss over weirs and baffles to allow secondary scum to pass
- Screened openings within the IFAS zone, at the water line above the media retention screens, allowing secondary scum to pass
- Spray bars located throughout the aeration basin to minimize scum trapping

Existing Return Activated Sludge System Improvements

No improvements are planned for the existing RAS system in the expansion phase. As noted in the Project Definition Report, RAS system capacity expansion will be required when the WRF influent flows reach about 10 mgd (ADMM).

Aeration Basin Drainage System

A new aeration basin drainage system will be installed as part of the secondary expansion project. This new system will include a new plant drain pump station, and connect into the existing drainage system at the WRF. Following are the key features of the aeration basin drainage system:

- New plant drain pump station, located in the PE piping gallery.
- WEMCO Prerostal™ System is proposed.
- The majority of mixed liquor from Aeration Basins 1 and 2 can be drained through the new system. The existing system (RAS pumps) will be required for complete drainage of the basins 1 and 2.
- All basin drainage from Aeration Basins 3 and 4 will be through the new aeration basin drainage system and plant drain pump station.
- The system is designed to complete the drainage of one aeration basin within 12 hours.
- Drainage of the primary clarifiers will also be accomplished through the new plant drain pump station.

- It may also be possible to drain the secondary clarifiers to the new drain pump station. Further investigation will be conducted in the next design phase. These clarifiers are currently drained by the RAS pumps.

IFAS Biofilm Carrier Media Transfer

Features to transfer the biofilm carrier media between aeration basins will be included in the design of the IFAS system. The need to transfer the biofilm carrier media will be minimal. During the startup and commissioning phase of the project, media will be transferred to one basin at a maximum fill value to verify system performance. After the performance has been verified, media will be distributed between the appropriate aeration basins in service to provide treatment. Any additional media transfer after this point will be minimal.

The system proposed to transfer carrier media is:

- Include guide-rails and lifting mechanisms for each IFAS zone, allowing a submersible solids-handling pump to be utilized
- Provide a submersible solids-handling pump to be interchangeable between IFAS zones
- Utilize temporary, flexible piping to transfer media between the appropriate reactors

As the design continues, and an IFAS manufacturer is pre-selected, the use of a permanent media transfer system will be evaluated. It may be warranted to utilize the new plant drain pump station to assist with media transfer, but this will need to be coordinated with the IFAS manufacturer.

Existing Secondary Clarifiers

No improvements are planned for the secondary clarifiers in the expansion phase. As noted in the Project Definition Report, a new Secondary Clarifier 4 is recommended when the WRF influent flows reach about 10 mgd ADMM.

Blower System Improvements

Process Aeration Blower System

The facility secondary expansion will include improvements to the blower system. Required blower capacity will be povided with new high-speed direct drive turbo blowers. The existing multistage centrifugal system will remain available for backup, to provide the required redundancy to the turbo units, and for use during peak air demands. During the next phase of design, turbo blowers will be considered for immediate replacement of the existing multistage centrifugal blowers.

High Pressure Plant Air System

The secondary expansion will include extending the existing plant air system. The existing rotary screw compressors located in the digester faciltiy will continue to operate. Room for additional plant air capacity is provided in the new blower building. Space is allocated for two 50 hp rotary screw compressors, an air receiver, and two regenerative dessicant air dryers. This expansion will double the existing plant air capacity. Plant air from the new blower building will provide air to the northern half of the plant but will also be interconnected with the existing plant air distribution. Final selection and sizing of the new high pressure plant air components will be developed further in the next design phase.

The existing plant air compressors are on standby power and operate in a LEAD/LAG sequence. Redundancy is provided by the LAG compressor. The new plant air compressors will not be on standby generator power, but with the piping system intertied with the existing air source, air will available plant-wide during a utility outage.

Disinfection

The WRF secondary expansion will include improvements to the disinfection system, the chemical building, and the plant water (PW) pump station. Process description is as follows:

- Ultraviolet disinfection: Provides inactivation of pathogens as the primary disinfection for plant effluent.
- Hypochlorite metering pumps: Provide a metered dose of sodium hypochlorite to reuse disinfection system, the plant water pump station, and into the RAS suction line for secondary biological control.
- Magnetic flow meter: Measures plant effluent flow.
- Drain pump: Drains plant effluent facility channels and floor drains.
- Hypochlorite storage: Storage of 12.5 percent sodium hypochlorite that is delivered from a tanker truck. The storage system will be designed to accept only partial loads of sodium hypochlorite.
- Hypochlorite transfer pump: Transfer hypocholrite between strorage tanks or from the storage tank to totes or barrels for use in the water distribution system (approximately 724 gallons per year).
- Plant water pumps – Provide plant water (W4) to the plant water system including an automatic plant water strainer.

Reuse System

The facility secondary expansion will include the addition of a ultraviolet light (UV) disinfection system downstream of the reuse filters. The UV disinfection will provide primary disinfection for the Class A reuse system. Sodium hypochlorite will be added as a secondary disinfectant to provide a residual when the water is delivered to the reuse customer (currently Pronghorn golf course).

The primary measurements required for proper UV disinfection are the flow rate and the UV transmittance. Flow rate will be measured using the existing magnetic flow meters installed downstream of the low head reuse pumps in the reuse facility. Transmittance will be measured with a flow through UV transmittance element sampled between the reuse pumps and the UV chambers.

Solids Treatment

The existing solids treatment system, with modifications to the existing solids building, will continue to provide the necessary biosolids processing Facilities. The existing solids treatment system consists of the following unit processes:

- Gravity belt thickening of secondary waste activated sludge (WAS)
- Anaerobic digestion of combined primary sludge and thickened WAS
- Belt filter press dewatering of digested sludge
- Asphalt drying bed storage and land application of Class B biosolids

The existing 2-meter gravity belt thickener located on the ground floor of the solids building is planned to continue to provide the necessary WAS thickening capacity based on an operational schedule of 7 days per week and 24 hours per day. No near-term improvements to the existing gravity belt thickener (GBT) are planned, except for polymer feed pump modifications. The GBT capacity is currently limited by the filtrate drain capacity. Changes to the drain will be required before the GBT can be fully utilized under future conditions.

No near-term improvements are currently planned for the existing anaerobic digestion facilities. The plant operational staff will continue to optimize thickened solids feed to the digesters (primary sludge feed target of 5 percent dry solids and thickened WAS feed target of 8 percent dry solids) to prolong the capacity of the existing anaerobic digesters. However, future expansion of the existing digestion system will be necessary to maintain the minimum 15 day solids residence time (SRT) necessary to comply with Class B biosolids regulations for anaerobic digestion.

Dewatering improvements are planned for the solids building, so that two belt filter presses can be operated in parallel to process future digested sludge loadings on a preferred schedule of one shift per day and 5 days per week. A new belt filter press (BFP) will replace the existing dewatering centrifuge in the solids building. In addition, either modifications will be made to the existing BFP for continued use, or the existing BFP will be replaced by a new BFP. The decision regarding which option will be implemented is pending. While more costly, the benefits to providing two new identical presses include a lower, more accessable profile, easier operation and maintenance, and more effective odor and moisture control inside the solids building.

The existing polymer system in the solids building will be modified as follows to support both the WAS thickening and digested sludge dewatering processes:

- Increase the polymer mix concentration from 0.25 percent to 0.50 percent.
- Add a W4 rapid fill line to the polymer mix tank with a capacity of 125 gallons per minute (gpm).
- Modify polymer feed configuration to use dedicated polymer feed pumps to each point of use. The existing two polymer feed pumps will feed each BFP. Add a third polymer feed pump sized to feed the GBT.

In order to mitigate struvite formation problems at the existing degas beds return pump station, the filtrate from the BFPs will be rerouted to directly flow by gravity to the primary influent distribution structure ahead of the primary clarifiers.

Other solids building planned improvements consist of interior building corrosion repair and re-coating. In addition, improvements to the ventilation and foul air exhaust system are planned for the BFP dewatering facilities, located on the mezzanine of the solids building.

Instrumentation and Control

Design of the instrumentation and controls systems will be coordinated with an ongoing SCADA Standards project. Additionally, another project is relocating the Fiber Optic System and Server hardware to the existing DAFT building. The DAFT building and other facilities will no longer be used for their original purpose.

The project plan for programmable logic controllers is outlined below:

- **Primary Treatment**. A new Allen-Bradley ControlLogix programmable logic controller (PLC) will be provided at the new primary sludge pump station for the primary treatment processes. A new ControlLogix remote input/output (I/O) rack will be provided at the existing primary treatment building.
- **Aeration**. A new Allen-Bradley ControlLogix PLC will be provided at the new blower building for monitoring and control of the aeration flow split, aeration, and blower processes. A new ControlLogix remote I/O rack may be considered for installation in the new gallery at the south end of the aeration basins as an I/O collection center to minimize conduit and wiring costs. The existing blower and aeration PLCs that are located in the existing blower/aeration building are Allen-Bradley SLC format and will be either abandoned or demolished.
- **Plant Water**. A new Allen-Bradley ControlLogix PLC will be provided at the new plant water pump station for monitoring and control of the chemical storage, chemical feed, chlorine contact, and plant water pumping processes. A remote I/O rack may be considered for installation at the new chemical building as an I/O collection center to minimize conduit and wiring costs. The existing plant water PLC located in the existing plant water pump station is Allen-Bradley SLC format and will be either abandoned or demolished.
- **Potable Water**. A new Allen-Bradley ControlLogix PLC will be provided at the existing potable water building for monitoring and control of the potable water storage and distribution processes. Because the plant water area facilities will be built in the first phase of construction, it may be worth considering a plant water PLC remote I/O rack for the potable water building (instead of a ControlLogix processor) as a cost saving alternative.
- **Solids Handling**. The existing Allen-Bradley ControlLogix PLC at the existing solids handling building electrical room will be used to accommodate new I/O and monitoring/control functions. It is possible that a new remote I/O rack will be required if the design requires large quantities of new I/O. In addition, a new human-machine interface (HMI) operator station will be provided on the mezzanine of the existing solids building.

- **Package Systems**. All package system PLCs will be Allen-Bradley family with Ethernet communication capability. The following package system PLCs are anticipated on the project:
  - High Speed Turbo Blowers
  - UV Disinfection Systems
  - Belt Filter Press(es)

Detailed instrumentation and control information is included in each of the process technical memoranda.

Plant Water Distribution

The site plant water distribution system will consist of the existing distribution system, connection to the new plant water pump station, and expansion of the plant water distribution piping to the new facilities for the expansion of the WRF: Primary Clarifier 3, Aeration Basin 4, new blower building, the chemical facility, and reuse UV facility.

Potable Water Distribution

The site potable water distribution system will consist of the existing distribution system, the existing potable water pump station, and provision of potable water to the chemical facility for safety showers.

Compressed Air Distribution

Compressed air distribution will also be routed to the new primary sludge pump station, primary influent splitter box, new blower building, new plant water pump station, new reuse disinfection facility, and the new hypochlorite facility. Air receivers will be located in certain facilities to provide air storage near the usage points to help stabilize air pressure.

Contract Document Specifications

Attachment C includes a table of contents for the technical specifications that will be provided to the contractor. The individual specifications will be developed during the design of the project.

Construction Sequencing and Phasing

Pending cash flow and financial analysis of the phasing plan, the following major facility construction sequence is recommended:

- Phase 1a—Aeration Basin (AB) 4, Blower Building, mixed liquor (ML) piping, ML splitter box.
- Phase 1b—New hypochlorite facility, new plant effluent UV and plant water pumping facility, secondary effluent piping improvements, new reuse UV facility and reuse piping relocation work
- Phase 1c—Primary Clarifier (PC) 3, new primary sludge pump station, with new primary influent (PI), PE piping

- Phase 2—PI/PE piping improvements associated with existing PC 1 and PC 2, and existing primary sludge pump station improvements
- Phase 3—AB 3 IFAS conversion
- Phase 4—AB 2 IFAS conversion
- Phase 5—AB 1 IFAS conversion
- Phase 6—Solids process improvements
- Site Civil and Plant Utilities work

Constraints

- Phase 1a, 1b, and 1c work could begin concurrently at notice to proceed, or that work could be staged to manage cash flow. Reuse facility work needs to be completed during the non-irrigation season (for the UV and filter work), but that work also needs to be done subsequent to the Phase 1b (PLE UV) work being completed. Cash flow could be managed by postponing this reuse work until later in the project.
- Relocation of the Pronghorn reuse piping needs to be completed prior to the construction of the new effluent UV facility. Plant effluent pipe construction needs to be coupled with the construction and startup of the new effluent UV facility.
- Phase 2 PI/PE tie-ins require the shutdown of PC 1 and PC 2 and that work cannot occur until Phase 1a (AB 4) and Phase 1c (PC 3) are complete. In addition Phase 3 (AB 3 conversion) and operation in IFAS mode is a prerequisite for removing PC 1 and PC 2 from service.
- Phases 3, 4, and 5 shall be performed sequentially following completion of Phase 1a.
- Phase 4 and 5 (IFAS Basin conversion for AB 2 and AB 1) could be conducted in parallel since AB 3 and AB 4 would be operating in IFAS mode with excess IFAS media.
- Phase 6 (Solids) has no known constraints, but operational needs suggest completing that solids work early in the overall construction schedule.
- Site civil work and plant utilities work will be conducted throughout the overall construction schedule, integrated into the project elements described above as specific areas of the site are impacted.

Additional sequencing analysis and detailing will occur during subsequent design phases. Specific operational constraints and sequencing requirements will be coordinated with Bend staff, and incorporated into the final contract documents.

Opportunities for Deferral of Project Elements

The cost of building all the required process facilities needed to meet the full 20-year planning period is cost-prohibitive. As a result, the design has identified opportunities to defer some of the costs associated with fully accommodating the 2008 facilities plan projected 2030 flows and loads, while still avoiding any stranded investment in facilities. The following facilities were identified as candidates for cost deferral, and therefore these facilities are not being designed to meet the full 2030 facilities plan flow and load projections. These project elements will be "phased in" over the 20 year planning horizon to more closely match observed influent flows and loads:

- The primary clarifiers.
- The installed integrated fixed-film activated sludge (IFAS) carrier media volume.
- The installed blower capacity.
- The secondary clarifiers.
- The return activated sludge (RAS)/waste activated sludge (WAS) pump station.

The 2008 facilities plan identified some non-process facility upgrades (new laboratory, administration building upgrades, etc.) that are not currently included in the defined project. The cost of these improvements is also being deferred and these non-process facilities are not included in the overall cost estimate presented here.

In addition, the 2008 facilities plan identified some upgrades and improvements to the existing effluent percolation ponds (Ponds 1 and 2). The condition of these ponds has not been further evaluated and the cost of these improvements is not included in the overall cost estimate presented here.

As the design work progresses, further opportunities for deferral of project elements (and individual pieces of equipment) may become obvious, and will be documented as they develop. The additional project elements that could possibly be deferred are as follows:

1. Installation of parallel 30-inch PI to PC 1 and PC 2 can possibly be deferred until beyond 30 mgd design flow.
2. Installation of screens, media, and other IFAS conversion elements for Aeration Basin 1 could be deferred until a later date. Three IFAS basins have enough capacity to meet the 2030 design criteria.

Retrofit of the existing primary sludge pump station could be deferred as long as the existing digester feed pumps and blend tank are kept in service.

Cost Estimate

The Schematic Design capital cost estimates are summarized in Table 5. Base construction costs are expressed in June 2011 dollars and now include a 25 percent contingency. The costs are <u>not</u> escalated to the mid-point of construction. No sales tax is included for the construction cost total.

The capital costs estimates shown in Table 5 are Class 3 cost estimates as defined by the Association for the Advancement of Cost Engineering International and adopted by the American National Standards Institute. An estimate of this type is normally expected to be within +30 percent or –20 percent of the actual construction cost. The final cost of the projects will depend on actual labor and materials costs, actual site conditions, productivity, competitive market conditions, bid dates, seasonal fluctuations, final project scope, final project schedule, and other variables. As a result, the final project costs will vary from the estimates presented in this report.

TABLE 5
Summary of Schematic Design Capital Cost Estimates
City of Bend WRF Secondary Expansion Project

Cost Item	Cost[a]
Base Construction Costs	
Phase 1a—AB 4, Blower Building, ML piping, ML splitter box	$7,060,009
Phase 1b—New hypochlorite facility, new plant effluent UV and plant water pumping facility, secondary effluent piping improvements, new reuse UV facility and reuse piping relocation work	$4,999,328
Phase 1c— PC 3, new primary sludge pump station, with new PI, PE piping	$1,679,645
Phase 2— PI/PE piping improvements associated with existing PC 1 and PC 2, and existing primary sludge pump station improvements	$214,062
Phase 3— AB 3 IFAS conversion	$1,585,367
Phase 4—AB 2 IFAS conversion	$1,684,724
Phase 5— AB 1 IFAS conversion	$1,388,773
Phase 6— Solids process improvements	$1,557,126
Subtotal Base Construction Costs (rounded)	$20,169,000
Construction Markups	
Subcontractor Markups	$96,000
Contractor OH&P, Bonds, Mobilization and Insurance[b]	$3,635,000
Contingency (25%)	$5,975,000
Subtotal Construction Markups	**$9,706,000**
Owner Furnished Equipment (None)	$0
TOTAL CONSTRUCTION COSTS[c]	**$29,875,000**
EAL Costs (30% of construction)	$8,962,000
TOTAL PROJECT COSTS[c]	**$38,837,000**

[a] All costs are in June 2011 dollars. Escalation to mid-point of construction is not included.

[b] Contractor markups are based on base construction costs. Contingency is applied to all construction costs.

[c] Construction costs and total project costs do not include the cost for non-process facilities (new laboratory, administration building improvements, etc.) not the cost for upgrades and improvements to the existing effluent percolation ponds (Ponds 1 and 2).

Attachments

Attachment A—Equipment List

Attachment B—Pipe Schedule

Attachment C – Table of Contents (Contract Document Specifications)

Attachment A—Equipment List

Bend Water Reclamation Facility Secondary Expansion

MAJOR EQUIPMENT LIST

LAST UPDATE - 5/31/2011

FACILITY / EQUIPMENT NAME	IDENTIFICATION NUMBER	EQUIPMENT DESCRIPTION	MANUFACTURER 1	VENDOR	CAPACITY	POWER REQUIRED (HP)	POWER REQUIRED (kW)	EQUIP VOLTAGE	MOTOR TYPE	DRIVE	SPECIFICATION SECTION	SPECIFICATION AUTHOR	DATE LAST REVISED	LAST REVISION PROVIDED BY	EQUIPMENT COST	COMMENTS
21-PRIMARY CLARIFICATION																
Primary Clarifier No. 3 Mechanism			WesTech	Doug Allie, Goble Sampson	13,500 ft-lbs continuous operating torque	0.5		460		constant speed		Menniti			$188,000.00	quote for stainless steel mechanism; includes mechanism, center column, EDI, feedwell, skimmers, scum box, center cage 65' diameter x 8'10" SWD cage drive COP primary clarifier mechanism
22-PRIMARY SLUDGE PUMPING																
Primary Sludge Pumps 1,2, and 3		2 stage progressing cavity pump	Moyno	Apsco - Sean Clark/Elaine Stone	180 gpm @ 175 ft TDH	15		460		Variable speed		Menniti			$39,900.00	quote includes 15 hp gear motor and accessories, spare stator = $3,162, does not inlcude VFD current quotes are for 180 gpm @ 100 ft of head - head increased with more conversative assumptions and approximately
Primary Scum Pump 1 and 2		2 stage progressing cavity pump	Moyno	Apsco - Sean Clark/Elaine Stone	180 gpm	15				variable speed		Menniti			$39,900.00	
31-AERATION BASINS																
Large Anoxic Mixers 1-4, 2-4, 3-4, 4-3, 4-4		floating mixer				7.5				constant		Leaf			$95,000.00	moto sizes based on exisitng mixers
Small Anoxic Mixers 4-1, 4-2		floating mixer				3				constant		Leaf			Included	motor size based on existing mixers
MLR Pumps 1, 2, 3, 4, 5, 6, 7, and 8		Vertical Line Shaft Pump	Morrison Pump Coompany	Pump Tech	6,000 gpm @ 4.0 ft	15		460	TEFC	variable speed		Leaf			$520,000.00	no quotes collected yet for this project, quote for 15 HP Flygt pump from CWS Hillsboro project (8/5/2010) $26,500
32-AERATION BLOWERS																
Aeration Blowers 1, 2, 3, 4,		Direct drive, high speed turbo blower	Neuros	Dean Wood - Treatment Equipment Company, Neuros	5,500 SCFM @ 8 psig	300		480	PMSM	Variable Speed	44 42 19.02	Krumsick	2/10/2011	j. krumsick	$784,000.00	
Aeration Blower 5			Neuros	Dean Wood - Treatment Equipment Company, Neuros	1,500 SCFM @ 8 psig	100		480	PMSM	Variable Speed	44 42 19.02	Krumsick	2/10/2011	j. krumsick	$103,000.00	
Air Compressor and Dryer		Rotary Screw compressor and dessicant dryer			200 SCFM/ each at 100 psi	50		480		Constant Speed		Krumsick				
42-HYPOCHLORITE FACILITY																
Hypochlorite Storage Tanks 1, 2		3,000 gallons vertical fiberglass storage tank			3,000 gallons			120	n/a	n/a		Thompson				
Hypochlorite Metering Pumps 1, 2, 3			Grundfos	TMG Services, Thomas Gazdik	3 gallons per hour at 30 psi	frac		120			44 44 13.01	Thompson			$6,000.00	
Hypochlorite Metering Pumps 4			Grundfos	TMG Services	10 gallons per hour at 110 psi	frac		120			44 44 13.01	Thompson			$2,000.00	
Hypochlorite Transfer Pump		Magnetically coupled centrifugal pump	Finish Thompson	Grainger Page 3861	20 gpm at 20 feet	0.5		120		constant speed		Thompson			$1,000.00	
43-PLANT EFFLUENT DISINFECTION FACILITY																
In-Channel Low Pressure High Output UV		2 banks per channel, 3 channels total	Wedeco	Goble Sampson - Wedeco			184	480	na	n/a		Thompson			$1,345,680.00	
Plant Water Pump	PWP-1, PWP-2, PWP-3, PWP-4	5 stage vertical turbine pump	Flowserve	APSCO	375 gpm at 105 psi	30		460	TEFC	Variable speed	44 42 56.03	Thompson	5/20/2011	Thompson	$320,000.00	
Plant Water Motorized Strainer			SP Kinney		2,500 gpm @120 psi	5		480	TEFC		44 43 33.13	Thompson				
44-REUSE DISINFECTION FACILITY																
In-Vessel Medium Pressure High Output UV			Aquionics	Treatment Equipment Company - Dean Wood	2.5 mgd		108	480	na			Thompson			$371,404.00	
67-DEWATERING																
Belt Filter Press 1 & 2		2.0 meter Belt Filter Press, low profile gravity and wedge sections, control panel	Andritz	APSCO - Shawn Clark	2 meter machine, 1050 lb/hr/m, 75 gpm/m	6		480		variable speed		Krumsick	3/28/2011	j. krumsick	$275,000 per unit	
Cake Pump 1 & 2		two stage	Moyno	APSCO - Shawn Clark	30 gpm	10.5		480	TEFC	Variable Speed	44 42 56.13	Krumsick				
Wash Water Pump 3		horizontal, frame mounted			100 gpm @ 110 ft	7.5			TEFC	Constant Speed		Krumsick				
68-POLYMER SYSTEM																
Polymer Feed Pump 3			Moyno		3.1 - 0.4 gpm	0.5			TEFC	variable speed		Krumsick				

Bend Water Reclamation Facility Secondary Expansion
MAJOR EQUIPMENT LIST
LAST UPDATE - 5/31/2011

FACILITY

EQUIPMENT NAME	IDENTIFICATION NUMBER	EQUIPMENT DESCRIPTION	MANUFACTURER 1	VENDOR	CAPACITY	POWER REQUIRED (HP)	POWER REQUIRED (kW)	EQUIP VOLTAGE	MOTOR TYPE	DRIVE	SPECIFICATION SECTION	SPECIFICATION AUTHOR	DATE LAST REVISED	LAST REVISION PROVIDED BY	EQUIPMENT COST	COMMENTS
85-HVAC																
16-Pump Room Supply Fan		Inline cabinet supply fan w/economizer assembly, filter housing and duct heater	Cook			1		460	ODP	Constqant Speed		Forester				
22-Existing PSPS Pump Room Supply Fan		Inline cabinet supply fan w/economizer assembly, filter housing and duct heater	Cook			1		460	ODP	Constant Speed		Forester				
22-Existing PSPS Pump Room Exhaust Fan		Centrifugal roof exhauster				0.5		460	TEAO	Constant Speed		Forester				
22-New PSPS Pump Room Supply Fan		Inline cabinet supply fan w/economizer assembly, filter housing and duct heater	Cook			1		460	ODP	Constant Speed		Forester				
22-New PSPS Pump Room Exhaust Fan		Cantrifugal roof exhauster				0.5		460	TEAO	Constant Speed		Forester				
22-New PSPS Electrical Room Supply Fan		Inline cabinet supply fan w/economizer assembly, filter housing and duct heater	Cook			1		460	ODP	Constant Speed		Forester				
32-Blower Room Supply Fan		Inline cabinet supply fan w/economizer assembly, filter housing and duct heater	COOK			1		460	ODP	Constant Speed		Forester				
32-Electrical Room Supply Fan		Inline cabinet supply fan w/economizer assembly, filter housing and duct heater	Cook			1		460	ODP	Constant Speed		Forester				
35/36 - RAS/WAS PS Pump Room Supply Fan		Inline cabinet supply fan w/economizer assembly, filter housing and duct heater	Cook			1		460	ODP	Constant Speed		Forester				
35/36 - RAS/WAS PS Pump Room Exhaust Fan		Centrifugal Roof Exhauster				0.5		460	TEAO	Constant Speed		Forester				
35/36 - RAS/WAS PS Electrical Room Supply Fan		Inline cabinet supply fan w/economizer assembly, filter housing and duct heater	Cook			1		460	ODP	Constant Speed		Forester				
52 - UV Treatment Room Supply Fan		Inline cabinet supply fan w/economizer assembly, filter housing and duct heater	Cook			1	x	460	ODP	Constant Speed		Forester				
52 - UV Electrical Room Supply Fan		Inline cabinet supply fan w/economizer assembly, filter housing and duct heater	Cook			1	x	460	ODP	Constant Speed		Forester				
81-Pump Room Supply Fan		Inline cabinet supply fan w/economizer assembly, filter housing and duct heater	Cook			1		460	ODP	Constant Speed		Forester				
81-Electrical Room Supply Fan		Inline cabinet supply fan w/economizer assembly, filter housing and duct heater	Cook			1		460	ODP	Constant Speed		Forester				

Attachment B—Pipe Schedule

Service	Legend	Size(s) (in.) (Note 2)	Installation (Note 4)	Material (Note 3)	Specification Section	Joint Type (Note 5)	Lining/Coating (Note 6)	Test Pressure and Type (Note 7)	Remarks
Air High Pressure	AHP	ALL	EXP	STL	40 27 00.03	FL, W, S	NONE / No. 5	P, XXX psig	
				COP	40 27 00.13	S, W	NONE / NONE		
			BUR	CLDI	40 27 00.01	PRJ	CEMENT MORTAR		
			SUB	SST	40 27 00.08	FL, W, S	NONE / NONE		
Air, Instrument	AI	ALL	EXP	STL	40 27 00.03	FL, W, S	NONE / No. 5	P, XXX psig	
				COP	40 27 00.13	S, W	NONE / NONE		
			SUB	SST	40 27 00.08	FL, W, S	NONE / NONE		
Air Low Pressure	ALP	ALL	EXP, EMB	STL	40 27 00.03	FL, W, S	NONE / No. 5	P, 15 psig	
			SUB	SST	40 27 00.08	FL, W, S	NONE / NONE		
Blended Digested Sludge	BDS	ALL	ALL	CLDI	40 27 00.01	FL, GR	CEMENT MORTAR / No. 5	H, XX psig	
Boiler Exhaust	BE								
Chemical Cleaning Solution	CCS	ALL	ALL	SST	40 27 00.20	S, FL, G	NONE / NONE	H, XX psig	Double tape wrap joint and fittings
Condensate Drain	CD	ALL	EXP, SUB, EMB	COP	40 27 00.13	S, W	NONE / NONE	G	
			BUR	PVC-DWV	22 10 01.02	S, W	NONE / NONE		
Chlorine Solution	CS	ALL	ALL	PVC	40 27 00.10	F, S, W	NONE / No. 25	H, XXX psig	
Drain (sanitary)	D	<=4	EXP	CISP	22 10 01.03	C	NONE / No. 5	G	
			EMB, BUR, SUB	PVC-DWV	22 10 01.02	W	NONE / NONE		
		>=6	EMB, EXP, SUB	CLDI	40 27 00.01	FL, GR	CEMENT MORTAR / REMARKS		Coat EXP No. 5, SUB No. 2, EMB No. 7
			BUR	PVC	33 05 01.12	HU	NONE / NONE		
Digester Gas	DG	ALL	ALL	SST	40 27.00.08	FL, W	NONE / NONE	H, 1 psig	
Dry Polymer	DPO	ALL	ALL	SST	40 27 00.20	FL, W, S	NONE / NONE	P, XX psig	
Digested Sludge	DS	<= 2-1/2	EXP, SUB, EMB	SST	40 27 00.07	S	NONE / NONE	H, XX psig	
		3				FL, W			
		>=4	EXP, SUB, EMB	CLDI	40 27 00.01	FL, GR	CEMENT MORTAR/ REMARKS		Coat EXP No. 5, SUB No. 2, EMB No. 7
			BUR			PRJ			Polyethylene Encase
			BUR	HDPE	33 05 01.10	FL, W	NONE / NONE		
Emergency Overflow	EOF	ALL	ALL	CLDI	40 27 00.01	FL, GR	CEMENT MORTAR / REMARKS		Coat EXP No. 5, SUB No. 2, EMB No. 7, BUR Polyethylene Encase
			BUR	CLDI		PRJ			
Filtrate	FILT	<=12	ALL	PVDF-STL	40 27 00.06	FL, GR, PRJ	PVDF / REMARKS	G	Coat EXP No. 5, SUB No. 2, EMB No. 7, BUR Polyethylene Encase
Filter To Waste	FTW							H, XX psig	
Hot Water	HW	ALL	ALL	STL	41 27 00.03	FL, S, W	NONE / No. 5	H, XX psig	
Hot Water Return	HWR	ALL	ALL	STL	42 27 00.03	FL, S, W	NONE / No. 5	H, XX psig	
Hot Water Supply	HWS	ALL	ALL	STL	42 27 00.03	FL, S, W	NONE / No. 5	H, XX psig	
Irrigation	IR							H, XX psig	

Service	Legend	Size(s) (in.) (Note 2)	Installation (Note 4)	Material (Note 3)	Specification Section	Joint Type (Note 5)	Lining/Coating (Note 6)	Test Pressure and Type (Note 7)	Remarks
Liquified Propane Gas	LPG	ALL	ALL	STL	42 27 00.03	FL, S, W	NONE / No. 5	H, XX psig	
Liquid Polymer	LPO	ALL	ALL	PVC	40 27 00.10	FL, S, W	NONE / REMARKS	H, XX psig	Coat EXP No. 25
Mixed Liquor	ML	<=3	ALL	PVC	40 27 00.10	FL, S, W	NONE / REMARKS	H, XX psig	Coat EXP, SUB, EMB No. 25, BUR none
		4 thru 30	EMB, EXP, SUB	CLDI	40 27 00.01	FL, GR	CEMENT MORTAR / REMARKS		Coat EXP No. 5, SUB No. 2, EMB No. 7
			BUR			PRJ			Polyethylene Encase.
			BUR	HDPE	33 05 01.10	FL, W	NONE / NONE		
		>=36	BUR	WS	33 05 01.01	W	CEMENT MORTAR / CEMENT MORTAR		
			BUR	HDPE	33 05 01.10	FL, W	NONE / NONE		
Mixed Liquor Recycle	MLR	<=3	ALL	PVC	40 27 00.10	FL, S, W	NONE / REMARKS	H, XX psig	Coat EXP, SUB, EMB No. 25, BUR none
		4 thru 30	EMB, EXP, SUB	CLDI	40 27 00.01	FL, GR	CEMENT MORTAR / REMARKS		Coat EXP No. 5, SUB No. 2, EMB No. 7
			BUR			PRJ			Polyethylene Encase.
			BUR	HDPE	33 05 01.10	FL, W	NONE / NONE		
		>=36	BUR	WS	33 05 01.01	W	CEMENT MORTAR / CEMENT MORTAR		
			BUR	HDPE	33 05 01.10	FL, W	NONE / NONE		
Sodium Hypochlorite	NAOCL	ALL	ALL	PVC	40 27 00.10	FL, S, W	NONE / REMARKS	H, XX psig	Use chemical resistant solvent cement. COAT EXP No. 25
Overflow Roof Drain	OD	ALL	ALL	CLDI	40 27 00.01	FL, GR	CEMENT MORTAR / REMARKS	H, XX psig	Coat EXP No. 5, SUB No. 2, EMB No. 7, BUR Polyethylene Encase
			BUR			PRJ			
Overflow	OF	ALL	ALL	CLDI	40 27 00.01	FL, GR, PRJ	CEMENT MORTAR / REMARKS	H, XX psig	
			BUR			PRJ			
Plant (Process) Drain	PD	<=3	ALL	PVC	40 27 00.10	FL, S, W	NONE / REMARKS	H, XX psig	Coat EXP, SUB, EMB No. 25, BUR none
		>=4	ALL	CLDI	40 27 00.01	PRJ	CEMENT MORTAR / REMARKS		Polyethylene Encase
			BUR	PVC	33 05 01.12	HU	NONE / NONE		
			BUR	HDPE	33 05 01.10	FL, W	NONE / NONE		
Primary Effluent	PE	<=3	ALL	PVC	40 27 00.10	FL, S, W	NONE / REMARKS	H, XX psig	Coat EXP, SUB, EMB No. 25, BUR none
		4 thru 30	EMB, EXP, SUB	CLDI	40 27 00.01	FL, GR	CEMENT MORTAR / REMARKS		Coat EXP No. 5, SUB No. 2, EMB No. 7
			BUR			PRJ			Polyethylene Encase.
			BUR	HDPE	33 05 01.10	FL, W	NONE / NONE		
		>=36	BUR	WS	33 05 01.01	W	CEMENT MORTAR / CEMENT MORTAR		
			BUR	HDPE	33 05 01.10	FL, W	NONE / NONE		
Primary Influent	PI	<=3	ALL	PVC	40 27 00.10	FL, S, W	NONE / REMARKS	H, XX psig	Coat EXP, SUB, EMB No. 25, BUR none
		4 thru 30	EMB, EXP, SUB	CLDI	40 27 00.01	FL, GR	CEMENT MORTAR / REMARKS		Coat EXP No. 5, SUB No. 2, EMB No. 7
			BUR			PRJ			Polyethylene Encase.
			BUR	HDPE	33 05 01.10	FL, W	NONE / NONE		
		>=36	BUR	WS	33 05 01.01	W	CEMENT MORTAR / CEMENT MORTAR		
			BUR	HDPE	33 05 01.10	FL, W	NONE / NONE		
Plant Effluent	PLE	<=3	ALL	PVC	40 27 00.10	FL, S, W	NONE / REMARKS	H, XX psig	Coat EXP, SUB, EMB No. 25, BUR none
		4 thru 30	EMB, EXP, SUB	CLDI	40 27 00.01	FL, GR	CEMENT MORTAR / REMARKS		Coat EXP No. 5, SUB No. 2, EMB No. 7
			BUR			PRJ			Polyethylene Encase.
			BUR	HDPE	33 05 01.10	FL, W	NONE / NONE		
		>=36	BUR	WS	33 05 01.01	W	CEMENT MORTAR / CEMENT MORTAR		
			BUR	HDPE	33 05 01.10	FL, W	NONE / NONE		
Polymer Solution	PO	ALL	ALL	SST	40 27.00.08	FL, W	NONE / NONE	H, XX psig	

Service	Legend	Size(s) (in.) (Note 2)	Installation (Note 4)	Material (Note 3)	Specification Section	Joint Type (Note 5)	Lining/Coating (Note 6)	Test Pressure and Type (Note 7)	Remarks
Primary sludge	PS	3	ALL	PVC	40 27 00.10	FL, S, W	NONE / REMARKS	H, XX psig	Coat EXP, SUB, EMB No. 25, BUR none
		>=4	BUR	CLDI	40 27 00.01	PRJ	CEMENT MORTAR / REMARKS		Polyethylene Encase.
			EXP, SUB, EMB			FL, GR			Coat EMB No. 7, EXP No. 4, SUB No. 2
			BUR	HDPE	33 05 01.10	FL, W	NONE / NONE		
Return Activated Sludge	RAS	<=3	ALL	PVC	40 27 00.10	FL, S, W	NONE / REMARKS	H, XX psig	Coat EXP, SUB, EMB No. 25, BUR none
		>=4	BUR	CLDI	40 27 00.01	PRJ	CEMENT MORTAR / REMARKS		Polyethylene Encase.
			EXP, SUB, EMB			FL, GR			Coat EMB No. 7, EXP No. 4, SUB No. 2
			BUR	HDPE	33 05 01.10	FL, W	NONE / NONE		
Recycle	RCY								
Roof Drain	RD	ALL	ALL, REMARKS	CISP	40 27 00.02	No-Hub	NONE / NONE	PC	To 5 feet outside bldg lines
			BUR	PVC	33 05 01.12	HU			Beyond 5 feet outside bldg lines
Raw Sewage	RS	ALL	ALL	CLDI	40 27 00.01	FL, GR, PRJ	CEMENT MORTAR / REMARKS	H, XX psig	Coat EXP No. 5, SUB No. 2, EMB No. 7, BUR Polyethylene Encase
			BUR	HDPE	33 05 01.10	FL, W	NONE / NONE		
Recirculated Sludge	RSD	<=3	ALL	PVC	33 05 01.09	FL, S, W	NONE / REMARKS	H, XX psig	Coat EXP, SUB, EMB No. 25, BUR none
		>=4	BUR	CLDI	40 27 00.01	PRJ	Cement Mortar/Remarks		Polyethylene Encase.
			EXP, SUB, EMB			FL, GR			Coat EMB No. 7, EXP No. 4, SUB No. 2
			BUR	HDPE	33 05 01.10	FL, W	NONE / NONE		
Sample Line	XX/SA	ALL	ALL	Remarks	Remarks	Remarks	Remarks	Remarks	XX = primary service (Note 1)
Scum	SC	<=3	ALL	PVC	40 27 00.10	FL, S, W	NONE / REMARKS	H, XX psig	Coat EXP, SUB, EMB No. 25, BUR none
		>=4	ALL	GLDI	40 27 00.01	HU	GLASS / REMARKS		Coat EXP No. 5, EMB No. 7, except BUR end No. 29 and SUB end No. 2
			BUR	HDPE	33 05 01.10	FL, W	NONE / NONE		
Secondary Effluent	SE	<=3	ALL	PVC	40 27 00.10	FL, S, W	NONE / REMARKS	H, XX psig	Coat EXP, SUB, EMB No. 25, BUR none
		4 thru 30	EMB, EXP, SUB	CLDI	40 27 00.01	FL, GR	CEMENT MORTAR / REMARKS		Coat EXP No. 5, SUB No. 2, EMB No. 7
			BUR			PRJ			Polyethylene Encase.
			BUR	HDPE	33 05 01.10	FL, W	NONE / NONE		
		>=36	BUR	WS	33 05 01.01	W	CEMENT MORTAR / CEMENT MORTAR		
			BUR	HDPE	33 05 01.10	FL, W	NONE / NONE		
Supernatant Return	SR	ALL	EXP, EMB, SUB	CLDI	40 27 00.01	FL, GR	CEMENT MORTAR / REMARKS	H, XX psig	Coat EMB No. 7, EXP No. 4, SUB No. 2
			BUR			PRJ			Polyethylene Encase.
			BUR	HDPE	33 05 01.10	FL, W	NONE / NONE		
Sanitary Sewage(Gravity)	SS	< =4	EXP	PVC-DWV	22 10 01.02	W	NONE / NONE	G	
			EMB, BUR, SUB	PVC	33 05 01.12	HU	NONE / NONE		
		>=6	BUR	CLDI	40 27 00.01	PRJ	CEMENT MORTAR / REMARKS		Polyethylene Encase.
			EMB, EXP, SUB			FL, GR			Coat EMB No. 7, EXP No. 4, SUB No. 2
			BUR	CISP	22 10 01.03	C	NONE / No. 5		
			BUR	HDPE	33 05 01.10	FL, W	NONE / NONE		
Tank Drain	TD	< =4	EXP	PVC-DWV	22 10 01.02	W	NONE / NONE	G	
			BUR, SUB	PVC	33 05 01.12	HU	NONE / NONE		
		>=6	EMB, EXP, SUB	CLDI	40 27 00.01	FL	CEMENT MORTAR / REMARKS		Coat EXP No. 5, SUB No. 2, EMB No. 7
			BUR			PRJ			Polyethylene Encase.
			BUR	HDPE	33 05 01.10	FL, W	NONE / NONE		

Service	Legend	Size(s) (in.) (Note 2)	Installation (Note 4)	Material (Note 3)	Specification Section	Joint Type (Note 5)	Lining/Coating (Note 6)	Test Pressure and Type (Note 7)	Remarks
Thickened Digested Sludge	TDS	<=3	EXP, SUB, EMB	PVC	40 27 00.10	FL, S, W	NONE / No. 25	H, XX psig	
		>=4	BUR	CLDI	40 27 00.01	PRJ	CEMENT MORTAR / REMARKS		Polyethylene Encase.
			EXP, SUB, EMB			FL, GR			Coat EXP No. 5, SUB No. 2, EMB No. 7
			BUR	HDPE	33 05 01.10	FL, W	NONE / NONE		
Thickener Underflow	TUF	4 - 24	EMB, EXP	CLDI	40 27 00.01	FL, GR	CEMENT MORTAR / No. 5	H, XX psig	
			BUR			PRJ	CEMENT MORTAR / REMARKS		Polyethylene Encase.
			BUR	HDPE	33 05 01.10	FL, W	NONE / NONE		
Thickened Activated Sludge	TWAS	<=3	ALL	PVC	40 27 00.10	FL, S, W	NONE / No. 25	H, XX psig	
		>=4	BUR	CLDI	40 27 00.01	PRJ	CEMENT MORTAR / REMARKS		Polyethylene Encase.
			EXP, SUB, EMB			FL, GR			Coat EMB No. 7, EXP No. 4, SUB No. 2
			BUR	HDPE	33 05 01.10	FL, W	NONE / NONE		
Vent	V	ALL	ALL	CISP	40 27 00.02	NO-HUB	NONE / No. 5	N/A	
Waste Activated Sludge	WAS	<=3	ALL	PVC	40 27 00.10	FL, S, W	NONE / No. 25	H, XX psig	
		>=4	BUR	CLDI	40 27 00.01	PRJ	CEMENT MORTAR / REMARKS		Polyethylene Encase.
			EXP, SUB, EMB			FL, GR			Coat EMB No. 7, EXP No. 4, SUB No. 2
			BUR	HDPE	33 05 01.10	FL, W	NONE / NONE		
Potable Water (Avion)	W1	<=3	EXP, SUB, EMB	COP	40 27 00.13	FL, S, W	NONE / No. 5	H, XX psig	Exposed only in non-process areas or where specifically shown on drawings
			EXP, SUB	SST	40 27 00.20	FL, S, W	NONE / NONE		Exposed in process areas
			BUR	PVC	40 27 00.10	S, W	NONE / NONE		
		>=4	BUR	CLDI	40 27 00.01	PRJ	CEMENT MORTAR / REMARKS		Polyethylene Encase.
			EXP, SUB, EMB			FL, GR			Coat EMB No. 7, EXP No. 4, SUB No. 2
Potable Water (Well)	W2	<=3	EXP, BUR, EMB	COP	40 27 00.13	FL, S, W	NONE / No. 5	H, XX psig	Exposed only in non-process areas or where specifically shown on drawings
			EXP, SUB	SST	40 27 00.20	FL, S, W	NONE / NONE		Exposed in process areas
			BUR	PVC	40 27 00.10	S, W	NONE / NONE		
		>=4	BUR	CLDI	40 27 00.01	PRJ	CEMENT MORTAR / REMARKS		Polyethylene Encase.
			EXP, SUB, EMB			FL, GR			Coat EMB No. 7, EXP No. 4, SUB No. 2
Reuse Water (level 4, Class A)	W3	<=3	EXP, BUR, EMB	COP	40 27 00.13	FL, S, W	NONE / No. 5	H, XX psig	Exposed only in non-process areas or where specifically shown on drawings
			EXP, SUB	SST	40 27 00.20	FL, S, W	NONE / NONE		Exposed in process areas
			BUR	PVC	40 27 00.10	S, W	NONE / NONE		
		>=4	BUR	CLDI	40 27 00.01	PRJ	CEMENT MORTAR / REMARKS		Polyethylene Encase.
			EXP, SUB, EMB			FL, GR			Coat EMB No. 7, EXP No. 4, SUB No. 2
Chlorinated Effluent (Plant Water)	W4	<=3	EXP, BUR, EMB	COP	40 27 00.13	FL, S, W	NONE / No. 5	H, XX psig	Exposed only in non-process areas or where specifically shown on drawings
			EXP, SUB	SST	40 27 00.20	FL, S, W	NONE / NONE		Exposed in process areas
			BUR	PVC	40 27 00.10	S, W	NONE / NONE		
		>=4	BUR	CLDI	40 27 00.01	PRJ	CEMENT MORTAR / REMARKS		Polyethylene Encase.
			EXP, SUB, EMB			FL, GR			Coat EMB No. 7, EXP No. 4, SUB No. 2

Service	Legend	Size(s) (in.) (Note 2)	Installation (Note 4)	Material (Note 3)	Specification Section	Joint Type (Note 5)	Lining/Coating (Note 6)	Test Pressure and Type (Note 7)	Remarks

NOTES:

1. Where piping carries two or more service designations the piping material and test pressure shall conform to the requirement for the first service listed, e.g. CGW/OF would require the material used for CGW piping.

2. ">" Greater Than
   "<" Less Than
   "<=" Less Than or Equal To
   ">=" Greater Than or Equal To
   "ALL" All sizes

3. A20: Alloy 20
   CISP: Cast Iron Soil Pipe
   CLDI: Cement-Lined Ductile Iron
   CPVC: Chlorinated Polyvinyl Chloride
   COP: Copper
   DWV: Drain, Waste, Vent Pipe
   FRP: Fiberglass Reinforced Plastic
   GALV: Galvanized Steel
   GLDI - Glass Lined Ductile Iron
   GLSTL - Glass Lined Carbon Steel
   HDPE - High Density Polyethylene
   PIP - Preinsulated Pipe
   PP: Polypropylene
   PT: Plastic tubing
   PVC: Polyvinyl Chloride
   PWPE: Profile Wall Polyethylene
   RCP - Reinforced Concrete Pipe
   RCPP: Reinforced Concrete Pressure Pipe
   SST: Stainless Steel
   STL: Mill Type Carbon Steel
   WS: Fabricated Welded Steel
   CSS: Coated stainless steel

4. Installations
   EXP: Exposed (interior or exterior)
   BUR: Buried
   EMB: Embedded (in concrete)
   SUB: Submerged
   ALL: All installations

5. Joints as specified in Section 40 27 00 PROCESS PIPING - GENERAL and in the sections referenced
   FL - Flanged
   GR - Grooved
   HU - Hub and Spigot
   MJ - Mechanical Joint
   PRJ - Proprietary Restrained Joint
   S - Screwed
   W - Welded, Soldered, Brazed
   C - Flareless Compression Fitting
   BS - Bell and Spigot
6. Coating system number as specified in Section 09 90 00, PAINTING AND PROTECTIVE COATINGS, and as specified in Article, PIPE CORROSION PROTECTION.
   Poly: Polyethylene wrap per Section 40 27 00
   Tape: Tape wrap per Section 40 27 00
   FP: Fluoropolymer
7. H: Hydrostatic Test
   P: Pneumatic Test
   G: Gravity Pipe - Test pressure is not shown on gravity pipes.
   Test to highest liquid level that pipe can be subject to.
   PC: Test per Uniform Plumbing Code
   PSIG: Pressure

Remarks:

1) Heat trace as specified in Section 40 05 33.
2) Insulate as specified in Section 40 32 13.
3) Where maximum operating temperatures are not indicated the operating temperature is ambient or not applicable.
4) Where short sections of existing pipe are relocated, contractor to match the existing pipe material.
5) Use 316 SST pipe.
6) Use 316 SST forged flanges for all submerged service.
7) Grooved fittings or joints are not acceptable for this service.
8) HDPE FA pipe shall have a 50 psi pressure rating and SDR (standard dimension ratio) = 32.5
9) Refer to drawings for type of service being sampled.
10) Secondary containment required. Refer to Section 40 27 00
11) All buried piping to be Restrained Joint pipe and fittings.

Attachment C— Table of Contents (Contract Document Specifications)

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SPECIFICATIONS

VOLUME 1

VOLUME 3

END OF SECTION

TM 3—Primary Treatment Improvements

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DATE: October 3, 2011

PROJECT: Schematic Design Report
Bend Water Reclamation Facility Secondary Expansion

Background

This technical memorandum details the options that were evaluated for primary treatment at the Bend Water Reclamation Facility (WRF). As part of the Bend WRF Secondary Expansion Project, a new primary clarifier will be constructed along with an associated primary sludge pump station. The existing primary sludge pump station will also be upgraded as part of the current project.

The Project Definition Report documents the following evaluations:

- Determination of the primary sludge pump type for the new and existing primary sludge pump stations.
- Determination of the material for the new primary clarifier mechanism.
- Determination of how to address the exisitng primary clarifier mechanisms in the current project.
- Condition assessment of the exisitng primary clarifier mechanisms and structure.
- Requirements for upgrading the existing primary sludge pump station ventilation to meet the National Fire Protection Association (NFPA) 820 *Standard for Fire Protection in Wastewater Treatment and Collection Facilities*.

Design Criteria

Table 1 lists the design criteria for primary treatment. The design surface overflow rates were developed during the facility planning effort (Carollo, 2008) and used here as the primary clarifier design basis. CH2M HILL endorses the use of these values for the current design.

TABLE 1
Primary Treatment Design Criteria
City of Bend Water Reclamation Facility

Item	Design Criteria
Primary Clarifiers	
Number of Units	Two existing; one new
Diameter	65 feet
Sidewater Depth	9 feet
Average Day Maximum Month SOR	1,000 gpd/ft^2 [a]
Firm SOR under Average Day Maximum Month Flow Conditions	1,500 gpd/ft^2 [b]
Maximum SOR under Peak Hour Wet Weather Flow Conditions	3,000 gpd/ft^2 [a]
ADMM Capacity – all units in service	10 mgd
Firm ADMM Capacity – one unit out of service	10 mgd
Peak Weather Capacity – all units in service	29.9 mgd
Primary Sludge Pumping	
Mass Flow Rate	63,300 pounds per day (2030 Maximum Week Primary Sludge Production)
Solids Concentration	2% to 5% TS
Design Flow Rate	Primary design condition: 151,600 gpd @ 5% TS
	Secondary design condition: 380,200 gpd @ 2% TS
Minimum Flow Rate	Primary design condition: 40,000 gpd @ 2% TS
	Secondary design condition:16,000 gpd @ 5% TS
Primary Sludge Pump Design Conditions (5% TS)	180 gpm/pump @ 175 feet TDH (58 feet static)
Discharge Location	Anaerobic Digester 3
Pump Type	Two-stage progressing cavity
Number of Pumps	Three
Drive Type	Variable
Power	15 hp
Primary Scum Pumping	
Primary Scum Pump Design Conditions	180 gpm/pump @ 181 feet TDH (64 feet static)
Pump Type	Two-stage progressing cavity
Number of Pumps	2
Drive Type	Variable
Power	15 hp

[a] All units in service.
[b] Largest unit out of service.

gpd = gallons per day; gpd/ft^2 = gallons per day per square foot; hp = horsepower; SOR = surface overflow rate; TDH = total dynamic head; TS = total solids;

Primary Treatment Evaluations

Primary Sludge Pump Type

The existing primary sludge pump station contains two air driven diaphragm pumps for primary sludge pumping. The primary sludge pump type for the existing and new primary sludge pump stations was evaluated considering two pump alternatives:

1. Air driven diaphragm pumps
2. Progressing cavity pumps

Progressing cavity pumps are the recommended alternative because of the following advantages:

- Continuous discharge flow during pump operation, which allows more accurate flow measurement and better process control.
- Capability to operate at higher discharge pressures and therefore can convey the thicker primary sludge more reliably and against higher static head.
- Wider range of operation relative to percent solids, providing operations staff with greater reliability should primary sludge thickness be greater than 5 percent solids at times.

Because primary sludge containing grit can be abrasive, reducing stator and rotor life, the material selection for the rotor and stator on the progressing cavity pumps will be important. A material such as natural rubber or urethane with a durometer hardness of 45-50 for the stator and chrome plated tool steel for the rotor material can help increase abrasion resistance. CH2M HILL will work with progressing cavity pump manufactures to ensure appropriate material selection and design criteria (pump speed and head conditions per stage) for the proposed primary sludge application due to possible abrasion that can increase the frequency of rotor and stator replacement.

Primary Clarifier 1 and 2 Mechanisms

The existing primary clarifier mechanisms are in need of rehabilitation and/or replacement. Four alternatives were considered:

1. Do nothing with the existing primary clarifier mechanisms and replace them when they reach the end of their useful life.
2. Sandblast and recoat the existing primary clarifier mechanisms.
3. Replace the mechanisms with new painted steel mechanisms.
4. Replace the mechanisms with new stainless steel mechanisms.

Present worth cost estimates were developed for these alternatives and evaluated. Based on the results of the primary clarifier condition assessment, it is acceptable for the City of Bend to do nothing with the existing primary clarifier mechanisms and replace them with new stainless steel mechanisms when they reach the end of their useful life. This will preserve available budget to address other, higher impact areas in the treatment plant as part of the current project.

Primary Clarifier 3 Mechanism

For Primary Clarifier 3, a present worth comparison of installing a painted steel or stainless steel primary clarifier mechanism was performed. Stainless steel is the recommended material for installation in the new primary clarifier. Although the stainless steel mechanism represents a higher initial capital investment, the material will not require recoating over its lifetime and therefore represents the material selection with the best life cycle cost.

Primary Clarifier Condition Assessment

CH2M HILL performed condition assessment of the protective coatings on the City's Primary Clarifier 1 as part of the schematic design phase work during the WRF Secondary Expansion. This work included visual observations of the clarifier and mechanisms and limited field tests to evaluate paint thickness and adhesion. Paint chip samples were collected and sent to the Corvallis CH2M HILL Laboratory for lead testing.

The protective coatings on the Primary Clarifier 1 steel mechanism are currently in fair condition. The most apparent corrosion is on the edges of angle members, center column, and feed well where paint is readily chipping and peeling. The Primary Clarifier 2 mechanism is assumed to be in similar condition. The City has reportedly replaced the coatings on the primary clarifier mechanism three times since original construction. The scum baffle and v-notch weir are fiberglass and appear to be in very good condition. Metal brackets holding the scum baffle appear to be coated and appear to be in good condition.

Concrete in the below-water areas is in good condition. Concrete in the launders is in poor to fair condition and may require spot rehabilitation to extend the life of the concrete. Lining of the concrete launders is not recommended at this time. No condition assessment was performed for the mechanical condition of the motor and gear drive mechanism.

Based on the information gathered during this project, CH2M HILL believes that to preserve the capital budget of the current project it is acceptable to keep the existing clarifier mechanisms in service without recoating. However, some minor repair work should be included in the current project.

Samples of paint chips were collected from the center column and center cage of the primary clarifier. ***Substantial lead concentrations were found in the existing coatings tested. Therefore, special provisions for handling and disposal of lead-based paint residue are required upon replacement of the existing mechanisms.***

NFPA 820 Compliance for the Existing Primary Sludge Pump Station

The existing primary sludge pump station was built as part of the original plant construction in 1978 before NFPA 820 was adopted. Without upgrades to bring the existing primary sludge pump station into compliance, the space will be designated Class 1 Division 2 according to NFPA 820 once construction upgrades are made. The following upgrades are required so the space can be unclassified following the Secondary Expansion Project based on the NFPA 820 standards:

- Replace the existing ventilation system with a new filtered supply fan and exhaust fan to meet NFPA 820 requirements for (1) 6 air changes per hour, (2) push-pull configuration and, (3) fan construction.
- Provide a new environmental monitoring system to monitor supply and exhaust fans for ventilation status.
- Provide audible and visual alarms within the interior space.
- Provide Go/No-Go entry lights outside of each entry into the building.
- Provide supervised signaling for entry ways and space alarms.
- Provide interface between environmental monitoring system and supervisory control and data acquisition (SCADA) to transfer alarm and trouble signals to a monitored location.

These upgrades will be completed as part of the Bend WRF Secondary Expansion Project. Based on the retroactivity clause of NFPA 820, CH2M HILL feels the existing facility is compliant until construction modification are made to the structure. There is the possibility that authority having jurisdiction could potentially deem the situation at the existing primary sludge pump station unsafe and force the City of Bend to make the required upgrades prior to the Secondary Expansion project. However, CH2M HILL believes this to be unlikely because primary sludge dry wells are considered low risk based on the provisions of NFPA 820. Primary sludge pump stations can be declassified as discussed above and do not require gas monitoring for declassification because combustible gases are not present.

Catalog cuts of the alarm beacons and strobes, the supply fan, and the environmental monitoring panel are provided in Attachment D.

Process Description

Existing Primary Clarifiers 1 and 2

A 30-inch influent pipe discharges to the existing primary splitter box. The splitter box splits flow to the two existing clarifiers and has the capability to connect a future third primary clarifier. Yard piping updates to increase the conveyance of primary influent from the headworks will use the existing connection in the primary influent splitter box to connect an additional 30-inch primary influent pipe. This will eliminate the ability to install future additional primary clarifiers using this existing infrastructure.

Flow is split to the primary clarifiers via fixed weirs and is then flow is conveyed to each clarifier through a 24-inch pipe. The primary influent pipe feeds the bottom of the 65-foot diameter clarifier through the primary clarifier influent feed well. A conventional rake mechanism rotates along the bottom of the clarifier collecting settled sludge. A 6-inch primary sludge pipe from each clarifier is routed to the primary sludge pump station. The existing primary sludge pump station is attached to the existing primary influent splitter structure. Water overflows v-notched weirs and is discharged through a 24-inch primary effluent pipe.

As the rake mechanism rotates, a spray header and skimmer arm collect scum from the surface of each clarifier and direct scum into a scum box. The spray header is equipped with spray nozzles that drive the scum towards the scum box. The scum box in each clarifier has a 6-inch scum pipe that conveys primary scum to the primary sludge pump station.

Primary Clarifier 3

The new primary clarifier will be located to the west of the existing Primary Clarifiers 1 and 2. A new 30-inch primary influent pipe will discharge into a new primary influent splitter box. A second 30-inch connection will be provided for a future parallel PI line to serve future additional primary clarifiers. The new primary influent splitter box will have connections for two future primary clarifiers in addition to Primary Clarifier 3. Flow will be directed to Primary Clarifier 3 by flowing over a fixed weir and conveyed through a 30-inch primary influent pipe. The new primary clarifier will be designed to match the existing primary clarifiers to ensure that all the units function as uniformly as possible. The primary effluent from Primary Clarifier 3 is discharged through a 30-inch pipe to ensure the system has capacity to convey the design peak flow.

Existing Primary Sludge Pump Station

The primary sludge pump station is adjacent to the primary clarifier splitter box and primary scum pit. The 6-inch primary sludge pipe from each primary clarifier and the 6-inch primary scum pipe connect to the suction header. The header allows each of the three pumps (two primary sludge pumps, one primary scum pump) to draw from either clarifier or the scum pit if one of the pumps is out of service. The discharge from the primary sludge/scum pumps is combined in a header that discharges to either the digester feed wet well or Anaerobic Digester 3.

New Primary Sludge Pump Station

The new primary sludge pump station is adjacent to the new primary clarifier splitter box and primary scum pit, but is not structurally connected. The 6-inch primary sludge pipe from Primary Clarifier 3 and the 6-inch primary scum pipe connect to the suction header. The header allows the two pumps (one primary sludge pump, one primary scum pump) to draw from either the clarifier or the scum pit if one of the pumps is out of service. The discharge from the primary sludge/scum pumps is combined in a header that discharges to either the digester feed wet well or Anaerobic Digester 3. The new primary sludge pump station has a separate electrical room for housing electrical gear and instrumentation and control equipment.

EPA Reliability/Redundancy and Clarifier Capacity

The U.S. Environmental Protection Agency (EPA) classifies wastewater treatment plants into three levels of system reliability. Based on discussions with Oregon Department of Environmental Quality (DEQ), confirmed as part of this predesign effort, the Bend WRF must meet the reliability and redundancy requirements of a Class II facility. This means that the primary clarifiers must provide treatment capacity for 50 percent of the design flow with the largest unit out of service. For Primary Clarifiers, this requirement is interpreted as the ability to treat 50 percent of the peak wet weather flow. Also, regarding pumping, the backup primary sludge pump must ensure sufficient capacity to pump 100 percent design flow with any pump out of service.

Table 2 summarizes the design SORs for the primary clarifiers for each condition listed as well as the required clarifier capacity based on these design SOR values and based on the EPA reliability and redundancy criteria. The firm capacity of the primary clarifiers is based on one unit being out of service and the remaining primary clarifiers successfully treating the average day maximum month flow. The EPA reliability and redundancy criteria are based on successfully treating 50 percent of the peak wet weather flow with one unit out of service. Primary Clarifier 3 is being installed as part of this project because the EPA reliability and redundancy criteria cannot be met for the 2030 peak weather flow condition with only 2 primary clarifiers.

TABLE 2
Primary Clarifier Capacity and EPA Redundancy Requirements
City of Bend Secondary Expansion Project

		Start-Up		2030	
	Design SOR (gpd/ft^2)	Required Capacity (mgd)	Capacity of 2 PCs (mgd)	Required Capacity (mgd)	Capacity of 3 PCs (mgd)
ADMMF - all units in service	1,000	6.0	6.6	11.9	10.0
Firm ADMMF - one unit out of service	1,500	6.0	5.0	11.9	10.0
PWWF - all units in service	3,000	14.7	19.9	29.1	29.9
PWWF - one unit out of service	3,000	7.4	10.0	14.6	19.9

The design SOR values result in a rated ADMM primary clarifier capacity that is less than the 2030 ADMM flow. Thus, a fourth primary clarifier may be needed prior to 2030. However, the stated design SORs are conservative and it is likely that the three primary clarifiers can treat the 2030 ADMM flow without adverse impacts to the surrounding unit processes (aeration basins and digestion). Once Primary Clarifier 3 is online, the City of Bend can evaluate the actual capacity of the primary treatment system. This will allow the timing of the need for a fourth primary clarifier to be accurately determined.

The primary scum pumps will be designed to provide full redundancy to the primary sludge pumps. If one primary sludge pump is offline, the primary scum pump in the same pump station can be transferred into primary sludge service. The primary scum wet well would be manually drained a few times a week (similar to the current operational approach) until the primary sludge pump can be brought back online.

Instrumentation and Control Strategy

Primary Treatment Overview

Primary influent (PI) exits the headworks through two 42-inch pipes, one directing flow to the eastern primary treatment train (existing Primary Influent Splitter 1, existing Primary Clarifier 1, existing Primary Clarifier 2, and existing Primary Sludge Pump Station 1) and one directing flow to the western primary treatment train (Primary Influent Splitter 2, Primary Clarifier 3, and Primary Sludge Pump Station 2). Drawing 5-CY-100 provides an overview of the proposed yard piping improvements for PI conveyance from the headworks to the Primary Influent Splitters. These improvements are described here.

The existing 30-inch PI pipe existing the headworks and feeding the eastern primary treatment train will be upgraded to a 42-pipe are part of the current project. The proposed eastern 42-inch pipe splits into two 30-inch PI pipes (one existing, one proposed). The existing easterly 30-inch PI pipe will remain in service. Provisions will be made to install the second easterly 30-inch pipe in the future. The proposed western 42-inch pipe continues from an existing stub out in the headworks and will split into two 30-inch PI pipes. One 30-inch PI pipe will be installed as part of the current project. Provisions will be made to install the second 30-inch PI pipe in the future.

The existing easterly 30-inch PI pipe feeds the existing Primary Influent Splitter 1. Existing Primary Influent Splitter 1 divides flow evenly between Existing Primary Clarifiers 1 and 2 using two fixed weirs. The proposed westerly 30-inch PI pipe feeds Primary Influent Splitter 2. Primary Influent Splitter 2 directs flow to Primary Clarifier 3 by passing flow over a fixed weir and into a drop box. Flow will be evenly divided between Primary Clarifier 3 and Future Primary Clarifiers 4 and 5 using fixed weirs in the same fashion as Primary Influent Splitter 1.

PI flows into the center of each clarifier through a flocculating feed well with an energy dissipating inlet. Primary effluent (PE) exits the clarifier over V-notch weirs and is directed to the aeration basins. Primary sludge (PS) is scraped by the primary clarifier mechanism to a sludge box adjacent to the center feed column where it is withdrawn by the primary sludge pumps. PS from Existing Primary Clarifiers 1 and 2 discharges to Existing Primary Sludge Pump Station 1. PS from Primary Clarifier 3 discharges to Primary Sludge Pump Station 2. There is one PS Pump per clarifier. Redundancy is provided by the primary scum pumps.

Scum (SC) is prevented from flowing over the effluent V-notch weirs with a full circumference scum baffle inset from the effluent v-notch weirs. Scum is directed to the scum beach with a skimmer that rotates with the mechanism. The scum beach is located adjacent to the clarifier walkway. Water sprays located on the clarifier walkway encourage scum movement from the center of the clarifier toward the scum beach. The water sprays are manually turned on and off and operate continuously when turned on. Scum drains by gravity to the scum wet well attached to the primary influent splitter. Scum from Existing Primary Clarifiers 1 and 2 is directed to Existing Primary Influent Splitter 1. Scum from Primary Clarifier 3 is directed to Primary Influent Splitter 2. Primary Scum Pump 1 withdraws scum from the scum wet well in Existing Primary Influent Splitter 1. Primary Scum Pump 2 withdraws scum from the scum wet well in Primary Influent Splitter 2.

PS and primary SC are pumped with progressing cavity pumps. PS and primary SC are discharged into a common header and directed to the solids handling facility. There is a flow meter and solids density meter on the main discharge header in each primary sludge pump station. The discharge from Primary Sludge Pump Station 2 is connected to the discharge of Existing Primary Sludge Pump Station 1. PS from both sources travels to the solids handling facility in the existing PS piping.

The proposed eastern and western 42-inch PI pipes have manual isolation valves at the headworks. The western 42-inch PI pipe splits at a 42-inch tee, and a single 30-inch PI pipe is routed to Primary Influent Splitter 2. The westerly outlet of the tee is blind flanged for future connection. The existing easterly 30-inch concrete PI pipe will have an isolation butterfly valve cut into the pipeline. Initially, the western primary treatment train will be needed for redundancy only, allowing existing Primary Clarifier 1 or 2 to be taken offline. Once the influent flows reach the capacity of the eastern primary treatment train, the western primary treatment train will be put into continuous service.

Primary Clarifier Mechanism

The primary clarifier mechanisms operate at constant speed and are turned on and off at a local control panel provided by the manufacturer of the equipment. The plant SCADA system monitors the on/off position and torque of each primary clarifier mechanism.

Primary Clarifier Scum System

Primary SC drains continuously to the scum wet wells associated with Primary Influent Splitters 1 and 2. There is a plant water spray header located in the scum wet well with an automated control valve to turn the spray header on and off. The water surface level in the scum wet well will be continuously monitored with a level element. The primary scum pump will be automatically controlled based on the water surface level in the scum wet well. When the level in the scum wet well reaches an operator-adjustable high level, the control valve isolating the scum wet well from the intake manifold opens, the primary scum pump turns on, and the valve turning on the plant water spray header turns on. The scum wet well is drained to a operator-adjustable low level at which point the spray header is turned off, the primary scum pump is turned off, and isolation valve is closed.

The discharge pressure of the primary scum pumps is monitored continuously. An alarm notifies plant operations staff if the discharge pressure reaches an operator-adjustable high set point. The primary scum pump is also turned off automatically if the pressure reaches the operator-adjustable high set point.

Primary Sludge Pumping System

The primary sludge pumps can operate in one of two modes: constant speed or intermittent operation. The operational mode of the primary sludge pump is manually operator selectable from the SCADA system.

In constant speed mode, the pumps run 24 hours per day, with the pump speed adjusted manually from the SCADA system to reflect changes in the sludge removal needs each day. The speed of the primary sludge pumps will be changed using an adjustable frequency drive (AFD).

The primary sludge pumps can also be operated using a SCADA controlled on/off timer (intermittent operation). This would allow each pump to run in turn, keeping the discharge pressure of the pump lower and extending the life of the stator/rotor assembly on the pumps. The pump speed of each pump is constant at an operator-adjustable set point. The run time per day for each pump is also an operator-adjustable set point based on the sludge blanket depth and the sludge density. The SCADA system would then turn the primary sludge pumps on and off at regularly spaced intervals during each hour to maintain a relatively constant loading rate to the anaerobic digesters.

The sludge density and PS flow rate are monitored by a sludge density meter and flow meter located in the common discharge header at each primary sludge pump station. Each clarifier will have a sludge depth probe to monitor the primary sludge blanket. The sludge blanket depth and sludge density will be used to stop a pump during intermittent timer mode to prevent pumping low solids primary sludge to the digester.

Design Development Issues

- Refine the primary sludge and primary scum pump selections to ensure longevity and minimize maintenance requirements. Examine the design flow rates for the primary sludge pumps to ensure that they can turn down to allow for near continuous operation.
- Confirm that the current pump arrangement provides sufficient excess space to remove the rotor and stator assembly for maintenance.
- Address modifications to the existing primary sludge pump station and primary influent splitter.
- Investigate the application of sludge density meters and sludge blanket detectors for measuring primary sludge concentration and control pump operation.

Attachments

Attachment A—Equipment Data Sheets

- Primary Clarifier Mechanism
- Primary Sludge Pumps
- Primary Scum Pumps

Attachment B—Schematic Design Fact Sheets

- Fact Sheet 1—Primary Clarifier Mechanism Fact Sheet
  Appendix A – Manufacturer Information, WesTech Primary Clarifier Mechanism
- Fact Sheet 2—Primary Sludge Pump Type
  Appendix A—Manufacturer Information, Gormann Rupp Air Diaphragm Pump
  Appendix B—Manufacturer Information, Moyno Progressing Cavity Pump

Attachment C—Primary Clarifier Condition Assessment

- Bend WRF Primary Clarifier Conditions Inspection
  Appendix A—Primary Clarifier Inspection Photos (CD)
  Appendix B—Summary of Dry Film Thickness Measurements
  Appendix C—Lead Test Results for Bend WRF Primary Clarifier 1, March 28, 2011

Attachment D—Vendor Catalog Cuts for Equipment Required for NFPA Compliance.

- Alarm beacons and strobes – Cooper Notification
- Supply Fans - Cook
- Environmental monitoring panel – Simplex

Attachment A—Equipment Data Sheets

Bend Water Reclamation Facility Secondary Expansion

EQUIPMENT DATA SHEET

SPEC SECTION: ______

LEAD ENGINEER: Menniti

FACILITY NAME: 21 - Primary Clairifcation

EQUIPMENT NAME: Primary Clarifier No. 3 Mechanism **QUANTITY:** 1

IDENTIFICATION NO.: ______

MATERIAL HANDLED: PS - Primary Sludge

CAPACITY: 13,500 ft-lbs continuous operating torque

LOCATION: x dry ______ wet x exterior ______ hazardous

POWER REQUIRED: 0.5 hp 460 volts 3 phase

DRIVE: constant speed
(Constant speed, 2 speed, variable speed)

ENCLOSURE TYPE: MOTOR: ______ CONTROL PANEL: ______

SYNCHRONOUS SPEED (rpm): ______

MOUNTING TYPE: ______
(Horizontal or Vertical):

SUPPORT UTILITIES REQUIRED: ______

EQUIPMENT DESCRIPTION: ______
(Size, configuration)

MANUFACTURERS: **NO. 1:** WesTech **NO. 2:** ______

MODEL: COPC2 **MODEL:** ______

EQUIPMENT WEIGHT: ______ lbs

EQUIPMENT COST: **QUOTE:** $188,000 **DELIVERY TIME:** ______

VENDOR: Doug Allie, Goble Sampson

MISCELLANEOUS COMMENTS, DATA, AND INFORMATION: quote
for stainless steel mechanism; includes mechanism, center column, EDI, feedwell, skimmers, scum box, center cage
65' diameter x 8'10" SWD cage drive COP primary clarifier mechanism

LOCATION OF EQUIPMENT: P&ID Sheet No. ______ Construction Sheet No. ______

REVISION	DATE	NO.	BY

Bend Water Reclamation Facility Secondary Expansion

EQUIPMENT DATA SHEET

SPEC SECTION: ____________

LEAD ENGINEER: Menniti

FACILITY NAME: 22 - Primary Sludge Pumping

EQUIPMENT NAME: Primary Sludge Pumps 1,2, and 3 **QUANTITY:** 3

IDENTIFICATION NO.: ____________

MATERIAL HANDLED: PS - Primary Sludge

CAPACITY: 180 gpm @ 175 ft TDH

LOCATION: x dry ____ wet ____ exterior ____ hazardous

POWER REQUIRED: 15 hp 460 volts 3 phase

DRIVE: Variable speed
(Constant speed, 2 speed, variable speed)

ENCLOSURE TYPE: MOTOR: ____________ CONTROL PANEL: ____________

SYNCHRONOUS SPEED (rpm): ____________

MOUNTING TYPE: horizontal
(Horizontal or Vertical):

SUPPORT UTILITIES REQUIRED: ____________

EQUIPMENT DESCRIPTION: 2 stage progressing cavity pump
(Size, configuration)

MANUFACTURERS: **NO. 1:** Moyno **NO. 2:** Seepex

MODEL: 2F090G1 **MODEL:** 5x6 model 55 BN 12-T

EQUIPMENT WEIGHT: ____ lbs

EQUIPMENT COST: **QUOTE:** $39,900 **DELIVERY TIME:** ____________

VENDOR: Apsco - Sean Clark/Elaine Stone

MISCELLANEOUS COMMENTS, DATA, AND INFORMATION: quote
includes 15 hp gear motor and accessories, spare stator = $3,162, does not inlcude VFD
current quotes are for 180 gpm @ 100 ft of head - head increased with more conversative assumptions and approximately
100 ft of primary sludge piping found on as built drawings that are not on design drawings.

LOCATION OF EQUIPMENT: P&ID Sheet No. ____ Construction Sheet No. ____

REVISION	DATE	NO.	BY

Bend Water Reclamation Facility Secondary Expansion

EQUIPMENT DATA SHEET

SPEC SECTION: ______

LEAD ENGINEER: Menniti

FACILITY NAME: 22 - Primary Sludge Pumping

EQUIPMENT NAME: Primary Scum Pump 1 and 2 **QUANTITY:** 2

IDENTIFICATION NO.: ______

MATERIAL HANDLED: SC - Scum

CAPACITY: 180 gpm

LOCATION: x dry ____ wet ____ exterior ____ hazardous

POWER REQUIRED: 15 hp ____ volts ____ phase

DRIVE: variable speed
(Constant speed, 2 speed, variable speed)

ENCLOSURE TYPE: MOTOR: ______ CONTROL PANEL: ______

SYNCHRONOUS SPEED (rpm): ______

MOUNTING TYPE: ______
(Horizontal or Vertical):

SUPPORT UTILITIES REQUIRED: ______

EQUIPMENT DESCRIPTION: 2 stage progressing cavity pump
(Size, configuration)

MANUFACTURERS: **NO. 1:** Moyno **NO. 2:** Seepex

MODEL: 2F090G1 **MODEL:** 5x6 model 55 BN 12-T

EQUIPMENT WEIGHT: ____ lbs

EQUIPMENT COST: **QUOTE:** $39,900 **DELIVERY TIME:** ______

VENDOR: Apsco - Sean Clark/Elaine Stone

MISCELLANEOUS COMMENTS, DATA, AND INFORMATION:
assume same pump as primary sludge pumps

LOCATION OF EQUIPMENT: P&ID Sheet No. ____ Construction Sheet No. ____

REVISION	DATE	NO.	BY

Attachment B—Schematic Design Fact Sheets

Primary Clarifier Mechanisms

ATTACHMENT B TO: TM 3—Primary Treatment Improvements

PROJECT: Schematic Design Report
Bend Water Reclamation Facility Secondary Expansion

Objective

A new primary clarifier and associated new primary sludge pump station will be constructed as part of the Bend Water Reclamation Facility (WRF) Secondary Expansion Project. The existing primary clarifier mechanisms are also in need of rehabilitation and/or replacement. This fact sheet presents:

- The present worth comparison of installing a painted steel or stainless steel primary clarifier mechanism for Primary Clarifier 3.
- The present worth evaluation of addressing the existing mechanisms on Primary Clarifiers 1 and 2.

Existing Primary Clarifier Mechanisms

Background

The existing primary clarifiers came online in the early 1980s and are therefore approximately 30 years old. The drives on the existing primary clarifiers were replaced in 2004 with WesTech drives. The mechanisms, rake arms and bridges have not been replaced during that time but have been well-maintained over the years. City of Bend staff indicates that the mechanisms and associated infrastructure have been recoated three times since initial installation.

The existing primary clarifier mechanisms and rake arms were recommended for rehabilitation in the 2008 Facilities Plan. The condition of the existing primary clarifier mechanisms and rake arms was assessed for corrosion and material deterioration on March 21, 2011, to determine if they can be recoated or must be replaced. The full condition assessment report is provided as Attachment C to *TM 3 – Primary Treatment Improvements*. The condition assessment indicates that the existing primary clarifier mechanisms need some minor structural rehabilitation but are in overall good structural condition. The existing primary clarifier mechanisms need to be recoated for corrosion protection if they are not replaced as part of this project.

Comparison of Alternatives

The City of Bend has four alternatives for addressing the existing primary clarifier mechanisms as part of the current Secondary Expansion Project:

1. Do nothing with the existing primary clarifier mechanisms and replace them when they reach the end of their useful life.
2. Sandblast and recoat the existing primary clarifier mechanisms.
3. Replace the mechanisms with new painted steel mechanisms.
4. Replace the mechanisms with new stainless steel mechanisms.

Table 1 summarizes the expected lifetime of primary clarifier mechanisms and drives based on CH2M HILL experience.

TABLE 1
Expected Lifetime of Primary Clarifier Mechanisms
City of Bend Water Reclamation Facility

Part	Expected Lifetime Based on CH2M HILL Experience
Gear box and drive assembly	~20 years if well maintained
Primary clarifier coating system	10–20 years with good practices for sand blasting, painting and field quality control
Steel primary clarifier mechanism	~40 years if well maintained and with recoating for painted mechanisms and minor structural rehabilitation over the lifetime of the mechanism

Based on CH2M HILL experience with coating systems, the expected lifetime is approximately 20 years. However, the primary clarifier mechanisms at the City of Bend have required recoating four times over a 30 year period. Therefore, a recoating time of 10 years was assumed for the present worth analysis presented here.

A budgetary quote for a new WesTech primary clarifier mechanism was obtained. Appendix A to this fact sheet provides catalog information for the Clarifier Optimization Package (COP). The primary clarifier package includes a drive unit, walkway assembly and platform, handrail, center column, energy dissipating inlet, feed well, rake arms, fiberglass reinforced plastic (FRP) weirs and baffles, scum skimmer assembly, and scum box. The WesTech mechanism is available in either painted steel or stainless steel. Table 2 provides the budgetary quotes for these two options. The budgetary quote for recoating the existing primary clarifier mechanism assemblies was also obtained from Fine Painting and is provided in Table 2. This quote assumes no lead paint is present in the existing coating system, standard 16 mil submersible epoxy coating, and work performed with tenting and environmental controls.

TABLE 2
Summary of Budgetary Quotes for Bend Primary Clarifiers
City of Bend Water Reclamation Facility

Item	Quote
Recoating One Existing Mechanism Assembly	$90,000
Painted Steel WesTech COP C2 Clarifier Assembly	$135,000
Stainless Steel WesTech COP C2 Clarifier Assembly	$188,000

A 40 year present worth comparative cost evaluation of the three alternatives is presented in Table 3. The analysis in Table 3 assumes the following:

- Discount rate = 1 percent.
- For Alternatives 1 and 2, the existing mechanisms replaced with stainless steel mechanisms after 10 years, based on the expected steel mechanism lifetime from Table 1.
- For Alternative 3, the painted mechanisms are recoated every 10 years based on the expected lifetime from Table 1.
- Operation and maintenance (O&M) costs other than recoating are the same for all alternatives and are therefore not included for this relative cost comparison.
- For Alternative 3, the stainless steel mechanism requires no major resurfacing throughout its 40 year lifetime.

TABLE 3
40 Year Present Worth Analysis for the Existing Primary Clarifier Mechanisms
City of Bend Water Reclamation Facility

	Alternative	Present Worth of Capital Costs	Present Worth of O&M Costs	Total 40 Year Present Worth
1	Do Nothing with Existing Mechanisms	$341,000	$0	$341,000
2	Recoat Existing Mechanisms	$341,000	$180,000	$521,000
3	New Painted Steel Mechanisms	$270,000	$445,000	$715,000
4	New Stainless Steel Mechanisms	$376,000	$0	$376,000

Recommendation

Based on the results of the primary clarifier condition assessment, it is acceptable for the City of Bend to do nothing with the existing primary clarifier mechanisms and replace them with new stainless steel mechanisms when they reach the end of their useful life. This will preserve available budget to address other, higher impact areas in the treatment plant as part of the current project. If the City decides to install new primary clarifier mechanisms, a credit of $22,000 can be obtained if the existing WesTech drive units are reused.

New Primary Clarifier Mechanism

Background

The third primary clarifier will be installed as part of this project to provide the required capacity for the influent rates projected in the year 2030. Primary Clarifier 3 will have identical dimensions to the existing primary clarifiers.

Comparison of Alternatives

The City of Bend has two alternatives for the new primary clarifier mechanism assembly installed as part of the current Secondary Expansion Project:

1. Installed painted steel mechanisms
2. Install stainless steel mechanisms.

The expected lifetimes summarized in Table 1 and the costs summarized in Table 2 apply to the new primary clarifier mechanism. A 40 year present worth comparative cost evaluation of the two alternatives is presented in Table 4. The analysis in Table 4 assumes the following:

- Discount rate = 1 percent.
- For Alternative 1, the painted mechanisms are recoated every 10 years based on the expected lifetime from Table 1.
- O&M costs other than recoating are the same for all alternatives and are therefore not included for this relative cost comparison.
- For Alternative 2, the stainless steel mechanism requires no major resurfacing throughout its 40 year lifetime.

TABLE 4
40 Year Present Worth Analysis for the New Primary Clarifier Mechanism
City of Bend Water Reclamation Facility

	Alternative	Present Worth of Capital Costs	Present Worth of O&M Costs	Total 40 Year Present Worth
1	New Painted Steel Mechanisms	$135,000	$223,000	$358,000
2	New Stainless Steel Mechanisms	$188,000	$0	$188,000

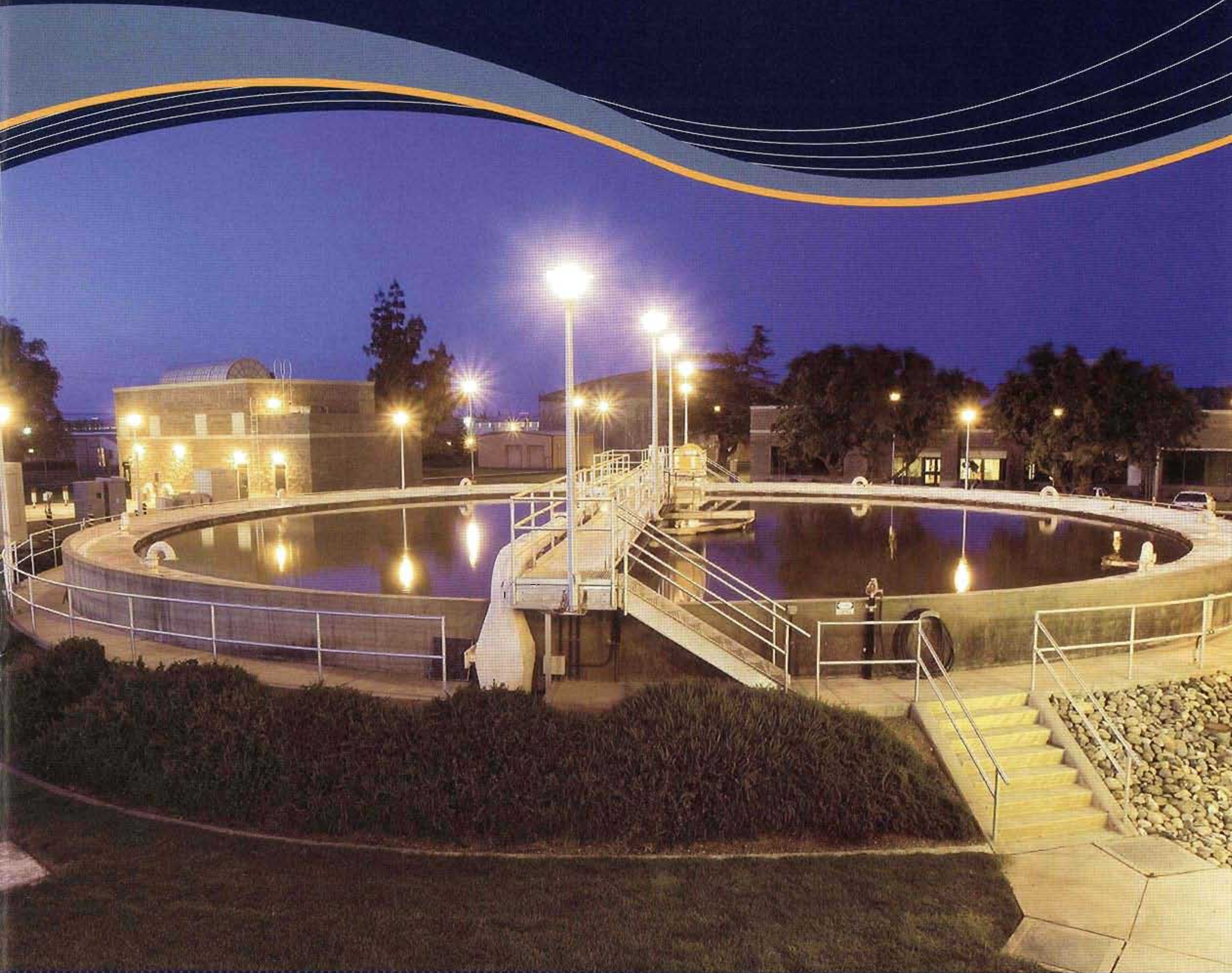
Recommendation

Stainless steel is the recommended material for installation in the new primary clarifier. Although the stainless steel mechanism represents a higher initial capital investment, the material will not require recoating over its lifetime and therefore represents the material selection with the best life cycle cost.

Appendix A—Clarifier Optimization Package Catalog Information

Clarifier Optimization Package

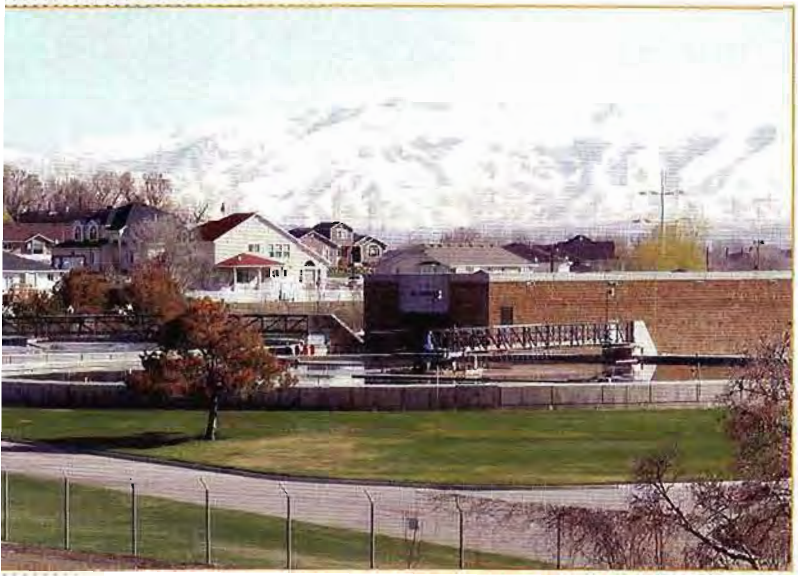
Advanced Clarifier Technology



ISO 9001 WesTech CERTIFIED QUALITY SYSTEM

WesTech

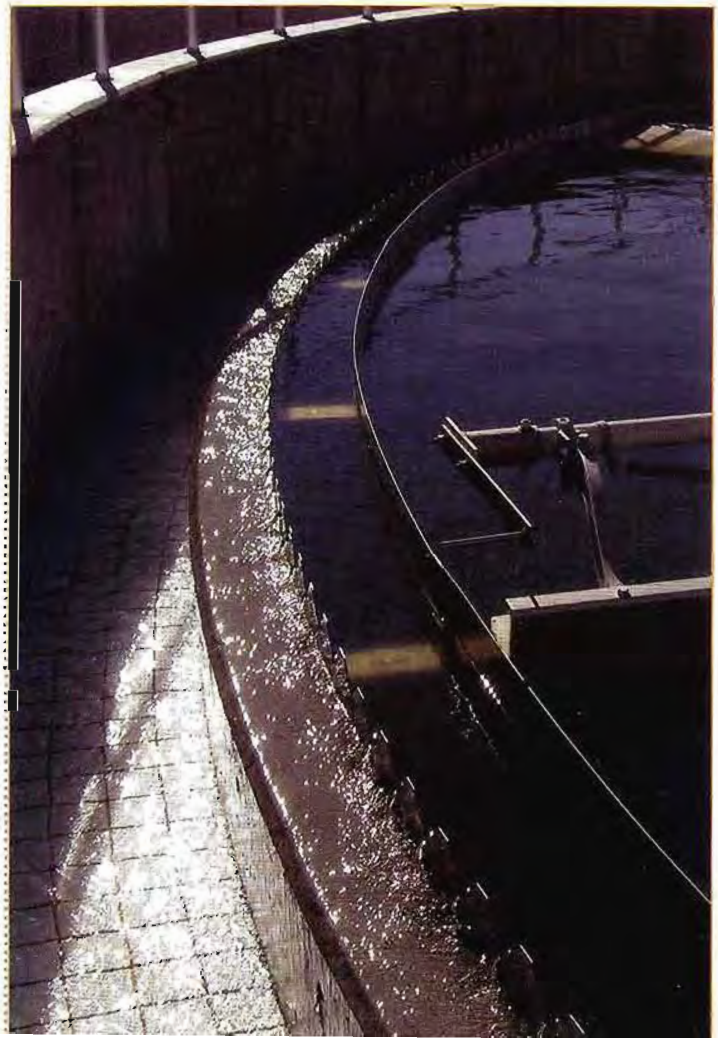
A Delicate Balance



Long-standing rules of thumb, based on manufacturing economics rather than process optimization, have clouded our understanding of clarification design. There are three basic, but interrelated, objectives of clarification:

- **to maximize the flow rate through the clarifier**
- **to produce the cleanest possible effluent**
- **to maximize underflow concentration (or minimize return sludge flow rates)**

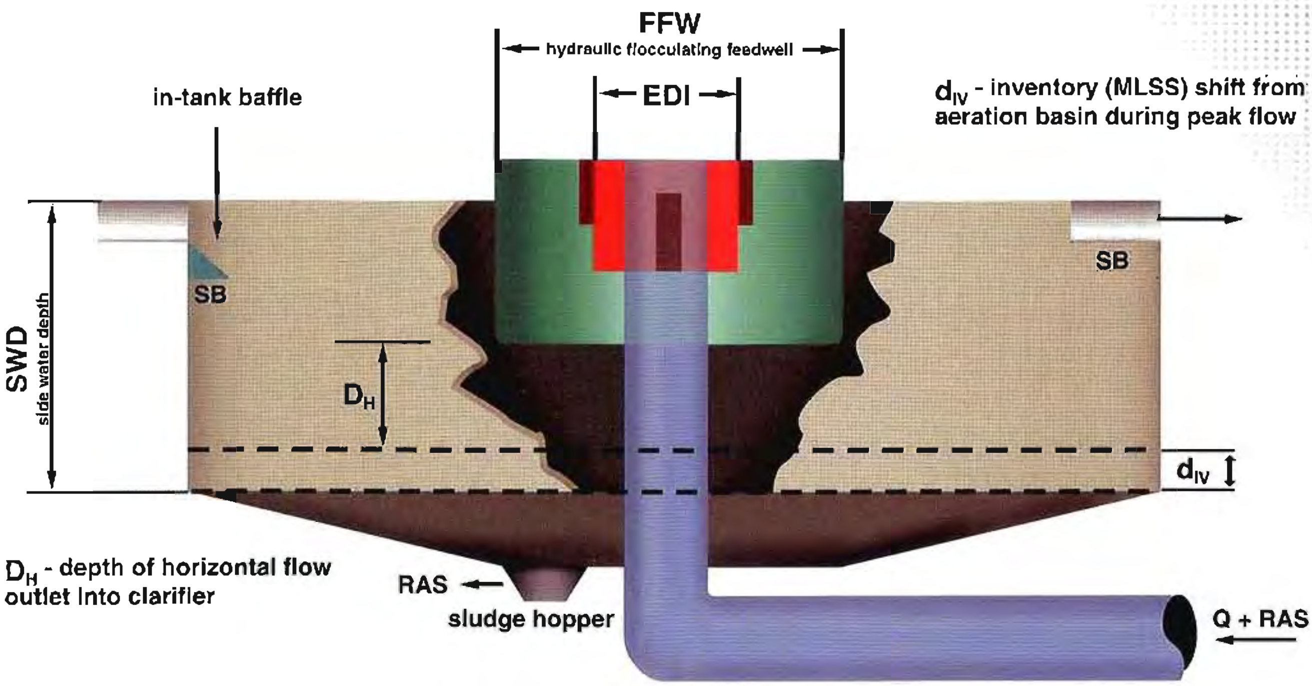
Because of the interaction of clarification process variables, optimal clarifier performance relies on a delicate balance of these interrelated priorities. The trick is how to design and size each component to generate the optimum package.



For more than fifteen years, with 450 installations and 800 individual clarifiers, WesTech has been improving the performance of both primary and secondary clarifiers with our Clarifier Optimization Package (COP™). Our experience has extended to all regions of the United States and foreign countries, in both municipal and industrial applications. This considerable experience has allowed us to constantly improve the original Clarifier Optimization Package.

The clarifier design produced by our mass balancing and sizing programs today can deliver better results than yesterday, and the COP™ Clarifier designed in the future will be better still. This unique approach to clarifier design has been adopted by several of the consulting engineering firms in the United States, and will serve the municipal and industrial markets in the future. WesTech looks forward to partnering with you to improve the effluent quality and capacity of both your primary and secondary clarifiers.

Understanding the Critical Zones of the Clarifier



Zone	Problem	The WesTech COP Solution
Center Column	Floc shear	Size column diameter and port openings to reduce energy
Energy Dissipating Inlet (EDI)	Not installed or outdated design	Include new impinged-flow design Dual-Gate™ EDI. Introduce flow into feedwell without destructive currents
Flocculating Feedwell (FFW)	Poor flocculation, blanket scour at higher flow, eddy current created	Optimize EDI-FFW diameter and depth to promote flocculation, eliminate sludge blanket scour, and remove eddy currents
Effluent Baffling	Wall (density) currents short-circuiting, TSS carryover	Supply Crosby/Stamford baffling to control density currents at peak flow
Sludge Blanket	Excessive depth, denitrification, TSS carryover, sludge inventory near periphery	Provide spiral scrapers with properly designed depth for sludge transport capacity. Additional spiral scrapers are included when required.
Sludge Withdrawal	Rat-holing (ineffective removal due to high RAS rate / low RAS concentration) results in deep sludge blanket	Replace or modify sludge hopper or suction removal mechanism with spiral scrapers and sludge withdrawal ring
Scum Removal	Insufficient removal	Employ additional skimmer arm(s), feedwell skimmers, anti-rotation baffles, and automatic scum box flushing

Nine COP™ Design Features

9 Effluent Launder Covers

Eliminate algae growth and minimize maintenance time.

1 Scum Removal

Removes scum build-up from within the feedwell and from clarifier surface.

2 Basin Configuration

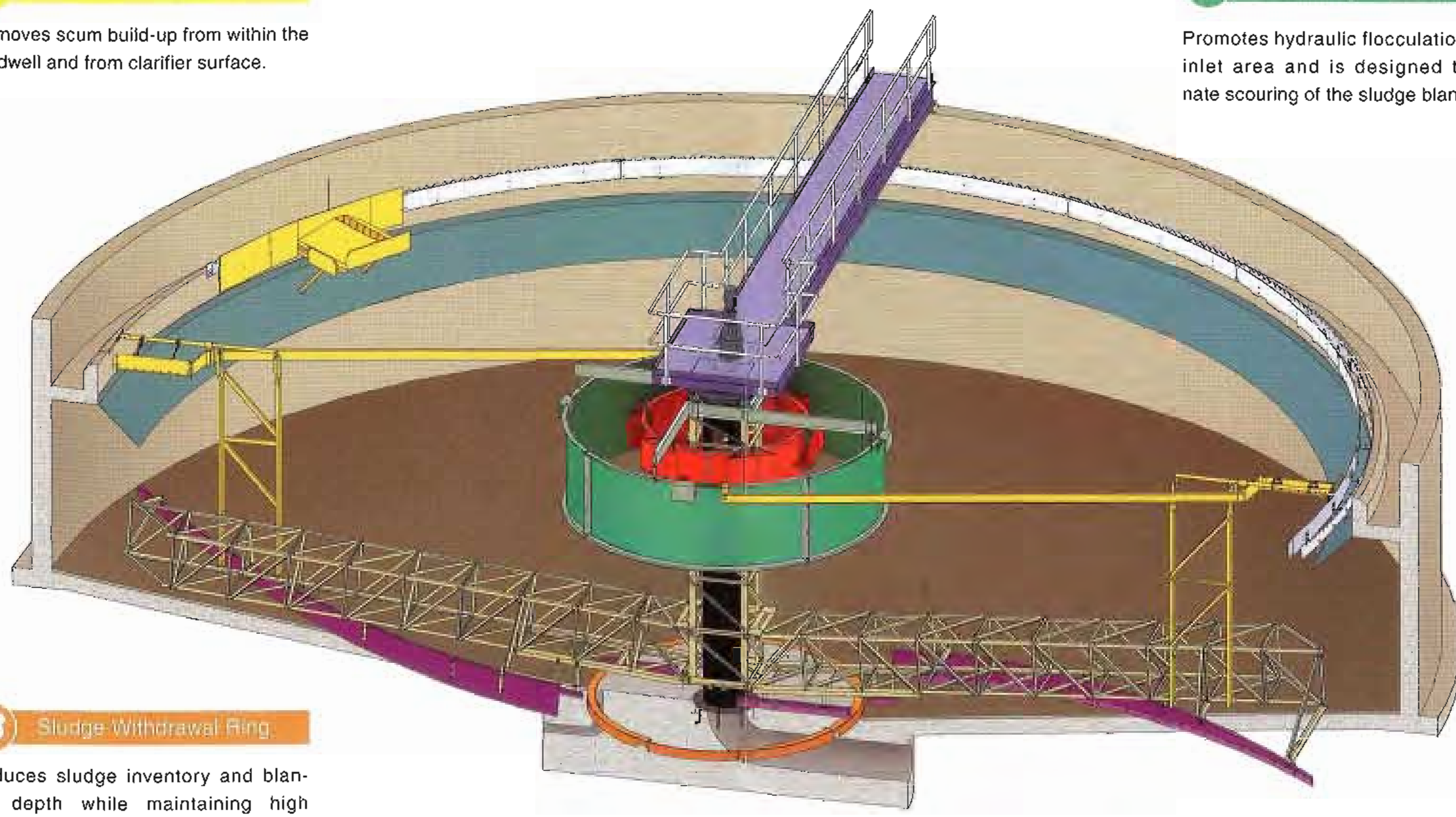
Uses deeper side water depth (SWD) and proper floor slope design for maximum capacity and highest effluent quality for the least cost.

3 Density Current Baffle

Eliminates wall currents and prevents short-circuiting. The wall-mounted baffle is low in cost and requires no maintenance.

4 Flocculating Feedwell (FWW)

Promotes hydraulic flocculation in the inlet area and is designed to eliminate scouring of the sludge blanket.



5 Energy Dissipating Inlet (EDI)

Converts the high energy feed from the center column into a lower velocity flow that is gently mixed in an impinged or tangential flow into the flocculating feedwell to maximize flocculation.

8 Sludge Withdrawal Ring

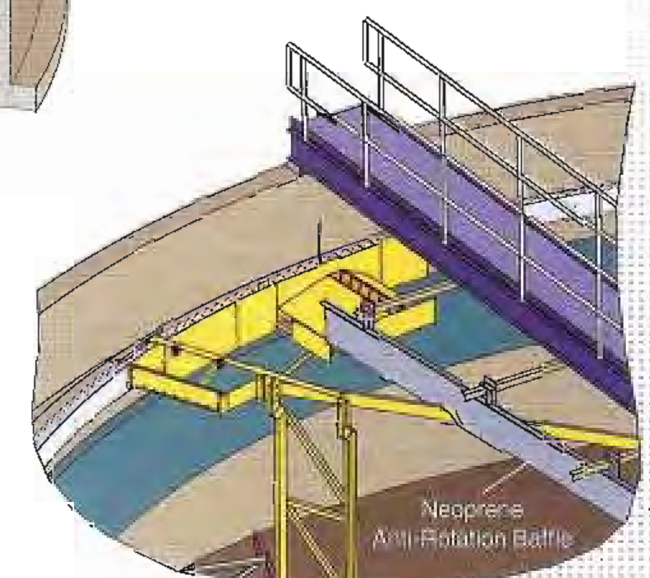
Reduces sludge inventory and blanket depth while maintaining high concentration. Provides rapid solids removal in conjunction with spiral rake blades.

7 Center Column

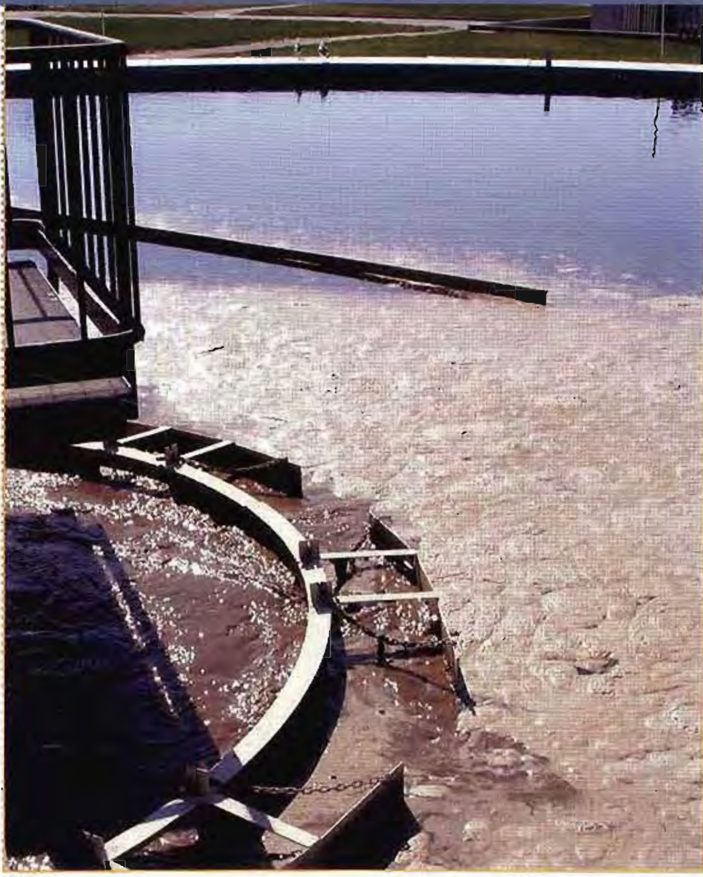
Minimizes floc shearing and reduces influent energy.

6 Spiral Rake Blades

Increase sludge transport capacity, providing rapid solids removal, and lower sludge blankets. Eliminate septicity and denitrification.



Research and Design



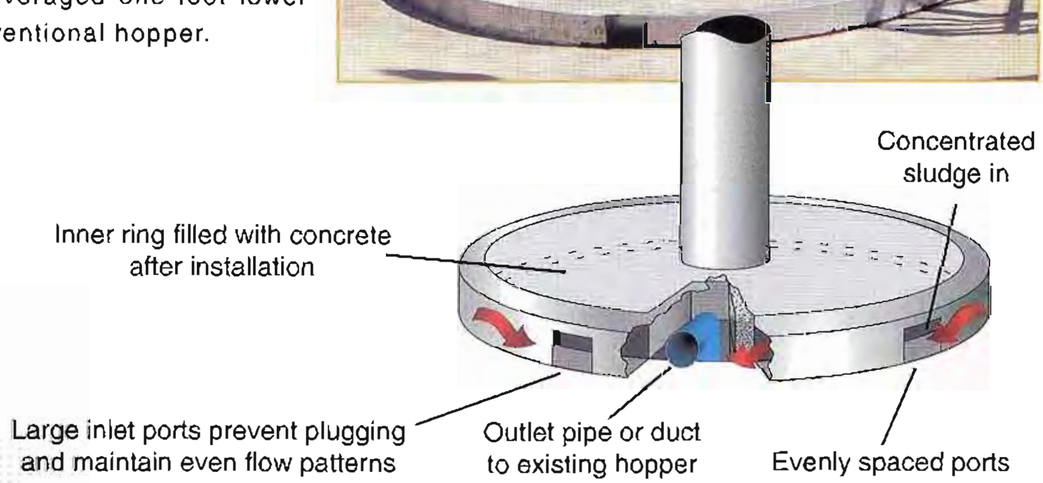
Dual Gate EDI

WesTech has developed a new Energy Dissipating Inlet (EDI) design which uses impinging flows to both promote flocculation and dissipate incoming energy. Flow enters at the water surface, ensuring that the full volume of the flocculation well is used for gentle mixing and flocculation of the biological solids. Opposing adjustable gates are arranged so that incoming flow impinges on itself, effectively dissipating incoming energy and eliminating focused flow streams that could carry into the clarification zone. The result is a well-flocculated mixed liquor that spreads gently and evenly into the clarifier without disturbing settled solids on the basin floor.

Side-by-side studies at the Central Weber Wastewater Treatment Plant in Ogden, Utah showed a 27% reduction in effluent suspended solids when using the new Dual-Gate™ EDI versus a conventional EDI in shallow secondary clarifiers.

Sludge Withdrawal Ring Produces Lower Sludge Blankets

Side-by-side studies at the Central Davis Wastewater Reclamation Facility in Kaysville, Utah compared the performance of a WesTech Sludge Withdrawal Ring to a standard sludge hopper in identical clarifiers. The research showed conclusively that a Sludge Withdrawal Ring can reduce the depth of the sludge blanket in a secondary clarifier. Sludge blankets in the clarifier with the Sludge Withdrawal Ring averaged one foot lower than in the basin with the conventional hopper.



Retrofits

Retrofit Your Clarifier

In addition to new installations, WesTech has upgraded scores of existing clarifiers to the COP™ design, resulting in performance improvements, reduced maintenance headaches, and overall cost savings. No more seal failures or plugging to deal with in suction clarifiers. No more deep sludge blankets and associated process problems in standard scraper clarifiers. No more drive unit main bearing failures to cause shutdowns.

In Memphis, Tennessee, WesTech upgraded three (3) 180 ft. dia. primary clarifiers and seven (7) 140 ft. dia. secondary clarifiers to the COP™ design. Performance improvements included an increase in suspended solids removal in the primary clarifiers from 30% to 60%, and a reduction in secondary clarifier effluent suspended solids of as much as 30%.

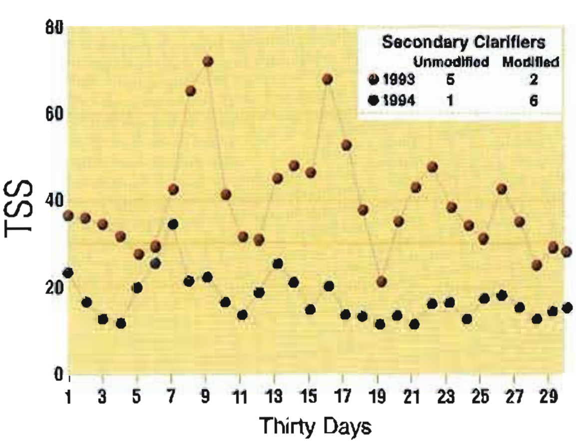
Fact

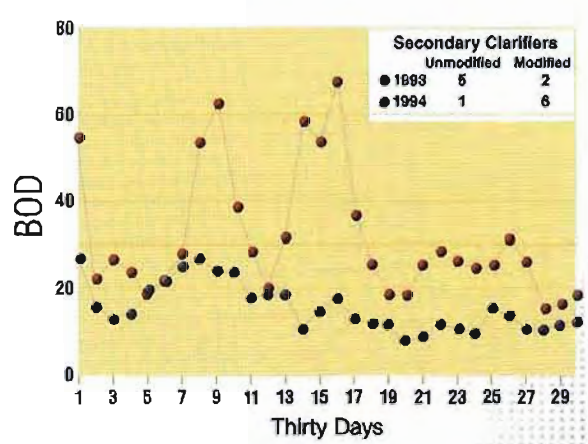
Conversion of primary conventional multi-blade scrapers to spiral scrapers has eliminated 75-90% of the sludge inventory, increased underflow concentration and eliminated septicity, which was evidenced by a $SBOD_5$ increase and gas evolution.

Fact

Conversion of secondary multi-bladed scrapers to spiral scrapers has reduced sludge blankets and increased underflow concentration by 75% at a 25-35% higher solids loading on the clarifiers.

Retrofit Improvement Results





WesTech has retrofitted and upgraded virtually every type and model of clarifier. WesTech COP™ clarifier upgrades will increase performance and capacity.

Advanced Clarifier Technology

Component designs are being continually refined through field experience and the application of emerging technologies. Such continual refinement provides our customers with demonstrated trouble-free, highly efficient, proven equipment. Available as new equipment or as retrofit to existing installations, WesTech design programs will optimize the performance of all types of clarifiers. Because we design to the specific process and existing dimensional requirements of each plant, WesTech is the clear choice in all clarifiers.

WesTech Clarifier Designs

- COP™ Optimization Package
- Cage and Shaft Drive
- Spiral Rake Blade
- Segmented Rake Blade
- Gravity Thickeners
- Suction Header
- Suction Pipe
- Peripheral Feed
- Rim Drive

Founded in 1973, WesTech designs, engineers, and supplies water, wastewater, and process equipment for municipal and industrial customers around the world. From headworks to tertiary treatment, from petrochemical process to water reclamation and drinking water, from small communities to large cities and factories, WesTech offers a wide array of custom process solutions for any application. Call today or visit us online to learn how our process equipment and experience can benefit your plant.

...Call today to discuss your process equipment needs.

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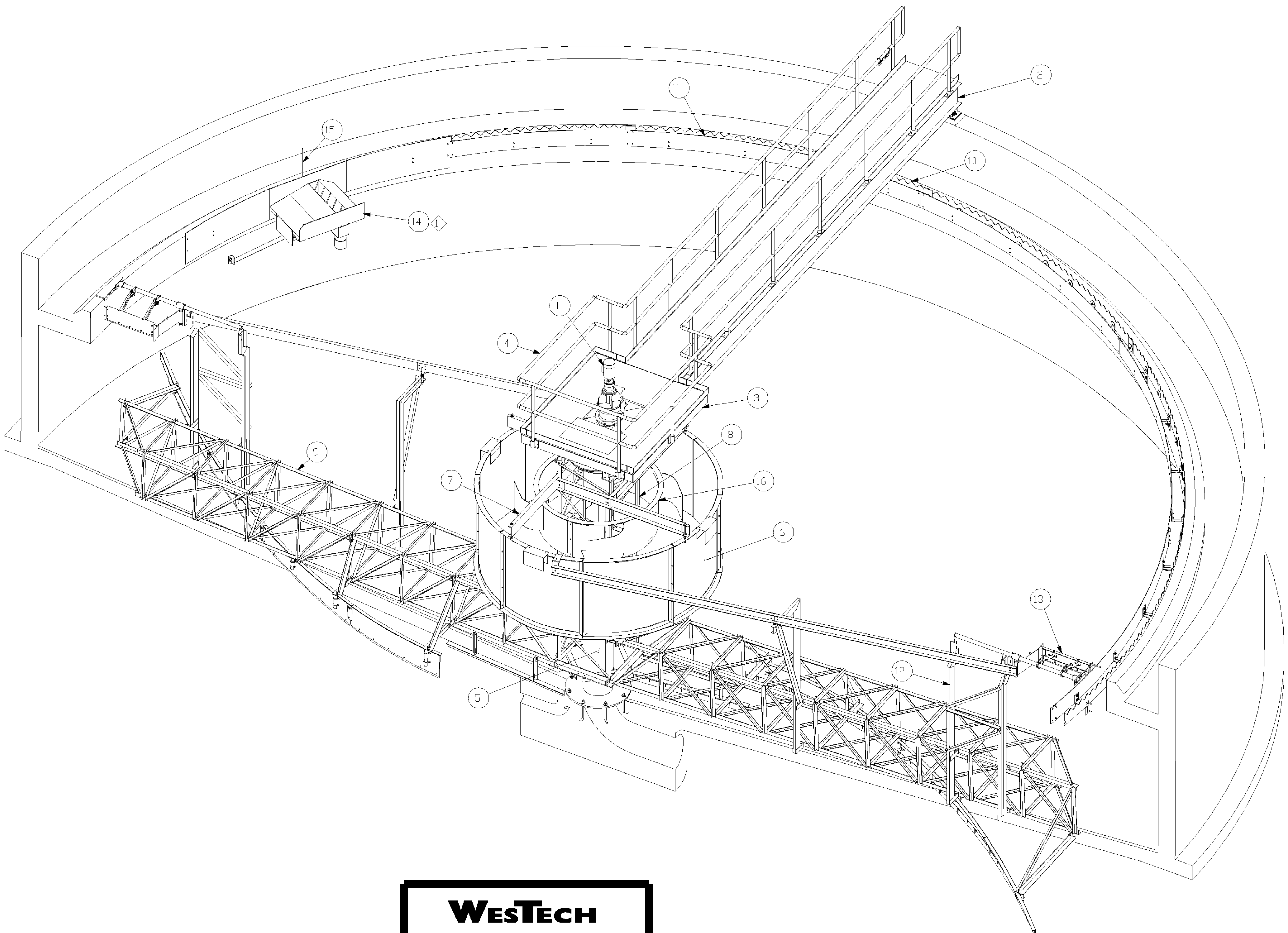
Represented by:



EQUIPMENT LIST

ITEM	DESCRIPTION/REMARKS
1	31" DRIVE UNIT W/ TORQUE CONTROL DEVICE, 13500 FT-LBS TORQUE.
2	3'-0 WIDE STL WALKWAY W/ 1-1/4" ALUM GRATING
3	7'-6 LG. x 6'-6 W. STL PLATFORM (W/ MIN. 2'-0 CLEAR AROUND DRIVE) W/ 1-1/4" ALUM GRATING.
4	ALUM HANDRAIL 1 1/2" NOM.DIA. x 3'-6" HIGH, 2-RAIL W/ 4 IN. EXTRUDED KICKPLATE.
5	1'-6 O.D. STL CENTER INFLUENT COLUMN (1/4" WALL) W/ INFLUENT PORTS.
6	12'-0 INS.DIA. x 5'-0 SIDEDEPTH STL FEEDWELL (3/16" STL PLATE) W/ 4-BAFFLED SCUM PORTS.
7	STL FEEDWELL SUPPORTS.
8	3'-0 SQ. STL DRIVE CAGE.
9	(2) 3'-0 W. x 3'-0 H. STL RAKE ARMS W/ SPIRAL BLADES, SLUDGE SCRAPER BLADES, OUTWARD RAKING BLADES, AND ADJUSTABLE 304SS SQUEEGEES.
10	WEIR PLATE (FRP 1/4" x 9" DEEP) W/ 90° V-NOTCHES 2 1/2" DEEP @ 6" INTERVALS.
11	BAFFLE (FRP 1/4" x 1'-0" DEEP, 2'-0 DEEP AT SCUMBOX) W/ FRP SUPPORTS.
12	STL SKIMMER BLADE W/ SUPPORTS.
13	SCUM SKIMMER ASSEMBLY W/ NEOPRENE WIPERS
14	3'-0 SCUM BOX (STL) W/ SUPPORTS AND 6" DISCHARGE PIPE CONN. W/ FLEXIBLE COUPLING.
15	SCUM FLUSHING VALVE
16	6'-0 INS.DIA. x 2'-6 SIDEDEPTH ENERGY DISSIPATING INLET WELL (3/16" STL PLATE) W/ MULTIPLE INLET GATES.

WESTECH
FOR INFORMATION ONLY
03/09/11

NOTES:
1 SCUMBOX ROTATED FOR CLARITY.

REVISION	BY	CHKD	DATE	LTR

PREPARED FOR: BEND, OR

ENGINEER: ..

CONTRACTOR: ..

CUSTOMER P.O. NO.:

COP CLARIFIER GENERAL ARRANGEMENT - TANK CUTAWAY VIEW
DESCRIPTION (COP_HALF_FINAL_ASSEM) 0030

TYPE	SIZE
COPC2	65'-0 DIAMETER

SPIRAL BLADE 50' TO 100'

DATE	STD. BY	STD.CHKD.	STD.APPVD	SCALE	DATE	PROJ. BY	PROJ.CHKD.	PROJ.APPVD
10/10	KW	RCF	RDB	NONE	03/11	BS		

WESTECH

DRAWING NUMBER	PROJECT NUMBER	REV.
D101	1060730A	0

Primary Sludge Pump Type

ATTACHMENT B TO: TM 3—Primary Treatment Improvements

PROJECT: Schematic Design Report
Bend Water Reclamation Facility Secondary Expansion

Objective

A new primary clarifier and associated new primary sludge pump station will be constructed as part of the Bend Water Reclamation Facility (WRF) Secondary Expansion Project. The existing primary sludge pump station contains two air driven diaphragm pumps for primary sludge pumping. This fact sheet evaluates the primary pump type for the existing and new primary sludge pump stations. Two pump alternatives are considered:

1. Air driven diaphragm pumps
2. Progressing cavity pumps

Existing Infrastructure

The existing primary sludge pump station contains two existing air driven diaphragm primary sludge pumps. The air diaphragm pumps are provided with air from two air compressors located in the digester facility. The compressors in the digester facility serve the plant wide air demands. Each compressor can provide 100 pounds square inch (psi) of pressure and 246 standard cubic feet per minute (scfm) of air flow.

The existing air diaphragm pumps were identified for rehabilitation in the Facilities Plan. Table 1 provides the design data collected from the O&M manual information for the existing pumps. Currently, the pump is controlled by manual adjustment at the control panel for each pump when the discharge flow needs to be changed.

Flow measurement of the air driven diaphragm pumps is not currently monitored due to the intermittent discharge surge of the pumps. In order to provide flow measurement to the digester, primary sludge is first pumped to a small digester feed tank where it is mixed with thickened activated sludge (TWAS). A single WEMCO Hidrostal pump then draws the mixed primary sludge and TWAS and directs it to the digester. There is a flow meter on the discharge of the Hidrostal pump that measures the blended TWAS and primary sludge flows fed to the digesters. TWAS flows are measured separately at the TWAS pumps, allowing plant staff to determine the primary sludge flow through subtraction.

TABLE 1
Design Data for Existing Primary Sludge Pumps
Bend WRF Secondary Expansion

Parameter	Value
Type	Air Driven Diaphragm
Manufacturer	Gormann Rupp (Ramparts Division)
Model	40P
Size	4 inches x 4 inches
Maximum Flow Rate	180 gpm
Design Total Dynamic Head (TDH)	50 feet
Maximum TDH	200 feet
Maximum Air Requirement	180 scfm
Maximum Air Pressure	100 psi

gpm = gallons per minute.

Design Criteria

Primary Sludge Flow Rate

Table 2 summarizes the estimated primary sludge flow rates for three solids concentrations at the loading conditions associated with the minimum plant flow, the start-up maximum month flow, and the 2030 maximum week flow. In order to maximize available digester capacity, the City would like to operate with thick primary solids. Process calculations show that routine operation with 5 percent primary sludge (coupled with 8 percent TWAS) will significantly extend the available digester capacity, while still meeting Class B biosolids criteria.

TABLE 2
Primary Sludge Flow Rates
Bend WRF Secondary Expansion

	Minimum Flow[a]		Start-Up Maximum Month Flow		2030 Maximum Week Flow	
Solids Concentration	**Total (gpd)**	**Per Clarifier[b] (gpm)**	**Total (gpd)**	**Per Clarifier[c] (gpm)**	**Total (gpd)**	**Per Clarifier[c] (gpm)**
2%	40,000	14	88,100	31	257,600	89
4%	20,500	7	45,200	16	131,800	46
5%	16,000	6	35,200	12	102,700	36

[a]The minimum primary sludge flow based on an influent plant flow of 2.5 mgd.
[b]Assumes two primary clarifiers are online.
[c]Assumes three primary clarifiers are online.

gpd = gallons per day; gpm = gallons per minute.

Design Constraints

Three pump alternatives were initially considered during Project Definition: Air driven diaphragm, progressing cavity, and screw-induced centrifugal. The maximum recommended solids concentration for screw-induced centrifugal pumps like the WEMCO Hidrostal digester feed pump is 5 percent solids. Because the City would like to routinely operate at a 5 percent primary sludge concentration (and at times, operate above 5 percent solids), screw-induced centrifugal pumps were not considered further.

The digester feed pumping system consists of a single WEMCO Hidrostal pump. The City of Bend is currently optimizing the operation of the Hidrostal pump to feed the digester with 5 percent primary sludge and 8 percent TWAS and will determine if operation in this manner is feasible long term. With only a single pump installed, the digester feed pump lacks redundancy. The existing piping system allows both the primary sludge and TWAS to bypass the digester feed tank and pump and be discharged directly to the digesters. Given the lack of redundancy with the existing digester feed pumping system, the ability to pump thickened primary sludge directly into Digester 3 is a required design criteria.

Total Dynamic Head Requirements

The pumping system maximum total dynamic head (TDH) requirements are driven by two factors:

1. **The design sludge concentration of 5 percent.** Because of the increased viscosity of thick primary sludge, the higher the sludge concentration, the higher the head requirements for pumping.

2. **Provision of the ability to pump directly to Digester 3.** The weir elevation of the primary clarifier is 3,360.4 feet. The maximum water surface elevation of the digester feed tank is 3,372.0 feet. The maximum water surface elevation of the digester is 3,418.0 feet. Thus, providing the ability to pump directly to the digester increases the static head requirements by 42 feet in addition to dynamic loses through the longer pipe network.

Additional design assumptions and criteria:

- Nearly continuous feeding of the digester will provide the best performance of the digester including consistent gas production and minimum risk of foaming. A single pump will provide both the minimum startup flow and the peak design condition.
- CH2M HILL recommends a maximum pipe velocity of 7 feet/second.

Air Diaphragm Pumps

Air diaphragm pumps operate by drawing sludge from the clarifier underflow into the diaphragm and then quickly compressing the diaphragm, forcing the volume of water through the pump discharge. This fill and empty cycle is called a stroke and each stroke discharges a fixed volume. The number of strokes per minute is an operator adjustable parameter between 0 and 40, allowing the flow rate of the pump to be set. The discharge time is also an operator adjustable parameter between 0 and 3 seconds. The discharge time is adjusted to optimize the performance of the pump at a given head condition. The goal is to generate a full, smooth, unlabored stroke that produces the maximum discharge volume. The air flow rate and pressure to the pump are also adjusted to match the operating flow and head conditions.

The pulse action of air diaphragm pumps generates a high flow during pump discharge and zero flow when the diaphragm is filling. Averaged over a length of time, the pumps provide the target nominal flow. The maximum head conditions on the pump are generated, not by the nominal flow but by the high flow during discharge. The existing air diaphragm pumps have a maximum volume per stroke of 4.5 gallons. If the discharge time is set to 0.5 seconds, this generates a flow rate of 540 gpm per pump. If all three air diaphragm pumps are synchronized, pumping 5 percent solids to Digester 3, this generates a TDH of 259 feet, which is beyond the capabilities of the pump. If the pumps are timed such that only one pump discharges at a time, the TDH is 180 feet. This is within the capability of the pump though it is at the high end of the pump curve. The discharge velocity is 6.1 feet/second under this condition, which is within the stated maximum velocity design criteria of 7 feet/second.

The maximum cycle rate for each pump would be 20 cycles per minute. At 4.5 gallons per cycle, the maximum pumping rate is 90 gpm. This is well within the design flows presented in Table 2 for 5 percent solids. CH2M HILL has successfully programmed the air diaphragm pumps at the Columbia Boulevard Wastewater Treatment Plant in Portland, Oregon, to ensure only one pump is operating at a time.

Summary

The existing air diaphragm pumps are capable of pumping 5 percent solids directly to Digester 3, but must be timed such that two pumps never stroke at the same time.

Progressing Cavity Pumps

Each progressing cavity pump will be designed to deliver a flow rate of 180 gpm. This is twice as high as the 2030 maximum week flow primary solids flow rate for 2 percent sludge. Therefore, the worst-case TDH requirements for the current alternative comparison are based on a flow of 180 gpm. The progressing cavity pump will be designed to allow the pump to be turned down or timed to meet the minimum flow criteria. The design head conditions will be based on pumping 5-percent sludge at 180 gpm. Table 3 provides the TDH requirements of the pump.

Progressing cavity pumps are normally designed with a limit of 70 feet of head per operating stage and with a maximum pump speed of 250 rotations per minute (rpm) for abrasive materials such as primary sludge to limit pump wear. The head conditions in Table 3 assume all pumps operate at once. If the pumps are operated such that only one pump runs at a time, a two stage pump can be provided. This will be critical to fit a progressing cavity pump into the existing primary sludge pump station and is well within the run times of the pump provided in Table 3.

TABLE 3
TDH Requirements for the Progressing Cavity Primary Sludge Pumping System
Bend WRF Secondary Expansion

Solids Concentration	To Digester Feed Tank	To Digester 3
2%	32 feet	78 feet
4%	79 feet	125 feet
5%	128 feet	175 feet

Comparison of Alternatives

Both alternatives evaluated are positive displacement pumps. They can both handle high solids concentrations (greater than 5 percent).

Alternative 1—Air Diaphragm

The existing air diaphragm pumps are Gormann Rupp model 40P. Dorr Oliver also manufacturers an equivalent air diaphragm pump. The equipment cut sheet is provided in Appendix A to this fact sheet.

If the existing air diaphragm pumps are retained for the current project, they can be upgraded to be controlled via the SCADA system. The flow rate can be calculated based on the pump settings; this will be less accurate than a flow meter measurement, but will still provide an estimate of primary sludge flow.

Advantages

- Same as existing, familiar pump operation and known wear potential for primary sludge characteristics.

Disadvantages

- Far less efficient than conventional electric motor driven pumps.
- Inability to measure primary sludge flow with a flow meter.
- Normal operation at 5 percent solids is at a TDH close to the maximum TDH of the pump. This provides for less operating contingency should a sludge thicker than 5 percent inadvertently be produced in the primary clarifiers.
- Increased plant air demand may require installation of an additional plant air compressor.

Alternative 2—Progressing Cavity

The progressing cavity pump requires a two-stage rotor cycle, increasing the length of the pump. The two stage progressing cavity pump will require demolition of the existing pump pad and rearrangement of the existing primary sludge pump station to make the pumps fit.

There are multiple motor and bearing arrangement options available and there are options that will work with the space constraints of the existing pump station.

Appendix B to this fact sheet provides equipment cut sheets for the Moyno progressing cavity pump selection. Other manufacturers include Seepex and Netzsch. The progressing cavity pump quotes assume a variable speed drive with a maximum flow rate of 180 gpm. The design conditions for the pump will be narrowed once the pump type and desired operational strategy are determined.

Advantages

- Lower power consumption compared to the air diaphragm pump.
- Ability to measure primary sludge flow with a flow meter.
- Ability to pump against very high TDH conditions, providing flexibility should the design parameters change in the future.

Disadvantages

- More susceptible to grit abrasion than the air diaphragm pumps. However, this can be minimized with proper material selection and appropriate maximum and average pump speed selection.

Comparative Cost Evaluation

The budgetary quotes for the Gorman-Rupp Model 40P pump and the Moyno model 2F090G1A 15 horsepower (hp) progressing cavity pump with piggyback belt and pulley motor arrangement are provided in Table 4. The annual operating cost for each pump is summarized in Table 4 as well. The following assumptions were made to determine the annual operating cost:

- The progressing cavity pump is pumping 180 gpm against 175 feet of head requiring 11 hp of energy.
- The yearly run time of each progressing cavity pump is 400 hours at the start up maximum month flow condition.
- The air diaphragm pump is operating at 60 gpm against 180 feet of head.
- The yearly run time of each air diaphragm pump is 1,000 hours at the start up maximum month flow condition.
- The air flow requirement is 90 scfm at a pressure of 91 psi resulting in a required compressor power of 15.5 hp.
- The power cost is estimated at $0.041/kilowatt-hour (kWh).

TABLE 4
Cost Summary for Primary Sludge Pump Type
Bend WRF Secondary Expansion

Item	Capital Cost per Pump	Annual Energy Cost per Pump
Air Diaphragm Pump	$28,000	$570
Progressing Cavity Pump	$39,900	$140

A 20 year present worth comparative cost evaluation of the three alternatives is presented in Table 5. The analysis in Table 5 assumes the following:

- Discount rate = 1 percent.
- For the progressing cavity pump, the stator is replaced every 5 years at a cost of $3,500. Note that the stator replacement may occur more frequently if there is significant grit in the primary sludge.
- For the air diaphragm pump, the diaphragm is replaced once per year at a cost of $200. The check valve balls are replaced once per year at a cost of $150. Each pump contains two check balls.
- The two existing air diaphragm pumps are replaced as part of the Secondary Expansion Project. For both alternatives, four new pumps are installed.
- Operating cost assumes only three pumps in operation since the second pump in the new primary sludge pump station is installed to provide redundancy.

TABLE 5
20 Year Present Worth Analysis for Primary Sludge Pump Type
City of Bend Water Reclamation Facility

	Alternative	Present Worth of Capital Costs	Present Worth of O&M Costs	Total 20 Year Present Worth
1	Air Diaphragm Pumps	$112,000	$60,000	$172,000
2	Progressing Cavity Pumps	$159,600	$46,000	$205,600

Recommendations

Even though the present worth costs are slightly higher, progressing cavity pumps are the recommended alternative because they provide the following advantages:

- Continuous discharge flow when operating, which allows more accurate flow measurement and better process control.
- Capability to operate at higher discharge pressures and therefore can convey the thicker primary sludge more reliably.

- Wider range of operation relative to percent solids, providing operations staff with greater reliability should primary sludge thickness be greater than 5 percent solids at times.

Primary Sludge Pump Operation

Digester Feeding and PS Pump Operation

Bend would like to get rid of the mix tank upstream of the Digester 3. However, the mix tank allows plant staff to meter and measure the digester influent flow. The primary sludge and primary scum pumps will be designed to route past the existing digester feed tank, directly to Digester 3. Removing the mix tank means that the ability to accurately measure flow and the ability to pump thick sludge to the digester are key design criteria for the new primary sludge pumps.

For digester stability, the digesters should be fed as continuously as possible. The suggested operational approach will be to use the turndown range of the progressing cavity pump/drive and use an alternating pump approach. With the alternating pump approach, each of the five installed primary pumps (or the number operating) will be operated in sequence for a fixed period of time at the set flow rate. When the time is up, the next pump will run. The pump will be shut off early if (1) sludge density falls below the target, (2) primary sludge depth falls below target, or (3) primary scum falls below the flow setpoint. The alternating pump approach will also limit the head conditions on the pumps, reduce rotor and stator wear, and reduce the required pump turndown design.

It is possible that low flow rates will create difficulties re-suspending the solids that settle in the primary sludge lines when the pump is off, particularly in the section of piping between the clarifier and the pump intake. If the City of Bend observes this to be the case, then it may be necessary to periodically operate a pump at the maximum output for a short period of time. This operation can be programmed into the SCADA system for each pump to minimize clogging issues.

Appendix A—Manufacturer Information, Gormann Rupp Air Diaphragm Pump

Specification Data
SPEC-40P 05/08/09

RAMPARTS®
Air Driven Diaphragm Pump

Model 40P

Size 4" x 4"

PUMP SPECIFICATIONS

Size: 4" x 4" (102 mm x 102 mm) - ASA 125# Flanges. Handles up to 1-1/8" (28,5 mm) Diameter Spherical Solids (Limited by Check Valve).

Pump Castings: Ductile Iron; Unlined or Lined.

Optional Linings*: Chlorosulfonated Polyethylene (Hypalon® or Equivalent); Chloroprene (Neoprene® or Equivalent); Ethylene Propylene Diene Manomer (Nordel® or Equivalent); Fluorocarbon (Viton® or Equivalent) Nitrile (Buna-N).

Diaphragm/Gaskets*: Chlorosulfonated Polyethylene (Hypalon® or Equivalent); Chloroprene (Neoprene® or Equivalent); Ethylene Propylene Diene Manomer (Nordel® or Equivalent); Nitrile (Buna-N); Dura-XL (TPE w/an Olefinic Base); Dura-S (TPE w/a Polyamide [Nylon® or Equivalent] Base).

Air Cylinder: Steel Casing; Ductile Iron Piston; Glass-Filled Fluoro Plastic (Teflon® or Equivalent) Piston Seals; Chrome Plated Shaft and Tube; Polyamide (Duralon® or Equivalent) Rod Bearing; Pressure-Activated Polyurethane Shaft Seal; Stroke Indicator Rod.

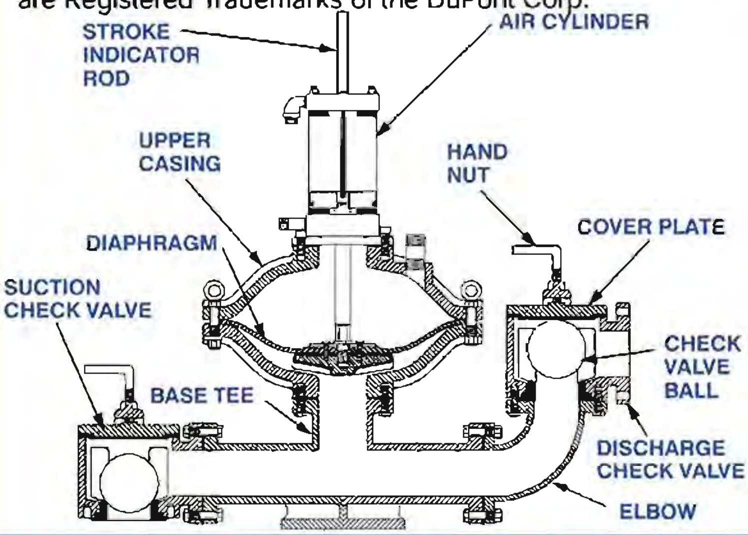
Check Valves: Ball Type, 90° Quick Opening, Unlined or Lined With The Same Materials As Shown Above For Pump Castings.

Check Valve Balls: Available In The Same Materials As Shown Above For Pump Casting Linings, As Well As Fluoro Plastic (Teflon® or Equivalent) and Urethane.

Check Valve Seats: Available In The Same Materials As Shown Above For Diaphragms and Gaskets, As Well As Steel and Stainless Steel.

* Other Materials Available Upon Request.

Duralon, Hypalon, Neoprene, Nordel, Nylon, Teflon and Viton are Registered Trademarks of the DuPont Corp.



RECOMMENDED PERFORMANCE RANGE

0-30 Strokes per Minute.
0-145 GPM (0,0-9,1 Liters per Second).
20-150 Feet (6,1-45,7 Meters) Discharge Head.
Maximum Suction Lift 20 Feet (6,1 Meters).
Consult The Performance Curve For Performance Maximums.

PUMP OPTIONS

Pulsation Stabilizers or Air Chambers; Stabilizer/Chamber Mounting Tees; Suction Elbow; Pump Stands with or Without Casters; Diaphragm Failure Detection; Flap Check Valves (Up to 2" [50,1 mm] solids).

CONTROL OPTIONS**

Control Panels: Nema 4X Fiberglass Enclosure; Dual Pressure Adjustments; Solid State/Digital; 115 Volt. Consult the Factory for Available Control Panels.

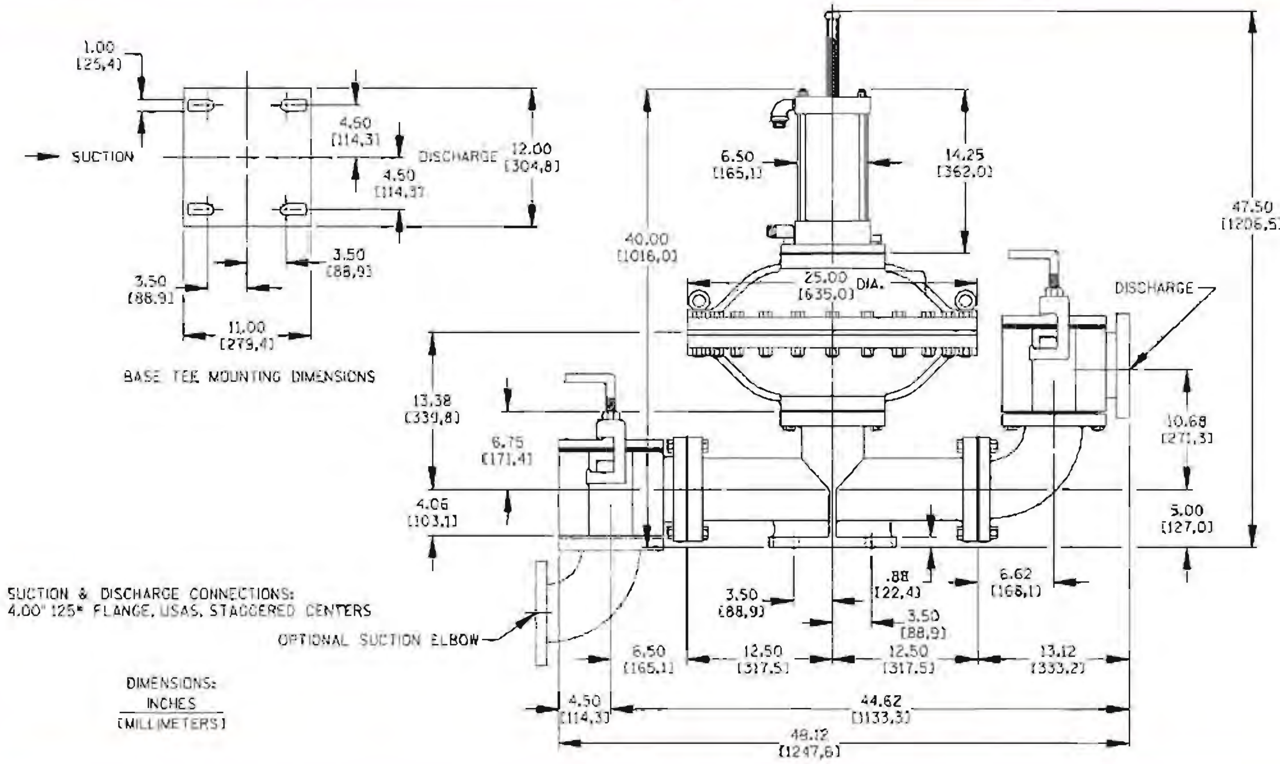
Air Controls: External to Pump; Easily Serviced; Replaceable Filter and Muffler Element.

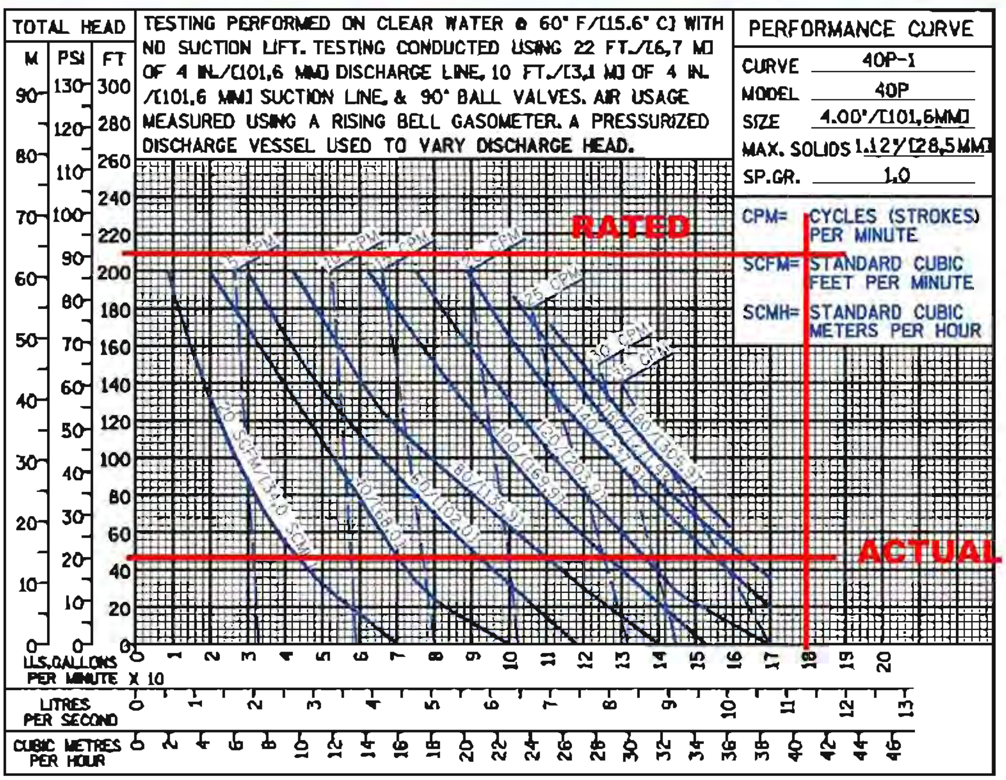
**** Pump Warranty Void If Not Operated With Ram-Parts or RamParts Approved Control.**

RamParts®
Pumps

Printed in U.S.A.

Specification Data	APPROXIMATE DIMENSIONS and WEIGHTS	NET WEIGHT: 745 LBS. (338 KG.) SHIPPING WEIGHT: 925 LBS. (420 KG.) EXPORT CRATE: 30,6 CU. FT. (0,87 CU. M.)
SPEC-40P 05/08/09		





RamParts® Pumps

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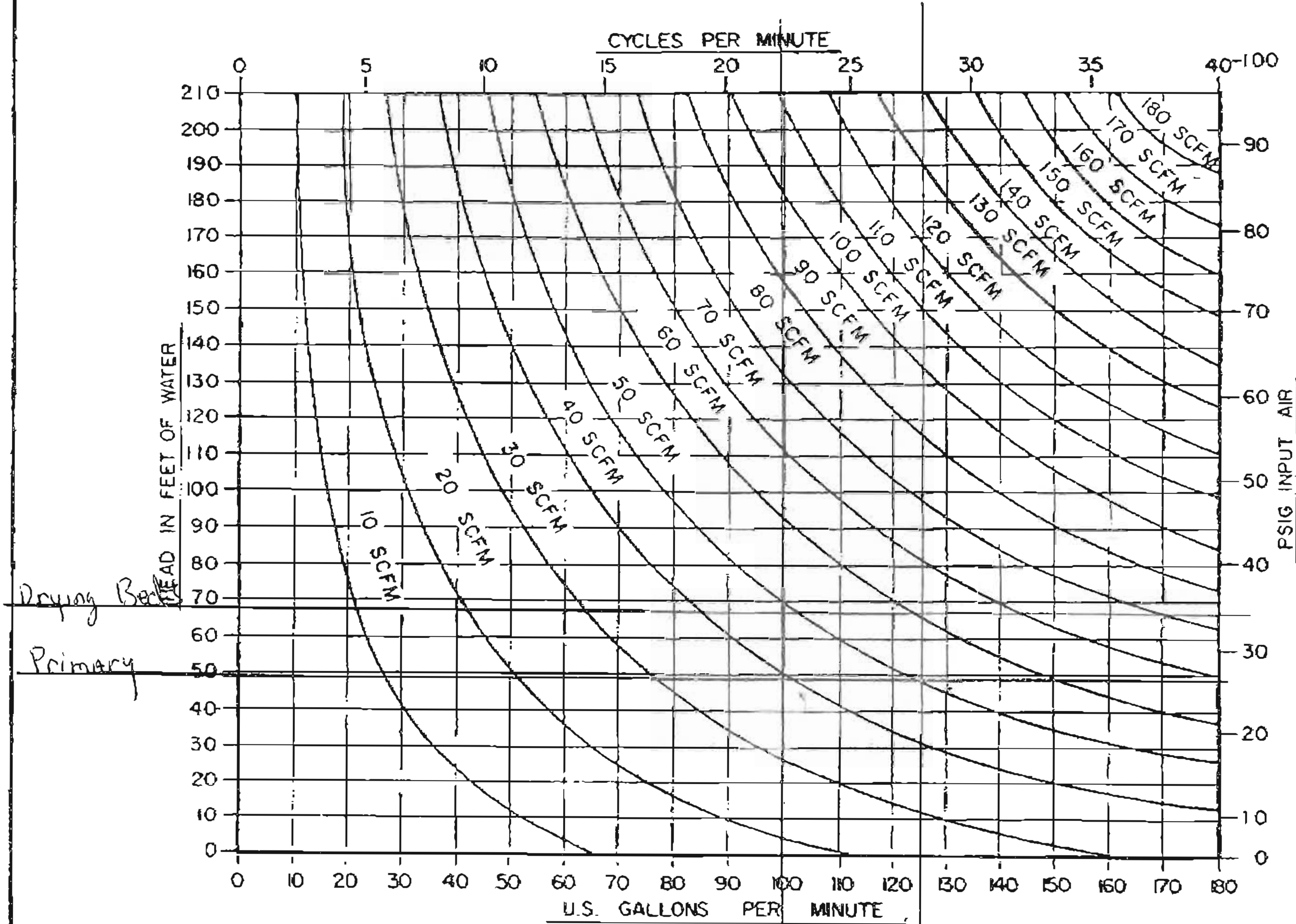
Kentwood, MI. 49512
Ph. 616.656-2250 Fax 616.656-2255
www.RamPartspumps.com

Printed in U.S.A.

MODEL 40P PERFORMANCE CURVE

BASED ON CLEAR WATER at 60°F
0 FEET SUCTION LIFT

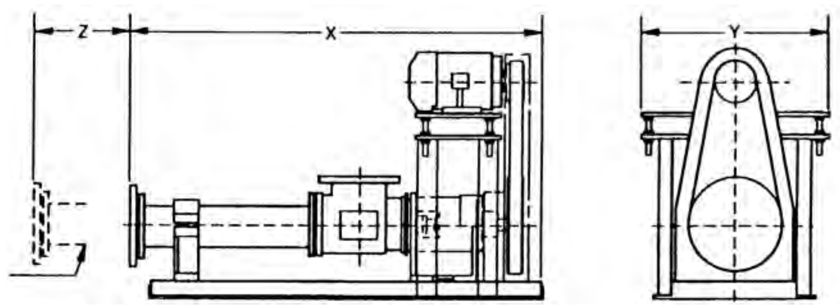


20' MAXIMUM SUCTION LIFT
4 CFM = 1 COMPRESSOR H.P.

DRAWING NUMBER
A06 - 4A - 017

Appendix B—Manufacturer Information, Moyno Progressing Cavity Pump

PIGGYBACK BELT AND PULLEY ARRANGEMENT



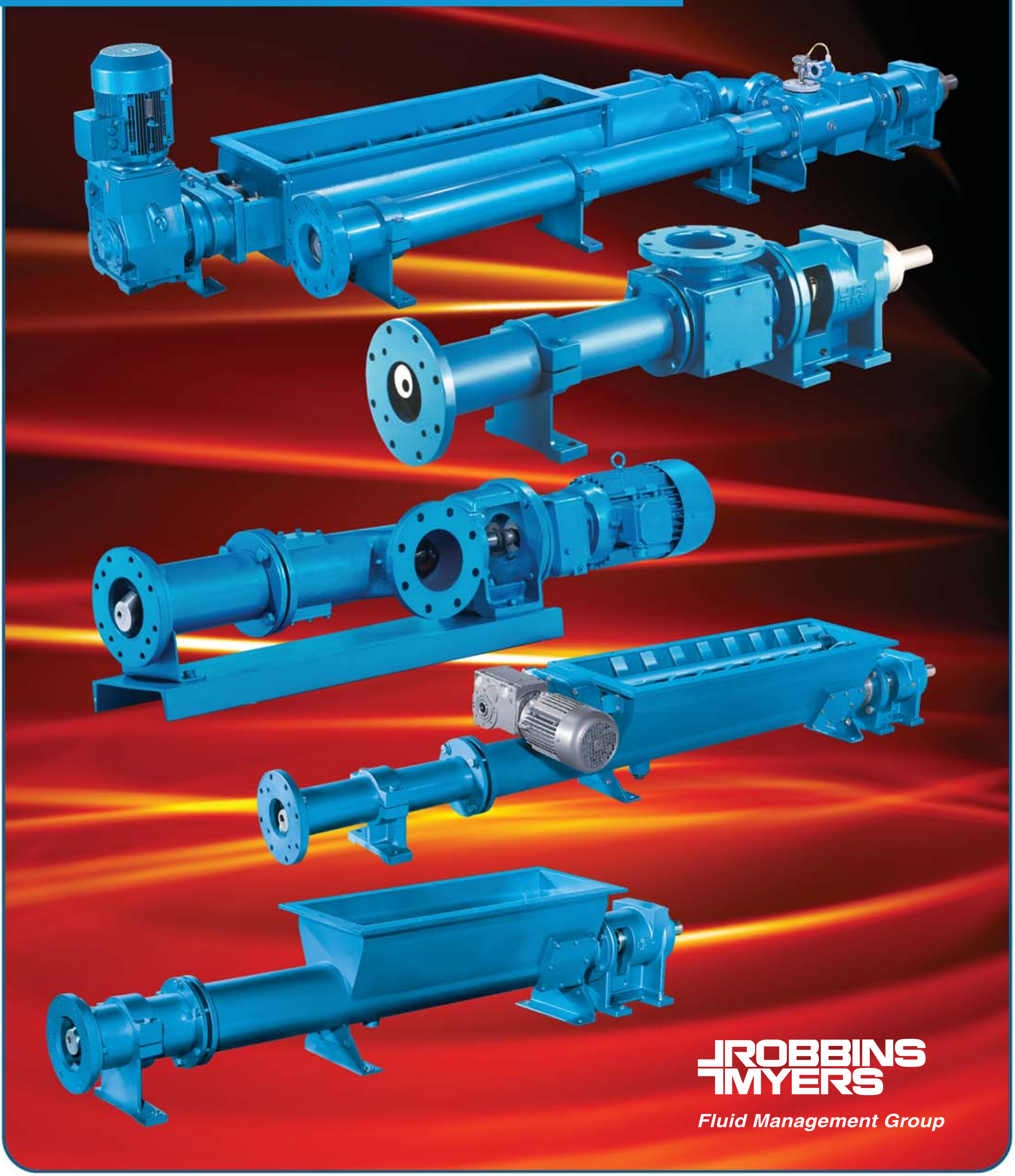
PUMP	X	Y	Z	MAX HP	MAX UNIT WT.	PUMP	X	Y	Z	MAX HP	MAX UNIT WT.
1E008G1	43	23	7	5	670	1G090G1	68	30	7	30	1,670
2E008G1	51	23	7	10	780	2G090G1	92	32	7	60	3,390
4E008G1	68	26	7	20	980	1G115G1	67	30	9	40	2,800
6E008G1	84	30	7	30	1,060	2G115G1	90	32	9	60	3,920
1E012G1, 1E018EG1	46	23	7	5	680	6H036G1	135	34	10	75	4,000
2E012G1, 2E018EG1	58	23	7	10	790	6H050G1	168	37	10	100	4,350
4E012G1	80	26	7	20	1,000	4H065G1	120	37	10	100	4,680
6E012G1	102	30	7	30	1,090	6H065G1	155	37	10	100	4,980
1E022G1, 1E033EG1	48	23	7	10	820	2H090G1	96	32	10	60	3,920
2E022G1, 2E033EG1	61	23	7	20	1,050	4H090G1	146	37	10	100	4,720
4E022G1	87	26	7	30	1,180	1H115G1	71	30	10	40	2,900
1E036G1	51	26	7	20	990	2H115G1	94	34	10	75	4,290
2E036G1	65	30	7	30	1,140	4H115G1	141	37	10	100	5,060
1E050G1	56	26	7	20	1,030	1H175G1	76	32	13	50	3,460
2E050G1	76	30	7	30	1,220	2H175G1	102	37	13	100	5,040
6F012G1	107	30	8	30	1,270	6J065G1	160	42	12	150	5,720
4F022G1	91	30	8	40	1,900	4J090G1	151	42	12	150	5,610
6F022G1	117	30	8	40	2,040	6J090G1	200	42	12	150	5,780
1F036G1, 1F054EG1	53	23	8	15	900	4J115G1	146	42	12	150	6,300
2F036G1, 2F054EG1	68	26	8	30	1,260	6J115G1	193	42	12	150	6,560
4F036G1	97	30	8	40	2,290	1J175G1	79	32	12	60	4,390
1F050G1, 1F075EG1	58	23	8	20	1,090	2J175G1	106	37	12	100	5,160
2F050G1, 2F075EG1	78	30	8	40	1,920	4J175G1	161	42	12	150	6,220
4F050G1	118	30	8	40	2,320	1J345G1	99	37	12	100	5,670
1F065G1	59	26	8	25	1,550	2J345G1	145	42	12	150	6,660
2F065G1	76	30	8	30	1,670	6K115G1	207	47	13	200	7,060
1F090G1	65	30	8	30	1,590	4K175G1	172	47	13	200	7,210
2F090G1	90	30	8	30	1,730	6K175G1	225	47	13	200	7,740
6G022G1	121	32	7	50	2,360	1K345G1	111	37	13	100	5,810
4G036G1	102	32	7	50	2,630	2K345G1	157	42	13	150	6,820
6G036G1	130	32	7	60	3,590	3K345G1	203	47	13	200	7,460
4G050G1	123	32	7	60	3,490	1K620G1	145	37	13	100	6,110
6G050G1	163	32	7	60	3,640	2K620G1	225	42	13	150	7,320
1G065G1, 1G098EG1	61	26	7	25	1,660	1K800G1	136	42	13	150	6,890
2G065G1, 2G098EG1	79	32	7	50	2,540	2K800G1	195	47	13	200	7,700
4G065G1	115	32	7	60	3,690	1K1500G1	195	47	26	200	8,000

All dimensions in inches.
Dimensions and weights are estimates only. Actual values may vary.

MOYNO

Always the Right Solution™

Moyno® 2000 Pumps



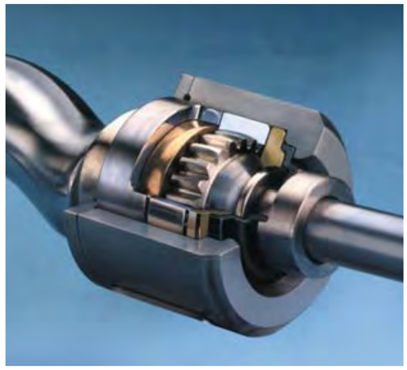
ROBBINS MYERS

Fluid Management Group

Moyno® 2000 Pumps
Offer Superior Pumping Performance

Moyno® 2000 pumps set the standard in positive displacement pumping applications. The proprietary Moyno 2000 gear-type universal joint design effectively handles radial and thrust loads for maximum performance and long life. These rugged pumps are able to handle abrasive materials in excess of 80% solids and offer a performance range to 4,500 GPM with pressure to 1,500 PSI.

By incorporating advanced technology, superior design and proprietary manufacturing processes, Moyno 2000 pumps offer the best value, and the most effective pumping solutions for the most extensive range of applications to satisfy all of your pumping needs.



Features & Benefits

Moyno 2000 Pumps offer maximum performance, value and application versatility with minimum maintenance.

- Sealed gear-type universal joint drive train effectively handles radial and thrust loads in the most demanding applications
- Low total cost of ownership
- Superior abrasion resistance
- Pump municipal sludge in excess of 50% solids further distances with higher volumetric efficiencies than any other progressing cavity pump
- Standard flange and close-coupled models available
- Open inlet configurations in 1-, 1.5- and 2-meter lengths to align with standard feed areas from centrifuges
- Independently driven bridge breakers for high viscosity, solids-laden fluids to eliminate product bridging

Typical Applications

Municipal Wastewater Treatment
- Municipal sludge
- Lime slurry dosing
- Filter press & incinerator feeds
- Raw sewage transfer

Paper
- Adhesives
- Coatings
- Latex
- Starch

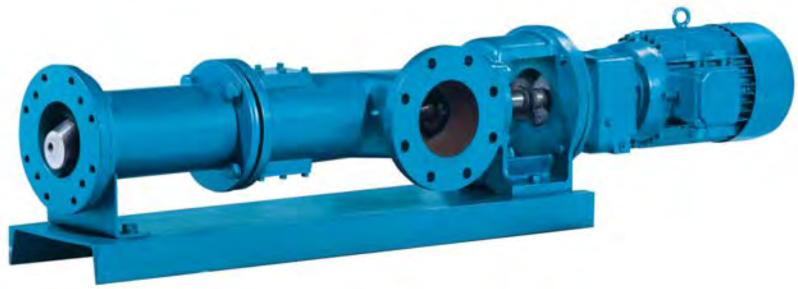
Oil and Gas
- Crude oil transfer
- Treater battery system
- Oil/water separation

Food
- Ground meat emulsions
- Sauces and juices
- Grape must
- By-products and wastes

Chemical
- Caustics
- Detergents
- Paint
- Solvents

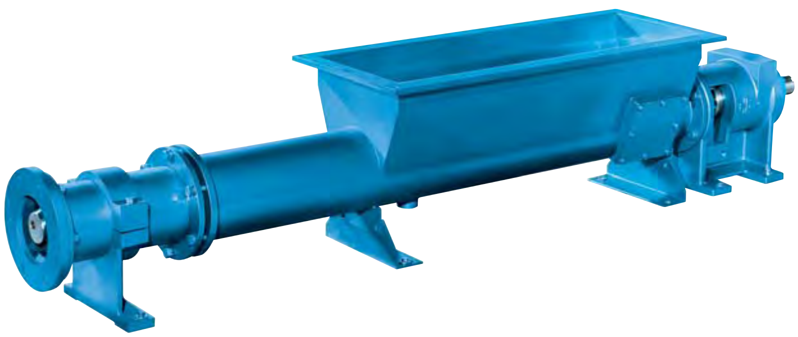
Building Materials
- Gypsum
- Plaster
- Resins

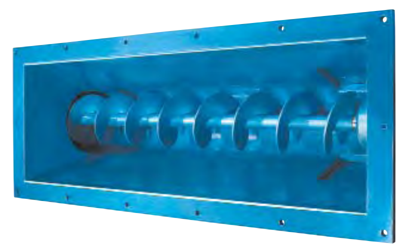
General
- Clay slurries
- Deicing fluids
- Hazardous waste
- Industrial sludges



Moyno® 2000 CC Pumps

The Moyno® 2000 CC Pump provides unmatched performance in a compact, close-coupled configuration. It is designed for municipal and industrial applications where close-coupled configurations are preferred, but the robustness of a gear joint drive is needed. The Moyno 2000 CC features a sealed gear-type universal joint drive train and optimized rotor/stator pumping element geometry. The pump is designed to efficiently transfer a broad range of viscosities and solids.

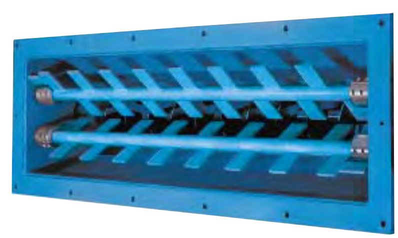




Moyno® 2000 G2 Pumps

The Moyno® 2000 G2 Pump is a versatile, high-performance pump featuring a wide, open throat hopper design that minimizes plugging that could occur in a standard inlet. A single auger feed mechanism ensures positive product feed into the pumping elements for increased fill efficiency when handling semi-dry or high solids content sludges.

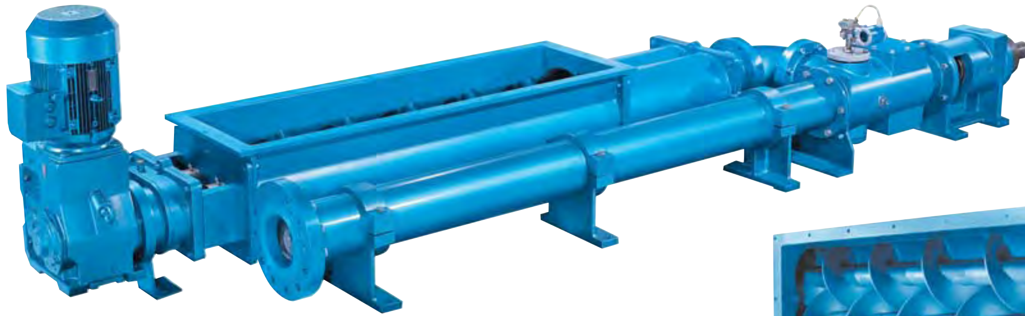
The Moyno 2000 G2 also features Moyno's crown gear-type universal joint drive train and optimized rotor/stator pumping element geometry.

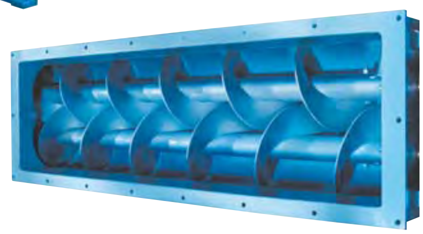


Moyno® 2000 G3 Pumps

The Moyno® 2000 G3 Pump is ideally suited for handling semi-dry, high solids content fluids that have a tendency to "bridge" in the inlet hopper. Featuring a series of finger mechanisms mounted on two counter-rotating shafts positioned above the pump's auger feed, this bridge breaker device prevents the accumulation of material in the throat of the pump. The bridge breaker is independently driven for flexibility in controlling pump and bridge breaker speed to meet specific application requirements.

The 2000 Model G3 Pump also features Moyno's crown gear-type universal joint – the heaviest duty drive train configuration available in the industry.





Moyno® 2000 HS Systems

The Moyno® 2000 HS system is a significant technology advancement for the wastewater treatment industry. It can pump filter cake further distances with higher volumetric efficiencies than any other progressing cavity pump. Its twin-screw feeder supplies a constant, pressurized feed rate to the pump resulting in a 100 percent pump cavity fill rate. The Moyno 2000 HS System features an integral hopper with a twin-screw auger feeder and specially designed progressing cavity pump that efficiently handles dewatered municipal sludge to over 50 percent solids. The enhanced design of the Ultra-Feed™ pump rotor provides superior volumetric efficiency.

The Moyno® 2000 HS System combines high pump efficiency with low discharge pressure to provide unmatched performance in high solids sludge cake transfer. Compared to hydraulically driven, piston ram type pumps and open conveyors, the Moyno 2000 HS System requires lower capital investment, lower operating costs and less maintenance.

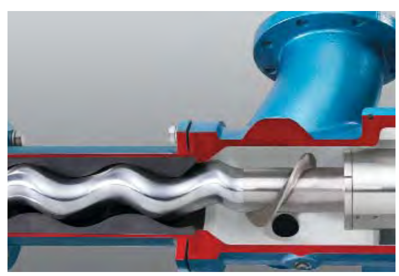
For application versatility, the Moyno 2000 HS System offers varying twin screw feeder and hopper lengths to match wide feed areas from centrifuges and belt filter presses. The twin screw feeder and the hopper length can be readily modified without changing the pump arrangement.

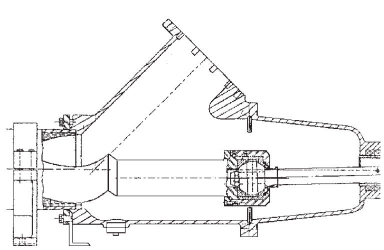
Moyno® 2000 G4 Pumps

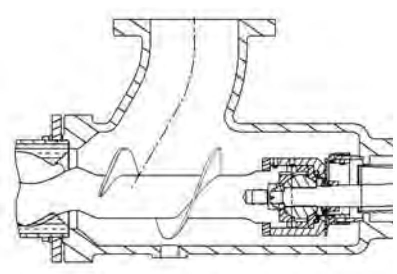
The Moyno® 2000 G4 Pump features proprietary Ultra-Feed® rotor technology.

The high-efficiency G4 progressing cavity pump's 45° inlet lowers friction loss and provides for gentler handling of the product. It also features a universal joint that is out of the fluid flow path for unobstructed flow to the pump cavity inlet. The G4 progressing cavity pump design results in lower overall system pressure and its constant, non-pulsating flow imparts less stress on piping, machinery and drive systems.

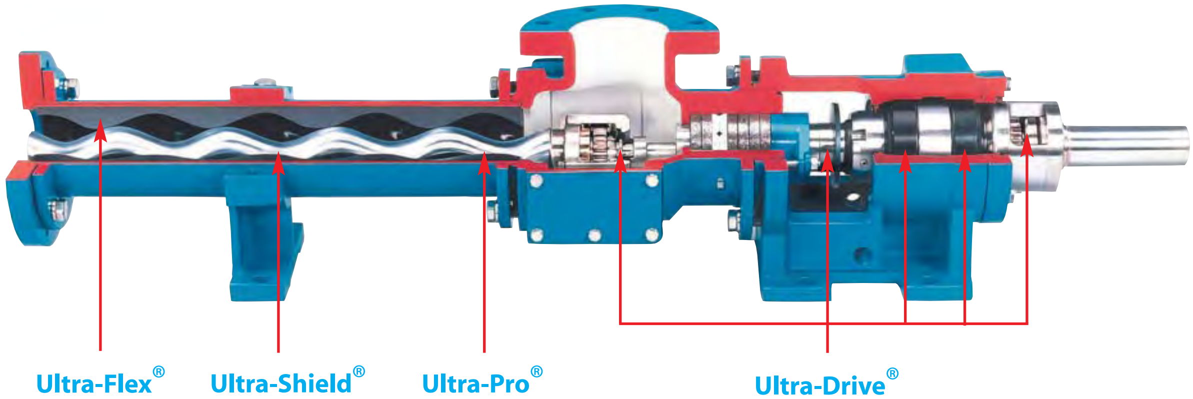
The patented auger feed on the Ultra-Feed rotor head smoothly stuffs product directly into the cavity without obstruction. The Ultra-Feed rotor configuration is designed to enhance flow of high solids content materials and optimize volumetric efficiency.







Ultra-Technologies Provide Greater Customer Value



Moyno is able to deliver superior performance and greater overall customer value because of its proprietary Ultra-Technologies.

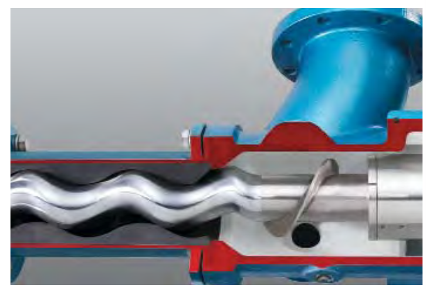
Proprietary **Ultra-Shield®** rotor coatings assure peak performance and excellent wear resistance under highly abrasive and/or corrosive service conditions.

Ultra-Pro® rotor/stator configuration options allow end users to optimize their Moyno pump flow rate and pressure capability to match application requirements.

Proprietary **Ultra-Drive®** gear joint drive train configuration is designed to handle the high thrust and radial forces of even the most demanding applications. The hollow shaft design provides the shortest progressing cavity pump footprint and extends bearing and seal life.

The extensive range of Moyno **Ultra-Flex®** stator elastomers offer application versatility to handle specific fluid conditions for peak operating efficiency, longer life and less maintenance.

Ultra-Serv® service programs provide comprehensive applications engineering support, expert pump repair services and quick parts shipments for trouble-free pump performance and reduced downtime.



Ultra-Feed® auger provides superior feed and flow efficiency.

Moyno® 2000 G1 Pumps

The Moyno® 2000 G1 Pump is a versatile, high-performance pump designed to handle a wide range of applications from shear-sensitive chemicals to difficult-to-process slurries and sludges.

The Moyno 2000 G1 features the highly acclaimed crowned gear universal joint drive train configuration to provide exceptional torque and thrust control. Patented joint seals effectively protect the gear joints from pumpage contamination.

Pump Accessories and Options

Moyno 2000 pumps offer an extensive range of accessories and options, designed to meet specific application requirements.

Flush Gland – allows packing leakage to be flushed away from the pump, preventing potential damage to seals and packing

Fiber Deflector – to prevent ragging around pump connecting rod and rotor head

Shaft Sleeve – protects drive shaft from wear in highly abrasive applications

Control Packages – various control packages are available, including the advanced, integrated touch screen packages found on the 2000 HS System as well as run-dry fluid detection

Slip Ring Injection System – reduces nominal line pressure when transferring extremely dry material over long distances

Wide variety of drive options, couplings, mechanical seals, packing, motor controls, gauge packages and jacketing for handling materials that must be kept hot or chilled

Grinders – including the twin shaft Annihilator™ with patented spacer/cutter assembly and the single shaft Pipeliner™ with self-adjusting headstock

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Fluid Management Group

Bulletin 120-H
Printed in U.S.A.
3M TDH 210

Attachment C—Primary Clarifier Condition Assessment

MEMORANDUM CH2MHILL

Bend WRF Primary Clarifier Condition Inspection

TO:	Jim Wodrich, City of Bend Paul Roy, City of Bend
COPIES:	Brady Fuller, CH2M HILL
FROM:	Lizzy English/CH2M HIL Brady Fuller, CH2M HILL
REVIEWED BY:	Jerry Duppong/CH2M HILL
DATE:	March 23, 2011

Contents

Section **Page**

Executive Summary

CH2M HILL performed condition assessment of the protective coatings on the City's Primary Clarifier 1 as part of the Schematic Design Phase work during the WRF Secondary Expansion. This work included visual observations of the clarifier and mechanisms and limited field tests to evaluate paint thickness and adhesion. Paint chip samples were collected and sent to the Corvallis CH2M HILL Laboratory for lead testing.

The protective coatings on the Primary Clarifier 1 steel mechanism are currently in fair condition. The most apparent corrosion is on the edges of angle members, center column, and feed well where paint is readily chipping and peeling. The Primary Clarifier 2 mechanism is assumed to be in similar condition. The City has reportedly replaced the coatings on the primary clarifier mechanism three times since original construction. The scum baffle and v-notch weir are fiberglass and appear to be in very good condition. Metal brackets holding the scum baffle appear to be coated and appear to be in good condition.

Concrete in the below-water areas is in good condition. Concrete in the launders is in poor to fair condition and may require spot rehabilitation to extend the life of the concrete. Lining of the concrete launders is not recommended at this time. No condition assessment was performed for the mechanical condition of the motor and gear drive mechanism.

Based on the information gathered during this project, CH2M HILL believes that to preserve the capital budget of the current project it is acceptable to keep the existing clarifier mechanisms in service without recoating. However, some minor repair work should be included in the current project.

Due to original age of coatings, there is a possibility that some paint on the mechanism may contain lead. Samples of paint chips were collected from the center column and center cage of the primary clarifier. ***Substantial lead concentrations were found in the existing coatings tested. Therefore, special provisions for handling and disposal of lead-based paint residue are required upon replacement of the existing mechanisms.***

Introduction

This memorandum documents the results of the March 21, 2011, Primary Clarifier Inspection performed by CH2M HILL staff Brady Fuller and Lizzy English. This work was undertaken to observe the condition of the protective coatings on metal components of the primary clarifier and develop for the City recommendations on whether to repaint or replace the mechanism as part of the current project, or whether it is acceptable to defer major improvements to the existing primary clarifier mechanisms.

Background

The City of Bend is in the Predesign Phase of the Bend WRF Secondary Expansion Project. Primary Clarifier Improvements is included in CH2M HILL Scope for this project. The primary clarifiers were constructed and put into service in approximately 1981. Each is a 65-foot-diameter, 9-foot-sidewater-height concrete, in-ground clarifier, with an outboard launder (launder is located radially beyond the exterior tank wall). The floor to top of scum plate was measured at 9.5 feet the day of the inspection.

According to discussions with plant staff, the City used a red oxide primer and a coal tar epoxy top coat on the most recent clarifier re-coating project. A product provided by Denfeld Paint was used. No data were available on the coating product. The last re-coating project was performed in approximately 2004 by City staff.

Documentation of Inspection Results

To facilitate the City's future access to information related to painting of the primary clarifiers, the photographs taken during this project are attached in Appendix A. Appendix B contains tables summarizing dry film thickness measurements. Appendix C contains the testing results for the lead in the existing coating system.

Summary of Field Observations and Tests

Field observations of the primary clarifier were made by CH2M HILL staff on March 21, 2011, to determine the condition of the existing coatings on the metal components of the primary clarifier. Protective coatings on the mechanism were observed from within the emptied Clarifier (No. 1).

The launder was surcharged with primary effluent during the entire period of inspection, so launder inspection was performed from the perimeter of the clarifier on the adjacent sidewalk.

Although the field testing consisted of primarily visual observations, paint thickness and spot adhesion tests were also performed. Paint thickness measurements were made with a DeFelsko Corporation PosiPen, which is a dry film thickness gauge instrument borrowed from City staff (see Appendix B Tables 1, 2, 3, and 4 for test results). Paint adhesion tests were made by undercutting the paint to the metal substrate at coating defects using a 5-way paint scraper and razor blade. The paint adhesion tests were subjective tests, and were not performed to identify specific paint adhesion values.

The top coat of black paint (coal tar epoxy) on the Center Column (Table 2 in Appendix B) and Rake Arm (Table 1 in Appendix B) chipped away easily to the previously applied coat of paint, as if the previous coat cured prior to a top coat being placed (missed recoat window). The next coating layer could be cut away to reveal the thin red coat primer. Using the paint scraper with full force of the arm, the bare metal layer underneath was revealed. The black top coat appeared well adhered to the red oxide primer. Some portions of the rake arm members have dried paint drips and runs that still exhibit good corrosion protective properties.

Rust formations ("tubercles") were noted at areas where a coating defect to bare steel was present. The tops of rake arm members, generally, have the most tubercles. There appears to be little metal loss under the rust tubercles.

The fiberglass v-notch weirs appear in good structural condition, as does the fiberglass scum baffle. Some fasteners are missing, or loose. At least one painted steel bracket holding the scum baffle to the concrete wall is loose and hanging by a single bolt. A sealant is visible between the v-notch weir and the concrete launder wall. This appears in degraded condition and should be replaced.

Feed well and walkway paint thickness gauge results are located in Appendix B, Tables 3 and 4. The feed well had spotty corrosion occurring and the walkway handrail appeared in good condition.

The concrete surfaces were also observed. In general, the concrete interior wall and floor of the clarifier were found to be in good condition. The sludge pit in the center was also in good condition. Some concrete leaching was observed in the launders suggesting rehabilitation is needed to extend the life of the concrete.

Samples of paint chips were collected from the center column and center cage of the primary clarifier and sent to an contract laboratory for testing. These paint samples were found to contain 25 milligrams per liter (mg/L) (top layer of paint) and 6,150 mg/L (all layers of paint to metal surface) of lead. These results indicate that the City will need to develop provisions for worker safety and environmental protection when the existing paint is removed. Based on hazardous waste regulations under Subtitle C of the Resource Conservation and Recovery Act (RCRA) and 40 Code of Federal Regulations (CFR), all blasted paint chips will need to be packaged and disposed of as hazardous waste as the limit is 100 mg/L of lead, which is greatly exceeded in the test results.

Conclusions and Recommendations

Based on observations and review of existing information for the Bend WRF Primary Clarifier Inspection, the following conclusions and recommendations were developed:

1. No significant structural deterioration was observed on the submerged portions of the clarifier mechanism. A cash allowance is recommended for welding and structural repair of discovered minor structural items during construction. It is common for abrasive blasting to reveal imperfections and minor structural damage that can easily be repaired by qualified welders.
2. The paint on the surfaces mechanisms is in poor condition and does contain high amounts of lead. The paint is in need of replacement either during this project or in the near future. This work should include:
    a. Abrasive blasting to remove the existing paint and prepare the metal to SSPC SP-5, “White Metal.”
    b. Application of three coats of a chemical resistant epoxy (an epoxy product that is suitable for exposure to primary wastewater).
    c. City will need to develop provisions for worker safety and environmental protection when the existing paint is removed and disposed as hazardous waste
3. The fiberglass weirs and scum baffle are in good condition. No additional work appears to be necessary for the weirs.
4. The submerged concrete is in good condition. No corrective actions (concrete repair or painting) appear to be necessary for the submerged concrete surfaces.
5. Some leaching of the concrete has occurred in the launders. However, the level of concrete deterioration is not sufficient to warrant corrective action with a protective

coating system at this time. A cash allowance is recommended to address spot repair of bugholes and minor structural damage. City staff could perform some of these maintenance activities at low cost as well. Structural engineer should recommend a polymer modified mortar (or other similar product) for bughole and spot repair.

6. Existing expansion/contraction joints were visible in the launder, but were not adequately inspected. Minor repair and application of sealant may be warranted during construction. Such repairs may be addressed by a cash allowance to pay contractor for such minor repairs.

If the City of Bend chooses to repaint the existing clarifier mechanisms at some point in the near future, the protective coating should be applied by an industrial coating applicator with a minimum of 5 years of experience. Depending on the time of year that the clarifier is painted, it will be necessary to include provisions for containment and environmental conditioning (heating, dehumidification).

Although coal tar epoxy has been successfully used in the past, this product is being used less in the industry due to concerns related to application and potential issues related to removal and disposal. Provisions will need to be included in the specifications to require the contractor to adequately test and dispose of coal-tar containing residue for this project. Alternative coating products that do not contain coal tar are now available that have good performance capabilities for this application.

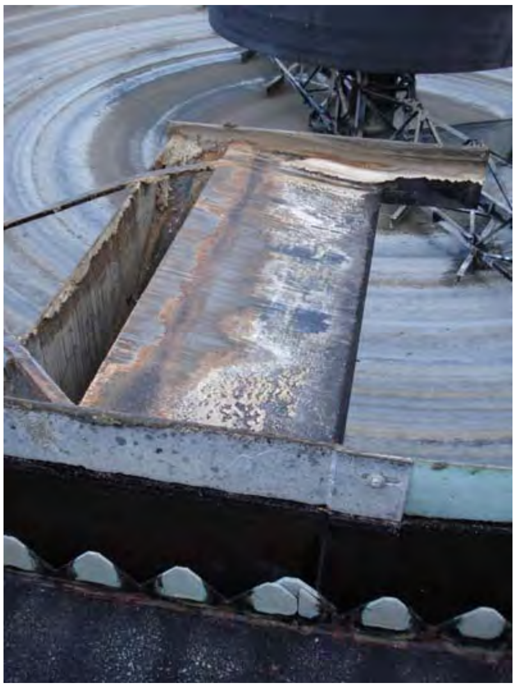
Based on the information gathered during this project, CH2M HILL believes that to preserve the capital budget of the current project it is acceptable to keep the existing clarifier mechanisms in service without recoating. However, some minor repair work should be included in the current project. The mechanisms could be recoated to prolong their useful life or replaced with near mechanisms when necessary in the future.

Appendix A— Primary Clarifier Inspection Photos

APPENDIX A
TO THE BEND WRF PRIMARY CLARIFIER CONDITION INSPECTION MEMORANDUM

Primary Clarifier Inspection Photographs

Inspection photographs are provided in the attached CD. Representative photographs are shown below.



Appendix B— Summary of Dry Film Thickness Measurements

Appendix B

Table 1: Rake Arm Paint thickness gauge results in mils and notes on condition

Rake Arm Section	Bottom Chord	Angle Members Vertical	Angle Members Horizontal	Steel Rakes Condition
1	16	15	15	
2	14	17	15	
3	16	13	10	
4	14	17	12	
5	17	17	15	
6	18 and 20	20	18	Corrosion on underside of rakes especially near center column, see video and pictures
7	18	16, 18, 14	15	Corrosion on underside of rakes especially near center column, see video and pictures
8	16	12	15	
9	17	17, 14	15	
10	16	14	15	
11	19	13	15	
12	18	16	15	

Table 2: Center Column Paint thickness gauge results in mils and notes on condition

Center Column and Cage	General Observation	Horizontal, Paint thickness (mils)
	Spotty Corrosion occurring	16 to 17

Table 3: Feed Well paint thickness gauge results in mils and notes on condition

Feed well	General Observation	Paint Thickness (mils)
	Spotty corrosion occurring	12 to 14

Table 4: Walkway Paint thickness gauge results in mils and notes on condition

Walkway	Handrail	Bridge Assembly
	good condition	8 to 10

Appendix C— Lead Test Results for Bend WRF Primary Clarifier 1 dated March 28, 2011

CH2M HILL
Applied Sciences Laboratory (ASL)
1000 NE Circle Blvd, Building 10
Suite 10350
Corvallis, OR 97330
Tel 541.768.3120
Fax 541.752.0276
ASL@CH2M.com

March 28, 2011

Bend WRF Secondary Expansion

391657.A3.SD.PR

RE: Laboratory Report for Bend WRF Secondary Expansion
ASL Report #: K1501

Jerry Duppong/SEA:

On March 25, 2011, CH2M HILL Applied Sciences Laboratory received two samples with a request for analysis of selected parameters. All analyses were performed by CH2M HILL unless otherwise indicated below. The results included in this report only relate to the samples listed on the following Sample Cross-Reference page. This report shall not be reproduced except in full, without the written approval of the laboratory.

The analytical results and associated quality control data are enclosed. Any unusual difficulties encountered during the analysis of your samples are discussed in the case narrative.

CH2M HILL Applied Sciences Laboratory appreciates your business and looks forward to serving your analytical needs again. If you should have any questions concerning the data, or if you need additional information, please call Ben Thompson at (541) 758-0235, extension 23132.

Authorized and Released By:

Ben Thompson
Laboratory Project Manager

Enclosures

cc:
Brady Fuller/BND
Lizzy English/BND

NELAC OR100022

Samples will be disposed at no additional cost to clients, 30 days (10 days for air) after the final report is issued. Storage of samples and containers beyond this may be available for an additional fee. Samples classed as hazardous based on hazardous waste regulations under Subtitile C of RCRA and 40CFR, will either be returned to client at the client's expense or the client will be charged a $5 per sample disposal fee.

CLIENT SAMPLE CROSS-REFERENCE
For Samples Received March 25, 2011

ASL Report #: K1501

Sample ID	Client Sample ID	Date Collected	Time Collected
K150101	Center Column, all layers	03/24/2011	
K150102	Center Column, Top layer	03/24/2011	

CASE NARRATIVE
METALS ANALYSIS

Lab Name: CH2M HILL/LAB/CVO ASL SDG#: K1501

Project: Bend WRF Secondary Expansion Project #: 391657.A3.SD.PR

I. Method(s):

Analysis: SW6010
Preparation: SW3050

II. Receipt/Holding Times:

All acceptance criteria were met.

III. Analysis:

A. Initial Calibration(s):
All acceptance criteria were met.

B. Calibration Verification(s):
All acceptance criteria were met.

C. Blanks:
All acceptance criteria were met.

D. Laboratory Control Sample(s):
All acceptance criteria were met.

E. Matrix Spike/Matrix Spike Duplicate Sample(s):
Analyzed in accordance with standard operating procedure.

F. Interference Check Sample(s):
All acceptance criteria were met.

G. Serial Dilution(s):
All acceptance criteria were met.

H. Digestion Exception(s):
None.

I. Analytical Exception(s):
Client sample results are reported on an "As Received" basis.

IV. Documentation Exception(s):

None.

V. I certify that this data package is in compliance with the terms and conditions agreed to by the client and CH2M HILL, both technically and for completeness, except for the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or designee, as verified by the following signatures.

Prepared by: [signature] Date: 3-28-11

Reviewed by: B Heathman Date: 03-28-11

CH2M HILL Applied Sciences Laboratory (ASL)

Client Information		Lab Information	
Project Name:	**Bend WRF Secondary Expansion**	**Lab Batch ID:**	**K1501**
Date Received:	03/25/11	Analysis Method:	SW6010B
Type:	See C.O.C.	Units:	mg/Kg
Matrix:	Other	Report Revision No.:	0
Basis:	As Received		

Client Sample ID	Lab Sample ID	Dilution Factor	MRL	Lead Result	Qualifier	Date Analyzed
Metals						
Center Column, all layers	K150101	10	12.3	6150		03/28/11
Center Column, Top layer	K150102	10	3.85	24.9		03/28/11

U=Not detected at specified reporting limit
J=Estimated value below reporting limit
E=Estimated value above calibration range
*=See case narrative

1000 NE Circle Blvd, Building 10, Suite 1035C
Corvallis, OR 97330
Tel 541.768.3120 Fax 541.752.0276

CH2M HILL Applied Sciences Laboratory (ASL)

Client Information		Lab Information	
Project Name:	**Bend WRF Secondary Expansion**	**Lab Batch ID:**	**K1501**
Date Received:	N/A	Analysis Method:	SW6010B
Type:	See C.O.C.	Units:	mg/Kg
Matrix:	Soil	Report Revision No.:	0
Basis:	Dry Weight		

Client Sample ID	Lab Sample ID	Dilution Factor	MRL	Lead Result	Qualifier	Date Analyzed
Metals						
SB1-0328	SB1-0328	1	0.50	0.50		03/28/11

U=Not detected at specified reporting limit
J=Estimated value below reporting limit
E=Estimated value above calibration range
*=See case narrative

CH2M HILL Applied Sciences Laboratory (ASL)

Client Information

Client Sample ID: **BS1S0328**

Project Name: Bend WRF Secondary Expansion
Type: QC
Matrix: Soil

Lab Information

Lab Sample ID: **BS1S0328**

Dilution Factor: 1
Report Revision No.: 0

Analyte	CAS#	Spike Amount	Sample Result	Units	%Recovery	Analysis Method	Date Analyzed
Metals							
Lead	7439-92-1	50.0	51.3	mg/Kg	103	SW6010	03/28/11 14:23

U=Not detected at specified reporting limit
J=Estimated value below reporting limit
E=Estimated value above calibration range
*=See case narrative

1000 NE Circle Blvd, Building 10, Suite 10350
Corvallis, OR 97330
Tel 541.768.3120 Fax 541.752.0276

CH2MHILL Applied Sciences Lab
CHAIN OF CUSTODY RECORD
AND AGREEMENT TO PERFORM SERVICES

1000 NE Circle Blvd., Suite 10350
Corvallis, OR 97330
(541) 768-3120 FAX (541) 752-0276

COC # ______

Project # or Purchase Order #
391657.A3.SD.PR

Project Name
Bend WRF Secondary Expansion

Company Name or Home Address/Phone Number

Email Address for Reporting
Jerry.duppong@ch2m.com
Brady.fuller@ch2m.com
Lizzy.english@ch2m.com

Report Copy to:
Brady Fuller, PE
377 SW Century Drive
Bend, OR 97702

Turnaround Time: ☒24 hours ☐48 hours ☐72 hours ☐7 days ☐14 days ☐21 days (STD)

Drinking Water? Yes ☐ No ☒

Sample Disposal: Dispose ☒ Return ☐

Requested Analytical Method #

THIS AREA FOR LAB USE ONLY

Lab # K1501 | Page | of

EPA Tier QC Level: 1 (Screening) 2 3 4

Date (Sampling)	Time (Sampling)	COMP	GRAB	WATER	SOIL	AIR	CLIENT SAMPLE ID	TOTAL # OF CONTAINERS	UNPRES	H_2SO_4	HNO_3	HCl	NaOH	ZnAcNaOH				Canister ID	Lab ID
3/24/11							Center Column, Steel Beam, All layers												1
3/24/11							Center Column, Top Layer												2

Possible Hazard Identification: ☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Volatile Contaminants/Odorous ☐ Biohazard ☐ Other ______

Relinquished By: Lizzy English	Date/Time: 3/24/2011	Received By: Kathy McKenz	Date/Time: 3/25/11 1505
Sampled By and Title (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name)	Date/Time
Received By (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name)	Date/Time
Received By (Please sign and print name)	Date/Time	Shipped Via: UPS Fed-Ex Other______	Tracking #

Special Instructions

CH2MHILL
Applied Sciences Laboratory (ASL)

Sample Receipt Record

Batch Number: K1501 Date received: 3/25/11

Client/Project: Bend WRF Checked by: KM

Checked by:

VERIFICATION OF SAMPLE CONDITIONS (verify all items) * HD = Client Hand delivered Samples

Observation	NA	YES	NO
Radiological Screening for DoD	X		
Were custody seals intact and on the outside of the cooler?			X
Type of packing material: Ice Blue Ice Bubble wrap fedex envelope			
Was a Chain of Custody provided?		X	
Was the Chain of Custody properly filled out? If not document in SRER		X	
Were the sample containers in good condition (broken or leaking)?		X	
Containers supplied by ASL?			X
Any sample with < 1/2 holding time remaining? If so contact LPM			X
Samples have multi-phase? If yes, document on SRER			X
Was there ice in the cooler? Enter temp. If >6°C contact client/SRER °C			X
All VOCs free of air bubbles? No, document on SRER	X		
pH of all samples checked and met requirements? No, then document in SRER	X		
Enough sample volume provided for analysis? No, document in SRER		X	
Did sample labels agree with COC? No, document in SRER		X	
Dissolved/Soluble metals filtered in the field?	X		
Dissolved/Soluble metals have sediment in bottom of container? Document in SRER	X		

Sample ID	Reagent	Reagent Lot Number	Volume Added	Initials

Attachment D—Vendor Catalog Cuts Equipment for NFPA Compliance

COOPER Notification

Series Colored Lens Strobe Appliances: Strobes, Horns Strobes, Speaker Strobes and Multitone Strobes with Amber, Blue, Green or Red Lens

Description:

Wheelock colored lens strobe notification appliances - strobes, horn strobes*, speaker strobes, and multi-tone strobes - are built with the same high quality circuits and parts used in the Cooper Wheelock life safety strobes and speakers, and are available with clear, amber or blue lenses, with other colors available through special order. The colored lens strobe products are listed under UL Standard 1638 for general signaling and the amber lenses been tested to meet UL 1971 light distribution. These appliances are suitable for indoor applications, with specific models available for outdoor and weatherproof applications. The indoor models can be wall or ceiling mounted (model dependent) to standard electrical boxes or to Wheelock's surface mount boxes. The outdoor models can be wall mounted to standard electrical boxes or to Wheelock's surface mount boxes. The RSS models have an integrated strobe mounting plate that can be mounted to standard electrical boxes or to Wheelock's surface mount boxes.

The strobes have been tested to operate from 16 to 33 vdc (using filtered or FWR voltage). Intensity options for these models include multi-candela models with four field selectable settings of 15, 30, 75, and 95cd. High ceiling models can be field selectable for 115 or 177 cd.

Audible strobe appliances can be field set to provide either High (HI) dBA, Medium (MED) dBA or Low (LO) dBA sound output. Speaker strobes have field selectable input voltage of 25/70 VRMS and field selectable taps of 1/8, 1/4, 1/2, 1 and 2 watts. The Series E70-24MCC and E90-24MCC Multi-Candela provides four selectable light output intensities in one unit and incorporate a Speaker Mounting Plate attached to the speaker for ease of installation. Weatherproof speaker strobes have field selectable taps of 1/8, 1/4, 1/2, 1, 2, 4, and 8 watts.

All inputs are compatible with standard supervision of circuit wiring by an FACP and provide a synchronized strobe appliance when used in conjunction with a Sync Module (SM), Dual Sync Module (DSM) or Wheelock power supplies with patented sync protocol.

Other Wheelock signaling products can be provided with colored lens strobes - contact Customer Service for availability.

Features:

- Approvals include: UL 1638
- Amber Lenses have been tested to meet UL 1971 light distribution
- Choice of strobe lens colors – amber, blue, red (some models or by special order)
- Field selectable candela settings of 15/30/75/95cd or high intensity models with 115/177cd settings
- Indoor 24VDC models with UL "Regulated Voltage" at 16-33 VDC using filtered DC or unfiltered FWR input voltage
- Weatherproof strobe notification appliances 12 VDC
- Multitone appliance
- Strobes can be synchronized with Wheelock's SM or DSM sync modules or SAFEPATHTM4 power supplies
- Combination speaker/strobes available for voice messages with visual alerting
- Mount to standard electrical boxes
- High quality designs from the leader in fire notification alarms

Applications:

The Wheelock colored lens strobe products are designed for effective alerting of employees or personnel in industrial, military or government applications. They are ideal for Mass Notification systems and for emergency, warning or trouble notification in many industrial operations.

* NOTE: Horn strobes incorporates a temporal pattern (specified by ANSI/NFPA for standard emergency evacuation signaling.) The temporal pattern should be used only for fire evacuation signaling and not for any other purpose.

S5391

NOTE: All CAUTIONS and WARNINGS are identified by the ⚠ symbol. All warnings are printed in bold capital letters.

⚠WARNING: PLEASE READ THESE SPECIFICATIONS AND ASSOCIATED INSTALLATION INSTRUCTIONS CAREFULLY BEFORE USING, SPECIFYING OR APPLYING THIS PRODUCT. FAILURE TO COMPLY WITH ANY OF THESE INSTRUCTIONS, CAUTIONS OR WARNINGS COULD RESULT IN IMPROPER APPLICATION, INSTALLATION AND/OR OPERATION OF THESE PRODUCTS IN AN EMERGENCY SITUATION, WHICH COULD RESULT IN PROPERTY DAMAGE, AND SERIOUS INJURY OR DEATH TO YOU AND/OR OTHERS.

General Notes:

- Strobes are designed to flash at 1 flash per second minimum over the Regulated Voltage Range.
- Products are listed for indoor use with a temperature range of 32ºF to 120ºF (0ºC to 49ºC) and maximuim humidity of 93% (± 2%).
- Weatherproof products are listed for use with a temperature range of -31ºF to 150ºF (-35ºC to 66ºC) and maximum humidity of 95% RH.

Specification and Ordering Information

Model Number	Order Code	Lens Color	Strobe Candela Note 1	Strobe Voltage	Mounting	Indoor or Weatherproof	Agency Approvals
RSSA-24MCC-NW	0202	AMBER	15/30/75/95	24VDC	Ceiling/Wall	Indoor	UL
RSSB-24MCC-NW	0203	BLUE	15/30/75/95	24VDC	Ceiling/Wall	Indoor	UL
RSSG-24MCC-NW	0204	GREEN	15/30/75/95	24VDC	Ceiling/Wall	Indoor	UL
RSSR-24MCC-NW	5917	RED	15/30/75/95	24VDC	Ceiling/Wall	Indoor	UL
RSSA-24MCCH-NW	0525	AMBER	115/177	24VDC	Ceiling/Wall	Indoor	UL
RSSB-24MCCH-NW	6154	BLUE	115/177	24VDC	Ceiling/Wall	Indoor	UL
RSSG-24MCCH-NW	6155	GREEN	115/177	24VDC	Ceiling/Wall	Indoor	UL
RSSR-24MCCH-NW	6156	RED	115/177	24VDC	Ceiling/Wall	Indoor	UL
ASA-24MCC-NW	6162	AMBER	15/30/75/95	24VDC	Ceiling/Wall	Indoor	UL
ASB-24MCC-NW	6164	BLUE	15/30/75/95	24VDC	Ceiling/Wall	Indoor	UL
MTA-121575W-NW	0048	AMBER	15 Note 2	12VDC	Wall	Indoor	UL*
MTA-24MCCH-NW	6167	AMBER	115/177	24VDC	Ceiling/Wall	Indoor	UL*
MTB-24MCCH-NW	6168	BLUE	115/177	24VDC	Ceiling/Wall	Indoor	UL*
MTG-24MCCH-NW	6169	GREEN	115/177	24VDC	Ceiling/Wall	Indoor	UL*
MTR-24MCCH-NW	6170	RED	115/177	24VDC	Ceiling/Wall	Indoor	UL*
E50A-24MCC-NW	6165	AMBER	15/30/75/95	24VDC	Wall	Indoor	UL*
E50B-24MCC-NW	6166	BLUE	15/30/75/95	24VDC	Wall	Indoor	UL*
E70A-24MCC-NW	0209	AMBER	15/30/75/95	24VDC	Ceiling/Wall	Indoor	UL*
E70B-24MCC-NW	0210	BLUE	15/30/75/95	24VDC	Ceiling/Wall	Indoor	UL*
E90A-24MCC-NW	0213	AMBER	15/30/75/95	24VDC	Ceiling	Indoor	UL*
E90B-24MCC-NW	0214	BLUE	15/30/75/95	24VDC	Ceiling	Indoor	UL*
ET70WPA-2475-NW	0220	AMBER	30 Note 3	24VDC	Ceiling/Wall	Weatherproof	UL*
MTWPA-2475-NW	1649	AMBER	30 Note 3	24VDC	Ceiling/Wall	Weatherproof	UL*
MTWPA-24MCCH-NW	6171	AMBER	115/177	24VDC	Ceiling/Wall	Weatherproof	UL*
MTWPB-24MCCH-NW	6172	BLUE	115/177	24VDC	Ceiling/Wall	Weatherproof	UL*
MTWPG-24MCCH-NW	6173	GREEN	115/177	24VDC	Ceiling/Wall	Weatherproof	UL*
MTWPR-24MCCH-NW	6174	RED	115/177	24VDC	Ceiling/Wall	Weatherproof	UL*
RSSWPA-2475-NW	0240	AMBER	30 Note 3	24VDC	Ceiling/Wall	Weatherproof	UL
RSSWPA-24MCCH-NW	6158	AMBER	115/177	24VDC	Ceiling/Wall	Weatherproof	UL*
RSSWPB-24MCCH-NW	6159	BLUE	115/177	24VDC	Ceiling/Wall	Weatherproof	UL*
RSSWPG-24MCCH-NW	6160	GREEN	115/177	24VDC	Ceiling/Wall	Weatherproof	UL*
RSSWPR-24MCCH-NW	6161	RED	115/177	24VDC	Ceiling/Wall	Weatherproof	UL*
RSSPA-24MCC-NW	3308	AMBER	15/30/75/95	24VDC	Ceiling/Wall	Indoor	UL

Note 1: Candela ratings in the above table are per UL 1971 and are based on clear lenses. Models with 15/30/75/95 have 4 field-selectable candela settings, and models with 115/177 have 2 field-selectable candela settings. Intensity ratings are for clear lens – derate approximately 25% for amber, 55% for green, 70% for blue lenses, and 80% for red lenses.
Note 2: 15 candela models provide 15cd per UL 1971 and 75cd on axis per UL 1638.
Note 3: 30 candela weatherproof models provide 30cd per UL 1971 and 75 candela on axis at -31ºF and 185 candela on axis at 77ºF per UL 1638.
Note 4: 115/177 candela weatherproof models provide 115/177cd per UL 1971 and 50/75cd at -31ºF per UL 1638 (with UL 1971 light dispesion).

* UL Pending

Mounting Options Backboxes (ordered separately)

Indoor

Series	Flush Mount	Surface Mount
RSS	4” x 1-1/2”, 1-gang or 2-gang box	SHBB
AS	4” x 1-1/2”, 1-gang or 2-gang box	SHBB
MT	4” x 1-1/2”, 2-gang box	IOB
E50	4” x 2 1/8” (with extension ring)	E50SSB
E70	4” x 2-1/8” with extension ring	SBB
E90	4” x 2-1/8” with extension ring	SBB
RSSP	4” x 1-1/2”, 4” x 2 1/8”	SBL-2

Weatherproof

Series	Flush Mount	Surface Mount	
		Exposed Conduit	Concealed Conduit
MT	WFP	IOB	IOB+WP-KIT
ET70WP	WFP	IOB	IOB+WP-KIT
MTWP	WFP	IOB	IOB+WP-KIT
RSSWP	WFP	WPSBB	WPSBB+WP-KIT

Tone	HI/LO Volume	MT24VDC dBA Sound Output Anechoic Ratings at 10 Feet		
		20V	24V	31V
Horn	HI	97	99	100
	STD	91	93	94
Bell	HI	90	92	93
	STD	85	87	88
March Time	HI	97	99	100
	STD	91	93	94
Code 3 Horn	HI	97	99	100
	STD	91	93	94
Code 3 Tone	HI	93	95	96
	STD	88	90	91
Slow Whoop	HI	97	99	100
	STD	92	94	95
Siren	HI	96	98	99
	STD	91	93	94
HI/LO	HI	91	93	94
	STD	86	88	89

UL Max. Current Ratings (Maximum RMS Current Draw)								
Voltage		15cd	30cd	75cd	95cd	1575cd	115cd	177cd
RSSX-24MCC E70X-24MCC E90X-24MCC	16-33VDC	0.065	0.105	0.189	0.249	-	-	-
ASX-24MCC	16-33VDC	High - .095 Med - .080 Low - .074	High - .138 Med - .122 Low - .113	High - .221 Med - .201 Low - .198	High - .285 Med - .269 Low - .263	-	-	-
RSSPX-24MCC	16-33VDC	0.065	0.105	0.189	0.249	-	-	-
RSSWPX-2475W MTWPX-2475W	16-33VDC	-	-	0.138	-	-	-	-
RSSWPX-24MCCH MTWPX-24MCCH	16-33VDC						0.300	0.420
MTA-121575W*	8.0-17.5	-	-	-	-	0.255	-	-

Models	Voltage (VRMS)	Reverberant dBA at 10 Feet Per UL 1480 (Rated Watts)						
		1/8W	1/4W	1/2W	1W	2W	4W	8W
E50X-24MCC	25/70	77	79.5	82.5	85	88	-	-
E70X-24MCC	25/70	75	78	81	84	87	-	-
E90X-24MCC	25/70	75	78	81	84	87	-	-
ET70WPA-2475	25/70	77	80	83	86	88	91	93

Horn Setting	Volume	ASX-24MCC dBA Sound Output Anechoic dBA at 10 Feet		
		16.0VDC	24.0VDC	33.0VDC
Continuous	Low	86	90	92
	Medium	91	95	98
	High	95	99	101
Code 3	Low	86	90	92
	Medium	91	95	98
	High	95	99	101

Current Ratings for Multitone Audible Appliances with Horn Only		24VDC		12VDC	
		HI	STD	HI	STD
Horn	Broadband Horn (Continuous)	0.108	0.044	0.177	0.034
Bell	1560 Hz Modulated (0.07 Sec. ON/Repeat)	0.053	0.024	0.095	0.020
March Time Horn	Horn (0.25 Sec. ON/0.25 Sec. OFF/Repeat)	0.104	0.087	0.142	0.034
Code 3 Horn	Horn (ANSI S3.41 Temporal Pattern)	0.091	0.035	0.142	0.034
Code 3 Tone	500 Hz (ANSI S3.41 Temporal Pattern)	0.075	0.035	0.105	0.021
Slow Whoop	500-1200Hz Sweep (4.0 Sec. ON/0.5 Sec OFF/Repeat)	0.098	0.037	0.142	0.035
Siren	600-1200Hz Sweep (1.0 Sec. ON/Repeat)	0.104	0.036	0.152	0.03
HI/LO	1000/800 Hz (0.25 Sec. ON/Alternate)	0.057	0.025	0.114	0.026

For details using SM or DSM Sync Modules refer to data sheet S3000 or Installation Instructions P83123 for SM and P83177 for DSM. For wiring information on the power supply refer to Installation Instructions P84662 for PS-24-8MC.

Wheelock products must be used within their published specifications and must be PROPERLY specified, applied, installed, operated, maintained and operationally tested in accordance with their installation instructions at the time of installation and at least twice a year or more often and in accordance with local, state and federal codes, regulations and laws. Specification, application, installation, operation, maintenance and testing must be performed by qualified personnel for proper operation in accordance with all of the latest National Fire Protection Association (NFPA), Underwriters' Laboratories (UL), National Electrical Code (NEC), Occupational Safety and Health Administration (OSHA), local, state, county, province, district, federal and other applicable building and fire standards, guidelines, regulations, laws and codes including, but not limited to, all appendices and amendments and the requirements of the local authority having jurisdiction (AHJ).

Architects and Engineers Specifications

The audible/visual notification appliances shall be Wheelock colored lens strobe products or approved equals. These appliances shall be listed under UL Standard 1638. The amber lens shall be tested to meet UL 1971 light distribution.

The strobe appliances shall produce a minimum flash rate of 60 flashes per minute (1 flash per second) over the Regulated Voltage Range of 16 to 33 VDC and shall incorporate a Xenon flash tube enclosed in a rugged lexan lens. Strobe intensity shall be 75 candela minimum or shall be field selectable for 4 intensity levels The strobes shall operate over an extended temperature range of 32ºF to 120ºF (0ºC to 49ºC) and shall be listed for maximum humidity of 93%RH. Weatherproof strobe appliances shall operate over an extended temperature range of -31°F to +150°F (-35°C to +66°C) and maximum humidity of 95% RH.

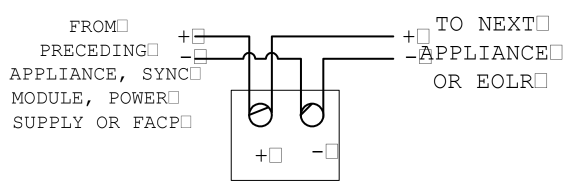
Horn strobes shall be able to produce a continuous output or a temporal code-3 output that can be synchronized. The horns shall have 3 sound level settings of 90, 95, and 99 dBA

Speaker strobes shall be able to have field selectable input voltage of 25/70 VRMS and field selectable taps of 1/8, 1/4, 1/2, 1 and 2 watts. Weatherproof speakers shall have field selectable taps of 1/8, 1/4, 1/2, 1, 2, 4, and 8 watts.

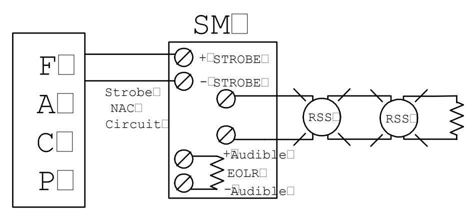
When synchronization of strobes or temporal Code-3 audibles is required, the appliances shall be compatible with Wheelock Series SM and DSM sync modules or the Wheelock PS-24-8MC Power Supply with built-in patented Sync Protocol. The strobes shall not drift out of synchronization at any time during operation. Audibles and strobes shall be able to be synchronized on a 2-wire circuit with the capability to silence the audible if required. If the sync module or power supply fails to operate (i.e. contacts remain closed), the strobes shall revert to a non-synchronized flash rate.

Wiring Diagrams #

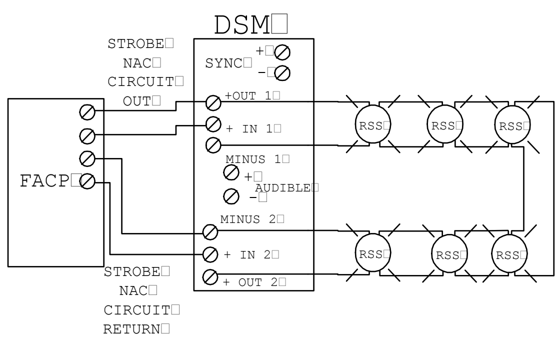
SERIES RSS APPLIANCE



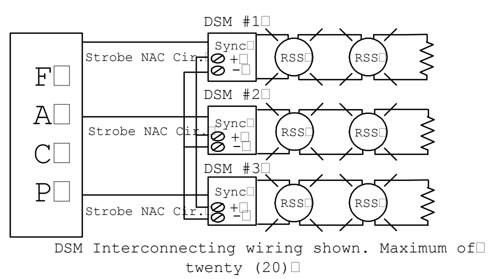
SERIES RSS APPLIANCE SYNCHRONIZED WITH SM MODULE SINGLE CLASS "B" NAC CIRCUIT



SERIES RSS APPLIANCES SYNCHRONIZED WITH DSM MODULE SINGLE CLASS "A" NAC CIRCUIT



SERIES RSS APPLIANCES SYNCHRONIZED WITH MULTIPLE DSM MODULES



WE ENCOURAGE AND SUPPORT NICET CERTIFICATION
3 YEAR WARRANTY
Made in USA
S9020 Colored Lens 02/08

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Long Branch, NJ 07740
P: 800-631-2148
F: 732-222-8707
www.coopernotification.com

FL Location
7565 Commerce Ct.
Sarasota, FL 34243
P: 941-487-2300
F: 941-487-2389

VA Location
P: 877-459-7726
F: 703-294-6560

Cooper Notification is Wheelock® MEDC SAFEPATH® WAVES Roam Secure

COOPER Notification

AdaptaLight® Stackable Beacon

PLC Compatible

101 Series

FEATURES

- PLC compatible
- Seven gasketed modules:
  steady-on or flashing incandescent
  steady-on or flashing halogen
  steady-on or flashing LED
  strobe
- Stackable in any combination or color
- Base unit comes with 85 dB pulsating horn
- Vibration resistant heavy duty industrial design
- Module rearrangement requires no wiring; screw terminals in base for field wiring
- 300,000 peak candlepower strobe
- Electrical interconnection between units is through solid copper busses

AGENCY APPROVALS

- UL 1638 Listed
- cUL Listed

The Edwards AdaptaLight Stackable Beacon is a unique audible-visual signaling device which can contain up to 5 light modules and a pulsating horn in a single "stack." It is for heavy duty use in locations where visibility over longer distances is required. All modules are gasketed. The base of the AdaptaLight Stackable Beacon contains a pulsating horn rated at 85dB at 10 feet. The horn can be operated as a sixth independent signal or in conjunction with any one of the light modules.

The steady-on modules provide a constant visual signal. They are ideal for start/stop functions, on/off process or continuous duty visual signaling applications.

The flashing modules command immediate attention. They work well as a warning signal when used with the steady-on module. Applications include signaling of equipment malfunction.

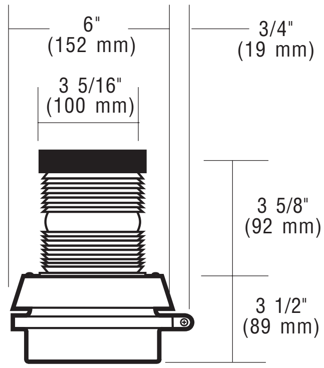
The strobe modules are ideal for high ambient light areas. It can effectively signal urgent status changes when used in conjunction with the incandescent or LED light modules. The LED modules are best for applications where long life (120,000 hours) is a requirement.

The AdaptaLight can be surface or 1/2" (13mm) NPT conduit pipe mounted in non-hazardous dust and weatherproof applications. For indoor applications, it may be vertically mounted with lenses facing either up or down. For weatherproof installation, the unit must be mounted vertically with lenses facing up. May also be corner mounted using the Cat. No. CBR, corner mount bracket, or wall mounted, using the Cat. No. WBR, wall mount bracket. See AdaptaBeacon Accessories page 3-118.

90 Fieldstone Court | Cheshire, CT 06410
Ph: 203.699.3300 | Fx: 203.699.3108
www.edwards-signals.com

Edwards Signaling & Security Systems®

TECHNICAL INFORMATION



Cat. No.	Module Type	Voltage	Nominal Current	Flash Rate	Replacement Horn	Replacement Light Source	Peak Candlepower
101BS-E1	Base Unit w/Horn	12V DC	0.05A (max)	-	118-E1	-	-
101BS-G1	with Horn	24V DC	0.05A (max)	-	118-G1	-	-
101BS-N5	(85 dB at 10 feet)	120V AC 50/60 Hz	0.05A (max)	-	123A-N5	-	-
101FIN*-E1	Flashing Incandescent	12V DC	1.0A	65 fpm	-	Industry Trade No. 94(1)	2374
101FINH*-G1	Flashing Halogen	24V DC	0.32A	65 fpm	-	50LMP-9WH-D(2)	653
101FINH*-N5	Flashing Halogen	120V AC 50/60 Hz	0.11A	65 fpm	-	50LMP-12WH-D(3)	879
101FLED**-G1	Flashing LED	24V DC	0.065A	65 fpm	-	-	color
101FLED**-N5	Flashing LED	120V AC 50/60 Hz	0.025A	65 fpm	-	-	dependent
101SIN*-E1	Steady-on Incandescent	12V DC	1.0A	-	-	Industry Trade No. 94(1)	2374
101SINH*-G1	Steady-on Halogen	24V DC	0.32A	-	-	50LMP-9WH-D(2)	653
101SINH*-N5	Steady-on Halogen	120V AC 50/60 Hz	0.11A	-	-	50LMP-12WH-D(3)	876
101SLED**-G1	Steady-on LED	24V DC	0.065A	-	-	-	color
101SLED**-N5	Steady-on LED	120V AC 50/60 Hz	0.025A	-	-	-	dependent
101ST*-E1	Strobe	12V DC	0.5A	65 fpm	-	91B-ST(4)	300,000
101ST*-G1	Strobe	24V DC	0.3A	65 fpm	-	91B-ST(4)	300,000
101ST*-N5	Strobe	120V AC 50/60 Hz	0.12A	65 fpm	-	91B-ST(4)	300,000

*Insert lens color: R - red, A - amber, B - blue, G - green, M - magenta, C - clear **Insert lens and LED color: R - red, A - amber, B - blue, G - green

(1) Projected lamp life based on manufacturer's calculated lamp life at 65 fpm and 50% duty cycle is 1,520 hours.

(2) Projected lamp life based on manufacturer's calculated lamp life at 65 fpm and 50% duty cycle is 15,000 hours. Can also be replaced with Industry Trade No. 1692.

(3) Projected lamp life based on manufacturer's calculated lamp life at 65 fpm and 50% duty cycle is 25,000 hours. Can also be replaced with Industry Trade No. 15T7DC.

(4) Strobe tube life at operating power to 75% efficiency is 3,000 hours.

SIGNAL INPUT LOAD CHARACTERISTICS*

Light Source Cat. No.	Operating Voltage	Max. off state leakage current (mA)	Continuous on Current (mA)	Surge (inrush/duration) Amps/milliseconds
101BS-G1	24V DC	25	50	2/1
101BS-N5	120V AC	25	50	2/1
101FINH( )-G1	24V DC	25	320	1.2/100
101FINH( )-N5	120V AC	25	110	1.15/8
101SINH( )-G1	24V DC	25	320	.36/1
101SINH( )-N5	120V AC	25	110	.5/8
101FLED( )-G1	24V DC	4	65	.07/1
101FLED( )-N5	120V AC	5	25	.09/8
101SLED( )-G1	24V DC	4	65	.07/1
101SLED( )-N5	120V AC	5	25	.09/8
101ST( )-G1	24V DC	1.5	300	0.33/1
101ST( )-N5	120V AC	5	120	2.1/1

*This device is PLC compatible and may be operated by PLCs with output characteristics that match the input load requirements of this signal.

D-04

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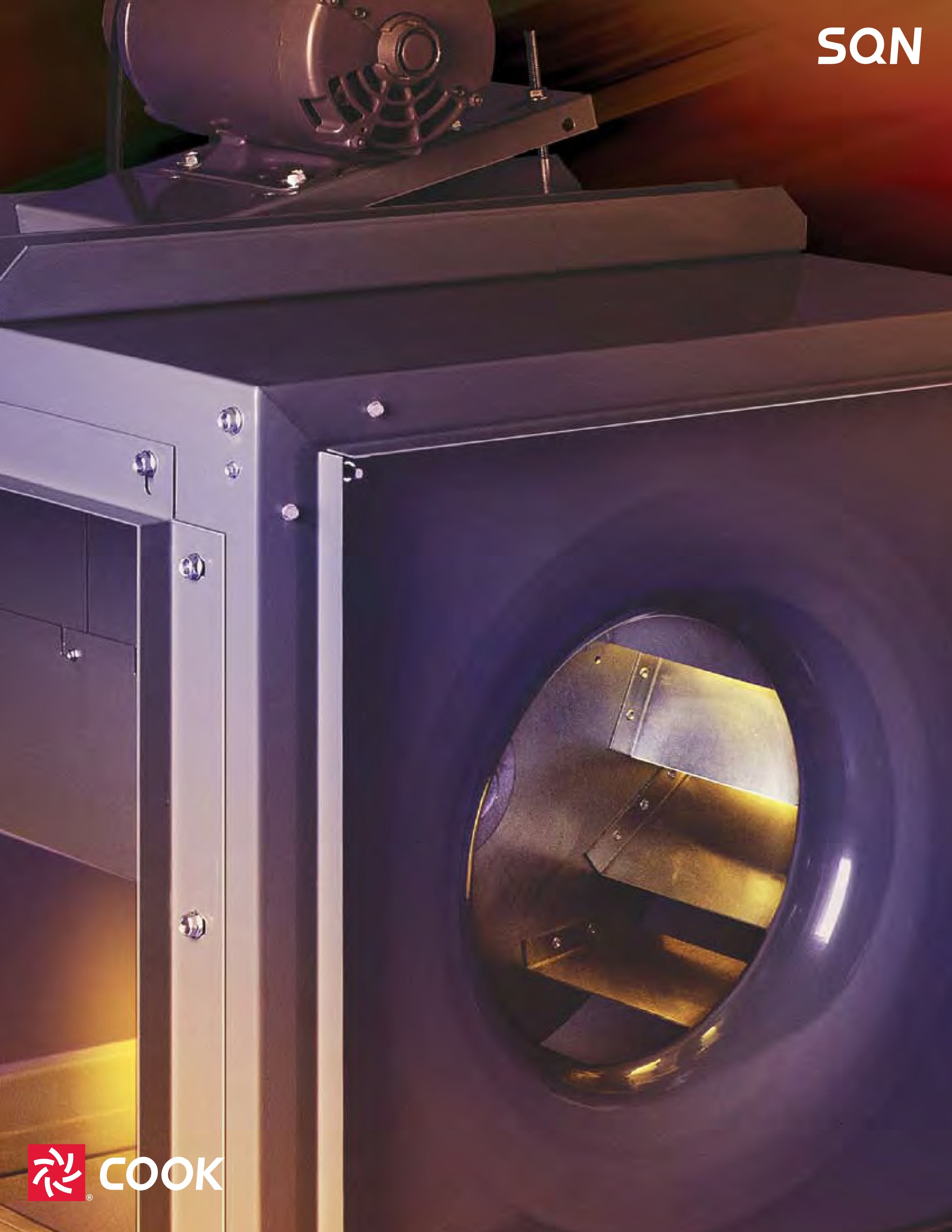


SQN

COOK

SQN

Square Inline Fans with Multi-Directional Discharge

INTRODUCTION

Cook's SQN - Square Inline Fan - is the most versatile fan in the industry. The SQN has the shortest depth of any available square inline fan. Standard universal mounting feet allows the customer to have total control of the fan's installation without the need to purchase any mounting accessories. Three access doors allow total access to the fans internal components in any vertical or horizontal mounting installation. By utilizing the side discharge options, installation costs, pressure loss, system effect and space requirements are reduced. (Side discharge options are illustrated on page 10) The SQN-B, SQN-HP and SQN-D are licensed to bear the AMCA Certified Ratings Seal for Air and Sound Performance.

SQN-B / SQN-HP

SQN-D

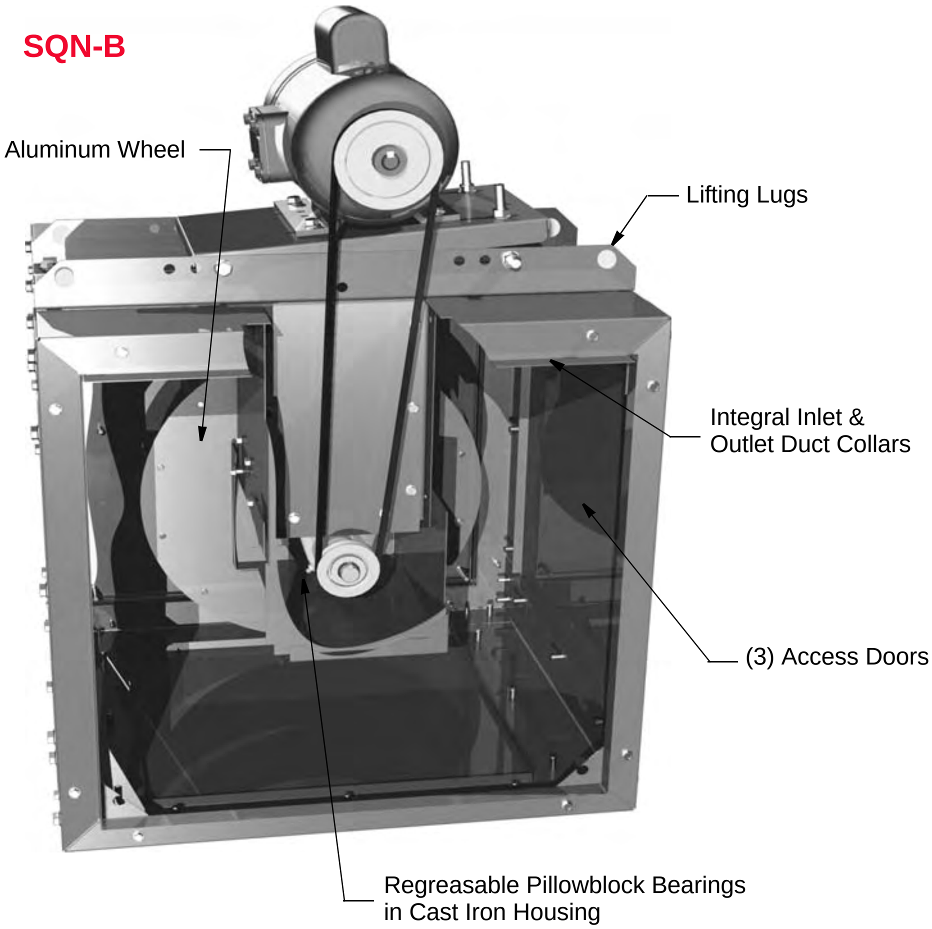
SQN

- Available in 7 direct drive sizes and 18 belt drive sizes. Capacities range from 100 to 26,000 CFM, with static pressures from 0 to 2-1/2 inches.

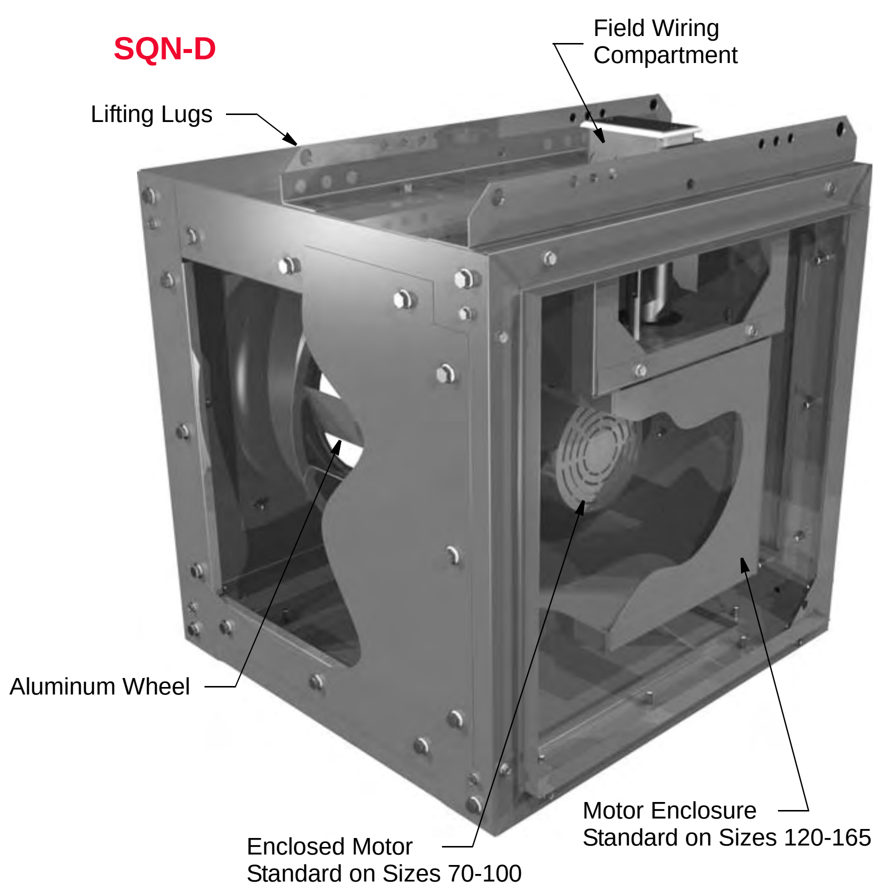
SQN-HP

- Available in 13 belt drive sizes. Capacities range from 1000 to 22,000 CFM, with static pressures from 1/4 to 5 inches.

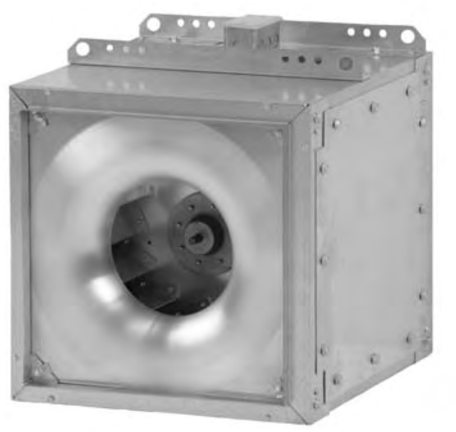
SQN-B


Aluminum Wheel
Lifting Lugs
Integral Inlet & Outlet Duct Collars
(3) Access Doors
Regreasable Pillowblock Bearings in Cast Iron Housing

SQN-D


Field Wiring Compartment
Lifting Lugs
Aluminum Wheel
Motor Enclosure Standard on Sizes 120-165
Enclosed Motor Standard on Sizes 70-100

Direct Drive



Description - Fan shall be duct mounted, direct driven centrifugal square inline.

Certifications - Fan shall be listed by Underwriters Laboratories (UL 705) and UL listed for Canada (CSA Standard 113 - M1984). Fan shall bear the AMCA Certified Ratings Seal for Sound and Air Performance.

Construction - The fan shall be of bolted construction utilizing corrosion resistant fasteners. Housing shall be minimum 18 gauge galvanized steel with integral duct collars. Bolted access doors shall be provided on three sides, sealed with closed cell neoprene gasketing. Housing shall be pre-drilled to accommodate universal mounting feet for vertical or horizontal installation. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM and static pressure. Unit shall be shipped in ISTA Certified Transit Tested Packaging.

Wheel - Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. An aerodynamic aluminum inlet cone shall be provided for maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204-05, Balance Quality and Vibration Levels for Fans.

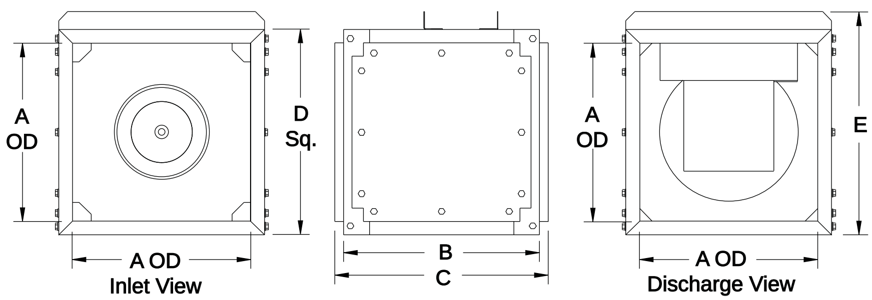
Motor - Motor shall be heavy duty type with permanently lubricated sealed bearings and furnished at the specified voltage, phase and enclosure.

Product - Fan shall be model SQN-D as manufactured by Loren Cook Company of Springfield, Missouri.

Loren Cook Company certifies that the SQN-D shown herein are licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 211 and AMCA Publication 311 and comply with the requirements of the AMCA Certified Ratings Program.

Type SQN-D is furnished standard with UL 705 Listing (Power Ventilator/ZACT) when furnished with factory supplied motor.

Type SQN-D is furnished standard with $_C$UL Listing (Power Ventilator) when furnished with factory supplied motor.



SQN-D Dimension Data

Size	A	B	C	D Sq.	E	Inlet and Rear Discharge Duct Size (ID)	Optional Side Discharge Duct Size (WxH) (ID)	Approx. Ship Wt.-Lbs.
70	10	12	14	12	13-9/16	10 sq.	6-1/8 x 6-15/16	70
90	12	15	17	14	15-9/16	12 sq.	9-1/8 x 8-15/16	90
100	12	20	22	14	15-9/16	12 sq.	14-1/8 x 8-15/16	100
120	16	20	22	18-7/16	20	16 sq.	14-1/8 x 12-9/16	125
135	18	20-1/4	22-1/4	20-3/4	22-5/16	18 sq.	14-1/4 x 13-1/8	150
150	20	21-7/8	23-7/8	23	25-1/16	20 sq.	15-15/16 x 16-1/8	175
165	22	25	27	25-5/16	27-3/8	22 sq.	19-1/8 x 18-1/8	200

All dimensions in inches.

Belt Drive

Description - Fan shall be duct mounted, belt driven centrifugal square inline.

Certifications - Fan shall be listed by Underwriters Laboratories (UL 705) and UL listed for Canada (CSA Standard 113 - M1984). Fan shall bear the AMCA Certified Ratings Seal for Sound and Air Performance.

Construction - The fan shall be of bolted construction utilizing corrosion resistant fasteners. Housing shall be minimum 18 gauge galvanized steel with integral duct collars. Bolted access doors shall be provided on three sides, sealed with closed cell neoprene gasketing. Pivoting motor plate shall utilize threaded L-bolt design for positive belt tensioning. Housing shall be pre-drilled to accommodate universal mounting feet for vertical or horizontal installation. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM, static pressure and maximum fan RPM. Unit shall be shipped in ISTA Certified Transit Tested Packaging.

Wheel - Wheel shall be centrifugal backward inclined, constructed of 100% aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204-05, Balance Quality and Vibration Levels for Fans.

Motor - Motor shall be Nema design B with class B insulation rated for continuous duty and furnished at the specified voltage, phase and enclosure.

Bearings - Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy duty regreasable ball type in a pillowblock cast iron housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.

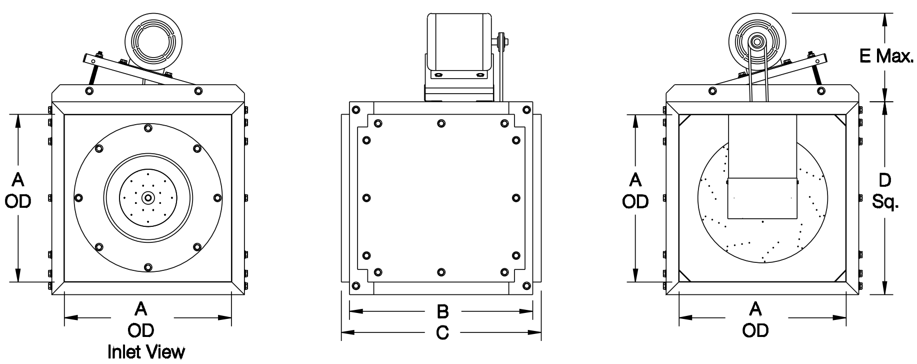
Belts and Drives - Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150 percent of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM.

Product - Fan shall be model SQN-B as manufactured by Loren Cook Company of Springfield, Missouri.

Loren Cook Company certifies that the SQN-B shown herein are licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 211 and AMCA Publication 311 and comply with the requirements of the AMCA Certified Ratings Program.

Type SQN-B is furnished standard with UL 705 Listing (Power Ventilator/ZACT) when furnished with factory supplied motor.

Type SQN-B is furnished standard with cUL Listing (Power Ventilator) when furnished with factory supplied motor.



SQN-B Dimension Data

Size	A	B	C	D Sq.	E	Inlet and Rear Discharge Duct Size (ID)	Optional Side Discharge Duct Size (WxH) (ID)	Max. Mtr. Frame Size	Approx. Ship Wt.-Lbs. Less Motor and Drive
60	12	20	22	14	12-1/2	12 sq.	14-1/8 x 8-15/16	143T	80
70	12	20	22	14	12-1/2	12 sq.	14-1/8 x 8-15/16	143T	80
80	12	20	22	14	12-1/2	12 sq.	14-1/8 x 8-15/16	143T	80
100	12	20	22	14	12-1/2	12 sq.	14-1/8 x 8-15/16	143T	80
120	16	20	22	18-7/16	12-1/2	16 sq.	14-1/8 x 12-9/16	145T	100
135	18	20-1/4	22-1/4	20-3/4	12-1/2	18 sq.	14-1/4 x 13-1/8	145T	125
150	20	21-7/8	23-7/8	23	12-3/4	20 sq.	15-15/16 x 16-1/8	145T	150
165	22	25	27	25-5/16	14-3/4	22 sq.	19-1/8 x 18-1/8	182T	175
180	24	28	30	27-5/8	14-3/4	24 sq.	21 x 20-1/8	182T	200
195	26	30-1/4	32-1/4	29-15/16	15	26 sq.	23-1/4 x 22-1/8	182T	225
210	28	32	35	31-1/4	15	28 sq.	24-1/2 x 24-1/8	182T	250
225	30	34-1/4	37-1/4	33-1/2	15-1/4	30 sq.	26-3/4 x 26-1/8	184T	300
245	33	34	38	36	17-1/4	33 sq.	26-1/16 x 29-1/8	213T	350
270	36-7/16	37-1/2	41-1/2	39-11/16	17-1/4	36-7/16 sq.	29-11/16 x 32-1/2	213T	400
300	40	38	42	44	17-1/4	40 sq.	30-1/8 x 36-1/8	213T	450
330	44	41-3/4	45-3/4	48-7/16	17-1/4	44 sq.	31-3/16 x 40-1/8	215T	500
365	46	42	46	50	17-1/4	46 sq.	32-3/16 x 42-1/16	215T	550
402	50-3/4	46-1/4	50-1/4	55-1/8	17-1/4	50-3/4 sq.	36-5/16 x 46-15/16	215T	650

All dimensions in inches.

Belt Drive
High Pressure

Loren Cook Company certifies that the SQN-HP shown herein are licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 211 and AMCA Publication 311 and comply with the requirements of the AMCA Certified Ratings Program.

Type SQN-HP is furnished standard with UL 705 Listing (Power Ventilator/ZACT) when furnished with factory supplied motor.

Type SQN-HP is furnished standard with cUL Listing (Power Ventilator) when furnished with factory supplied motor.

Description - Fan shall be duct mounted, belt driven, high pressure centrifugal square inline.

Certifications - Fan shall be listed by Underwriters Laboratories (UL 705) and UL listed for Canada (CSA Standard 113 - M1984). Fan shall bear the AMCA Certified Ratings Seal for Sound and Air Performance.

Construction - The fan shall be of bolted construction utilizing corrosion resistant fasteners. Housing shall be minimum 18 gauge galvanized steel with integral duct collars. Bolted access doors shall be provided on three sides, sealed with closed cell neoprene gasketing. Pivoting motor plate shall utilize threaded L-bolt design for positive belt tensioning. Housing shall be pre-drilled to accommodate universal mounting feet for vertical or horizontal installation. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM, static pressure and maximum fan RPM. Unit shall be shipped in ISTA Certified Transit Tested Packaging.

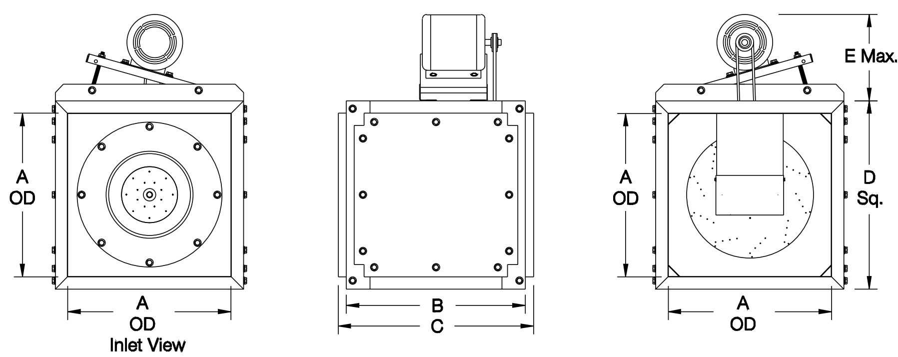
Wheel - Wheel shall be high pressure centrifugal backward inclined, constructed of 100% aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204-05, Balance Quality and Vibration Levels for Fans.

Motor - Motor shall be Nema design B with class B insulation rated for continuous duty and furnished at the specified voltage, phase and enclosure.

Bearings - Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy duty regreasable ball type in a pillowblock cast iron housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.

Belts and Drives - Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150 percent of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM.

Product - Fan shall be model SQN-HP as manufactured by Loren Cook Company of Springfield, Missouri.

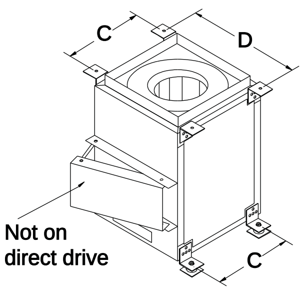


SQN-HP Dimension Data

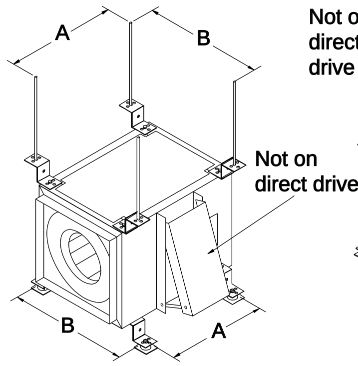
Size	A	B	C	D	E	Inlet and Rear Discharge Duct Size (ID)	Optional Side Discharge Duct Size (WxH) (ID)	Max.Motor Frame Size	Approx. Ship Wt.-Lbs. Less Motor and Drive
135	18	20-1/4	22-1/4	20-3/4	12-1/2	18 sq.	14-1/4 x 13-1/8	145T	125
150	20	21-7/8	23-7/8	23	12-3/4	20 sq.	15-15/16 x 16-1/8	145T	150
165	22	25	27	25-5/16	14-3/4	22 sq.	19-1/8 x 18-1/8	182T	175
180	24	28	30	27-5/8	14-3/4	24 sq.	21 x 20-1/8	182T	200
195	26	30-1/4	32-1/4	29-15/16	15	26 sq.	23-1/4 x 22-1/8	182T	225
210	28	32	35	31-1/4	15	28 sq.	24-1/2 x 24-1/8	182T	250
225	30	34-1/4	37-1/4	33-1/2	15-1/4	30 sq.	26-3/4 x 26-1/8	184T	300
245	33	34	38	36	17-1/4	33 sq.	26-1/16 x 29-1/8	213T	350
270	36-7/16	37-1/2	41-1/2	39-11/16	17-1/4	36-7/16 sq.	29-11/16 x 32-1/2	213T	400
300	40	38	42	44	17-1/4	40 sq.	30-1/8 x 36-1/8	213T	450
330	44	41-3/4	45-3/4	48-7/16	17-1/4	44 sq.	31-13/16 x 40-1/8	215T	500
365	46	42	46	50	17-1/4	46 sq.	32-3/16 x 42-1/16	215T	550
402	50-3/4	46-1/4	50-1/4	55-1/8	17-1/4	50-3/4 sq.	36-5/16 x 46-15/16	254T	650

All dimensions in inches.

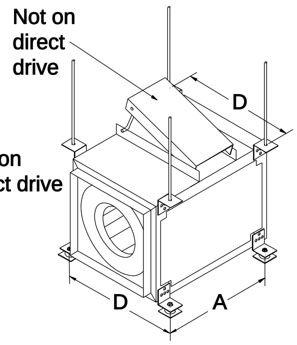
Universal Mounting - The SQN is provided with universal mounting feet for installation in any horizontal or vertical position. These feet are shipped loose for field installation in the desired location. The mounting feet are attached utilizing existing bolts in the fan. See the adjacent drawings for typical positions and dimensions.



Vertical Floor
or
Ceiling



Horizontal Floor or
Ceiling - Motor on side



Horizontal Floor
or Ceiling - Motor
on top or bottom

SQN-B

Size	A	B	C	D
60	17-15/16	17-11/16	11-15/16	17
70	17-15/16	17-11/16	11-15/16	17
80	17-15/16	17-11/16	11-15/16	17
100	17-15/16	17-11/16	11-15/16	17
120	17-15/16	22-1/8	16-3/8	21-7/16
135	18-1/8	24-3/8	18-5/8	23-3/4
150	19-3/4	26-1/16	20-15/16	25-3/4
165	22-15/16	28-3/8	23-1/4	28-1/16
180	25-7/8	30-5/8	25-1/2	30-3/8
195	28-1/8	33-1/16	27-15/16	32-11/16
210	29-7/8	35	29-1/4	34
225	32-1/8	36-5/8	31-1/2	36-1/4
245	30-3/8	41	32-3/4	40-3/8
270	33-7/8	44-11/16	36-7/16	44-1/16
300	34-3/8	49	40-3/4	48-3/8
330	38-1/8	53-1/8	45-1/8	52-13/16
365	38-3/8	55	46-3/4	54-3/8
402	42-5/8	60-1/8	51-7/8	59-1/2

All dimensions in inches.

SQN-D

Size	A	B	C	D
70	9-15/16	15-11/16	9-15/16	15
90	12-15/16	17-11/16	11-15/16	17
100	17-15/16	17-11/16	11-15/16	17
120	17-15/16	22-1/8	16-3/8	21-7/16
135	18-1/8	24-3/8	18-5/8	23-3/4
150	19-3/4	26-1/16	20-15/16	25-3/4
165	22-15/16	28-3/8	23-1/4	28-1/16

All dimensions in inches.

Fan Speed Control

Cook's FSC is a variable speed controller which can offer excellent energy conservation and lower sound levels when 100 percent of a direct drive fan operating capacity is not required. The FSC employs solid state circuitry for long life and dependability. The FSC is available only on 115V and 230V shaded pole or permanent split capacitor direct drive motors and is not available on 1140 RPM and 1725 RPM motors. The FSC is normally shipped loose for field installation. Optional pre-wiring is available.

Motors

Direct Drive

All direct drive motors are standard single phase 115-volt.

- Sizes 70 through 100 are either shaded pole or permanent split capacitor type motors.
- Sizes 120 through 165 are either permanent split capacitor (10750 RPM motors) or split phase (1725 RPM motors).
- FSC can only be used on either shaded pole or permanent split capacitor type motors.

Optional motors:

- Two speed, single-phase open motors supplied as 1725 RPM motors are 1725/1140.
- Explosion proof motors are available for some units, contact factory for details.
- These optional motors cannot use an FSC.

Belt Drive

Single-phase motors:

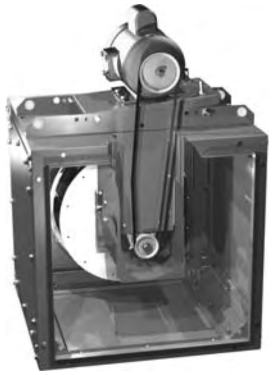
- Open drip motors from 1/6 to 1-1/2 HP.
- Two-speed, motors in 1725/1140 RPM, from 1/6 to 1 HP.
- TEFC and Class 1, Group D, explosion proof motors from 1/4 to 1 HP.

Three-phase motors:

- Three-phase ODP motors from 1/4 to 15 HP.
- Two-speed, two winding motors in 1725/1140 RPM, from 1/3 to 5 HP.
- TEFC and Class 1, Group D, explosion proof motors from 1/4 to 10 HP.
- Variable Frequency Drive (VFD) compatible motors are available, contact factory for details.

All single-phase and three-phase, single speed, open drip motors listed in performance tables are shipped factory installed.

Belt Tensioner - Cook's automatic belt tensioner eliminates the need for regular manual retensioning of fan belts. The risk of inadvertantly over-tensioning drive components is avoided and overall drive operating efficiency is enhanced. Available on sizes 120-402 to maintain proper belt tension.



Belt Guard - Belt guards are available which cover the drive assembly on the top, front and sides. The belt guard is constructed of minimum 18 gauge galvanized steel and has an open back which allows inspection and belt tensioning without removing the guard. Belt guards are factory installed.

Inlet Safety Screen - Inlet safety screens are used in non-ducted installations to protect personnel and prevent debris from entering the fan. This screen is constructed of 1/2" x 1/2" galvanized welded wire and is factory installed.

Flex Duct Connector - Flex Duct Connectors are available for the inlet or outlet of the SQN. These connectors provide a flexible connection between the fan and the attached ductwork. This reduces the transmission of noise and vibration to the ductwork as well as allowing for slight misalignment and easy removal of the fan without disturbing the rigid ductwork. Flex Duct Connectors consist of reinforced neoprene fabric and aluminum bands.

Flanged Inlet/Outlet - Flanged Inlet or Outlet connections are available which allow for flange type duct attachment in place of the standard slip connection. This type of connection allows the fan to be removed without disturbing the surrounding ductwork. Flanges are constructed of 1-1/2"x1-1/2"x1/8" structural angle and are factory mounted.

Motor Cover - The motor cover completely encloses the motor and drive assembly and also serves as an OSHA belt guard. The motor cover is constructed of 18 gauge galvanized steel and is intended for indoor use only. Motor covers are factory installed.

Outlet Safety Screen - Outlet safety screens are used on non-ducted installations to protect personnel and prevent debris from entering the fan. This screen is constructed of 16 gauge 1/2" x 1" expanded metal complete with mounting frame. This assembly is Lorenized® and factory installed.

Filter Box - A Filter Box is available which attaches to the inlet side of the SQN. This filter box is constructed of minimum 18 gauge galvanized steel and incorporates a removable access panel, washable slide-out filters and integral duct collars. Disposable filters are also available.

Inlet/Outlet Companion Flange - Inlet or Outlet Companion Flanges are available for use in conjunction with the optional Flanged Inlet or Outlet. The companion flange is attached to the adjacent ductwork to provide an exact mate to the flanged connection on the fan.

Backdraft Dampers - Backdraft dampers are available in gravity operated or motorized configurations for in-duct installation. These dampers feature an extruded aluminum frame, aluminum blades and aluminum hinge pins with nylon bushings. These dampers are shipped loose for field installation.

External Inlet Vane Damper - External Inlet Vane Dampers are used to provide precise air volume control while maintaining maximum efficiency and stable operation at reduced load conditions. Inlet Vane Dampers are available in aluminum or steel construction on sizes 135 through 402. These dampers are factory mounted and provided with an adjustment arm for manual or actuated control (actuator furnished by others). Cataloged performance is based on fans without inlet vane dampers.

Disconnect Switches

NEMA 1 - Indoor general purpose.
NEMA 1 (Lockable) - Indoor general purpose with locking capability.
NEMA 4 - Watertight and dust-tight.
NEMA 7 and NEMA 9 - Lockable, indoor, explosion proof.

NEMA 1

NEMA 1 (lockable)

NEMA 4

NEMA 7
NEMA 9

Vibration Isolators - Vibration isolation is recommended to reduce vibration and noise transmission to the floor or support structure. Isolators are available in both spring type and RIS (rubber-in-shear) type for floor or ceiling mounting. Housed spring floor isolators are also available where lateral movement must be limited. All isolators are shipped loose for field installation.

Model RC RIS Ceiling	Model SC Spring Ceiling	Model HF Housed Floor	Model SF Spring Floor	Model RF RIS Floor

Optional Coatings

Lorenized® is an electrostatically applied, baked polyester powder coating. Each component shall be subject to a five stage environmentally friendly wash system, followed by a minimum 2 mil thick baked powder finish. Coating must exceed 1,000 hour salt spray under ASTM B117 test method.

Cook Epoxy Powder is an electrostatically applied, baked epoxy powder coating. Final coating thickness is 2.5 - 3.5 mils. For outdoor applications an optional UV resistant topcoat is available to prevent cosmetic chalking of the coating.

Refer to the corrosion resistance guide in the Compute-A-Fan software for a listing of the coatings above and their resistance to a variety of chemicals. Additional special coatings are available.

Additional Accessories

Insulated Housing - An acoustical lining is available for the interior of the SQN. This fiberglass duct liner provides a reduction in noise of approximately 3dB in each of the eight octave bands.

Aluminum Construction - All aluminum construction is available on all sizes of SQN's.

TrueAlarm® Fire Alarm Controls

*UL, ULC Listed; FM, CSFM, and MEA (NYC) Approved**

Model 4010 Fire Alarm Control Panel for TrueAlarm Analog Sensors and IDNet™ Addressable Devices

Features

Standard features include:

- Up to 250 addressable TrueAlarm sensor or addressable device points using IDNet communications that operate *with either shielded or unshielded* twisted pair wiring**
- Four, 2 A notification appliance circuits (NACs) with solid state current protection
- Internal event reporting DACT module (standard on models 4010-9101, 4010-9102, & 4010-9150)

UL listed to Standard 864

Installation convenience features:

- Power-limited design with electronic modules contained on one-piece chassis
- Up-front terminal blocks for wiring access
- Compact NEMA 1 rated cabinet is available in beige or red and can be pre-shipped for early installation

Setup, programming, and maintenance features:

- Device level ground fault search, locate and isolate
- *Auto Program* for general alarm operation
- TrueAlarm individual analog sensing with front panel information and selection access
- "Dirty" TrueAlarm sensor maintenance alerts, service and status reports including "almost dirty"
- Default TrueAlarm sensor device type operation
- Duplicate address error detection
- Front panel or PC programming
- TrueAlarm sensor peak value performance report
- WALKTEST™ silent or audible system test†
- Software verification simulation mode

Supports the following IDNet devices:

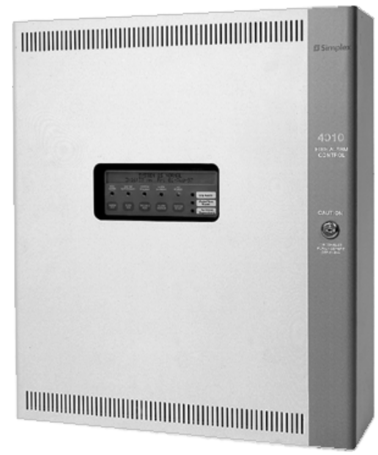
- Addressable manual stations
- Quad-state zone adapter modules (ZAMs) for initiating device monitoring
- IDNet ground fault/short circuit isolator base for TrueAlarm sensors
- Quad-state line powered individual addressable modules (IAMs) for initiating device monitoring and relay control

Available option modules include:

- Door mounted 24 LED annunciator (std. on ULC models)
- Network, or Point Reporting DACT
- Class A NAC adapter module
- RS-232 ports for printer and maintenance PC
- Additional power supply; Auxiliary Relay Module or City Interface
- Equipment for Suppression Release Applications (refer to data sheet S4010-0003)

Compatible with Simplex® auxiliary panels:

- TrueAlert® Addressable Controllers and NAC power extenders (IDNet controlled and conventional)
- 4003 Voice Control Panel
- 4081 Battery Cabinet with charger for 50 Ah batteries



4010 Fire Alarm Control Panel (with standard door)

Description

TrueAlarm fire alarm control panels have the ability to provide location accuracy for monitoring and control. When equipped with TrueAlarm analog sensing for smoke and heat detection, the processing power of the control panel also has the ability to analyze conditions at each location to provide accurate detection with significantly reduced maintenance costs.

The 4010 TrueAlarm Fire Alarm Control Panel has been specifically designed to provide addressable operation and analog detection in a cost-effective package for application sizes that previously were considered only appropriate for conventional zoned monitoring.

Installation and Service Ease. The 4010 mounts on a single chassis for quick installation and removal. Terminal blocks are large and up-front for easy access and inspection. Optional modules are easily and quickly installed and programmed as required.

The 4010 cabinet provides convenient stud markers for drywall thickness and nail-hole knockouts for quicker mounting. Smooth cabinet surfaces are provided for locally cutting conduit entrance holes exactly where required. 4010 cabinets and electronics can be ordered separately, allowing early cabinet installation.

Ground Fault Assistance. Ground fault problems often occur during installation. The 4010 provides isolating circuitry and software-controlled sequencing to isolate ground faults to specific identified locations. This assistance helps the installer to accurately locate the wiring problem for quicker repair.

* Refer to page 6 for listing details. This product has been approved by the California State Fire Marshal (CSFM) pursuant to Section 13144.1 of the California Health and Safety Code. See CSFM Listing 7170-0026:226 for allowable values and/or conditions concerning material presented in this document. It is subject to re-examination, revision, and possible cancellation. Accepted for use – City of New York Department of Buildings – MEA35-93E. Additional listings may be applicable; contact your local Simplex product supplier for the latest status. Listings and approvals under Simplex Time Recorder Co. are the property of Tyco Safety Products Westminster.

** TrueAlarm analog smoke detection and IDNet addressable devices are protected by one or more of the following U.S. Patents: 5,155,468; 5,173,683; 5,543,777; 5,400,014; 5,552,765; 5,552,763; DES. 377,460.

† WALKTEST system test is protected under U.S. patent # 4,725,818.

4010 Operator Control Summary

Extensive Feature List. The 4010 Fire Alarm Control Panel provides access to an extensive feature list that includes:

- Providing easy and powerful operator information with a logical, menu-driven display
- Extensive and automatic diagnostics for maintenance reduction
- History Logs available from the LCD or capable of (optionally) being printed
- Software Verification, allowing detailed logic programming simulation to be conducted without activating connected outputs
- Control Panel (or service PC) label editing
- Password access control
- Auto Program Quick Configuration (Quick-CFIG) of connected modules and IDNet devices for general alarm operation to quickly get the system up and running

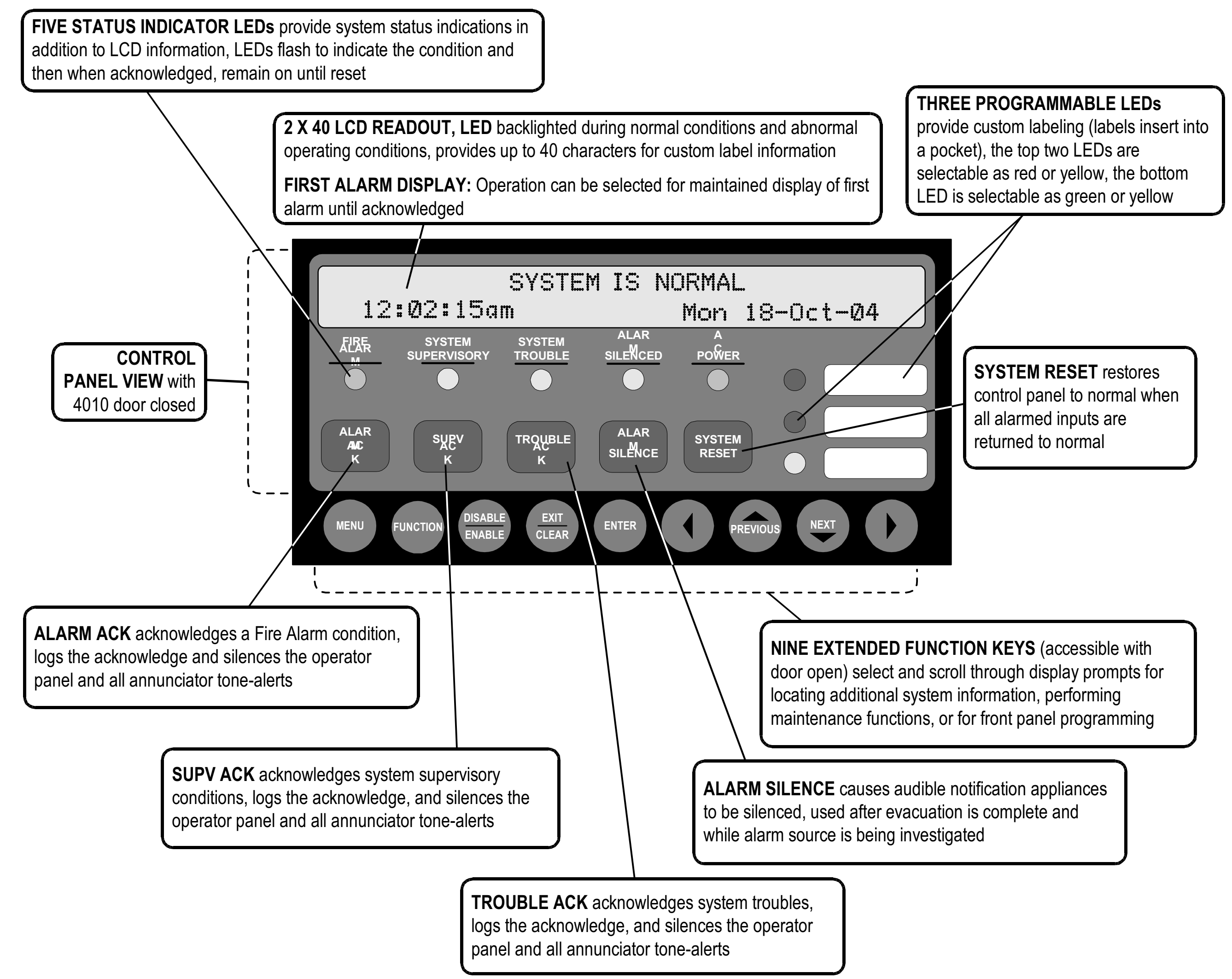
4010 Display Panel and Diagnostic Mode

Convenient Status Information. With the locking door closed, a window allows viewing of the status display. The 4010 status panel provides a two line by 40 character, super-twist LCD information display and eight status LED indicators as shown in the illustration below.

From this display, the LED indicators will describe the general category of activity being displayed with the LCD providing more detail. For the authorized user, unlocking the door will provide access to the control switches and allow further inquiry by scrolling the display for additional detail. (Refer to control panel functional illustration below.)

WALKTEST Diagnostic Operation Mode. The patented WALKTEST process allows a single person to perform system test. The system records test inputs such as intentional alarms or trouble and either logs the response (silent WALKTEST operation) or outputs a brief, recognizable audible notification signal (audible WALKTEST operation).

Extended Operator Control Panel Functions



IDNet Addressable Interface

Overview. The 4010 provides IDNet addressable device communications. Using a two wire circuit, individual devices such as manual fire alarm stations, TrueAlarm sensors, and sprinkler waterflow switches can be directly connected (or interfaced) to the IDNet controller to communicate their identity and status. This addressability allows the location and condition of the connected device to be displayed on the 4010 panel LCD and on system annunciators. Additionally, control circuits (fans, dampers, etc.) may be individually controlled by using a relay IAM (individual addressable module). The 4009 IDNet NAC Extender or the TrueAlert Addressable controller can be controlled for local or remote notification appliance expansion. (Refer to individual device documentation for further details.)

Capacity. A total of 250 addressable monitor and control points may be intermixed on the same pair of wires. By using Zone Adaptor Modules (ZAMs) or Individual Addressable Modules (IAMs), conventional initiating devices can be connected to the IDNet circuit.

IDNet Addressable Operation. The IDNet controller continuously interrogates each addressable device on the communication channel for status condition such as: normal, off-normal, alarm, supervisory, or trouble. Sophisticated poll and response communication techniques ensure supervision integrity and allow for "T-tapping" of the circuit for Class B (Style 4) operation.

Wiring Requirements. Refer to the specifications chart below. Distances are for shielded or unshielded wire. Shielded wire may provide protection from unexpected sources of interference and may be required for some applications.

Wiring Specifications

Size		18 AWG minimum
Wire	Preferred	Shielded twisted pair (STP)
	Acceptable	Unshielded twisted pair (UTP)
Farthest Distance from Control Panel to Device		Up to 2500 feet (762 m)
Total Wire Length Allowed With "T" Taps for Class B Wiring		Up to 10,000 ft (3 km).

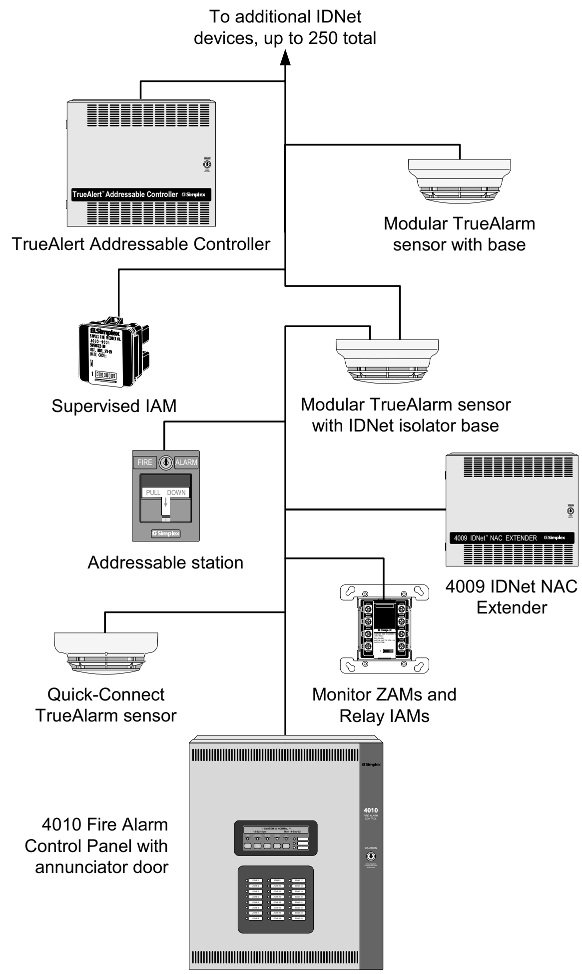
TrueAlarm Analog Sensors

TrueAlarm System Operation. IDNet communications are used for TrueAlarm smoke and temperature sensors. Every four seconds, smoke sensors transmit an output value based on their smoke chamber condition. The 4010 CPU maintains a current value, peak value, and an average value of each sensor's output. Status is determined by comparing the current sensor value to its average value. Tracking this average value as a continuously shifting reference point filters out environmental factors that cause shifts in sensitivity.

Programmable Sensitivity. The sensitivity of each sensor can be field programmed at the 4010 Control Panel for different levels of smoke obscuration (in percent) or for specific heat detection levels. In order to evaluate whether the sensitivity should be revised, the peak value is stored in memory and can be easily read and compared to the alarm threshold directly in percent.

TrueAlarm Analog Sensors *(Continued)*

TrueAlarm heat sensors can be selected for rate-of-rise detection as either 15° F (8.3° C) or 20° F (11.1° C) per minute with an independent fixed limit of 135° F (57° C) or 155° F (68° C). TrueAlarm heat sensors can also be programmed as a utility device to monitor for temperature extremes in the range from 32° F to 155° F (0° C to 68° C). This feature can provide freeze warnings or alert to HVAC system problems.



4010 Control Panel with Typical IDNet Devices

Diagnostics and Default Device Type

TrueAlarm operation gives the 4010 system the ability to automatically indicate when a sensor is almost dirty, dirty, and excessively dirty. The NFPA 72 (*National Fire Alarm Code*) requirement for a test of the sensitivity range of the sensors is fulfilled by the TrueAlarm ability to maintain the sensitivity level of each sensor.

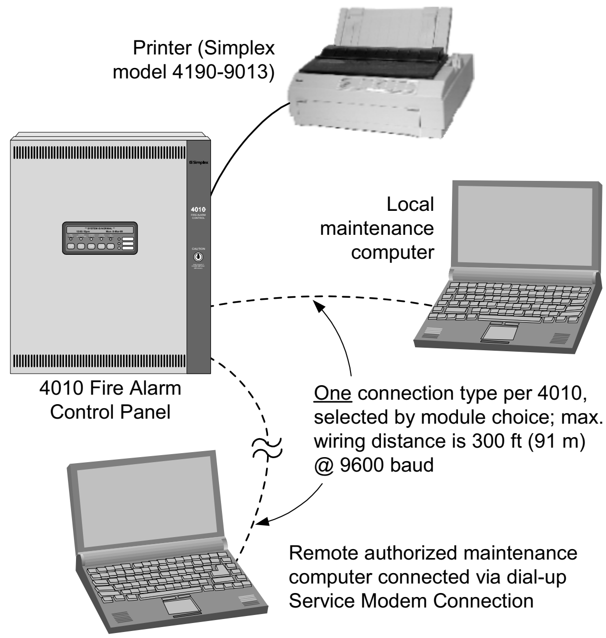
Modular TrueAlarm sensors use the same base and different sensor types (photoelectric smoke sensor, or heat sensor) can be easily interchanged to meet specific location requirements. This feature also allows intentional sensor substitution during building construction. When conditions are temporarily dusty, instead of covering the smoke sensors (causing them to be disabled), heat sensors may be installed without reprogramming the control panel. Although the control panel will indicate an incorrect sensor type, the heat sensor will operate at a default sensitivity to provide heat detection for building protection at that location.

TrueAlarm Information Details

True Alarm sensor data can be displayed on the system LCD, on a remote maintenance PC, or printed on a remote printer. With the proper operator access, a TrueAlarm Service Report can be generated to list the specific details of each TrueAlarm device. This report, as well as the Status Report can either be displayed on the remote maintenance PC or captured permanently by using a remote 80 character printer.

The report samples below illustrate the format provided on either the remote maintenance PC or a printer. This information is available at the system LCD by identifying the specific point of interest and reading one point at a time.

Model 4190-9013 is a UL Standard 864 listed 80 column, 24 pin dot matrix printer (refer to data sheet S4190-0011). (Model 2190-9039, a 24 VDC, 40 column printer, is compatible with the 4010 for event printing only. Refer to data sheet S2190-0014.)



RS-232 Connection Options
(refer to module selection on page 6)

TrueAlarm Status and Service Report Samples

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Simplex 4010 Fire Alarm System                                          Page 1
REPORT 3 : TrueAlarm Status Report                       2:43:03 pm Mon 18-Oct-04


Zone                                              Sensi-                        Almost
Name     Custom Label                             tivity   Device Status         Dirty
M1-1     ANALOG PHOTO     CLEAN ROOM               0.5 %   NORMAL
M1-2     ANALOG ION       CLEAN ROOM               1.3 %   NORMAL
M1-3     ANALOG PHOTO     MAIN LOBBY               2.5 %   NORMAL                *YES*
M1-4     ANALOG PHOTO     CONFERENCE ROOM 1        2.5 %   NORMAL
M1-10    HEAT DETECTOR    GARAGE                   135 F   NORMAL
M1-11    ANALOG PHOTO     KITCHEN                  3.7 %   NORMAL                *YES*
END OF REPORT
```

Typical TrueAlarm Status Report Information Printout and/or Maintenance PC Screen

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Simplex 4010 Fire Alarm System                                          Page 1
REPORT 4 : TrueAlarm Service Report                      2:56:09 pm Mon 18-Oct-04


Dev                                          Alarm      Avg    Current/    Peak/    State
Num   Custom Label                           at:        val    % alarm    % alarm
1     ANALOG PHOTO - CLEAN ROOM              0.5/ 83     67     68/ 1%      72/ 10%   NOR
2     ANALOG ION - CLEAN ROOM                1.3/209     94     97/ 2%     101/  1%   NOR
3     ANALOG PHOTO - MAIN LOBBY              2.5/185    117    117/ 0%     125/ 42%   NOR
4     ANALOG PHOTO - CONFERENCE ROOM 1       2.5/161     93     93/ 0%      93/  0%   NOR
10    HEAT DETECTOR - GARAGE                135F/253    ---     63/-67F     66/ 69F   NOR
11    ANALOG PHOTO - KITCHEN                 3.7/216    116    116/ 1%     110/ 36%   NOR
END OF REPORT
```

Typical TrueAlarm Service Report Information Printout and/or Maintenance PC Screen

Standard Panel Features

N2 Communications for Serial Annunciator Control. Control for up to 6 remote Simplex Annunciator products including 24 Point I/O Module, and LCD Annunciator. Includes extensive troubleshooting diagnostics.

Access Port. RS-232 service port for connecting PC tools for service diagnostics and for programming the CPU Flash EPROM memory.

IDNet Addressable Communications Channel. Addressable channel provides communications for up to 250 remote addressable devices, including TrueAlarm analog sensors and isolator bases (see descriptions on page 3).

Four NACs. Class B output is standard, rated for 2 A @ 24 VDC nominal, with solid state current protection. Class A operation is optional with the addition of an adapter module.

NAC operation can be selected for "on-until-Silence" or "on-until-Reset," and can be Temporal pattern, 20 or 120 bpm March Time pattern, or continuous. Each NAC is also individually selectable to control Simplex synchronized visible notification appliances and to control audible notification appliances using SmartSync™ control, allowing separate audible and visible appliance operation using a common 2-wire circuit. (Class A , Style Z, SmartSync circuits require SmartSync Control Module 4905-9938, refer to data sheet S4903-0010 for details.)

Two Auxiliary Output Circuits. Operation is programmable for trouble, alarm, supervisory, or other fire response functions. Output is one Form "C" dry contact each, rated 2 A @ 24 VDC. An optional relay kit is available for switching up to 1/2 A at 120 VAC.

Power Supply. Standard output is 4 A @ 28 VDC, filtered, non-regulated. Internal system power is provided separately, allowing the 4 A to be available for NAC and auxiliary power tap functions. Over-current protection is solid state and self-resetting.

Auxiliary Power Tap. Provides up to 1/2 A of the standard power supply voltage, over-current protected.

Battery Charger. Capable of charging up to 25 Ah sealed lead-acid batteries (4010 cabinet mounted). A recharge time of 24 hours is typical with stable 120 VAC input. For applications requiring larger batteries, external charger/cabinet assemblies are available.

A depleted battery cutout feature is programmable to advise and/or to reduce current when battery voltage is low.

Optional Expansion Slot Modules

(The 4010 is available with a Simplex Network Interface. 4010 points can be declared "public.")

Network Interface, Fixed Media. Available for wired applications.

Network Interface, Modular Media. Available for wired connections or fiber optic. Require separate media modules. May be both wired, both fiber optic, or one of each.

DACT, Point Reporting Module. Provides serial output information that can send location details to a remote receiving station.

Optional Expansion Slot Modules *(Cont'd)*

DACT, Event Reporting Module. For applications where simple event status information is required (Alarm, Trouble, Supervisory, and AC power failure).

Dual RS-232 Module. Available for interfacing to a printer and a maintenance PC.

Single RS-232 Module with Service Modem Connection. Provides one port dedicated for connection to a printer, and a second port dedicated for dial-in from a service computer, typically located off-site. With an off-site computer, programming changes and system diagnostics can be performed remotely, reducing service time for repair or reprogram. Security is maintained by password protection.

Optional Chassis Mount Modules

Standard 4 A Expansion Module provides two taps of 2 A each, 28 VDC, filtered, non-regulated, similar to the standard power supply capacity.

Suppression Release Power Supply provides two taps of 2 A each, regulated at 24 VDC ± 10%. May also be used for other applications requiring regulated voltage. Use for suppression release requires a front panel mounted release appliqué that is provided with this power supply and also may be ordered separately.

Battery Meter Module provides panel mounted ammeter and voltmeter for power supply monitoring.

Dual Circuit Class A NAC Adapter Module mounts on the main 4010 printed circuit assembly and provides the additional circuitry needed for Class A operation.

Dual Circuit City Connect Module provides the interface required for direct wired reporting to conventional city connection circuits. (Available with or without disconnect switches.)

Expansion Power Distribution Module provides two additional termination points for the 1/2 A auxiliary power output, or for one tap of the expansion power supply.

Relay Option Module. Provides three relays, one each for Alarm, Supervisory, and Trouble. Relay contacts are selectable for normally open or normally closed and are rated 2 A @ 32 VDC maximum.

N2 Communications Modules

Up to six of the following modules may be connected to the Simplex N2 serial communications bus.

4606-9101 LCD Annunciators provide remote acknowledge, reset, and alphanumeric status display. (Refer to data sheet S4606-0001.)

24 LED Annunciator Doors are standard on ULC listed models and are available as door-only assemblies for electronics only packages or other aftermarket applications. This option uses the 24 Point I/O module with all points pre-assembled as LED outputs, with individual labels and each LED is selectable as red or yellow.

4605 Series 24 Point I/O Modules are available for remote mounting and provide 24 points that can be programmed as either general purpose switch inputs or system controlled outputs. Typical applications are for remote annunciators and monitoring and control of other related processes. (Refer to data sheet S4010-0002.)

4010 Fire Alarm Control Selection Chart and Module Location Rules (refer to diagrams on page 8)

Category	Model	Description	Voltage	Color
Control Panel Assembly (select one)	4010-9101	**UL Listed 4010 Fire Alarm Control Panel** with: door, cabinet, power supply/battery charger, IDNet interface, 4 NACs, 2 auxiliary relays, and external N2 communications interface; 4010-9101 and 4010-9102 include internal common event reporting DACT	120 VAC	Beige
	4010-9102			Red
	4010-9201		240 VAC	Beige
	4010-9202			Red
	4010-9101C	English — **ULC Listed 4010 Fire Alarm Control Panel**; same as above except: with 24 LED Annunciator door; and without DACT	120 VAC	Beige
	4010-9101CF	French		
	4010-9150	UL Listed — **4010 Fire Alarm Control Panel electronics only**, for pre-shipped cabinets, requires door and cabinet ordered separately; -9150 has event reporting DACT	120 VAC	NA
	4010-9150C	ULC Listed — English		
	4010-9150CF	ULC Listed — French		

Optional Expansion Slot Features (two slots are available, select modules as required)

Category	Model	Description	
Reporting and Network Modules (select one)	4010-9810	DACT Module (Common Event Reporting)	Includes two, 7 ft (2.1 m) long RJ45 cables
	4010-9816	DACT Module (Point Reporting)	
	4010-9821	Network Interface Module with fixed, wired connections	
	4010-9817	Network Interface Module, Modular; requires 2 (In/Out) media modules (see below)	
RS-232 Communications (select one)	4010-9811	Dual RS-232 Interface Module	
	4010-9812	Single RS-232 Interface Module with Service Modem connection	
Media Modules	4010-9818	Network Wired Media Module	Media modules mount on the 4010-9817 module without impact to slot allocation space.
	4010-9819	Network Fiber Optic Media Module	

Chassis Mounted Expansion Modules (select as required)

Category	Model	Description	
Additional Power Supply (select one)	4010-9813	4 A Expansion Power Supply	120 VAC input
	4010-9823		240 VAC input
	4010-9814(CF)	Suppression Release Power Supply; 4 A @ 24 VDC, regulated ± 10%; includes front panel suppression appliqué; CF suffix selects French	120 VAC input
	4010-9824		240 VAC input
Optional Features (select one)	4010-9820	Battery Meter Module (ammeter and voltmeter)	
	4010-9825	24 VDC Expansion Power Distribution Module, provides two additional termination points for an expansion power supply tap or the auxiliary power output	
Optional Features (select as indicated)	4010-9806	Dual Circuit Class A (Style Z) NAC Adapter Module, **two maximum**	
	4010-9809	Dual Circuit City Connect Module	**Select one maximum**
	4010-9829*	Dual Circuit City Connect Module w/o disconnect switches	
	4010-9803	Relay Option Module	

Accessories

Category	Model	Description	
Optional Features	4010-9826	120 VAC Auxiliary Relay Kit, allows **one** auxiliary relay to control up to 1/2 A @120 VAC, select as required; **2 maximum**	
	4010-9830 (CAF)	Suppression Release Appliqué, required for suppression release applications; suffix CAF selects a French appliqué	
	2975-9801	Semi-flush trim, beige, 1-7/16" (37 mm) wide	
	2975-9802	Semi-flush trim, red, 1-7/16" (37 mm) wide	
Batteries (required if batteries are internal; select one size; **two batteries are required**)	2081-9272	6.2 Ah Battery, 12 VDC	
	2081-9274	10.0 Ah Battery, 12 VDC	
	2081-9288	12.7 Ah Battery, 12 VDC	
	2081-9275	18 Ah Battery, 12 VDC; **NOTE: This battery size will not allow bottom entry conduit**	
	2081-9287	25 Ah Battery, 12 VDC	
Cabinets (select one if pre-shipped)	2975-9215	Red Cabinet	Dimensions: 22" H x 18" W x 5-3/8" D (559 mm x 457 mm x 137 mm)
	2975-9214(CF)	Beige Cabinet; CF suffix has French labels	
Doors (select one if pre-shipped or for use with 4010-9150)	4010-9858	Red Door with dress panel	Dimensions: 22" H x 18" W x 5/8" D (559 mm x 457 mm x 16 mm)
	4010-9857(CF)	Beige Door with dress panel; CF has French labels	
	4010-9860 (CAF)*	Beige Door with 24 LED Annunciator and dress panel; CAF suffix selects French for ULC applications	Dimensions: 22" H x 18" W x 1-23/32"D (559 mm x 457 mm x 44 mm) [see also S4010-0002]
	4010-9861*	Red Door with 24 LED Annunciator and dress panel	

***** As of document revision date: 4010-9829 is not ULC listed; 4010-9860 and 4010-9861 are listed by UL and ULC and approved by CSFM and FM; 4010-9860CAF is ULC listed and FM approved only.

4010 Operating Specifications

Input Power Requirements	Voltage Range	Frequency	Maximum Current
AC Input, 120 VAC base models	102 to 132 VAC	60 Hz	2 A
AC Input, 240 VAC base models	204 to 264 VAC	50/60 Hz	1 A
AC Input with 120 VAC expansion power supply	102 to 132 VAC	60 Hz	4 A
AC Input with 240 VAC expansion power supply	204 to 264 VAC	50/60 Hz	2 A
Environmental			
Operating Temperature Range	32° to 120°F (0° to 49° C)		
Operating Humidity Range	up to 93% RH, non-condensing @ 100.4° F (38° C) maximum		
Output Ratings			
Standard Power Supply Output	4 A total @ nominal 28 VDC	Output switches to battery backup during mains failure or brownout conditions	
Auxiliary Power Tap	1/2 A maximum of standard power supply voltage		
Expansion Power Supply Output *	Additional 4 A @ nominal 28 VDC		
Suppression Release Power Supply Output *	Additional 4 A @ 24 VDC ±10%		

* Each power supply provides two output taps of 2 A each.

Current Ratings for Optional Modules and Remote LCD Annunciator

Model	Module	Supervisory Current	Alarm Current
4010-9810	DACT (Common Event Reporting)	40 mA	40 mA
4010-9816	DACT (Point Reporting)	40 mA	40 mA
4010-9821	Network, wired communications	125 mA	125 mA
4010-9817	Network Modular, add media cards separately	24 mA	24 mA
4010-9818	Network Wired Media	47 mA	47 mA
4010-9819	Network Fiber Optic Media	36 mA	36 mA
4010-9811	Dual RS-232	75 mA	75 mA
4010-9812	Single RS-232 with Service Modem	100 mA	100 mA
4010-9806	Dual Class A NAC Adapter	0 mA	0 mA
4010-9809	Dual Circuit City Connect	20 mA	36 mA
4010-9829	Dual Circuit City Connect w/o disconnect switches	20 mA	36 mA
4010-9803	Relay Option Module	10 mA	37 mA
4010-9860 4010-9861 & ULC 4010s	24 LED Annunciator door	60 mA	83 mA (all LEDs on)
4606-9101	Remote LCD Annunciator (refer to data sheet S4606-0001)	65 mA	140 mA

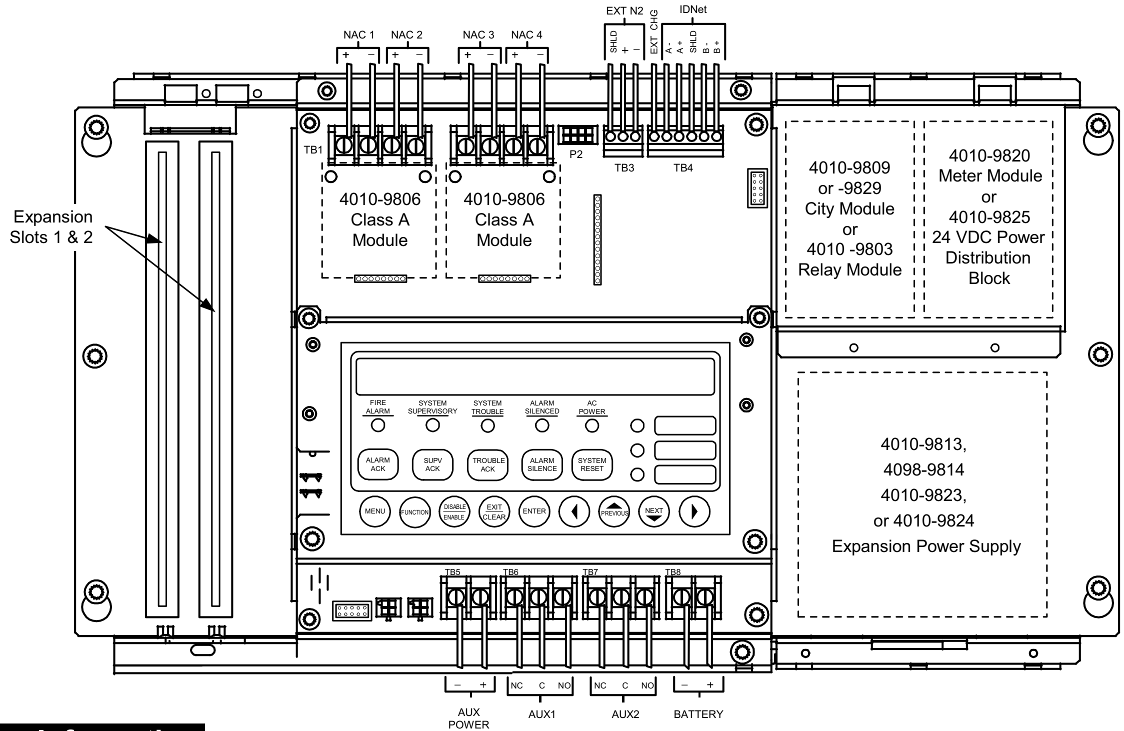
System Current (supplied separate from power supply output)

Base System with:	Supervisory Current**	Alarm Current**
no IDNet devices	195 mA	295 mA
50 IDNet devices	230 mA	330 mA
100 IDNet devices	265 mA	365 mA
150 IDNet devices	300 mA	400 mA
200 IDNet devices	335 mA	435 mA
250 IDNet devices	370 mA	470 mA

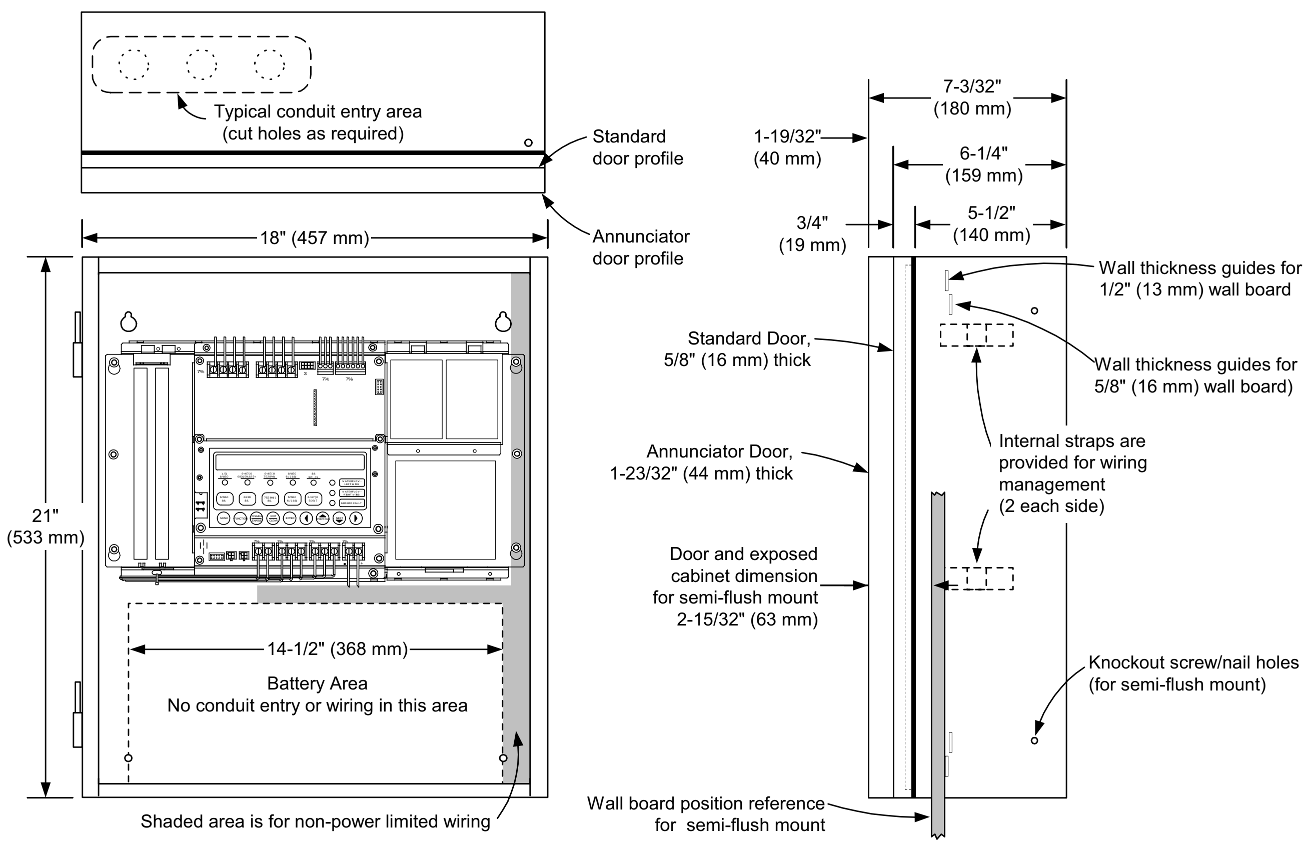
**** Current Calculation Information:**

1. To determine total supervisory current, add currents of modules in panel to base system value **and** all auxiliary loads.
2. To determine total alarm current, add currents of modules in panel to base system alarm current **and** add all panel NAC loads **and** all auxiliary loads.

4010 Module Layout Reference



Mounting Information



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TM 4—Secondary Treatment Improvements

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DATE: October 3, 2011

PROJECT: Schematic Design Phase
City of Bend WRF Secondary Expansion Project

Secondary Treatment Process Improvements and Evaluations

This technical memorandum (TM) presents the design criteria and schematic design information for the secondary treatment process improvements for the Bend Water Reclamation Facility (WRF). Results of the following evaluations are presented in the memorandum:

- Bioreactor configuration
- Air demand

The unit processes and associated equipment presented in this TM are:

- Primary effluent piping gallery
- Existing aeration basin improvements
- New Aeration Basin 4
- Mixed-liquor recycle pumps
- Anoxic zone/swing zone mixers
- Secondary scum removal system
- Existing secondary clarifiers
- Existing return activated sludge (RAS) system improvements
- Aeration basin drainage system
- Integrated fixed-film activated sludge (IFAS) biofilm carrier media transfer

Design Criteria

The influent WRF design criteria used as part of the secondary treatment process improvements are presented in Table 1.

TABLE 1
WRF Influent Design Criteria
City of Bend WRF Secondary Expansion Project

Flows and Loads*	Startup	Near-Term	Design	Build-out	PF to ADMM	Concentration (mg/L)
Influent Flow (mgd)						
Minimum Week	4.7	6.6	9.3	13.7	0.78	NA
Average Annual	5.5	7.8	10.9	16.0	0.92	NA
Average Day Maximum Month	6.0	8.5	11.9	17.5	1.00	NA
Maximum Week	6.3	8.9	12.4	18.3	1.04	NA
Maximum Day	6.8	9.7	13.6	20.0	1.14	NA
Peak Hour Dry Weather	10.8	15.3	21.4	31.5	1.80	NA
Peak Instantaneous Wet Weather	14.7	20.8	29.1	42.8	2.45	NA
5-Day BOD Loadings (lb/day)						
Minimum Week	8,991	12,749	17,848	26,247	NA	230.6
Average Annual	16,912	23,941	33,517	49,290	NA	368
Average Day Maximum Month	19,699	27,931	38,800	57,504	NA	394
Maximum Week	24,627	34,917	48,888	71,888	NA	471.7
TSS Loadings (lb/day)						
Minimum Week	9,443	13,389	18,744	27,565	NA	242.1
Average Annual	17,110	24,220	33,908	49,865	NA	373
Average Day Maximum Month	21,499	30,483	42,600	62,759	NA	430
Maximum Week	27,039	38,337	53,676	78,929	NA	517.9
TKN Loadings (lb/day)						
Minimum Week	1,605	2,276	3,186	4,685	NA	41.2
Average Annual	2,431	3,441	4,818	7,085	NA	53
Average Day Maximum Month	2,950	4,183	5,900	8,611	NA	59
Maximum Week	3,743	5,307	7,434	10,927	NA	71.7
Ammonia-Nitrogen (NH_3-N) Loadings (lb/day)						
Minimum Week	961	1,363	1,908	2,806	NA	24.6
Average Annual	1,284	1,818	2,545	3,743	NA	28
Average Day Maximum Month	1,900	2,694	3,600	5,546	NA	38
Maximum Week	2,287	3,242	4,536	6,675	NA	43.8
Total Phosphorus (lb/day)						
Minimum Week	195	276	387	569	NA	5.0
Average Annual	321	455	636	936	NA	7.0

TABLE 1
WRF Influent Design Criteria
City of Bend WRF Secondary Expansion Project

Flows and Loads*	Startup	Near-Term	Design	Build-out	PF to ADMM	Concentration (mg/L)
Average Day Maximum Month	385	546	764	1,124	NA	7.7
Maximum Week	470	666	933	1,372	NA	9.0

*Influent values are based on recent data collected through April 2009, supplemented with information from the wastewater characterization study completed in December 2009. As a result, some values differ from those presented in the Facilities Plan (Water Reclamation Facilities Plan – City Project No. SW0701, April 2008, Carollo Engineers). See *TM 1—Project Background, Criteria, and Objectives* for a definition of the flow scenarios.

ADMM = Average Day Maximum Month; 5-day BOD = biochemical oxygen demand; lb/day = pounds per day; mgd = million gallons per day; mg/L = milligrams per liter; PF = Peaking Factor; TKN = total Kjeldahl nitrogen; TSS = total suspended solids.

The discharge requirements as specified in the City's Water Pollution Control Facilities (WPCF) permit are presented in TM 1—Project Background, Criteria, and Objectives. The effluent treatment goals for the secondary treatment process are summarized below:

- Maintain the annual average total nitrogen (TN) limit of 10 milligrams per liter (mg/L). The process design for the IFAS system allows for a TN < 8.5 mg/L on the average day maximum month (ADMM) condition at a wastewater temperature of 17 degrees Celsius (°C).
- The Facilities Plan (Carollo, April 2007) indentified a process goal of maintaining nitrification during the coldest part of the season (wastewater temperature of 13°C). The process design for the IFAS system allows for nitrification (ammonia-N < 1.0 mg/L) or the ability to meet the TN limit of 10 mg/L (ammonia-N > 1.0 mg/L with TN < 10 mg/L) at a wastewater temperature of 13°C.

Table 2 presents the process-oriented design criteria for the secondary treatment process.

TABLE 2
Secondary Process Design Criteria
City of Bend WRF Secondary Expansion Project

Criteria	Value
Type of process	Integrated fixed-film activated sludge (IFAS) in a 4-stage Bardenpho configuration
Design suspended growth SRT	5 days
Design average annual temperature	17°C
Design 30-day minimum temperature	13.5°C
Effluent nitrogen requirements	Total nitrogen = 10 mg/L at average annual temperature and maximum month flows and loads
	Maintain full nitrification at 30-day minimum temperature and maximum month flows and loads
Design SVI	120 mL/g

TABLE 2
Secondary Process Design Criteria
City of Bend WRF Secondary Expansion Project

Criteria	Value
Clarifier capacity	Clarifier not overloaded with maximum week flows and maximum month inventory Clarifier capacity based on a state point analysis with a 10% derating factor on the theoretical capacity
Wet weather operating mode	Flows in excess of peak hour dry weather flow (primary effluent flow of 7.74 mgd per aeration basin) will be directed to Zone C
Plastic biofilm carrier media*	Bulk specific surface area = 500 m^2/m^3 (used for Schematic Design only, to be finalized with pre-selection of IFAS system manufacturer)
Plastic biofilm carrier volume (IFAS Zone, Cell B)*	8.5-mgd ADMM = 55% carrier fill in two aeration basins 11.9-mgd ADMM = 60% carrier fill in three aeration basins 17.5-mgd ADMM = 67% carrier fill in four aeration basins
IFAS Zone Bulk-liquid Dissolved Oxygen Concentration (mg/L)	6.0 mg/L (minimum 30-day wastewater temperature, 13.5°C) 4.0 mg/L (annual average wastewater temperature, 17°C)
Screen area sizing criteria	Maximum month loading rate = 55 m/hr
Screen submergence	35% of the side water depth
Maximum approach velocity toward screen wall	< 35 m/hr under all flow conditions
Return activated sludge rate (maximum, based on ADMM flow)	65%
Mixed liquor return rate (based on ADMM flow)	400%

*The specifications and associated carrier fill may be modified with the selection of the IFAS system manufacturer as the bulk specific surface area varies between manufacturers (see Attachment B).

mg/L = milligrams per liter; m/hr = meters per hour [loading rate is based on $m^3/hr/m^2$ of media retention screen area]; mL/g = milliliters per gram; SRT = solids retention time; SVI = sludge volume index.

Schematic Design—Evaluations

A number of evaluations and refinements were completed during the Schematic Design phase of the project. The updated evaluations were developed as a part of the previously presented Project Definition Report.

Bioreactor (Aeration Basin) Configuration

The proposed process configuration of the bioreactors (Aeration Basins 1, 2, 3, and 4) has been slightly refined from that presented previously in the Project Definition phase. The process simulator, Pro2D™, was used to optimize the layout of the bioreactor, improving overall system performance. A four-stage Bardenpho-type process, incorporating an IFAS system, is still proposed. The difference is a slight increase in volume for the aerobic zone (Cell C) and swing zone (Cell D).

TABLE 3
Bioreactor Configuration
City of Bend WRF Secondary Expansion Project

Criteria	Value
Length x Width	210 ft x 44 ft
Side water depth	15 ft
Total Anoxic volume per basin (including ANX swing zone)	0.34 MG (0.49 MG)
Pre-denitrification Anoxic Volume	0.34 MG
Post-denitrification Anoxic Volume (swing zone)	0.15 MG
Non-IFAS, aerobic volume per basin (including AER swing zone)	0.21 MG (0.36 MG)
IFAS aerobic volume per basin	0.31 MG
Total volume per basin	1.01 MG
Number of basins	Four
Number of individual zones per basin	Seven
Cell A, Anoxic Zone 1	0.083 MG
Cell A, Anoxic Zone 2	0.083 MG
Cell A, Anoxic Zone 3	0.17 MG
Cell B, IFAS Zone (L:W = 0.65)	0.31 MG
Cell C, Aerobic Zone	0.15 MG
Cell D, Post-Anoxic/Aerobic Swing Zone	0.15 MG
Cell E, Re-Aeration Zone	0.06 MG

MG = million gallons; ft = feet; ANX = Anoxic; AER = Aerobic, L:W = Length to Width ratio.

Figure 1 provides a schematic of the bioreactor configuration.

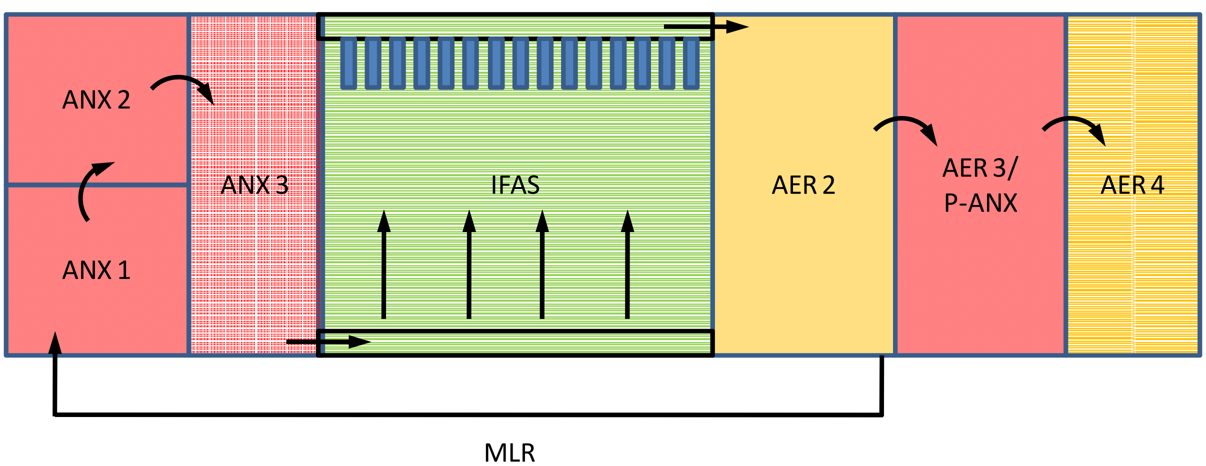


FIGURE 1
City of Bend WRF Bioreactor Configuration

Air Demand

Evaluations were completed during the Schematic Design phase to (1) refine the anticipated air demand through multiple influent conditions and scenarios and (2) to compare the annual air demand in the IFAS system to that estimated for the existing Modified Ludzack-Ettinger (MLE) process.

Anticipated Air Demand

Process simulations were developed to predict the air demand and various influent conditions, from startup through buildout scenarios. The aeration system in the IFAS zone will be designed to maintain a 4.0-mg/L bulk-liquid dissolved oxygen (DO) concentration under maximum month average day flow, loading, and annual average temperature. Table 4 presents the total air demand for the four treatment scenarios.

TABLE 4
Total Air Demand per Treatment Scenario
City of Bend WRF Secondary Expansion Project

Treatment Scenario Parameters	Startup (scfm)	Near-Term (scfm)	Design (scfm)	Buildout (scfm)
Influent Flow, ADMM (mgd)	6.0	8.5	11.9	17.5
Scenario A[a] (Wastewater Temperature = 13°C)				
Minimum Week	5,949	8,910	18,214	17,144
Annual Average	9,098	20,676	27,450	39,371
Average Day Maximum Month	13,370	23,922	32,263	47,922
Maximum Week	20,555	34,182	40,150	60,067
Scenario B[b] **(**Wastewater Temperature = 17°C)				
Minimum Week	4,559	7,576	10,346	15,324
Annual Average	7,473	15,682	19,742	28,396
Average Day Maximum Month	10,490	17,834	24,137	35,866
Maximum Week	15,406	26,893	30,860	46,374
Scenario C[c] (Wastewater Temperature = 23°C)				
Minimum Week	4,681	7,531	9,285	13,753
Annual Average	7,582	13,305	15,715	22,968
Average Day Maximum Month	9,591	16,945	19,813	29,737
Maximum Week	12,423	23,063	25,977	39,058

[a]Within Scenario A, bulk-liquid DO varies from 4 mg/L to 6 mg/L depending on the influent conditions. Also, some conditions warrant the use aeration in the swing zone to provide full nitrification.

[b]Within Scenario B, bulk-liquid DO varies from 2 mg/L to 4 mg/L depending on the influent conditions.

[c]Within Scenario C, bulk-liquid DO is held at 2 mg/L – this lower bulk-liquid DO is used as process simulations indicate nitrification is completed at these warmer temperatures by the suspended-growth environment.

DO = bulk-liquid dissolved oxygen; scfm = standard cubic feet per minute.

Coarse-bubble diffuser parameters used: alpha = 0.8, beta = 1.0, and OTE = 1.05% per foot

The air demand is delineated further to determine the minimum and maximum air demand per treatment zone within the bioreactor. This information is used to provide a preliminary size of the air piping required for each zone. This will be refined and updated accordingly when an IFAS system supplier is selected.

TABLE 5
Air Demand per Bioreactor Cell
City of Bend WRF Secondary Expansion Project

Description	IFAS - Cell B		Cell C		Cell D		Cell E	
	Min[1]	Max[2]	Min[a]	Max[b]	Min[a]	Max[b]	Min[a]	Max[b]
Startup								
% Air Distribution	0.76	0.81	0.19	0.1	0	0.07	0.06	0.02
Cell Air Demand per Basin (scfm)	1,732	8,325	433	1,028	-	719	137	206
Near-Term								
% Air Distribution	0.68	0.63	0.25	0.16	0	0.16	0.07	0.04
Cell Air Demand per Basin (scfm)	2,561	10,767	941	2,735	-	2,735	264	684
Design								
% Air Distribution	0.77	0.74	0.18	0.1	0	0.12	0.05	0.04
Cell Air Demand per Basin (scfm)	2,383	9,904	557	1,338	-	1,606	155	535
Buildout								
% Air Distribution	0.77	0.73	0.18	0.11	0	0.12	0.05	0.03
Cell Air Demand per Basin (scfm)	2,647	10,962	619	1,652	-	1,802	172	451

[a]Minimum air flow required to uniformly distribute plastic biofilm carriers is 6 $m^3/m^2/hr$ (= 904 scfm, based on Cell B configuration). Therefore, process air requirements govern aeration system sizing.

[b] Maximum air demand is based on the maximum week (MW) value: Start-up = 6.3-mgd MW, Near-term = 8.9-mgd MW, Design = 12.4-mgd MW, Buildout = 18.3-mgd MW

Max = maximum; min = minimum.

Coarse-bubble diffuser parameters used: alpha = 0.8, beta = 1.0, and OTE = 1.05% per foot.

As noted in Table 5, the majority of the air demand within each bioreactor is from the IFAS zone (Cell B). Coarse-bubble diffusers are required within this IFAS zone to impart the required bulk-liquid DO concentration, while also maintaining proper mixing of the biofilm carrier media. Since these coarse-bubble diffusers provide up to 80 percent of the air demand for the basins, there will be minimal air requirements in the remaining zones. It is recommended to use coarse-bubble diffusers in these zones as well, as there are minimal impacts with the lower oxygen transfer efficiency (OTE) given these lower air demands (less than 5 percent). Coarse bubble diffusers do have a slightly higher capital cost when compared to fine-bubble diffusers (10 to 15 percent), but these have the following benefits:

- Minimal maintenance requirements
- Result in identical discharge pressures across the bioreactor, minimizing impacts on the aeration blower control
- Provide the required process air with minimal increases in required energy (when compared to fine-bubble diffusers)

IFAS Air Demand to MLE Air Demand

An evaluation was completed to compare the air demand in the proposed IFAS system to that from the existing MLE system. The annual average startup conditions are used for this comparison. The Pro2D™ simulation was used to develop the monthly air demands for each configuration. Figure 2 provides the results of this evaluation, detailing how the air demand varies throughout the year.

The following assumptions were used to develop the comparison:

- Startup scenario, using current annual average influent flow and loads
- Average monthly temperatures from 2005 – 2008 (varies from 13.8°C to 22.3°C throughout the year)
- For the MLE process, nitrification factor of safety for aerobic solids retention time (SRT) was held constant throughout the year (at approximately 1.75)
- For the IFAS process, the IFAS reactor DO concentration was adjusted in the colder months to maintain nitrification (less than 1.0 mg NH_3-N/L)
- For the IFAS process, coarse-bubble diffusers were used throughout the bioreactor for the IFAS conversion
- Both comparisons have the effluent TN below 10 mg/L (with the IFAS system being lower than the MLE process)

From the evaluation, the yearly average from the annual average conditions for the MLE process is 7,358 standard cubic feet per minute (scfm). For the IFAS scenario, the similar yearly average for these conditions is 7,740 scfm.

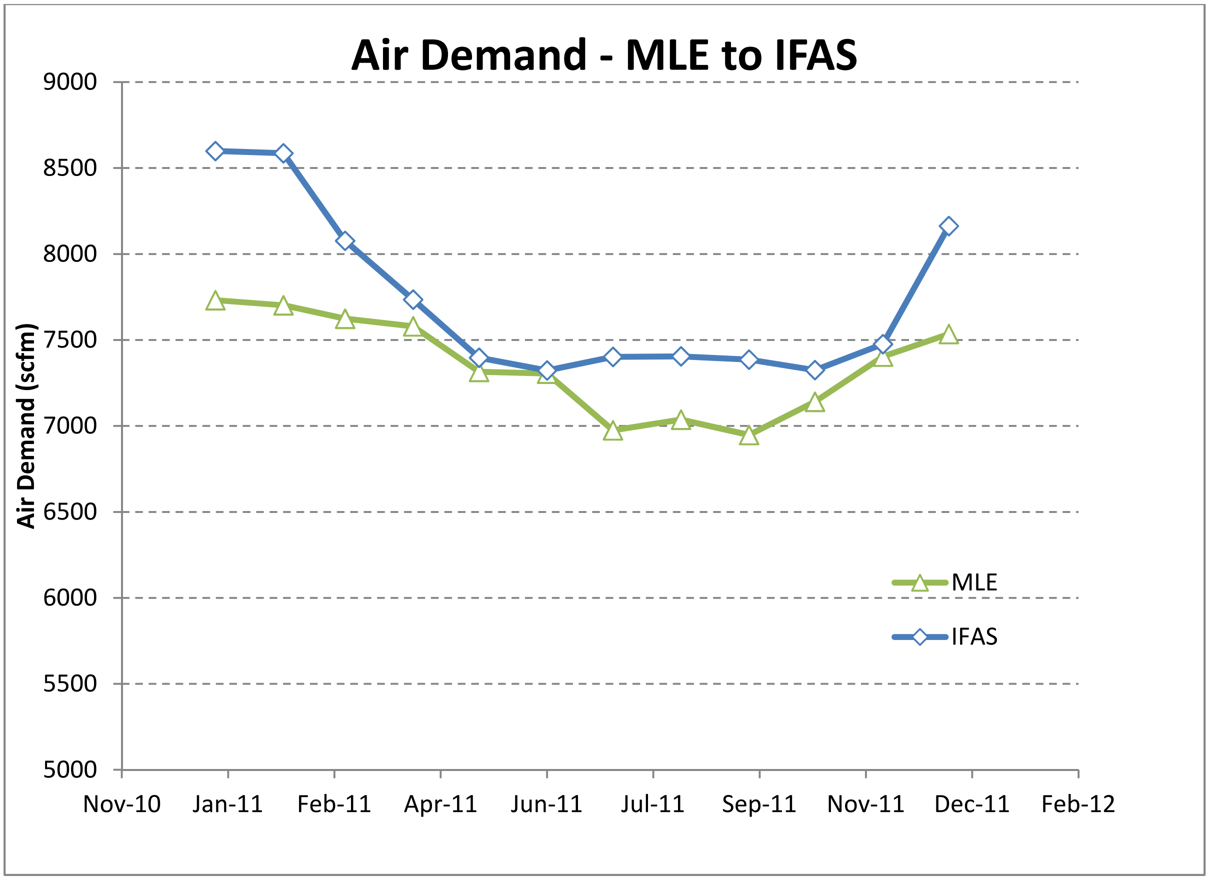


FIGURE 2
Air Demand – MLE to IFAS
City of Bend WRF Secondary Expansion Project

Schematic Design—Improvement Descriptions

The following sections present the key improvements proposed for the secondary treatment process at the Bend WRF. These build on the concepts presented in the Project Definition phase of the design. Three-dimensional models have been developed, detailing the Schematic Design improvements.

Primary Effluent Piping Gallery

Existing Aeration Basin 3 has a piping gallery attached to the south end. This piping gallery contains a 42-inch primary effluent (PE) header. Three 18-inch pipes and three 12-inch pipes are connected to the existing PE header. Each pipe is dedicated to a single aeration basin. The 18-inch pipes direct flow to the head of the basin and the 12-inch pipes direct flow to the first aerobic zone (Cell B). The existing piping gallery also contains an 18-inch RAS header. Three 10-inch RAS pipes are connected to the RAS header. Each pipe conveys RAS to one of the three existing aeration basins. The PE and RAS pipes have a flow meter and control valve to monitor and control flow.

The existing primary effluent piping does not have the necessary capacity to convey the full design peak flow. Two 18-inch PE pipes and one 12-inch PE pipe are necessary to convey the peak design flow through each basin. A description of this process and associated flow splits are presented in *TM 9 – Plant Hydraulic Improvements and Yard Piping*.

The typical recommendation for positioning a flow meter is to provide a straight run of pipe for five pipe diameters upstream and three pipe diameters downstream of the flow meter. This ensures uniform flow through the meter, maximizing its accuracy. It is also desirable to install control valves within a straight pipe run to maximize performance. The installation of the existing flow meters and control valves does not meet these standard design approaches. The new primary effluent and RAS piping will be installed following these recommendations, and the existing piping will be removed and rearranged so the configurations are consistent. Having consistent piping configurations will minimize potential control issues that may arise due to differences. The existing flow meters and control valves will be reused to minimize project costs.

The existing piping gallery will be expanded in the secondary expansion project. This will house the new PE piping, flow control valve, and flow meter assemblies. The existing gallery will be extended to serve Aeration Basin 4. A new PE piping gallery will also be provided for those features serving Aeration Basins 1 and 2.

Existing Aeration Basin Improvements/Aeration Basin 4

The improvements to the existing aeration basins are presented in this section. Aeration Basin 4 will be designed to match the existing aeration basins, incorporating the same features. The following is a list of process features included in the aeration basins:

- Existing anoxic environments (Cell A; Anoxic Zones 1, 2, and 3), to remain
  - Use existing surface mixers
- New IFAS zone (Cell B)
  - Mixed-liquor (ML) Distribution Channel
  - Coarse-bubble diffuser system
  - Biofilm carrier retention screens and support assemblies
  - IFAS Effluent Channel
  - Secondary scum removal (minimize trapping within) – screened openings to allow scum to pass into downstream zones
- Aerobic Zone (Cell C)
  - Coarse-bubble diffuser system
  - Mixed-liquor Recycle pumps located in this cell
- Swing Zone (Cell D – Aerobic/Anoxic)
  - Coarse-bubble diffuser system
  - Surface mixers
- Aerobic Zone (Cell E)
  - Coarse-bubble diffuser system

Mixed-Liquor Recycle Pumps

The mixed-liquor recycle (MLR) pumping system is required to return a nitrate-rich stream from the end of the bioreactor to the anoxic zones for denitrification. Process simulations indicate that the location of these MLR pumps to be within Cell C, with flow being returned to Cell A – Anoxic Zone 1. As noted in Table 2, the MLR pumping system is designed to provide a flow rate of 400 percent of the average day, maximum month flow. Following are the criteria:

- MLR Flow per aeration basin = 400% of 4.25 mgd = 17 mgd
- 17 mgd ≈ 12,000 gpm
- Using two MLR pumps per basin = 6,000 gpm/pump

The two MLR pumps will be controlled with adjustable frequency drives (AFDs). The speed of these pumps will be based on the nitrate level leaving the anoxic environment, with this adjusted to optimize the denitrification process. A secondary control will be based on influent flow, allowing the operations staff to adjust the MLR flow when required to address wet-weather conditions or similar.

Two options have been evaluated for the MLR pumping system: (1) axial-flow type pumps and (2) vertical-line shaft type pumps. Both of these systems provide the required MLR flow to meet the treatment goals.

TABLE 6
Mixed-Liquor Pumping Options
City of Bend WRF Secondary Expansion Project

Item	Wall Mounted Pump	Vertical Line Shaft Pump
Horsepower	15 hp	15 hp
Cost per Pump	$28,340	$55,000
Additional Installation Cost		$20,000/pump
Total Pump Cost (8 pumps total)	$226,720	$440,000
Total Additional Installation Cost		$160,000
Total Comparative Cost	$226,720	$600,000
Cost Difference		$373,280

The direct cost increase with the use of the vertical-line shaft pumps is approximately $400,000. Support features would be required for these pumps, which are not included in the direct cost. Magnetic flow meters or similar could also be utilized with these pumps, but these costs too are not reflected in the direct costs. The advantages of these pumps are as follows:

- Motor assembly is above the basin, providing ease of accessibility
- Pressure and flow measurement is applicable given access to piping

The primary disadvantage of the vertical-line pumps is the higher cost relative to the axial flow type pumps. In addition, pump removal may require a crane assembly or similar.

The schematic design drawings have been developed showing the axial-flow type pump system. The City reviewed the pumping options and selected the vertical-line shaft pump alternative. These pumps have been installed at Clean Water Services' Rock Creek Facility, as seen by the City on their tour, and have been successful.

Anoxic Zone/Swing Zone Mixers

The existing mixers within Cell A will be re-used in Aeration Basins 1, 2, and 3. New surface mixers, matching the existing mixers, will be installed in Cell A of Aeration Basin 4. New surface mixers will be installed in the swing zone (Cell D) for all aeration basins, matching those included in Cell A. The current mixers are Aqua Aerobics – SS AquaDDM mixers, provided with direct-drive assemblies. The following new mixers will be provided for the secondary expansion project:

- Five 7.5 hp SS AquaDDM mixers: one for Aeration Basin 4: Cell A, Anoxic Zone 3 and four for Aeration Basins 1 through 4: Cell D, Swing Zone
- Two 3 hp SS AquaDDM mixers for Aeration Basin 4: Cell A, Anoxic Zones 1 and 2

Secondary Scum Removal System

The general concept for scum removal is to allow this to pass through the aeration basins, along with the mixed-liquor that is conveyed to the secondary clarifiers. The scum will then be removed at the secondary clarifiers through the existing scum removal system. The following features are included in the aeration basin to help scum removal:

- Hydraulic profile that provides the appropriate headloss over weirs and baffles to allow secondary scum to pass
- Screened openings within the IFAS zone, at the water line above the media retention screens, allowing secondary scum to pass. Screens need to be sized to minimize headloss with size openings coordinated with the IFAS plastic biofilm carriers selected for the project.
- Spray bars located throughout the aeration basin to minimize scum trapping

Existing Secondary Clarifiers

No improvements are planned for the secondary clarifiers in the expansion phase. As noted in the Project Definition Report, Secondary Clarifier 4 is recommended when the WRF influent flows reach 10 mgd (ADMM).

Existing Return Activated Sludge System Improvements

No improvements are planned for the existing RAS system in the expansion phase. As noted in the Project Definition Report, RAS system capacity expansion is required to when the WRF influent flows reach 10 mgd (ADMM).

Aeration Basin Drainage System

A new aeration basin drainage system will be installed as part of the secondary expansion project. This new system will include a new plant drain pump station, and connect into the existing drainage system at the WRF. Following are the key features of the aeration basin drainage system:

- All drainage features within the IFAS zone need to be screened to prevent the loss of plastic biofilm carriers. Screen size to be coordinated with plastic biofilm carrier media manufacturer.
- New plant drain pump station, located in the PE piping gallery.
- WEMCO Hidrostal Pre-ro system is proposed.
- The majority of ML from Aeration Basins 1 and 2 can be drained through the new system. The existing system (RAS pumps) will be required for complete drainage of the basins 1 and 2.
- All basin drainage from Aeration Basins 3 and 4 will be through the new aeration basin drainage system and plant drain pump station.
- The system is designed to complete the drainage of one aeration basin within 12 hours.
- Drainage of the primary clarifiers will be also be accomplished through the new plant drain pump station

IFAS Biofilm Carrier Media Transfer

Features to transfer the biofilm carrier media between aeration basins will be included in the design of the IFAS system. The need to transfer the biofilm carrier media will be minimal. During the startup and commissioning phase of the project, media will be transferred to one basin at a maximum fill value to verify system performance. After the performance has been verified, media will be distributed between the appropriate aeration basins in service to provide treatment. Any additional media transfer after this point will be minimal.

The system proposed to transfer carrier media is:

- All drainage ports within the IFAS zone will have retention screens preventing loss of the plastic biofilm carrier media
- Include guide-rails and lifting mechanisms for each IFAS zone, allowing a submersible solids-handling pump to be utilized
- Provide a submersible solids-handling pump to be interchangeable between IFAS zones
- Utilize temporary, flexible piping to transfer media between the appropriate reactors

As the design continues, and an IFAS manufacturer is pre-selected, the use of a permanent media transfer system will be evaluated.

Schematic Design—Instrumentation and Control Strategy

Aeration Basin Overview

There are four stages in each aeration basin: pre-anoxic (Cells A1, A2, and A3), IFAS (Cell B), aerobic (Cells C and E) and an anoxic-aerobic swing zone (Cell D). There are mixers in Cells A1, A2, A3, and D. Two MLR pumps return nitrified mixed liquor from Cell C to cell A2. The flow direction is changed through the IFAS zone such that it runs perpendicular to the rest of the basin. An IFAS influent channel containing six side-flow weirs distributes flow uniformly across Cell B. Flow exits the IFAS zone through a screen wall and enters the IFAS effluent channel, directing the flow to Cell C.

PE and RAS are divided across the four basins using control valves and flow meters. Each basin has two 18-inch and one 12-inch primary effluent pipes and one 10-inch RAS pipe. RAS is always directed to Cell 1A. Primary effluent is either directed to Cell 1A or the IFAS effluent channel. The basins have two operating modes: normal and wet weather. During normal operation, all the primary effluent is directed to Cell 1A. During wet weather operation, some primary effluent is directed to the IFAS effluent channel.

The basin is designed to achieve total nitrogen (TN) removal to meet a permit limit of 10 mg-N/L, and includes a number of process controls to allow flexibility for WRF operations staff. The bulk-liquid dissolved oxygen (DO) in the IFAS zone will be controlled through a tiered approach. One control option incorporated into the system is based on an ammonia measurement in Cell 5. One advantage of the biofilm system is that the effluent ammonia concentration is a direct, linear relationship to the bulk-liquid DO concentration. This will allow operations to establish an effluent ammonia goal if warranted, which can optimize energy efficiency of the system. The effluent TN permit limit of 10 mg-N/L will still be met, but through a higher effluent ammonia and lower total nitrate-N concentrations. The MLR pump will have the option to be controlled based on a nitrate measurement in Cell A3 to maximize TN removal. There will be a secondary control option based on influent flow to the aeration basin. These options will provide flexibility in the operation of the MLR system, allowing the operators to optimize this feature.

A package programmable logic controller (PLC) will be used for control of the IFAS process including the aeration system; the MLR pumping system and wet weather operation can be incorporated into the design. This package PLC would be provided by the IFAS vendor. This control feature will be refined during the pre-selection phase of the project, when an IFAS equipment vendor is selected.

Basin Operating Modes

PE is directed to each basin through two 18-inch pipes and one 12-inch pipe. One 18-inch PE pipe discharges only to Cell A1. One 18-inch PE pipe discharges to either Cell A1 or to the IFAS effluent channel. There is a supervisory control and data acquisition (SCADA) control valve that changes the discharge location of the 18-inch pipe. The 12-inch PE pipe discharged only to the IFAS effluent channel. The basin will operate in one of two modes: normal and wet weather. The key concern with the IFAS system under wet weather flows is the hydraulic overloading of the screen wall, causing flow to back up in the IFAS zone. Hydraulic overloading of the screen wall also pushes media against the wall, compromising treatment. The hydraulic loading rate of the screen wall is a function of both the PE flow and MLR rate.

During normal operation, PE is fed to Cell A1 through one or both of the 18-inch PE pipes and the MLR pump is controlled based on the nitrate concentration in Cell A3. Basin hydraulics are designed to accommodate the 2030 maximum dry weather diurnal peak flow during normal operation. An operator adjustable set point on the influent flow rate will define the transition from normal operation to wet weather operation. The control system will automatically notify the operators of an approaching wet weather condition. The influent flow rate triggering a wet weather alarm is also an operator-adjustable set point.

There are three stages of wet weather flow depending on the severity of the event. The influent flow rate triggering Stage 1 wet weather operation is less than the maximum flow passable through the two 18-inch PE pipes. As the influent flow increases beyond the wet weather flow set point, the aeration basins will enter the Stage 1 wet weather operating mode. The MLR pump will transition from nitrate measurement control to influent flow paced and the pumping rate will be reduced. There will be an operator-adjustable set point for the MLR rate during Stage 1 wet weather mode. The SCADA system will calculate the total forward flow rate through the IFAS screen wall (PE directed to Cell 1A + MLR rate + RAS rate). There will be an interlock in the SCADA system to not allow the MLR rate to increase to a level that exceeds an operator-adjustable maximum total forward flow rate through the IFAS screen wall. The MLR rate will be reduced during Stage 1 wet weather operating mode.

Stage 2 wet weather mode occurs when flow through the two 18-inch PE pipes is maximized and the 12-inch PE pipe is necessary to pass all the influent flow. There will be an operator-adjustable set point for the maximum flow through two 18-inch PE pipes. The control system will transition from Stage 1 to Stage 2 wet weather mode automatically. The transition from Stage 1 to Stage 2 wet weather operating mode includes automatically opening the 12-inch PE pipe and turning off the MLR pump. An alarm will notify the operators of the impending transition, and the influent flow rate triggering the alarm is an operator-adjustable set point.

The Stage 3 wet weather operating mode switches the feed location of one 18-inch PE pipe from Cell 1A to the IFAS effluent channel by opening a valve in the pipe. The Stage 3 wet weather operating mode is beneficial if the IFAS screen wall is severely blinded by rags, media or in other situations where the screen wall becomes a hydraulic bottleneck. The Stage 3 wet weather operating mode can also be used to reduce the clarifier solids loading rate if the sludge blankets are observed to rise significantly during wet weather. The operators will manually initiate the transition from Stage 2 and Stage 3 wet weather operating mode from the human-machine interface. The operations staff must also manually take the aeration basins out of the Stage 3 wet weather operating mode.

The SCADA system will automatically transition from Stage 2 wet weather operation to Stage 1 wet weather operation to normal operation. The influent flow rates at which these transitions occur are an operator-adjustable set point. There will be interlock in the SCADA system such that the set points for transitioning out of the wet weather operating modes are lower than the set points initiating them.

Primary Effluent and Return Activated Sludge Flow Split

The primary effluent will be divided across the four aeration basins and between the three PE pipes feeding each basin using a most-open valve control scheme for adjusting valve position. The RAS flow will also be divided across the four basins using a most-open valve control scheme.

Aeration System

Blower control is described in *TM 5 – Blower System Improvements*. The blowers will be controlled to maintain a constant header pressure.

There are five automated control valves and air flow meters per aeration basin. Cell B has two air drops and Cells C, D and E each have a single air drop. The air flow in both air lines to Cell B be delivered at the same flow rate. Each aeration basin has three DO meters. The DO meters are located in Cells B, C, and E.

As noted above, there are two aeration operating modes for the IFAS zone (Cell B): ammonia mode and bulk-liquid DO mode. In the ammonia mode, the air flow rate is controlled based on an ammonia measurement in Zone 5. The target ammonia concentration is an operator-adjustable input parameter. If the ammonia concentration increases, the air flow rate to Cell B increases. If the ammonia concentration decreases, the air flow rate to Cell B decreases. It is possible that the control system programming will include a compound loop with DO as a secondary control parameter to avoid major fluctuations in blower speed as a result of short-term variations in the ammonia measurement.

In DO mode, the air flow rate is modulated to maintain the measured DO concentration within an operator-adjustable target value. Cells C and E will be operated in DO mode exclusively. Cell D is a swing zone and will be controlled based on the DO reading in Cell E when it is aerobic.

Mixed Liquor Recycle Pumping System

There are two MLR pumps per aeration basin. The two MLR pumps discharge into a common header with a flow meter. The two MLR pumps will operate in lead/lag fashion to achieve the target MLR rate.

The MLR pumping rate will be controlled based a nitrate measurement in Cell A1. The MLR rate will be modulated between operator-adjustable high and low limits of flow rate based on the measured nitrate concentration. When the nitrate concentration increases, the MLR rate will decrease.

The MLR pumps will also have a secondary control option based on influent flow pacing for normal basin operation. During Stage 1 wet weather operating mode, the MLR pumps will also operate based on influent flow pacing.

Tank Drain Pumping System

The tank drain pumping system consists of a single pump. The discharge location of the tank drain pump is selected by manually adjusting valves on a manifold in the west primary effluent gallery. The tank drain pump can discharge to either the 42-inch primary effluent header feeding the aeration basins or to either of the primary influent splitter boxes. There is a level element on the tank drain pump station that triggers high level alarm if the level in the wet well is over an operator-adjustable maximum level set point.

Mixer

The mixers will be manually controlled from SCADA. The mixers in Cells A1, A2, and A3 will run continously in anoxic zones. The SCADA system will have a manual mode selector for switching Cell D from anoxic to aerobic. When Cell D is in the anoxic mode, the control system will automatically stop air flow into Cell D by closing the air flow valves and turning on the mixers. When Cell D is in aerobic mode, the control system will automatically control DO based on an operator set point DO concentration in Cell E and turn off the mixers.

Outstanding Issues

The IFAS equipment and media can be procured through several different mechanisms. The procurement method selected will impact the approach to procurement of other process equipment used in the project. Common approaches for procuring unique equipment are as follows:

1. Design Bid Build
2. Owner Procured (Pre-Selection)
3. Owner Procured and Assigned to Construction Contractor

Attachments

Attachment A—Equipment Data Sheets

- Large Anoxic Mixers 1-4, 2-4, 3-4, 4-4
- Small Anoxic Mixers 4-1, 4-2
- MLR Pumps 1, 2, 3, 4, 5, 6, 7, and 8

Attachment B—Vendor Catalog Cuts

Attachment C—Schematic Design Fact Sheets

- Fact Sheet 1—RAS Flow Testing Results
- Fact Sheet 2—RAS/WAS Pump Station Ventilation
    Appendix A—Vendor Catalog Cuts

Attachment A—Equipment Data Sheets

Bend Water Reclamation Facility Secondary Expansion

EQUIPMENT DATA SHEET

SPEC SECTION: ______

LEAD ENGINEER: Leaf

FACILITY NAME: 31 - Aeration Basins

EQUIPMENT NAME: Large Anoxic Mixers 1-4, 2-4, 3-4, 4-3, 4-4 **QUANTITY:** 4

IDENTIFICATION NO.: ______

MATERIAL HANDLED: ML - Mixed Liquor

CAPACITY: ______

LOCATION: ______ dry x wet ______ exterior ______ hazardous

POWER REQUIRED: 7.5 hp ______ volts ______ phase

DRIVE: constant
(Constant speed, 2 speed, variable speed)

ENCLOSURE TYPE: MOTOR: ______ CONTROL PANEL: ______

SYNCHRONOUS SPEED (rpm): ______

MOUNTING TYPE: ______
(Horizontal or Vertical):

SUPPORT UTILITIES REQUIRED: ______

EQUIPMENT DESCRIPTION: floating mixer
(Size, configuration)

MANUFACTURERS: **NO. 1:** ______ **NO. 2:** ______

MODEL: ______ **MODEL:** ______

EQUIPMENT WEIGHT: ______ lbs

EQUIPMENT COST: **QUOTE:** $95,000 **DELIVERY TIME:** ______

VENDOR: ______

MISCELLANEOUS COMMENTS, DATA, AND INFORMATION: moto sizes based on exisitng mixers

LOCATION OF EQUIPMENT: P&ID Sheet No. ______ Construction Sheet No. ______

REVISION	DATE	NO.	BY

Bend Water Reclamation Facility Secondary Expansion

EQUIPMENT DATA SHEET

SPEC SECTION: ____________

LEAD ENGINEER: Leaf

FACILITY NAME: 31 - Aeration Basins

EQUIPMENT NAME: Small Anoxic Mixers 4-1, 4-2 **QUANTITY:** 2

IDENTIFICATION NO.: ____________

MATERIAL HANDLED: ML - Mixed Liquor

CAPACITY: ____________

LOCATION: ____ dry x wet ____ exterior ____ hazardous

POWER REQUIRED: 3 hp ____ volts ____ phase

DRIVE: constant
(Constant speed, 2 speed, variable speed)

ENCLOSURE TYPE: MOTOR: ____________ CONTROL PANEL: ____________

SYNCHRONOUS SPEED (rpm): ____________

MOUNTING TYPE: ____________
(Horizontal or Vertical):

SUPPORT UTILITIES REQUIRED: ____________

EQUIPMENT DESCRIPTION: floating mixer
(Size, configuration)

MANUFACTURERS: **NO. 1:** ____________ **NO. 2:** ____________

MODEL: ____________ **MODEL:** ____________

EQUIPMENT WEIGHT: ____ lbs

EQUIPMENT COST: **QUOTE:** Included **DELIVERY TIME:** ____________

VENDOR: ____________

MISCELLANEOUS COMMENTS, DATA, AND INFORMATION: motor size based on existing mixers

LOCATION OF EQUIPMENT: P&ID Sheet No. ____ Construction Sheet No. ____

REVISION	DATE	NO.	BY

Bend Water Reclamation Facility Secondary Expansion

EQUIPMENT DATA SHEET

SPEC SECTION: ____________

LEAD ENGINEER: Leaf

FACILITY NAME: 31 - Aeration Basins

EQUIPMENT NAME: MLR Pumps 1, 2, 3, 4, 5, 6, 7, and 8 **QUANTITY:** 8

IDENTIFICATION NO.: ____________

MATERIAL HANDLED: MLR - Mixed Liquor Recycle

CAPACITY: 6,000 gpm @ 4.0 ft

LOCATION: ____ dry x wet ____ exterior ____ hazardous

POWER REQUIRED: 15 hp 460 volts 3 phase

DRIVE: variable speed
(Constant speed, 2 speed, variable speed)

ENCLOSURE TYPE: MOTOR: TEFC CONTROL PANEL: ____________

SYNCHRONOUS SPEED (rpm): 900

MOUNTING TYPE: Vertical
(Horizontal or Vertical):

SUPPORT UTILITIES REQUIRED: ____________

EQUIPMENT DESCRIPTION: Vertical Line Shaft Pump
(Size, configuration)

MANUFACTURERS: **NO. 1:** Morrison Pump Coompany **NO. 2:** ____________

MODEL: VPS-16-14-02 **MODEL:** ____________

EQUIPMENT WEIGHT: ____ lbs

EQUIPMENT COST: **QUOTE:** $520,000 **DELIVERY TIME:** 20 weeks

VENDOR: Pump Tech

MISCELLANEOUS COMMENTS, DATA, AND INFORMATION: no
quotes collected yet for this project, quote for 15 HP Flygt pump from CWS Hillsboro project (8/5/2010) $26,500

LOCATION OF EQUIPMENT: P&ID Sheet No. ____ Construction Sheet No. ____

REVISION	DATE	NO.	BY

Attachment B—Vendor Catalog Cuts

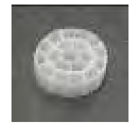
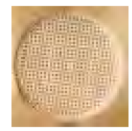
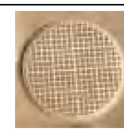
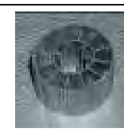
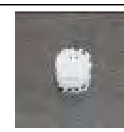
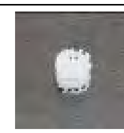
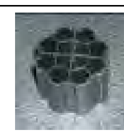
Bend WRF Secondary Improvements

IFAS Process Equipment

Major components of the IFAS process mechanical system constituents are depicted in Figure 1, Table 1, Figure 2, and Figure 3, respectively.

Figure 1. Diffuser grid assemblies in a moving-bed reactor.

Table 1
Plastic biofilm carrier characteristics[1] (McQuarrie, J.P., and Boltz, J.P. [2011] Moving bed biofilm reactor technology: process applications, design, and performance. *Water Environment Research*. **83**(6). 560-575)

Manufacturer	**Name**	**Bulk Specific Surface Area**[(1)]	**Nominal Carrier Dimensions (Depth; Diameter)**	**Carrier Photograph**
Veolia Inc.	AnoxKaldnes™ K1 or K1 Heavy	500 m^2/m^3	7 mm; 10 mm	
	AnoxKaldnes™ K3	500 m^2/m^3	12 mm; 25 mm	
	AnoxKaldnes™ Biofilm Chip (M)	1,200 m^2/m^3	2 mm; 48 mm	
	AnoxKaldnes™ Biofilm Chip (P)	900 m^2/m^3	3 mm; 45 mm	
	AnoxKaldnes™ Matrix™ Sol	800 m^2/m^3	4 mm; 25 mm	
Headworks BIO (Licensed by: Infilco Degremont, Inc.)	ActiveCell™ 450	450 m^2/m^3	15 mm; 22mm	
	ActiveCell™ 515	515 m^2/m^3	15 mm; 22 mm	
AqWise (Partnered with World Water Works, Inc.)	ABC4™	600 m^2/m^3	14 mm; 14mm	
	ABC5™	660 m^2/m^3	12 mm; 12mm	
Entex Technologies, Inc.	Bioportz™	589 m^2/m^3	14 mm x 18 mm	
Siemens Water Technologies Corp.	CM-10D™	750 m^2/m^3	9 mm x 13 mm	

(1) As reported by manufacturer.

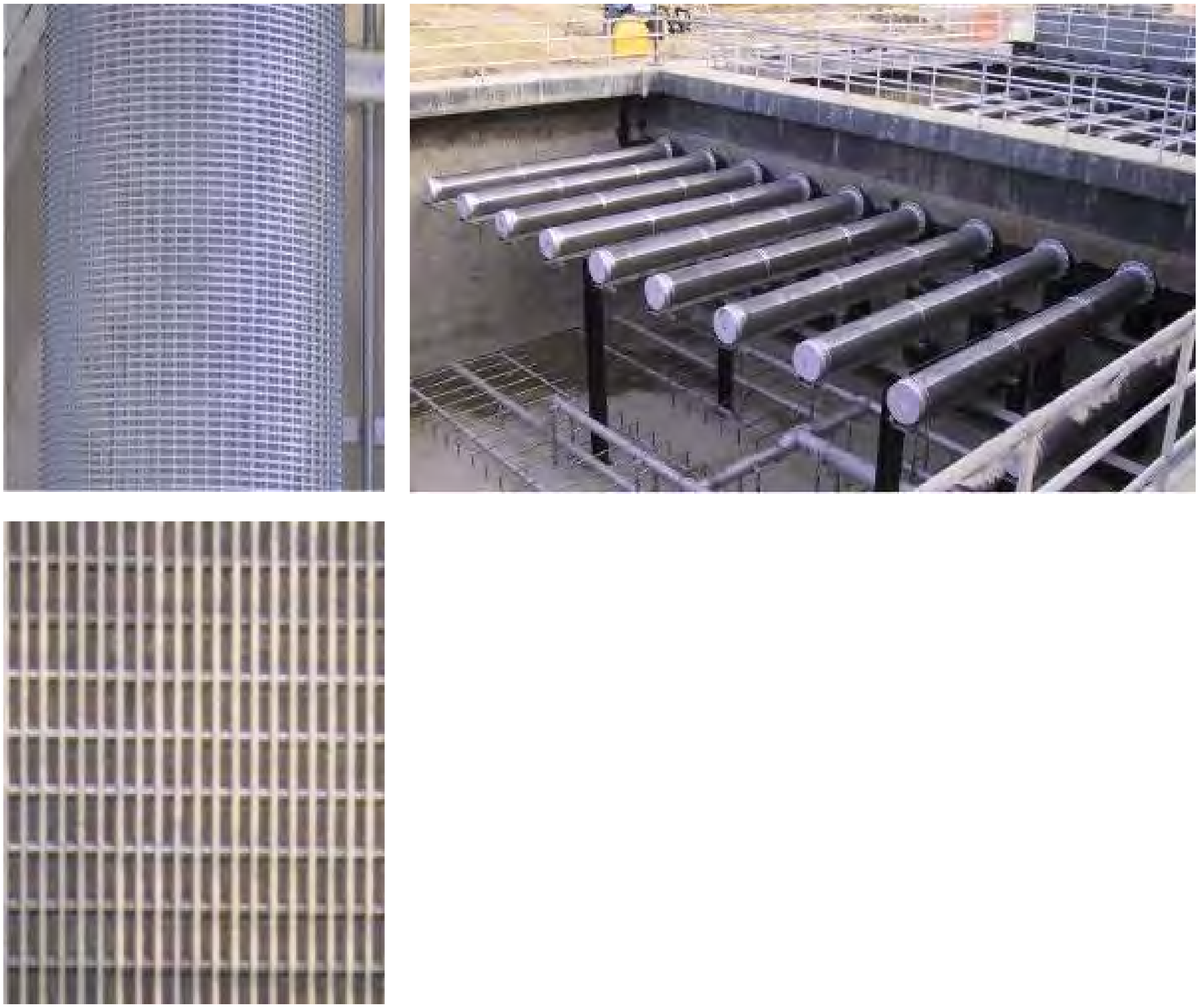


Figure 2. Horizontal cylindrical screens constructed of wedge-wire. Stainless steel coarse-bubble diffusers typically used in aerobic moving-bed reactors are also pictured on the tank floor.

Information Supporting Specification Development

The following information will be available to support or be included in the technical specification(s) developed for the procurement of IFAS process mechanical equipment:

1. Hydraulic profile
    a. At a minimum, the following flow conditions and streams will be considered:
        i. Maximum month average day flow rate (MMADF)
        ii. Peak hour flow rate (PHF) – all units in service
        iii. Peak hour flow rate – largest unit in each unit process out of service (or alternative worst case scenario evaluated to ensure no tank over flow)
        iv. Influent wastewater, return activated sludge (RAS), and internal mixed liquor recycle (IMLR) steam flow rates will be included in the calculations and identified on the hydraulic profile and/or in an associated narrative.
        v. If alternative flow schemes are utilized to manage dry- and wet-weather wastewater flow rates they will be identified on the hydraulic profile AND in an associated narrative.
    b. Hydraulic head loss resulting from all unit processes, hydraulic control points, and process piping comprising the treatment train will be accounted for and illustrated.
    c. A maximum hydraulic head loss of 2-inches will be allocated for each IFAS screen wall. The extent of hydraulic head loss will be identified on the hydraulic profile and/or in an associated narrative.
    d. Minimum tank freeboard restrictions will be identified on the hydraulic profile and/or in an associated narrative.
2. Design parameters
    a. Start-Up and Phasing (if applicable)
        i. Identify the number of expansion phases leading up to build-out capacity
        ii. Information described below as 2b. – 2e. will be defined for each phase of construction provided there is variability in the parameters or parameter values.
    b. Wastewater temperatures
        i. Average temperature (°C) during the MMADF condition (typically winter) or minimum sustained temperature (°C)
        ii. Annual average temperature (°C)
        iii. Peak monthly average temperature (typically summer) (°C) or maximum sustained temperature (°C)

c. Wastewater flow rate(s)

   i. Annual average day flow (AADF) rate (m^3/d)

   ii. Maximum month average day flow (MMADF) rate (m^3/d)

   iii. Maximum day average flow (MDF) rate (m^3/d)

   iv. Peak hour flow (PHF) rate (m^3/d)

   v. Return activated sludge (m^3/d) – not used in a MBBR

   vi. IMLR flow rate(s) (m^3/d) - Identify as constant or variable. If the IMLR stream(s) flow rate(s) varies describe the primer for flow rate variability, maximum flow rate, and minimum flow rate.

d. Raw sewage OR primary clarifier effluent wastewater characteristics depending on the flow stream influent to the bioreactor (at minimum).

   i. Five-day biochemical oxygen demand (BOD_5) (mg/L and kg/d)

   ii. Total suspended solids (TSS) (mg/L and kg/d)

   iii. Total Kjeldahl nitrogen (TKN) (mg/L and kg/d)

   iv. Ammonia-nitrogen (NH_3-N) (mg/L and kg/d)

   v. Total phosphorus (TP) (mg/L and kg/d)

   vi. Total alkalinity (ALK) (mg/L and kg/d as $CaCO_3$)

   vii. pH

e. Wastewater treatment plant effluent water quality standards

   i. Permit basis (examples follow)

      1. Annual average day

      2. Maximum month average day (calendar months)

      3. Maximum week average day (7-day rolling average)

      4. Maximum single (grab) sample observation

      5. Seasonal limitations

      6. Percent removal

   ii. Sample location and type (e.g., raw sewage and 24-hour composite, respectively)

   iii. Permit parameters and their value(s) (example follow)

      1. BOD_5 (mg/L and/or kg/d)

      2. TSS (mg/L and/or kg/d)

3. Total nitrogen (TN) (mg N/L and/or kg N/d)
4. NH_3-N (mg N/L and/or kg N/d)

3. WWTP simulations based on the design parameter(s). Simulations will identify:
    a. Process configuration
        i. Type of process (e.g., five-stage Bardenpho, A_2O, etc.)
        ii. Number of zones (i.e., physical zones separated by walls – not necessarily simulated zones)
        iii. Zone type and tag (e.g., ANA, ANX; AER AS; AER IFAS; RE-AER)
        iv. Individual zone volume(s)
        v. IMLR stream flow rate, type, and tag (e.g., ANA RCY; NRCY)
    b. IFAS volume (m^3) and tank (zone) dimensions
        i. Side-water depth (m)
        ii. Length (m)
        iii. Width (m)
    c. Air flow by zone
        i. Minimum air flow rate (m^3/hr)
        ii. Maximum air flow rate (m^3/hr)
    d. Biofilm surface area (m^2)
    e. Solids residence time (d)
    f. Mixed-liquor suspended solids concentration
        i. Minimum operating concentration (mg/L)
        ii. Maximum operating concentration (mg/L)
    g. Supplemental carbon addition (if applicable)
        i. compound (e.g., methanol, MicroC™, acetic acid)
        ii. Dose (kg/d)
        iii. Flow rate (m^3/d)
4. Physical system description (based on process design components named in Item 2)
    a. Process flow diagram
    b. Bioreactor process and instrumentation diagrams
    c. Preliminary site plan that identifies site constraints, proposed and future units.

d. Bioreactor structural drawings (or dimension mechanical drawings)

e. Bioreactor process mechanical drawings

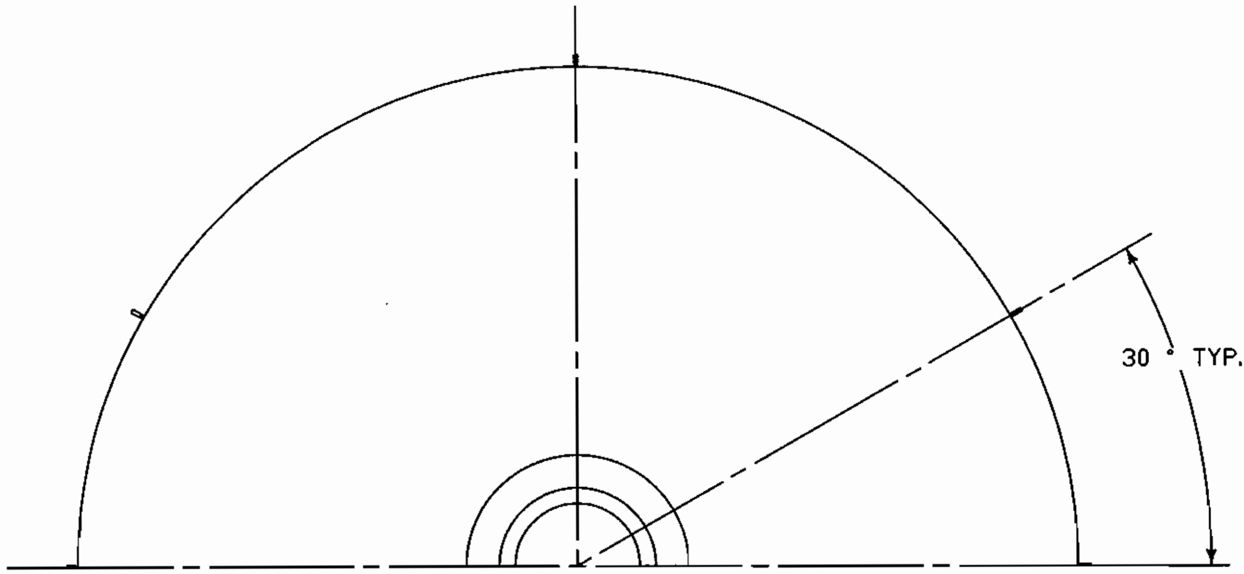
    i. No IFAS process mechanical equipment will be illustrated

    ii. Special attention will be given to the precise illustration and dimensioning of tank dewatering and water load equalization ports, and internal walls and system appurtenances.

Bend WRF Secondary Improvements

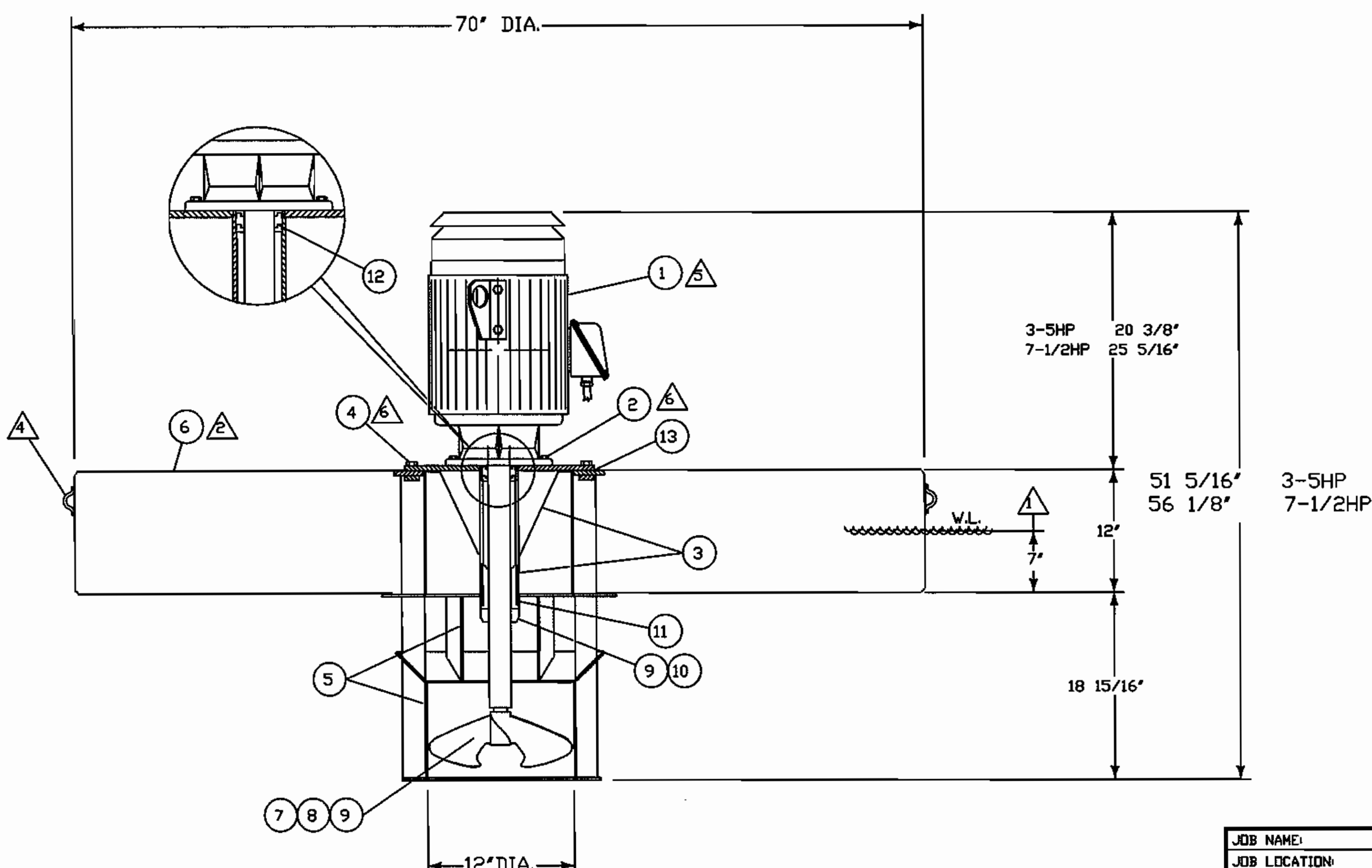
Anoxic Zone Mixers

Cell A, Anoxic Zone 1, 2	• (2)-3hp SS AquaDDM mixers (Aeration Basin 4) • Mooring cables for 3 point mooring • Mooring thimbles • Mooring clips • 12/4 power cable w/ support ties
Cell A, Anoxic Zone 3	• (1)-7.5hp SS AquaDDM mixer (Aeration Basin 4) • Mooring cables for 3 point mooring • Mooring thimbles • Mooring clips • 12/4 power cable w/ support ties
Cell D, Swing Zone	• (4)-7.5hp SS AquaDDM mixers (Aeration Basin 1 – 4) • 2-3hp SS AquaDDM mixers • Mooring cables for 3 point mooring • Mooring thimbles • Mooring clips • 12/4 power cable w/ support ties



NOTES:

1. APPROXIMATE OPERATING WATER LEVEL.
2. FLOAT IS FILLED WITH TWO COMPONENT POLYURETHANE FOAM.
3. ELECTRICAL CABLE
   RECOMMENDED SIZE AWG#_______
4. MOORING ANCHOR RING OF 304 STN. STL., QUANTITY OF 6, APPLICABLE FOR 3 OR 4 POINT MOORING.
5. MOTOR SPECIFICATIONS:
   ___HP, _________VOLT, 3 PHASE, 60 HERTZ, 1200 NOM. RPM, TEFC, 1.15 SERVICE FACTOR, CLASS F INSULATION, CONTINUOUS DUTY, NEMA DESIGN LETTER B, NONHYGROSCOPIC WINDINGS, CORROSION RESISTANT PAINT, ONE-PIECE 17-4 PH STN. STL. SHAFT.
6. THESE FASTENERS ARE TO BE SAFETY WIRED IN PLACE.
7. SPARE POWER SECTION INCLUDES ITEMS: 1,2,3,7,8,9,10,11,12



ITEM	QUAN.	PART NO:	DESCRIPTION	
13	1		MOTOR BASE GASKET	
12	2		LIP SEAL	
11	1		ANTI-DEFLECTION INSERT	DELRIN
10	1		LOWER SLINGER	316 STN. STL.
9	6		SET SCREW	316 STN. STL.
8	1		PROP PIN	17-4 PH STN. STL.
7	1		PROPELLER	316 STN. STL.
6	1		FLOAT ASSEMBLY	304 STN. STL.
5	1		INTAKE VOLUTE ASSEMBLY	304 STN. STL.
4	6		BOLT	316 STN. STL.
3	1		MOTOR BASE ASSEMBLY	304 STN. STL.
2	4		BOLT, MOTOR	316 STN. STL.
1	1		MOTOR	

JOB NAME:	DO NOT SCALE DRAWING	AQUA-AEROBIC SYSTEMS, INC. MANUFACTURERS OF WASTEWATER TREATMENT EQUIPMENT
JOB LOCATION:	DRN BY: VJB / CKD BY:	
ENGINEERS:	APP BY: / DATE:	
	SCALE: NOT TO SCALE	NAME: MIXER ASSEMBLY 298
	HP/SIZE: 3-7.5 HP	
	TYPE: SS	
	PATH:	SHEET 1 OF 1
REF. / ECO / DATE / BY / REVISION	CAD NO.:	DWG. NO.: 2801357

Bend WRF Secondary Improvements

Mixed-Liquor Pumping System

Design criteria:

- MLR Flow per Aeration Basin = 400% of 4.25 mgd = 17 mgd
- 17 mgd ≈ 12,000 gpm
- Using (2) MLR Pumps per Basin = 6,000 gpm/pump

Two options have been evaluated for the mixed-liquor recycle (MLR) pumping system:

- axial-flow type pumps

- vertical-line shaft type pumps.

PERFORMANCE CURVE

PRODUCT	TYPE
PP4660.490	

DATE	PROJECT	CURVE NO	ISSUE
2011-04-20		63-1258	11

	1/1-LOAD	3/4-LOAD	1/2-LOAD
POWER FACTOR	0.64	0.56	0.44
EFFICIENCY	79.5 %	79.5 %	77.0 %
MOTOR DATA	---	---	---

RATED POWER	15	hp
STARTING CURRENT ...	90	A
RATED CURRENT ...	27	A
RATED SPEED	575	rpm
TOT.MOM.OF INERTIA ...	0.38	kgm2
NO. OF BLADES	3	

BLADE ANGLE	IMPELLER DIAMETER
7 deg	580 mm

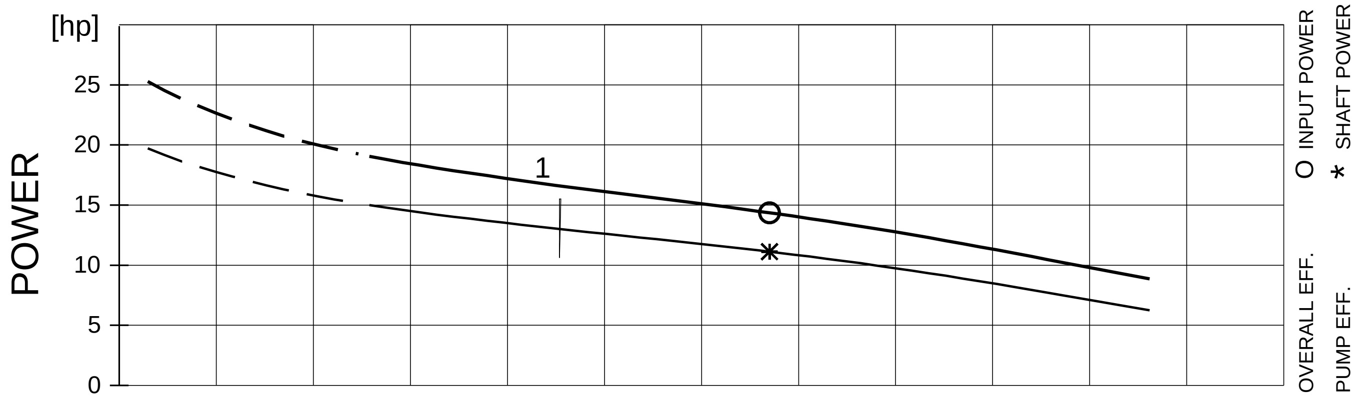
MOTOR #	STATOR	REV
25-26-12AA	31Y	12

FREQ.	PHASES	VOLTAGE	POLES
60 Hz	3	460 V	12

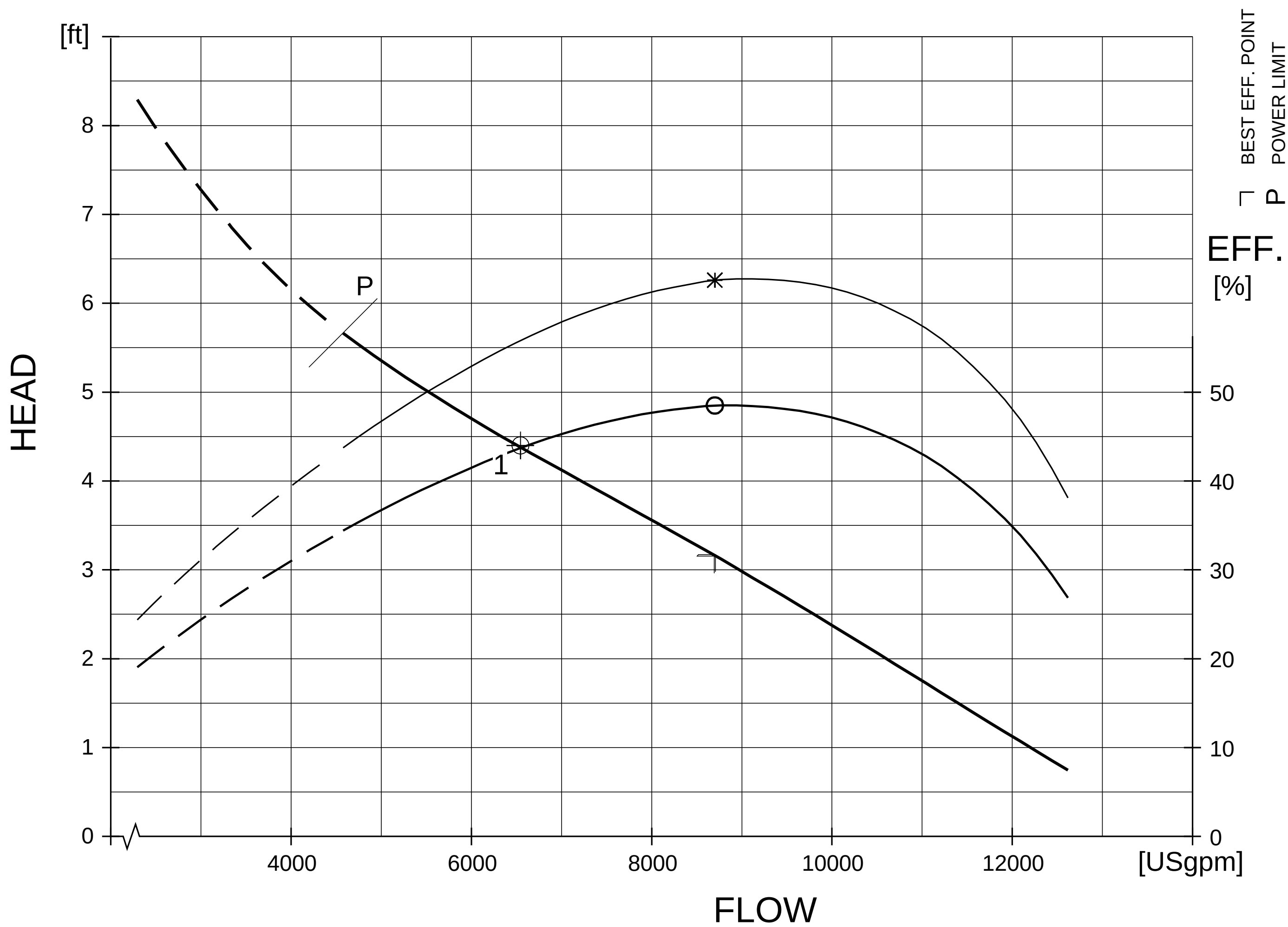
GEARTYPE	RATIO
---	---

COMMENTS

INLET/OUTLET	IMP. THROUGHLET
- / 23 inch	---



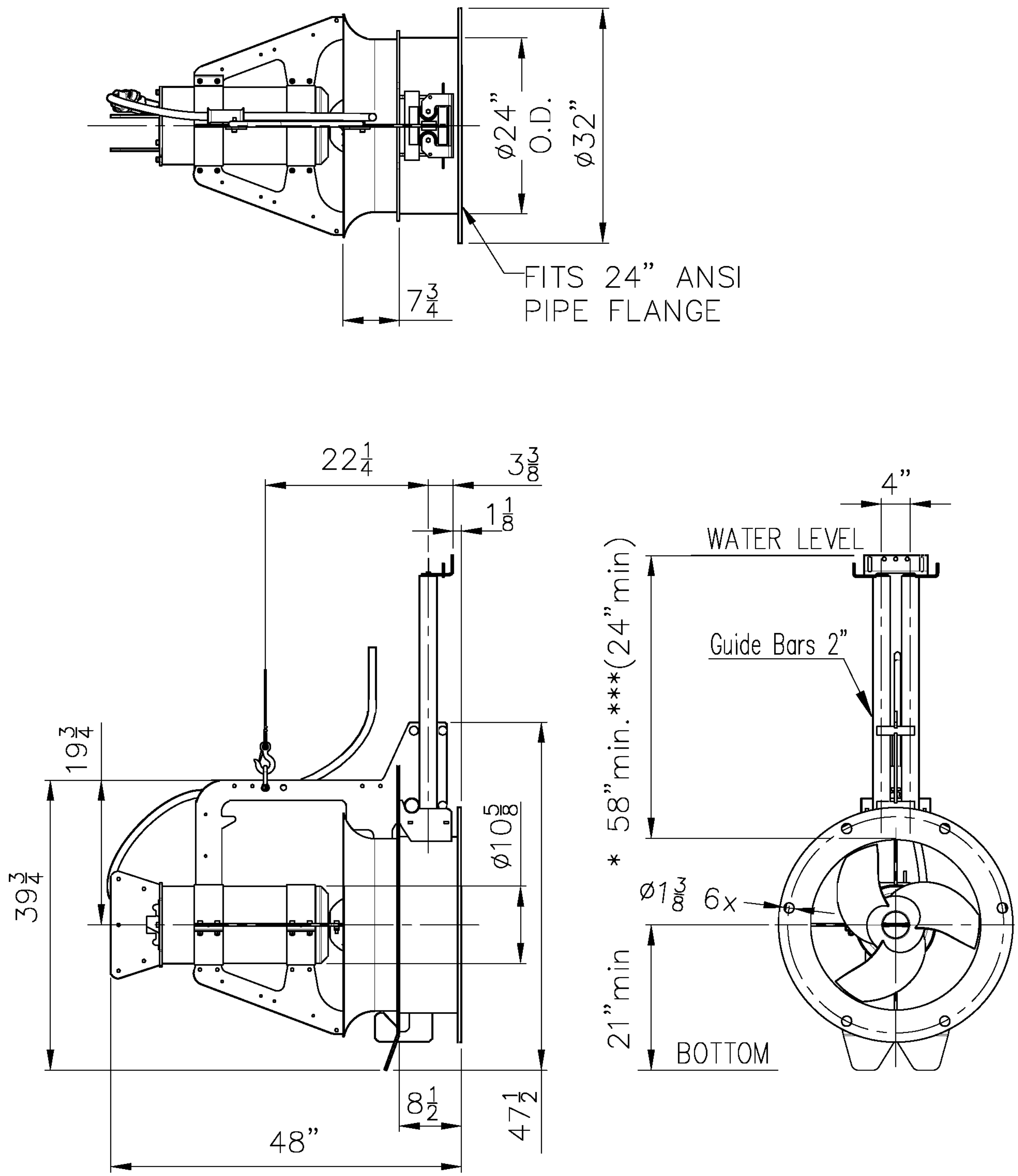
DUTY-POINT	FLOW[USgpm]	HEAD[ft]	POWER [hp]	EFF. [%]	NPSHre[ft]
1	6544	4.40	16.6 (13.1)	43.7 (55.8)	
B.E.P.	8701	3.16	14.4 (11.2)	48.5 (62.6)	



FLYPS3.1.6.6 (20090313)

HI B Curve

Performance with clear water and ambient temp 40 °C



* Guideline value, recommended minimum
submergence can be lower.
Contact ITT Flygt for more information.
*** With vortex protection shield

Weight (lbs)
Total
625

FLYGT AUTOCAD DRAWING	Denomination Dimensional drwg PP 4660.410,490 24" PIPE MOUNTED	Drawn by MRD	Checked by	Date 032107
		Scale		Reg no 5399
		14-68 22 39		A

PP-4600 Series Propeller Pumps

SCOPE

Furnish and install _________ submersible horizontal propeller pump(s). Each pump shall be equipped with _____HP, submersible electric motor connected for operation on a _____Volt, _____ Phase, 60 Hertz, _____ wire service, with 25 Ft. of _____ conductors with # _____ AWG size Subcab cable. All cables shall be chlorinated polyethylene rubber jacketed. Each unit shall be fitted with _____ feet (minimum) of lifting cable of adequate strength to permit raising and lowering the pump.

MANUFACTURER REQUIREMENTS

The pumping equipment specified herein shall be the design and fabrication of a single manufacturer which shall have sole source responsibility for said equipment.

PUMP DESIGN

The pump(s) shall be capable of handling raw, screened sewage. The pump(s) shall be able to be raised and lowered and shall be easily removed for inspection or service without the need for personnel to enter the pump sump. The pump, with its appurtenances and cable, shall be capable of continuous submergence under water without loss of watertight integrity to a depth of 130 Ft.

PUMP CONSTRUCTION

Each pump shall be of the integral design, close coupled, submersible type. All components of the pump, including motor shall be capable of continuous underwater operation. In addition, all components of the pump shall be capable of continuous operation completely submerged.

Major pump components shall be of ASTM 316 construction. The lubricant housing cover plate shall be of corrosion resistant plastic. All exposed nuts and bolts shall be of stainless steel.

All metal surfaces coming into contact with the pumped media, other than stainless steel, shall be protected by a factory applied powder coating of a polyester resin paint.

MOTOR

The multi-pole motor shall be directly connected to the propeller (gearbox designs are not acceptable) to produce a propeller speed of _____RPM. The pump motor shall be squirrel cage, induction, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180°C (356°F). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31.The stator shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable. The motor shall be designed for continuous duty, capable of sustaining a maximum of at least ten (10) evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of aluminum.

ELASTOMERS

All mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile rubber or optional Viton O-rings. Fitting shall be such that sealing is accomplished by metal-to-metal contact between machined surfaces. This will result in controlled compression of the O-rings without requiring a specific torque limit. No secondary sealing compounds, rectangular gaskets, elliptical O-rings, grease or other devices shall be used.

PROPELLER
The propeller shall be of 316 stainless steel, Factory balanced, non-clogging backward curved design. Each blade shall be laser cut and welded to the hub and tested to ensure that the propeller is properly balanced. The propeller shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in normal sewage applications. The propeller shall be_____ inches in diameter and have three blades, each at a blade angle of _____ degrees.

CABLE ENTRY
The cable entry housing shall be an integral part of the back plate. The cable entry shall have a double set of elastomer grommets in order to ensure a redundant system in the event of a cable entry seal failure. Single sealing systems will not be deemed acceptable. The cable entry shall be comprised of two cylindrical elastomer grommets, each flanked by washers and a ferrule designed with close tolerance fit against the cable outside diameter and the entry inside diameter. This will provide a leak proof, torque-free seal at the cable entrance. The assembly shall bear against a shoulder in the stator casing opening and be compressed by a gland nut threaded into it. Interaction between the gland nut and the ferrule should move the grommet along the cable axially instead of with a rotary motion. The junction chamber and motor compartment shall be separated by a terminal board which shall protect the motor interior from foreign material gaining access into the pump top. Connection between the threaded compressed type binding posts permanently affixed to the terminal board and thus perfectly leak proof. **Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.**

BEARINGS
All bearings shall have a minimum L10 rated life of 100,000 Hrs. The outboard propeller bearing shall be an angular contact bearing. The motor shaft end shall be supported by two bearings. A roller bearing shall take up the radial loads while an angular contact bearing shall take up the axial loads.

THERMAL SENSORS
Thermal sensors shall be used to monitor stator temperatures. The stator shall be equipped with three (3) thermal switches embedded in the end coils of the stator winding. These shall be used in conjunction with, and supplemental to, external motor overload protection, and wired to the control panel.

SHROUD ASSEMBLY
The pump assembly shall incorporate a bell shaped inlet shroud, 360 degrees around the propeller.

LUBRICANT HOUSING
The lubricant housing shall contain two compartments consisting of an inner and an outer section with four ports to connect and facilitate lubricant flow. In the event that the mixed media bypasses the outer seal, this design will allow the outer compartment to collect the heavier (denser) fluids by means of the simple process of gravity.

MECHANICAL SEALS
Each mixer shall be provided with two sets of lapped end face type mechanical seals running in oil reservoirs for cooling and lubrication. The mechanical seals shall contain positively driven rotary, corrosion resistant, Tungsten Carbide/Tungsten Carbide face rings for the outer seal assembly and Tungsten Carbide/Aluminum Oxide seal faces for the inner seal assembly or optional Silicon Carbide rings (select appropriate materials). The inner secondary seal shall be a leakage-free seal. The upper seal shall contain one stationary and one positively driven rotating corrosion resistant tungsten-carbide seal ring. The rotating seal ring shall have small back-swept grooves laser inscribed upon its face to act as a pump as it rotates, returning any fluid that should enter the dry motor chamber back into the lubricant chamber. In order to avoid seal failure due to sticking, clogging, and misalignment from elements contained in the mixed media, only the seal

faces of the outer seal assembly and its retaining clips shall be exposed to the mixed media. All other components shall be contained in the oil housing.

The seals shall require neither maintenance nor adjustment, but shall be easy to check and replace. Shaft seals without positively driven rotating members shall not be considered acceptable or equal.

Seal lubricant shall be FDA Approved, non-toxic.

PUMP TEST
The pump manufacturer shall perform the following inspections and tests on each pump before shipment from the factory:

a) Propeller(s), motor rating(s), and electrical connection(s) were checked for compliance to the purchase order.
b) All pumps are vacuum tested to establish sealing integrity. All pumps are momentarily energized to determine correct rotation and current draw (prior to immersion).
c) All pumps are run dry and/or immersed to determine correct shaft rotation, thrust direction, and power consumption.
d) After immersion test(s), all pumps are inspected for lubricant seepage and/or water infiltration, insulation defect(s), and resistance (Ohms).

Inspections and tests performed shall confirm the pump(s) listed have met all established quality assurance standards set for similar materials. All pumps shall be warranted against defects in design, workmanship, and material (with validation being the warranty card(s) shipped with the product(s).

A written report stating the foregoing steps has been done and may be required with each pump at the time of shipment (upon prior notice to the fabrication of the pumps).

WARRANTY
ITT WATER & WASTEWATER U.S.A., INC

For the period defined, ITT WATER & WASTEWATER offers a commercial warranty to the original End Purchaser against defects in workmanship and material on Flygt Products. Warranty covers Flygt parts and labor as outlined in **ADDENDUM – A**.

COVERAGE:
ITT WATER & WASTEWATER will pay the cost of parts and labor during the warranty period, provided that the Flygt product, with cable attached, is returned prepaid to an ITT WATER & WASTEWATER Authorized Service Facility for Flygt Product repairs. Coverage for Flygt parts and labor will be provided for the period shown in **ADDENDUM - A.** The warranty period will begin from date of shipment or date of a valid Start-up (For permanently installed pumps only). In cases where the Start-up date is used as the beginning of the warranty on a permanently installed Flygt pump, a Start-up Report completed by an approved service technician from an ITT WATER & WASTEWATER Authorized Service Facility for Flygt products must be received by the ITT WATER & WASTEWATER Area Service Manager for Flygt Products within thirty (30) days of the initial onset of the unit placed into service. If not received, the beginning of the warranty coverage will default to the Flygt product ship date. A Start-up for a permanently installed Flygt pump must occur within one (1) year from the date of shipment from an ITT WATER & WASTEWATER authorized facility for Flygt Products or warranty will automatically default to ship date as start of warranty. (See **STORAGE** section) When using the start-up date as the beginning of the warranty, a copy of the Start-up Report will be required to support any Warranty Claims. Warranty on Flygt Dewatering pumps will begin with ship date only. No other date on Flygt Dewatering pumps will be considered.

ITT WATER & WASTEWATER'S sole obligation under this Warranty for Flygt Products shall be to replace, repair or grant credit for Flygt Products upon ITT WATER & WASTEWATER'S exclusive determination that the Flygt Product does not conform to the above warranty. In the event that the Flygt product is replaced, warranty on the replacement product will be equal to the balance remaining on the original product or ninety (90) days, which ever is greater.

MISUSE:
This Warranty shall not apply to any Flygt product or part of Flygt product which (i) has been subjected to misuse, misapplication, accident, alteration, neglect, or physical damage (ii) has been installed, operated, used and/or maintained in a manner which is in an application that is contrary to ITT WATER & WASTEWATER'S printed instructions as it pertains to installation, operation and maintenance of Flygt Products, including but without limitation to (iii) operation of equipment without being connected to monitoring devices supplied with specific products for protection; or (iv) damaged due to a defective power supply, improper electrical protection, faulty installation or repair, ordinary wear and tear, corrosion or chemical attack, an act of God, an act of war or by an act of terrorism; or (v) has been damaged resulting from the use of accessory equipment not sold by ITT WATER & WASTEWATER or not approved by ITT WATER & WASTEWATER in connection with Flygt products.

WEAR PARTS:
This warranty does not cover costs for standard and/or scheduled maintenance performed, nor does it cover Flygt parts that, by virtue of their operation, require replacement through normal wear (aka: Wear Parts), unless a defect in material or workmanship can be determined by ITT WATER & WASTEWATER. Wear Parts are defined as Cutters, Cutting Plates, Impellers, Agitators, Diffusers, Wear Rings (Stationary or Rotating), Volutes (when used in an abrasive environment), oil, grease, cooling fluids and/or any items deemed necessary to perform and meet the requirements of normal maintenance on all Flygt equipment.

WARRANTY
ITT WATER & WASTEWATER U.S.A., INC

DISCLAIMERS:

(i) ITT WATER & WASTEWATER'S warranties are null and void when Flygt Products are exported outside of the United States of America without the knowledge and written consent of ITT WATER & WASTEWATER U.S.A., INC.; (ii) ITT WATER & WASTEWATER makes no independent warranty or representation with respect to parts or products manufactured by others and provided by ITT WATER & WASTEWATER (however, ITT WATER & WASTEWATER will extend to the Purchaser any warranty received from ITT WATER & WASTEWATER'S supplier for such parts or products).

LIMITATIONS:

ITT WATER & WASTEWATER NEITHER ASSUMES, NOR AUTHORIZES ANY PERSON OR COMPANY TO ASSUME FOR ITT WATER & WASTEWATER, ANY OTHER OBLIGATION IN CONNECTION WITH THE SALE OF ITS FLYGT EQUIPMENT. ANY ENLARGEMENT OR MODIFICATION OF THIS WARRANTY BY A FLYGT PRODUCT DISTRIBUTOR, OR OTHER SELLING AGENT SHALL BECOME THE EXCLUSIVE RESPONSIBILITY OF SUCH ENTITY.

THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ANY AND ALL OTHER EXPRESS OR IMPLIED WARRANTIES, GUARANTEES, CONDITIONS OR TERMS OF WHATEVER NATURE RELATING TO FLYGT PRODUCT(S), INCLUDING AND WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE WHICH ARE HEREBY EXPRESSLY DISCLAIMED AND EXCLUDED. PURCHASER'S EXCLUSIVE REMEDY AND ITT WATER & WASTEWATER'S AGGREGATE LIABILITY FOR BREACH OF ANY OF THE FOREGOING WARRANTIES IS LIMITED TO REPAIRING OR REPLACING FLYGT PRODUCTS AND SHALL IN ALL CASES BE LIMITED TO THE AMOUNT PAID BY THE PURCHASER HEREUNDER. IN NO EVENT IS ITT WATER & WASTEWATER LIABLE FOR ANY OTHER FORM OF DAMAGES, WHETHER DIRECT, INDIRECT, LIQUIDATED, INCIDENTAL, CONSEQUENTIAL, PUNITIVE, EXEMPLARY OR SPECIAL DAMAGES, INCLUDING BUT NOT LIMITED TO LOSS OF USE, LOSS OF PROFIT, LOSS OF ANTICIPATED SAVINGS OR REVENUE, LOSS OF INCOME, LOSS OF BUSINESS, LOSS OF PRODUCTION, LOSS OF OPPORTUNITY OR LOSS OF REPUTATION.

ITT WATER & WASTEWATER WILL NOT BE HELD RESPONSIBLE FOR TRAVEL EXPENSES, RENTED EQUIPMENT, OUTSIDE CONTRACTOR'S FEES, OR ANY EXPENSES ASSOCIATED WITH A FLYGT PRODUCT REPAIR SHOP NOT AUTHORIZED BY ITT WATER & WASTEWATER U.S.A., INC. REIMBURSEMENT COSTS FOR CRANES AND/OR ANY SPECIAL EQUIPMENT USED IN CONJUNCTION FOR THE REMOVAL AND/OR REINSTALLATION OF ANY FLYGT EQUIPMENT IS NOT COVERED UNDER THIS WARRANTY.

ANY UNAUTHORIZED ALTERATIONS TO SUPPLIED FLYGT EQUIPMENT USED WITHOUT ITT WATER & WASTEWATER SUPPLIED FLYGT BRAND CABLE OR CONTROLS WILL NOT BE COVERED UNDER THIS WARRANTY, UNLESS IT CAN BE PROVEN SUCH ANCILLARY EQUIPMENT IS SUITABLE FOR THE PURPOSE AND EQUAL TO ITT WATER & WASTEWATER SUPPLIED FLYGT BRAND CABLES OR CONTROLS THAT WOULD ORIGINALLY HAVE BEEN SUPPLIED WITH THE TYPE OF EQUIPMENT IN USE.

REQUIREMENTS:

A copy of Electrical System Schematics of the Control used (including a Control's Bill of Material) could be required to support a Warranty Claim when a non Flygt Brand Control is used. In addition, a written record, hereby known as "the log", will be associated with each unit serial number and must be maintained by the organization having product maintenance responsibility. The log must record each preventative maintenance activity and any repair activity during the life of the warranty or verification that an ITT Water & Wastewater authorized Service Contract for Flygt Products is in force and must be available for review and/or auditing. Failure to meet these conditions could render this warrant null and void. Such logs could be required to determine warranty coverage.

WARRANTY
ITT WATER & WASTEWATER U.S.A., INC

STORAGE:
Should a delay occur between ship date and the date of start-up, maintenance as outlined in ITT WATER & WASTEWATER'S Care & Maintenance Manual for Flygt Products must be performed by the "CONTRACTOR" and/or "OWNER" during any such period of storage. Documentation providing proof and outlining what maintenance was performed must be provided to ITT WATER & WASTEWATER or its Flygt Products representative within thirty (30) days of said maintenance, or the ITT WATER & WASTEWATER warranty for Flygt Products could be considered void.

CONTROLS:
Warranty coverage for permanently installed controls will start for the end purchaser on the date of shipment.. This warranty does not apply to controls that have been damaged due to a defective and/or improper input power supply, improper electrical protection, accidental damage, improper or unauthorized installation and/or repair, unauthorized alteration, negligence, environmental corrosion or chemical attack, improper maintenance or storage of control, any act of God, an act of war, an act of terrorism or damage resulting from the use of accessory equipment not approved by ITT WATER & WASTEWATER. Further, this warranty does not apply in the event an adjustment is found to correct the alleged defect.

Solid state devices will be covered for a period of one (1) year. Electrical control panels containing controllers, PLC's, drives, soft starts, and other computerized equipment will require Transient Voltage Surge Suppression (TVSS) protection in order to satisfy the requirements of this warranty. The protection equipment associated with the control must be kept in working condition during the life of the warranty. Auxiliary equipment supplied with the control (air-conditioners etc.) is limited by the respective original equipment manufacturer's warranty offered. Consumable items such as: light bulbs, fuses, and relays are covered under normal operating conditions. Electrical surges experienced during startups and/or during normal operating use of the control panel will cause the consumable items not to be covered under this warranty policy. Components not supplied by ITT WATER & WASTEWATER will not covered by this warranty.

TOP (The Optimum Pump Station)
ITT WATER & WASTEWATER will warrant the Flygt TOP pre-engineered fiberglass pump station components against defects in material and workmanship for a period of one (1) year from date of start-up or eighteen (18) months from date of shipment and is valid only to the original owner of the station. Warranty shall cover the cost of labor and materials required to correct any warrantable defect, excluding any removal and reinstallation costs, FOB ITT WATER & WASTEWATER'S authorized warranty service location for Flygt's TOP.

Flygt Products contained within a TOP pre-engineered fiberglass pump station will carry the standard ITT WATER & WASTEWATER warranty for Flygt products and/or accessories installed in the TOP pre-engineered fiberglass pump station.

All Flygt Product restrictions and/or limitations as outlined and described within the context of this warranty are germane to all sections of this ITT WATER & WASTEWATER Warranty document.

ITT WATER & WASTEWATER US - WWW
National Quality Assurance - US Corporate
prodqual@itt.com

WARRANTY
ITT WATER & WASTEWATER U.S.A., INC

ADDENDUM – WARRANTY COVERAGE BY PRODUCT

PRODUCT	PRODUCT SERIES AND CONFIGURATION	Months 1 - 12	Months 13 - 18	Months 19 - 36	Months 37 - 39	Months 40 - 60
Axial Flow/ Mixed Flow/ Centrifugal Pumps & Mixers	3000 Series (CP, NP, DP, CT, NT, CZ, LL) 4000 Series (SR, PP) 7000 Series (PL)	100%		50%		25%
Electrical Control Panels (permanently installed)	WWW Manufactured Control Panels - 3 - Years	100% - 1 YR	LIMITED - 2 - YR			
Abrasion/Corrosion Resistant & Chopper/ Grinder Pumps	3000 Series (MP, MF, MH, FS, FP, HP, HS) 5000 Series (HP, HS) 8000.280 Series (DP, DZ, DT, DS, DF)	100%				
Dewatering Pumps	2000 Series (BS, KS) 3000 Series (CS, NS, DS) 8000.280 Series (DS, DF)	100% (From Ship Date)				
TOPS	Fiberglass Pump Station	100% (From Ship Date)				
Accessories	Permanent / Portable	100% (From Ship Date)				
Hydro ejectors/ Aerators	HE, JA	100%				
Portable Pump Controls	Control Boxes (Nolta, MSHA etc,)	100% (From Ship Date)				
Small Pumps	3045, 3057, SX	100% (From Ship Date)				
Parts - *	All new spare parts	100% (From Ship Date)				

* - Parts that fail where used in a repair are warranted for one (1) year from the date of the repair for the failed part only – no labor.

PumpTech Inc.

SERVING THE PACIFIC NORTHWEST

PUMP SALES & SERVICE

April 21, 2011

CH2M Hill
2020 SW 4th Ave.
Suite 300
Portland, OR 97201

Attn: Adrienne Menniti
Ref: Bend Secondary Expansion – Mixed Liquor Re-Cycle Pumps

Dear Adrienne:

PumpTech Inc. is pleased to provide this preliminary selection and budgetary proposal for Morrison, vertical pumps, rated 6000 GPM @ 4' TDH for your Mixed Liquor Re-Cycle application.

For the purposes of this estimate, we have made the assumption that the total pump length (TPL) will be +- 20'. TPL along with materials of construction, coatings, etc can be finalized as you move along with your project.

I have attached Morrison Pump Company Equipment Data Sheet proposed performance curve for your use. I ask that you review this data and get back to me with any questions that you may have.

Unfortunately, with the upcoming holiday, I was unable to get you a drawing, but I have requested one and will forward on to you early next week.

Respectfully;

Jim DeWolf

Jim DeWolf
PumpTech Inc.
jdewolf@pumptechnw.com

PH: 503-659-6230
Fax: 503-659-8718

EQUIPMENT DATA

1.1 MORRISON PUMP COMPANY – Vertical High-Efficiency Lineshaft Pumps

Morrison Pump Model	:	VPS-16-14-02
Pump Bowl Model	:	Axial Flow MP-14-02-CH
Impeller Diameter	:	14 in.
Pump Performance (DP)	:	6,200 GPM @ 4 Ft. TDH
Pump Efficiency	:	78% @ Design Condition
Horsepower at DP	:	8 HP
Pump Speed	:	890 RPM
Total Pump Length	:	20 ft

<u>Material and Construction Features</u>

Pump Body

Elbow Column	:	A36 carbon steel
Bowl Casing	:	A36 carbon steel
Suction Bell	:	A36 carbon steel
Bearing Retainers	:	A36 carbon steel
Wear Ring	:	A36 carbon steel
Flanges	:	A36 carbon steel, parallel machined

Rotating Element

Shaft	:	316 Stainless Steel
Bearings	:	Nitrile Rubber
Propeller	:	316L stainless steel

Protective Finish

Preparation	:	non-ss parts – sandblast to white metal finish
Coating	:	Two-Part Epoxy (12 mils minimum)
Sacrificial Anodes	:	zinc

2.1 Driver

Manufacturer	:	USM
Model	:	VHS / NRR
Horse Power	:	15 HP
Speed	:	890 rpm
Power	:	3/60/460
Enclosure	:	TEFC

BUDGETARY PRICING AND TERMS OF DELIVERY

Item	Qty	Description	Unit Price
1.1 – 2.1	1	Morrison Axial Flow Pump Pump Model VPS-16-14-02 VHS 20 HP Motor, 890 rpm, PE	
		Total: CIF Portland OR	$55,000.00

Includes submittals, IOM manual, 1 site visit by Morrison technician, start-up assistance.

Delivery:

Technical Submittals: approx. 2 weeks after receipt of approved purchase order.
Equipment Delivery: Approx. 20 weeks after submittal approval, or per agreed delivery schedule.

Warranty:

Morrison Pump Company guarantees all pump equipment provided under this contract against defects of workmanship or faulty materials for a period of twelve (12) months after station acceptance, not to exceed 16 months after the date of delivery. Improper use, modifications or alteration of the equipment by others shall void the foregoing warranty. Morrison Pump Company shall not be liable under any circumstances for consequential damages, whether from breach or warranty (expressed or implied), negligence or otherwise. Electric motors shall be warranted by motor manufacturer.

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Bellevue, WA 98005
Ph: 425-644-8501
Fax: 425-562-9213
pumptech@pumptechnw.com
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Fax: 509-766-6331
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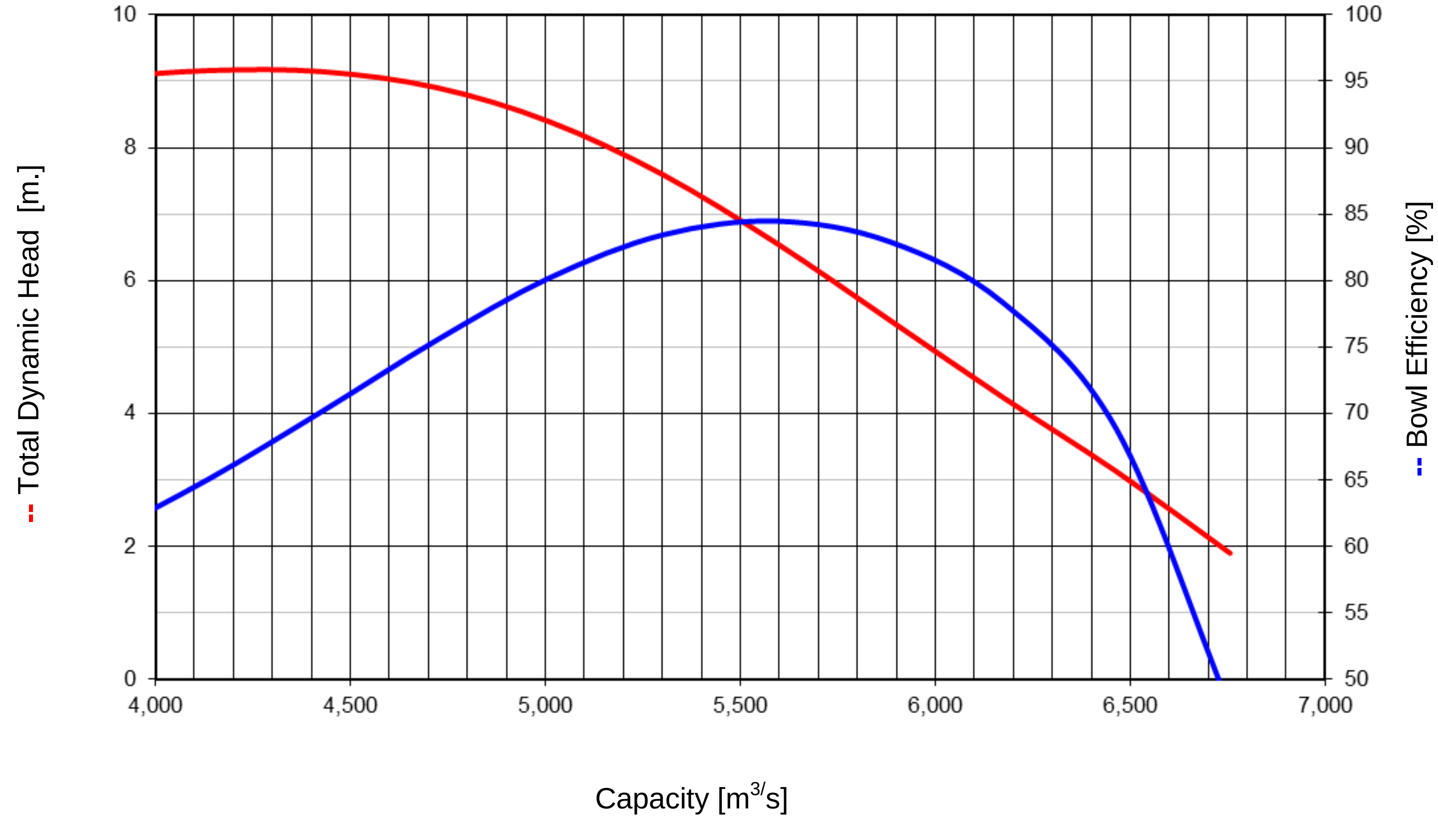
☐ PumpTech Inc.
321 S Sequoia Parkway
Canby, OR 97013
Ph: 503-659-6230
Fax: 503-659-8718
inquiries@pumptechnw.com
OR CONTRACTORS # 154997

Pump Performance

Axial Flow Impeller, One-Stage, High-Efficiency

Project No.: 5108
Project Name: CH2MHill
Date: 21-April-2011

MORRISON PUMP MODEL VPS-16-14-02
Rated Condition = 6,000 GPM @4.0 Ft. TDH



Pump Bowl Model No.:	MP-14-02-CH
Impeller Diameter:	14 in.
Shaft Speed:	890 RPM

MORRISON
PUMP COMPANY

WEMCO-HIDROSTAL
Prerotation Pumping System

Excellent
Power & Industrial
Solutions

WEIR
POWER & INDUSTRIAL

Cleans Wet-Wells Automatically
Prefabricated Prerotation Basin & Wet-Well Pumping System

Prefabricated Self-Cleaning Wet-Wells

The WEMCO-Hidrostal prefabricated sump system is simple and fast to install or retrofit into the wet-well.
The best part - all work is done above ground!

- Simple installation saves time and money
- All assembly work is done above ground
- No climbing into the wet-well for installation
- No anchor bolts in the floor of the wet-well
- Pre-located base anchors to insure proper alignment

- A rubber hose or hard piping from the base elbow discharge flange.
- A cast iron "fast-out" is anchored to the basin.
- A Hidrostal screw centrifugal immersible pump.
- The weight of the concrete sump holds it in place without the need for any anchorage to the wet-well

Dual Prerotation Basin

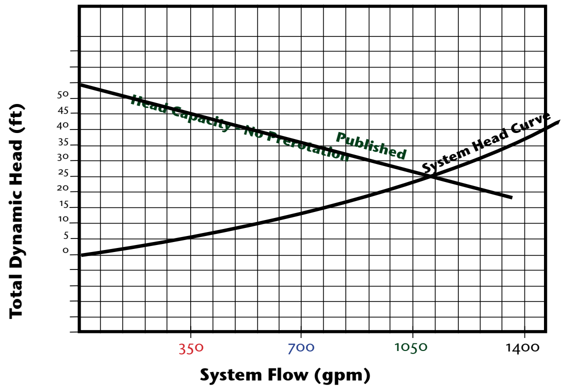
- Lightweight fiberglass basins are filled with concrete during on-site construction, eliminating expensive transportation costs.
- A built-in shelf supports and anchors the base elbow of the submersible pump, properly aligning the pump in the basin.
- Optional rubber hose attached to discharge elbow allows:
  - Easy attachment to final discharge pipe before lowering the assembly into the wet-well - No entry into the wet-well is required.
  - Simplifies alignment with existing piping in retrofit applications.

Installation Sequence

1. Prerotation system is assembled above ground for installation into the wet-well.
2. The system is lowered into the wet-well as a unit, providing a complete pumping system.
3. Installation complete! The pump can be raised and lowered for maintenance since it is independent of the base elbow.

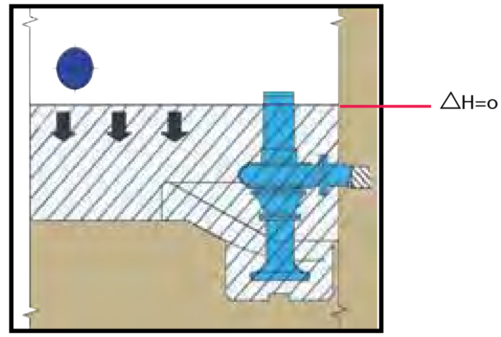
Prerotation Sequence

No Prerotation



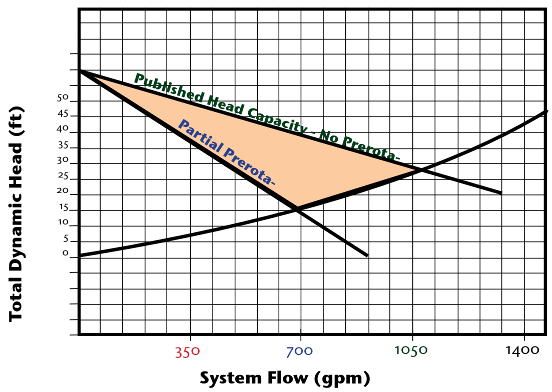
Hidrostal Pre-Rotation Performance
Pump Model ESK-S • Speed = 1160 rpm

Level above weir. Pump operates on published head capacity curve.



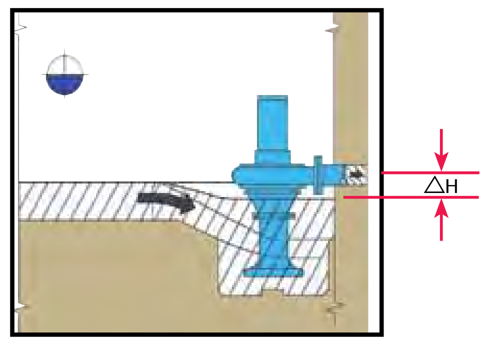
Events:
1. No △H in Prerotation Sump (high water level).
2. No Prerotation.
3. Pump operates on published head capacity curve.

Partial Prerotation



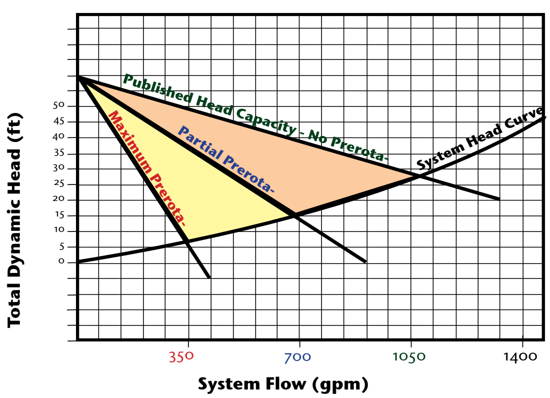
Hidrostal Pre-Rotation Performance
Pump Model ESK-S • Speed = 1160 rpm

Partial Prerotation. Pump capacity automatically reduced, floatables gently entrained.



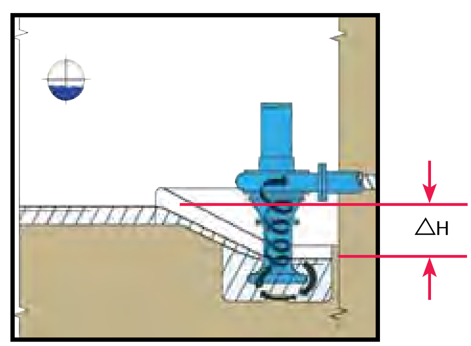
Events:
1. Flow forced through entrance channel, between forebay and prerotation sump.
2. △H creates rotation of fluid in prerotation.
3. Pump capacity decreases.

Maximum Prerotation



Hidrostal Pre-Rotation Performance
Pump Model ESK-S • Speed = 1160 rpm

Maximum prerotation and floatables' entrainment. Pump capacity reduced to minimum flow. Further flow reduction will turn off the pump.



Events:
1. Maximum △H in prerotation basin
2. Maximum rotation of fluid in prerotation sump.
3. △Maximum reduction in pump capacity.

Self-Cleaning Wet-Well Sequence

1-Typical influent of pump station with floating scum. Pump “Off”

2- Pump “on” and operating at full capacity

3- Start of prerotation. Floating material moves to prerotation basin where it is corralled.

4- Floating material is entrained and folded into pump suction by prerotation action and pumped from wet well.

5- Self-cleaning action occurs throughout the prerotation cycle, resulting in a clean wet-well every time the prerotation cycle occurs.

Represented by:

Weir Specialty Pumps

440 West 800 South
P.O. Box 209 (84110-0209)
Salt Lake City, UT 84101
USA

Tel: 801 359 8731
Fax: 801 530 7828
email: info@weirsp.com
web: www.weirsp.com

Excellent
Power & Industrial
Solutions

Attachment C—Schematic Design Fact Sheets

RAS Flow Testing Results

ATTACHMENT C TO: TM 4—Secondary Treatment Improvements

PROJECT: Schematic Design Report
Bend Water Reclamation Facility Secondary Expansion

Objective

The objective of the testing was to attempt to confirm peak return activated sludge (RAS) flow rates, and to further determine if any hydraulic limitations exist in the existing system.

Background

Scott Thompson and Brady Fuller performed RAS peak flow testing on February 8, 2011. This fact sheet documents their observations.

Procedure

1. Open all 3 RAS valves to 100 percent open from supervisory control and data acquisition (SCADA) in the operations building.
2. Go to field and observe the RAS "morning glory" outlets into the RAS wet well. (Confirm unsubmerged discharge.)
3. Observe the secondary clarifier mechanism RAS trough. Confirm if there are apparent hydraulic bottlenecks as evidenced by constricted flow. Observe the scum collection pump, which pumps to the gravity line that feeds the secondary scum wet well.
4. Observe the RAS pump drive's digital speed (rpm) readout. The pumps were not at maximum rotations per minute (rpm) (which is 880). The pumps were around 800 rpm.
5. Observe RAS flow control valve position. All valves were 100 percent open, except for the most southerly valve (from Secondary Clarifier 2), which had already started to close in response to operator initiated changes at conclusion of the test.

Observations

1. The clarifier peak flows quickly reached a maximum steady rate. Maximum sustained flow from each clarifier is as follows (see attached screen shot from SCADA):

   a. Clarifier 1 - 2.090 mgd
   b. Clarifier 2 – 2.046 mgd
   c. Clarifier 3 – 2.136 mgd
   d. This is a total of 6.272 mgd

2. The sum of RAS pump discharge rate (which is not directly controlled by the RAS withdrawal rate, but is a function of the RAS pumping control loop that maintains wet well level) to the three aeration basins was 4,431 gallons per minute (gpm) (6.38 million gallons per day [mgd]). The split is controlled by keeping RAS valve on the most distant aeration basin (#1) 100 percent open and adjusting valve position for the other two to split equally to all three.

3. Staff report daily "cleaning" of the RAS draft pipes by opening the flow control valves to 100 percent for a short period of time. Therefore, the testing performed on February 8, 2011, was a typical operating mode.

4. No hydraulic "pinch points" were observed in the secondary clarifier RAS trough that is mounted to the rake arm. The flow was turbulent and each vertical RAS suction tube was flowing and discharging up into the bottom of the RAS trough, creating turbulence at the location of the discharge. There was no apparent backwater up into the RAS trough.

5. Staff members report that they have significant hydraulic limitations when trying to drain existing Aeration Basins 1 and 2 back to the RAS suction pipe for RAS Pump 2, which is connected to the RAS wet well, and only two basins are online. The RAS discharge pipe sizes as-installed are too small to effectively allow pumped discharge within a reasonable time frame. Staff used to be able to drain an aeration basin during 8 hours, and now reportedly choose to have staff be onsite overnight and drain the aeration basins when flows and associated RAS flow rates are lower. The apparent reason for this change is the increased diurnal RAS rates that are proportional to plant inflow.

6. Design team has stated that the existing RAS pump station has the following capacity (per Project Definition Workshop): 6.3 mgd RAS/11.5 mgd average daily maximum month = 54 percent. The observed results match the assumptions made in Project Definition.

7. Installed RAS pumps have a rated capacity of 2,100 gpm/pump (~3 mgd per pump for two duty pumps) at 25 feet total dynamic head. No measurement of the discharge head of the RAS pumps was made as part of this work.

Recommendations

1. Secondary Expansion Team should consider how to modify RAS header to provide increased RAS conveyance for periods when only two basins are online.

2. Consider if any programming changes are needed for RAS flow control valve split. Consider changes to programming to address daily cleaning of RAS draft pipes.

RAS/WAS Pump Station Ventilation

ATTACHMENT C TO: TM 4—Secondary Treatment Improvements

PROJECT: Schematic Design Report
Bend Water Reclamation Facility Secondary Expansion

Objective

Modify the existing return activated sludge (RAS)/waste activated sludge (WAS) pump station to meet current National Fire Protection Association (NFPA) 820 requirements.

Background

The existing Bend Water Reclamation Facility (WRF) RAS/WAS pump station was built as part of the original plant construction in 1978 before NFPA 820 was adopted. The purpose of NFPA is to provide a degree of fire and explosion protection for the facilities and the protection of life.

Design Criteria

This facility is classified as a Sludge Pumping Station Dry Well under Table 6.2(a) Row 9. Table 1 lists the design criteria specific to addressing the ventilation and other requirements of NFPA 820.

TABLE 1
RAS/WAS Pump Station NFPA Design Criteria
City of Bend Water Reclamation Facility

Criterion	Value
Required building air changes per hour	6
Ventilation configuration	Push-pull, supply and exhaust
Required status monitoring	Supply fan, exhaust fan, entry, space alarms
Required alarms	Audible and visual inside space
Entry alarms	Go/no-go entry lights at each entry to building
Required monitoring	SCADA interface with environmental monitoring system

SCADA = supervisory control and data acquisition.

Evaluation of Alternatives

Ventilation upgrades at the RAS/WAS pump station are not required because the facility was constructed before the effective date of NFPA 820. In addition, there are no immediate planned improvements or modification to this existing building. Due to these factors, the facility falls under the retroactivity clause of NFPA 820 and should be acceptable to the Authority Having Jurisdiction in the current condition because of the low risk of this type of facility. However, when any modifications to the pump station are done, the ventilation will be required to be fully updated in compliance with NFPA 820.

Alternative 1—Update Ventilation System

Advantages

- Updates ventilation to meet NFPA 820 code requirements.
- Provides safeguards against fire and explosion hazards.
- Provides safeguards for personnel that may be at the work station located in this pump station.

Disadvantages

- Costs of construction, implementation, monitoring, and controls

Alternative 2 –Leave Ventilation as Existing

Advantages

- Defers cost of ventilation improvements until required by pump station modifications.

Disadvantages

- Risk, however small, of undetected hazardous gases in this semi-occupied space.

Recommendations

The recommendation for the RAS/WAS pump station ventilation is to defer improvements until modifications to the pump station trigger compliance with NFPA 820.

TM 5—Blower System Improvements

PREPARED FOR: Jim Wodrich, P.E./City of Bend

PREPARED BY: Jason Krumsick/CH2M HILL

REVIEWED BY: Dave Green, P.E./CH2M HILL
Brady Fuller, P.E./CH2M HILL
Jim Griffiths, P.E./CH2M HILL

DATE: October 3, 2011

PROJECT: Schematic Design Report
Bend Water Reclamation Facility Secondary Expansion

Background

This technical memorandum details presents the design criteria and schematic design information for blower system improvements for the Bend Water Reclamation Facility (WRF).

The facility currently uses multistage centrifugal blowers to provide process air to the aeration basins. Additonal process air capacity will be required with the construction of a fourth aeration basin and the use of integrated fixed-film activated sludge (IFAS) media.

The Project Definition Report documents the following decisions:

- A new blower building will be constructed with five 300 horsepower (hp) and one 100 hp high-speed direct drive turbo blowers. Space for a sixth blower will be reserved in this new blower building.
- Redundancy will be provided by the existing centrifugal blowers located in the existing blower building.
- The new blower building will provide process air to treat up to 8.5 mgd average day maximum month (ADMM) influent flow using the recommended 5 high-speed direct drive turbo blowers.
- The new blower electrical room will be sized to serve the ultimate blower building capacity.
- The new blower building facility will have space for rotary screw air compressors, air receiver, and desiccant air dryers to provide additional plant air capacity.

Design Criteria

The process air requirements for IFAS are summarized in Table 1. These air requirements will be revised in consultation with the selected IFAS manufacturer who will be identified early in the design development phase.

TABLE 1
IFAS Blower System Design Criteria
City of Bend Water Reclamation Facility

	Blower System Design Criteria (scfm)			
	Average Day Maximum Month Wastewater Flow			
Scenario Parameters	**Startup 6.0 mgd**	**Near-term 8.5 mgd**	**Design 11.9 mgd**	**Buildout 17.5 mgd**
Scenario A[a]				
Minimum Week	5,949	8,910	18,214	17,144
Annual Average	9,098	20,676	27,450	39,371
Average Day Maximum Month	13,370	23,922	32,263	47,922
Maximum Week	20,555	34,182	33,570	60,067
Scenario B[b]				
Minimum Week	4,559	7,576	10,346	15,324
Annual Average	7,473	15,682	19,742	28,396
Average Day Maximum Month	10,490	17,834	24,137	35,866
Maximum Week	15,406	26,893	30,860	46,374
Scenario C[c]				
Minimum Week	4,681	7,531	9,285	13,753
Annual Average	7,582	13,305	15,715	22,968
Average Day Maximum Month	9,591	16,945	19,813	29,737
Maximum Week	12,423	23,063	25,977	39,058

[a]Within Scenario A, bulk-liquid DO varies from 4 mg/L to 6 mg/L depending on the influent conditions. Also, some conditions warrant the use of aeration in the swing zone to provide full nitrification.

[b]Within Scenario B, bulk liquid DO varies from 2 mg/L to 4 mg/L depending on the influent conditions.

[c]Within Scenario C, bulk liquid DO is held at 2 mg/L.

DO = dissolved oxygen; mgd = million gallons per day; mg/L = milligrams per liter; scfm = standard cubic feet per minute.

Process Description

Blower System

The facility secondary expansion will include improvements to the blower system. Required blower capacity will be povided with new high-speed direct drive turbo blowers. The existing multistage centrifugal system will remain available for backup and redundancy and to use during peak air demands.

High-speed direct drive turbo blowers manufactures provide cooling for the blower motors and electrical equipment in one of two general ways. One way is to reject the air used for cooling to the building and the other way is to reject the air to the blower inlet air and out the blower discharge. Manufacturers that direct wast heat to the to the building gain slight benefits in blower efficiency. This is acomplished by avoiding preheating the blower intake air. This is offset by the power needed to run and additional fan and motor. Other benefits are reduced builiding heating during cold weather. Draw backs of this method are for the potential of additional ventilation or builiding cooling during hot weather. Manufacturers that reject heat to the Blowers inlet and discharge lose slight efficiencys associated with raising the inlet temperature of the air. Other draw backs to this cooling method is the absence of additional building heating druing cold weather. Benefits are that this method dose not add additional heat loading to the building that may requre additional ventilation and cooling during hot weather.

Table 2 contains the design data for the blower system.

TABLE 2
Blower System Design Data
City of Bend Water Reclamation Facility

Description	Criteria
New blower type	High-speed, direct-drive turbo
Number of new blowers	Five
Blower (quantity), size	Four 300 hp; one 100 hp
Discharge Pressure	8 psig
Capacity	300 hp – 5,500 scfm/blower
	100 hp – 1,500 scfm/blower
Total capacity	23,500 scfm
Existing blower type	Multistage centrifugal
Number of existing blowers	Four
Blower (quantity), size	Four 250 hp
Discharge pressure	8 psig
Capacity	3,500 cfm/blower
Total capacity	14,000 scfm

psig = pounds per square inch guage
hp = horsepower
scfm = standard cubic feet per minute

Plant Air System

The facility secondary expansion will include extending the existing plant air system. The existing rotary screw compressors located in the digester faciltiy will continue to operate.

Room for additional plant air capacity is provided in the new blower building. Space is allocated for two 50 hp rotary screw compressors, air receiver, and dessicant air dryers. This expansion will double the existing plant air capacity. Plant air from the new blower building will provide air to the northern half of the plant and will also be connected to the existing plant air distribution. Final selection and sizing of the new compressors will be developed further in the next design phase (design development).

Table 3 contains the design data for the plant air system.

TABLE 3
Plant Air System Design Data
City of Bend Water Reclamation Facility

Description	Criteria
Existing compressors (digester facitlity)	Rotary screw
Number of existing compressors	Two
Size of existing compressors	50 hp
Discharge pressure	100 psig
Capacity of exisitng	200 scfm/compressor
Existing dryers	Dessicant type, heatless regeneration
Number of dryers	Two
Capacity	200 scfm/dryer
New compressors	Rotary screw
Number of new (or future) compressors	Two
Size of new (or future) compressors	50 hp
Discharge pressure	100 psig
Capacity of new (or future)	200 scfm/compressor
New dryers (or future)	Dessicant type, heatless regeneration
Number of new (or future) dryers	Two
Capacity	200 scfm/dryer

psig = pounds per square inch guage
hp = horse power
scfm = standard cubic feet per minute

Reliability/Redundancy

Blowers System

The existing multistage centrifugal blower will provide aeration supply redundancy to the new high-speed turbo blower supply system.

Plant Air System

The existing plant air compressors are on standby power and operate in a LEAD/LAG sequence. Redundancy is provided by the LAG compressor. The new plant air compressors will not be on standby generator power, but the system will be intertied with the existing system that is on standby generator power. The new compressors will also be provided with LEAD/LAG sequencing.

Instrumentation and Control Strategy

Summary control narratives for new equipment are identified below.

Blowers

The new blowers will operate to maintain header pressure at a setpoint identified by operators via the human-machine interface (HMI) graphics (a proportional–integral–derivative controller [PID] controller in the programmable logic controller [PLC] will adjust blower speed). All running blowers will operate at the same speed. Blower total flow rate is calculated by adding air flows to all of the aeration basin feedpoints. When the total blower flow rate falls below a "low demand" setpoint, the system will operate in a LOW DEMAND mode. One blower is smaller than the rest, so it will be controlled slightly differently, as noted below.

During normal mode operation, the blowers will operate in a LEAD/LAG sequence. Operators will select the normal LEAD/LAG blower sequence via the HMI graphics (LEAD/LAG1/LAG2/LAG3/LAG4/LAG5). The lead pump will run continuously. As demand increases, an additional blower will be started if the PID controller requires the running blowers to operate over at 80 percent speed or above for a predetermined period of time. When demand lowers, lag blowers will be stopped sequentially if the PID controller allows the operating blowers to run at 50 percent speed or below for a predetermined period of time.

During low demand mode operation, only the small blower will run. If the small blower is out of service, control will default to the normal mode.

Because the existing blowers are less energy efficient than the new blowers, the existing blowers will be used only as a backup if the new blowers cannot handle the demand.

Plant Air Compressors

The new plant air compressors will operate to maintain pressure setpoint in the discharge piping. When discharge pressure falls below a "low" setpoint, the system will turn on. When discharge pressure reaches a "high" setpoint, the system will turn off.

In normal mode operation, the compressors will operate in a LEAD/LAG sequence. Operators will select the normal LEAD/LAG compressors via the HMI graphics.

Outstanding Issues

None.

Attachments

Attachment A—Equipment Data Sheets

- Aeration Blowers 1, 2, 3, 4
- Aeration Blower 5
- Air Compressor and Dryer

Attachment B—Vendor Catalog Cuts

- High-Speed, Direct-Drive Turbo Blowers 1–5 – Neuros
- High-Speed, Direct-Drive Turbo Blowers 1–5 – Kturbo
- Existing/Future Plant Air Compressors and Dryers – Rogers QNW G series

Attachment C— Fact Sheets

- Fact Sheet 1—Aeration System Blower Sizing Decisions

Attachment A—Equipment Data Sheets

Bend Water Reclamation Facility Secondary Expansion

EQUIPMENT DATA SHEET

SPEC SECTION: 44 42 19.02

LEAD ENGINEER: Krumsick

FACILITY NAME: 32 - Aeration Blowers

EQUIPMENT NAME: Aeration Blowers 1, 2, 3, 4, **QUANTITY:** 4

IDENTIFICATION NO.:

MATERIAL HANDLED: ALP - Air, Low Pressure Process

CAPACITY: 5,500 SCFM @ 8 psig

LOCATION: X dry ___ wet ___ exterior ___ hazardous

POWER REQUIRED: 300 hp 480 volts 3 phase

DRIVE: Variable Speed
(Constant speed, 2 speed, variable speed)

ENCLOSURE TYPE: MOTOR: PMSM CONTROL PANEL:

SYNCHRONOUS SPEED (rpm): 20,000 - 30,000

MOUNTING TYPE: Horizontal, Direct drive
(Horizontal or Vertical):

SUPPORT UTILITIES REQUIRED:
An active harmonic filter is required on the electrical feed to these blowers

EQUIPMENT DESCRIPTION: Direct drive, high speed turbo blower
(Size, configuration)

MANUFACTURERS: **NO. 1:** Neuros **NO. 2:** Kturbo

MODEL: NX300-C060 **MODEL:** TB300

EQUIPMENT WEIGHT: 4,270 lbs

EQUIPMENT COST: **QUOTE:** $784,000 **DELIVERY TIME:** 16-20 weeks

VENDOR: Dean Wood - Treatment Equipment Company, Neuros

MISCELLANEOUS COMMENTS, DATA, AND INFORMATION:
Quote includes variable speed drive and inverter, LCP, Blow off valve, Blow off silencer, electric line reactor
inlet air filter, discharge check valve, discharge butterfly valve, discharge expansion joint, spare set of air flilters

LOCATION OF EQUIPMENT: P&ID Sheet No. 08-I-012 Construction Sheet No.

REVISION	DATE	NO.	BY
Neuros quote	2/10/2011	1	j. krumsick

Bend Water Reclamation Facility Secondary Expansion

EQUIPMENT DATA SHEET

SPEC SECTION: 44 42 19.02

LEAD ENGINEER: Krumsick

FACILITY NAME: 32 - Aeration Blowers

EQUIPMENT NAME: Aeration Blower 5 **QUANTITY:** 1

IDENTIFICATION NO.:

MATERIAL HANDLED: ALP - Air, Low Pressure Process

CAPACITY: 1,500 SCFM @ 8 psig

LOCATION: X dry ___ wet ___ exterior ___ hazardous

POWER REQUIRED: 100 hp 480 volts 3 phase

DRIVE: Variable Speed
(Constant speed, 2 speed, variable speed)

ENCLOSURE TYPE: MOTOR: PMSM CONTROL PANEL:

SYNCHRONOUS SPEED (rpm): 20,000 - 30,000

MOUNTING TYPE: Horizontal, Direct drive
(Horizontal or Vertical):

SUPPORT UTILITIES REQUIRED:
An active harmonic filter is required on the electrical feed to this blower

EQUIPMENT DESCRIPTION:
(Size, configuration)

MANUFACTURERS: **NO. 1:** Neuros **NO. 2:** Kturbo

MODEL: NX100-C060 **MODEL:** TB100

EQUIPMENT WEIGHT: 1,850 lbs

EQUIPMENT COST: **QUOTE:** $103,000 **DELIVERY TIME:** 16-20 weeks

VENDOR: Dean Wood - Treatment Equipment Company, Neuros

MISCELLANEOUS COMMENTS, DATA, AND INFORMATION:
Quote includes variable speed drive and inverter, LCP, Blow off valve, Blow off silencer, electric line reactor
inlet air filter, discharge check valve, discharge butterfly valve, discharge expansion joint, spare set of air flilters

LOCATION OF EQUIPMENT: P&ID Sheet No. 08-I-012 Construction Sheet No.

REVISION	DATE	NO.	BY
Neuros quote	2/10/2011	1	j. krumsick

Bend Water Reclamation Facility Secondary Expansion

EQUIPMENT DATA SHEET

SPEC SECTION: ____________

LEAD ENGINEER: Krumsick

FACILITY NAME: 32 - Aeration Blowers

EQUIPMENT NAME: Air Compressor and Dryer **QUANTITY:** 2

IDENTIFICATION NO.: ____________

MATERIAL HANDLED: AHP - Air High Pressure Process

CAPACITY: 200 SCFM/ each at 100 psi

LOCATION: ____ dry ____ wet ____ exterior ____ hazardous

POWER REQUIRED: 50 hp 480 volts 3 phase

DRIVE: Constant Speed
(Constant speed, 2 speed, variable speed)

ENCLOSURE TYPE: MOTOR: ____________ CONTROL PANEL: ____________

SYNCHRONOUS SPEED (rpm): ____________

MOUNTING TYPE:
(Horizontal or Vertical): ____________

SUPPORT UTILITIES REQUIRED: ____________

EQUIPMENT DESCRIPTION: Rotary Screw compressor and dessicant dryer
(Size, configuration)

MANUFACTURERS: **NO. 1:** ____________ **NO. 2:** ____________

MODEL: ____________ **MODEL:** ____________

EQUIPMENT WEIGHT: ____ lbs

EQUIPMENT COST: **QUOTE:** ____________ **DELIVERY TIME:** ____________

VENDOR: ____________

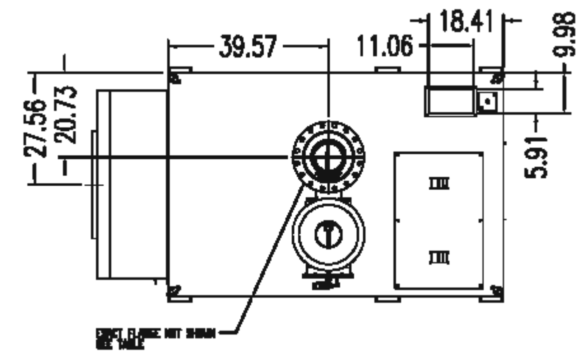
MISCELLANEOUS COMMENTS, DATA, AND INFORMATION: ____________

LOCATION OF EQUIPMENT: P&ID Sheet No. ____ Construction Sheet No. ____

REVISION	DATE	NO.	BY

Attachment B—Vendor Catalog Cuts

SYM	DESCRIPTION	Q'TY	
1	BLOWER ENCLOSURE	1	PX4331-SR-SPL07061801 (KCC)
2	BLOW-OFF VALVE	1	PE200 DARK GRAY 4G6-7.9B 4.3/0.6 (Chokwang-Paint)
3	BLOW-OFF SILENCER	1	PX4331-SR-SPL07061801 (KCC)
4	CONTROLLER	1	EX8616 BLUE (KCC)
5	DISCHARGE CONE	1	PX4331-SR-SPL07061801 (KCC)
6	NOISE SUPPRESSION COVER	1	
7	RADIATOR	1	
8	WATER PUMP	1	
9	WATER TANK	1	50 LITER, SST304
10	COOLING AIR INLET AND INLET INVERTER FILTER	1	
11	REACTOR	1	
12	INVERTER	1	
13	INLET AIR FILTER	1	



TOP VIEW

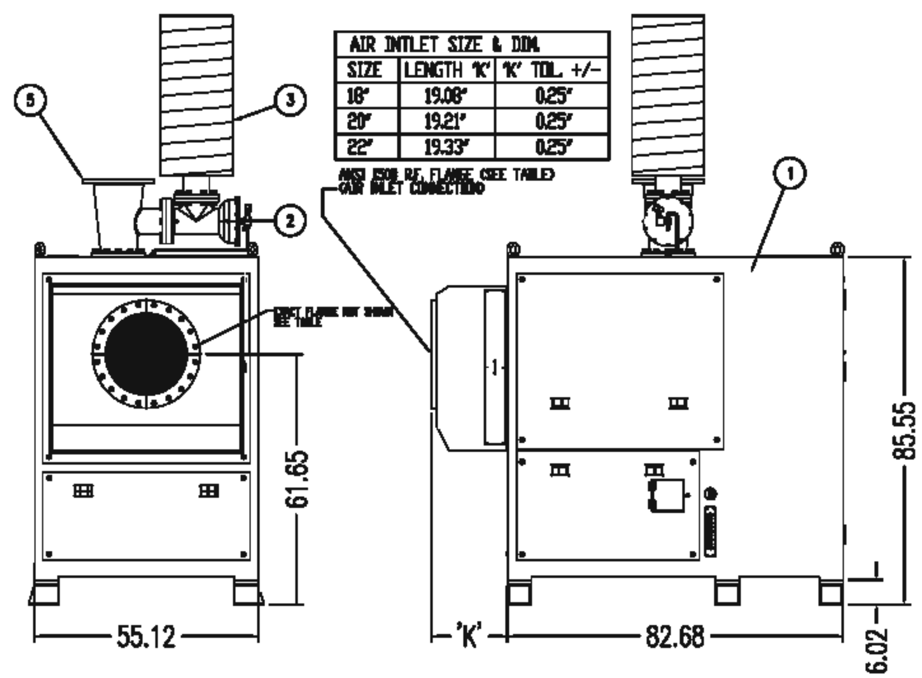
AIR INTLET SIZE & DIM.		
SIZE	LENGTH 'K'	'K' TOL. +/-
18"	19.08"	0.25"
20"	19.21"	0.25"
22"	19.33"	0.25"

ANSI 150# R.F. FLANGE (SEE TABLE) (AIR INLET CONNECTION)

LENGTH 'L': INCLUDING 1/8" THK. GASKET

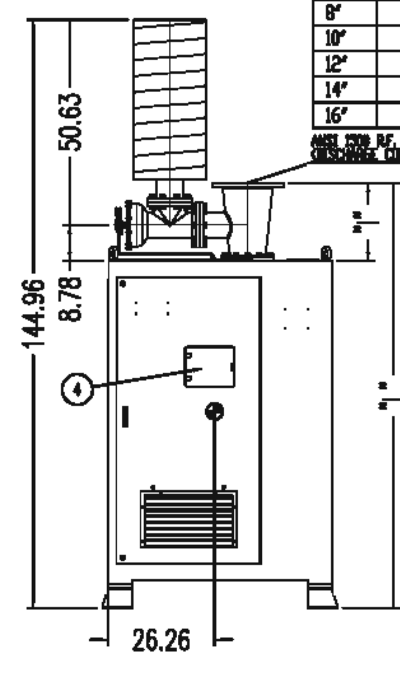
OUTLET AIR CONE EXIT SIZE			
SIZE	LENGTH 'l'	LENGTH 'L'	'L' TOL. +/-
8"	18.98"	104.65"	0.25"
10"	18.98"	104.65"	0.25"
12"	18.98"	104.65"	0.25"
14"	25.43"	111.11"	0.25"
16"	39.96"	125.64"	0.25"

ANSI 150# R.F. FLANGE (SEE TABLE) (DISCHARGE CONE CONNECTION)

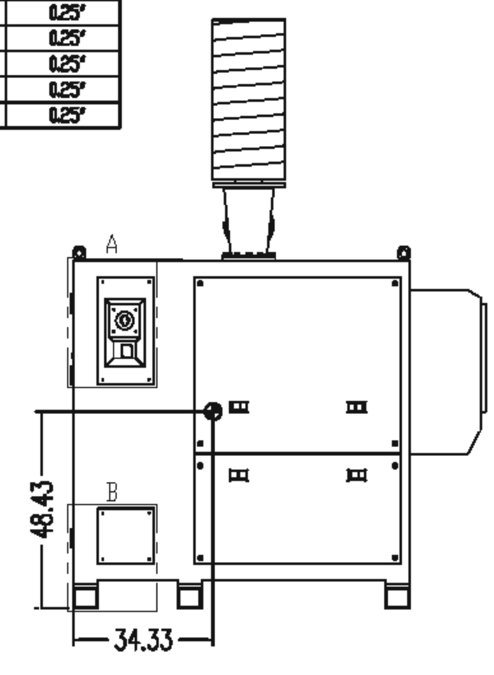


REAR VIEW

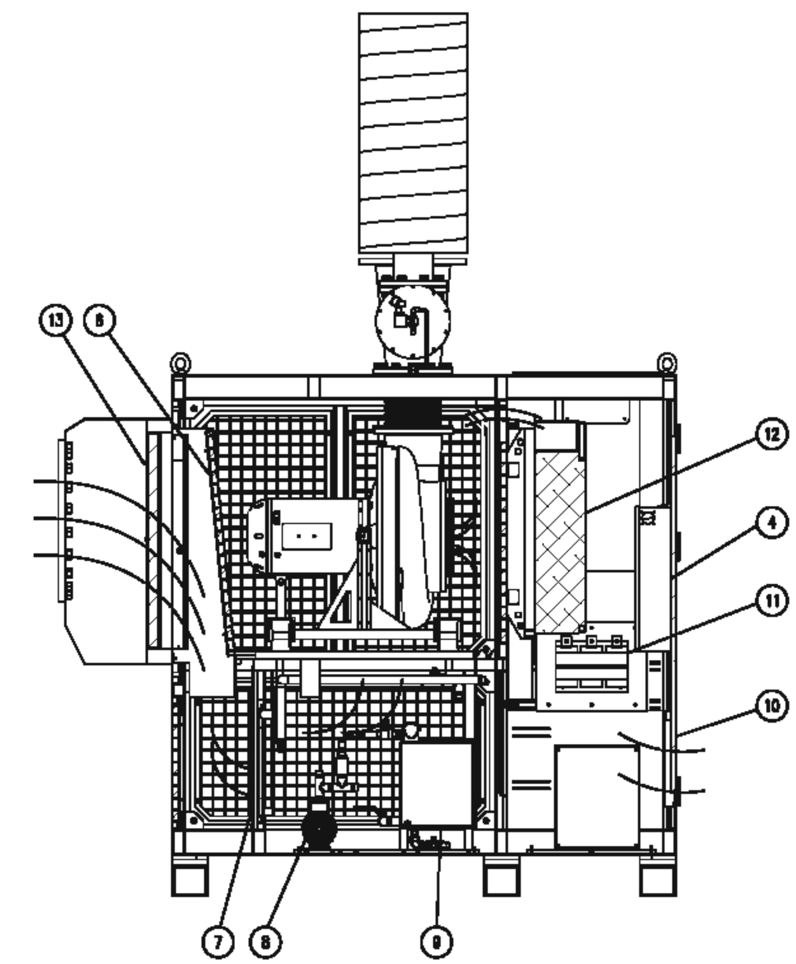
LEFT VIEW



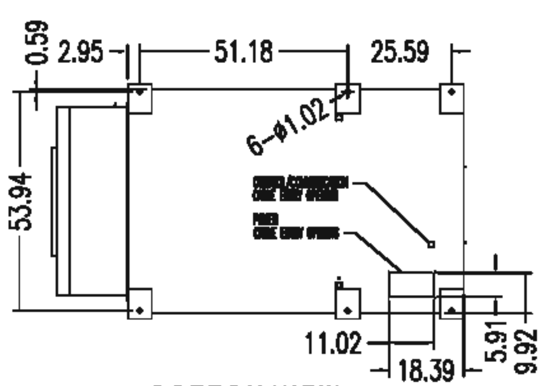
FRONT VIEW



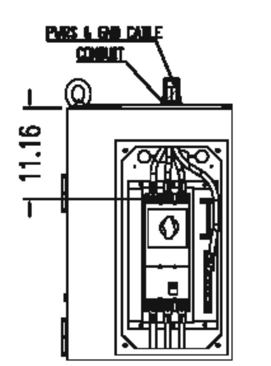
RIGHT VIEW



CUTAWAY VIEW

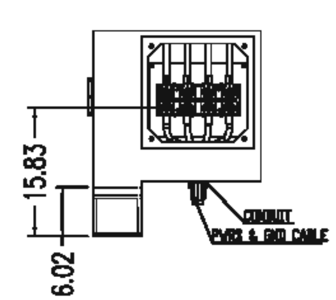


BOTTOM VIEW



DETAIL A

(COVER OMITTED FOR CLARITY)



DETAIL B

(COVER OMITTED FOR CLARITY)

DATE	PAR BY	VER. CHEC.	APP.	DESCRIPTION	REV.
SEPT/16/2010	D.P.			ISSUED FOR INFORMATION	A

UNLESS OTHERWISE NOTED:

1. ALL DIMENSIONS ARE IN (INCHES).
2. THIRD ANGLE PROJECTION:

APG-NEUROS

TITLE: NX-300 - 18" TO 22" ANSI R.F. FLANGED INLET - ANCHOR FOOT 8" TO 16" ANSI R.F. FLANGED OUTLET

PROJECT No.:

DRAWING No.: D-0300-810001

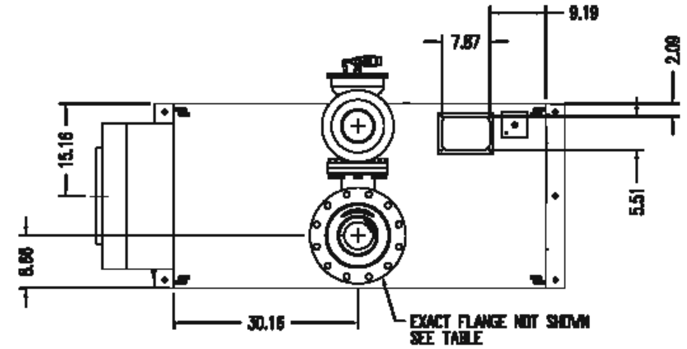
MSTR No.: NEUROS SEPT2010

SC.: 1/2" = 1'-0"

SHEET: 1 OF 1

REV: A

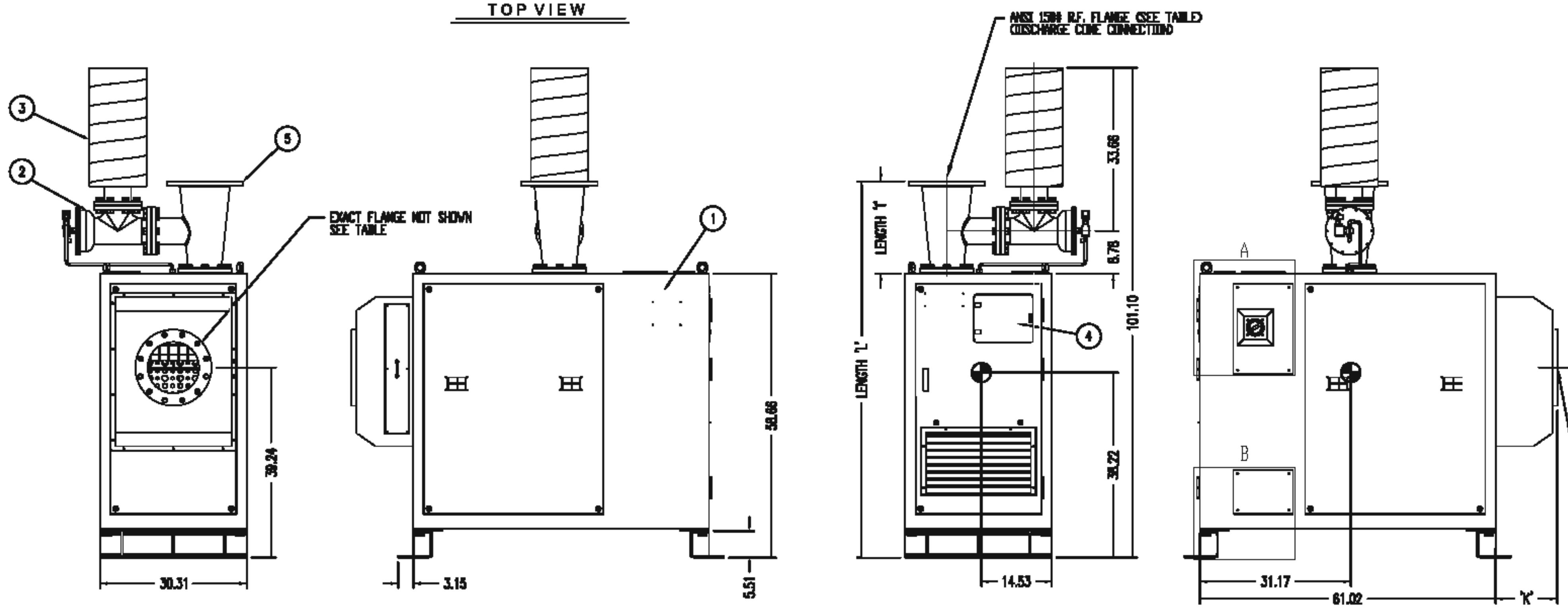
SYM	DESCRIPTION	Q'TY	
1	BLOWER ENCLOSURE	1	PX4331-SR-SPL07061801 (KCC)
2	BLOW-OFF VALVE	1	PE200 DARK GRAY 4G5-7.9B 4.3/0.6 (Chokwang-Paint)
3	BLOW-OFF SILENCER	1	PX4331-SR-SPL07061801 (KCC)
4	CONTROLLER	1	EX8616 BLUE (KCC)
5	DISCHARGE CONE	1	PX4331-SR-SPL07061801 (KCC)
6	NOISE SUPPRESSION COVER	1	
7	REACTOR	1	
8	INVERTER	1	
9	INLET AIR FILTER	1	
10	COOLING AIR INLET AND INLET INVERTER FILTER	1	



TOP VIEW

LENGTH 'L': INCLUDING 1/8" THK. GASKET

OUTLET AIR CONE EXIT SIZE			
SIZE	LENGTH 'l'	LENGTH 'L'	'L' TOL. +/-
6"	18.98"	77.76"	0.25"
8"	18.98"	77.76"	0.25"
10"	18.90"	77.68"	0.25"
12"	30.55"	89.34"	0.25"



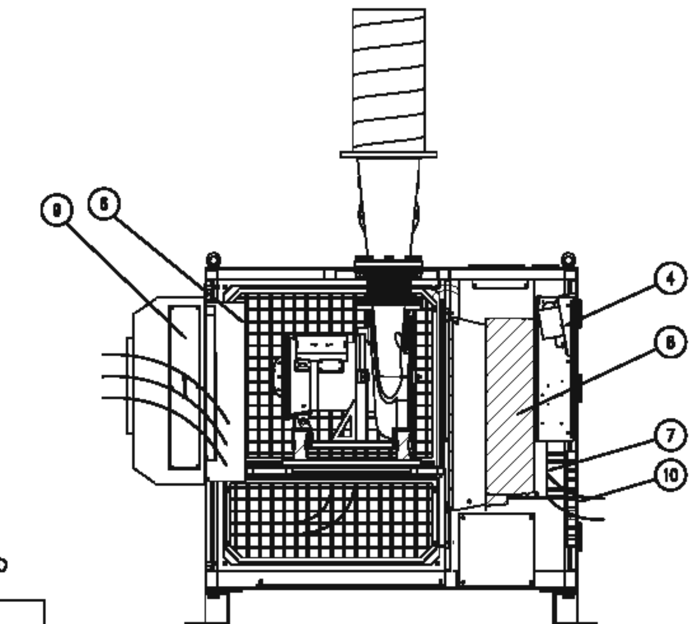
REAR VIEW

LEFT VIEW

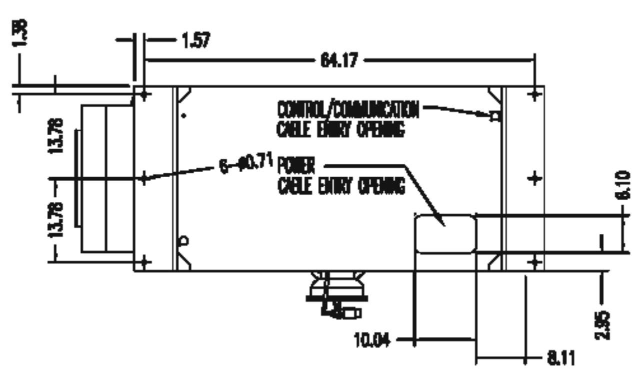
FRONT VIEW

RIGHT VIEW

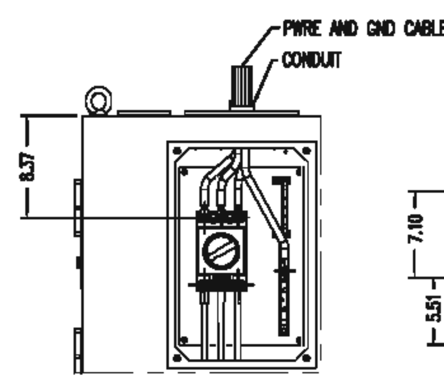
AIR INTLET SIZE & DIM.		
SIZE	LENGTH 'K'	'K' TOL. +/-
10"	13.00"	0.25"
12"	13.06"	0.25"
14"	13.19"	0.25"



CUTAWAY VIEW

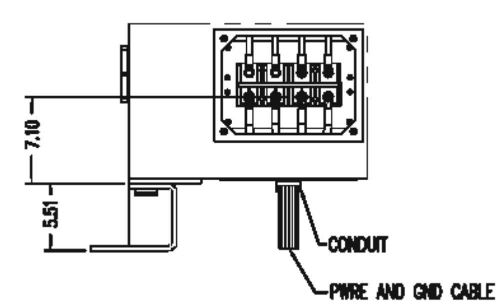


BOTTOM VIEW



DETAIL A

(COVER OMITTEM FOR CLARITY)



DETAIL B

(COVER OMITTEM FOR CLARITY)

UNLESS OTHERWISE NOTED:

1. ALL DIMENSIONS ARE IN [INCHES].
2. THIRD ANGLE PROJECTION:

APG-NEUROS

DATE	PAR BY	VER. CHEC.	APP.	DESCRIPTION	REV.
SEPT/16/2010	D.P.			ISSUED FOR INFORMATION	A

FOR / POUR

TITLE: NX-100 - 10" TO 14" ANSI R.F. FLANGED INLET - ANCHORED FOOT 6" TO 12" ANSI R.F. FLANGED OUTLET

PROJECT No.:

DRAWING No. / No. DE DESSIN: D-0100-810001

MSTR No.: NEUROS SEPT2010

SC. / ECH.: 3/4" = 1'-0"

SHEET / PAGE: 1 OF 1

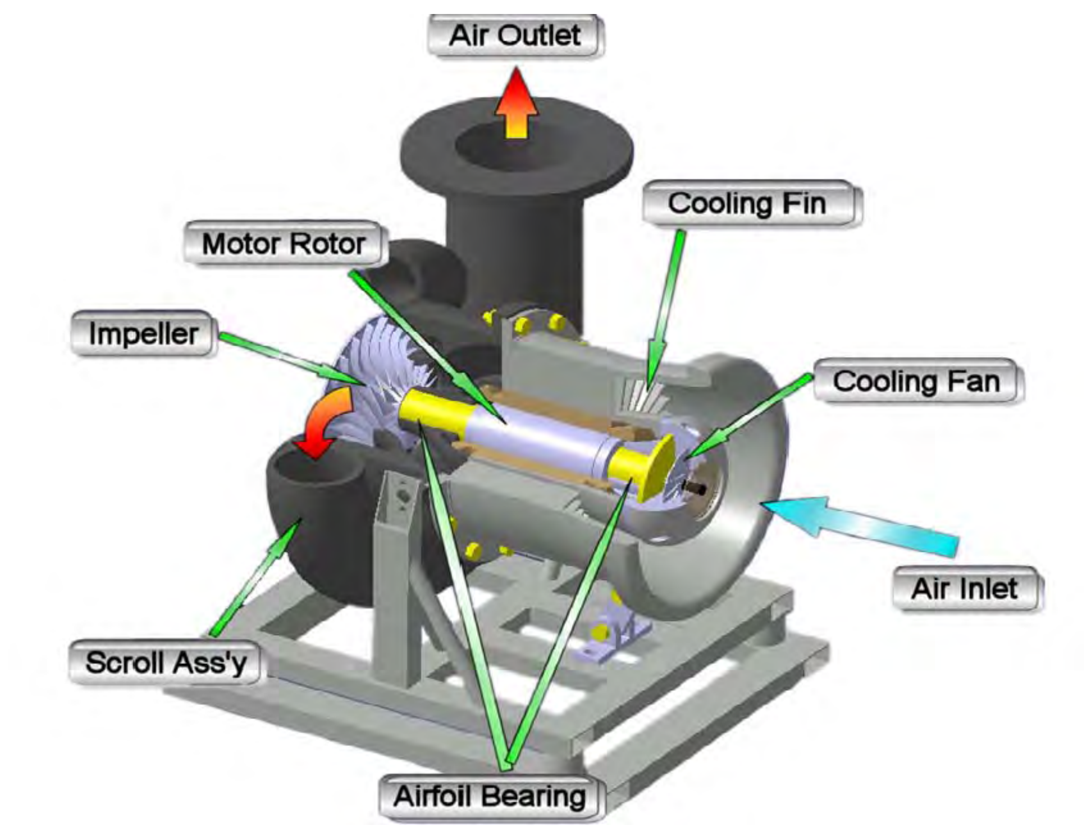
REV: A

Neuros Turbo Blower Scope of Supply Proposal

Bend Secondary Expansion

Prepared By APG-Neuros Inc.

Date
February 10, 2011



Neuros Turbo Blower Core

APG-Neuros Inc.
3200 Cours Le Courbusier, Boisbriand, QC, J7G-3E8
Tel: 450-939-0799 Fax: 450 939 2115
www.apg-neuros.com

Bend Secondary Expansion - Neuros Turbo Blower - Performance Data

Design Conditions			
Application	Aeration	Aeration	
Working Fluid	Air	Air	
Elevation	3625	3625	Feet
Atmospheric Pressure	13	13	PSIA
Inlet Pressure	12.8	12.8	PSIA
Inlet Temperature	101	101	Deg. F
Relative Humidity	15	15	%
System Design Requirements			
Maximum System Flow Rate	5500	1500	SCFM
Number of Blowers Operating	4	1	Units
Quantity Stand-By	0	0	Units
Design Condition Flow per Blower	5500	1500	SCFM
Design Discharge Pressure	8	8	PSIG
Blower Performance Data - At Design Conditions			
Model	**NX300-C060**	**NX100-C060**	
Rate Motor Output Power	300	100	hp
Maximum Air Flow @ Duty Discharge Pressure per Blower	5814	1779.8	SCFM
Minimum Air Flow @ Duty Discharge Pressure per Blower	2907	886.2	SCFM
Turndown from Maximum Flow	50.0%	50.2%	%
Shaft Power @ Design Condition per Blower	**238.6**	**69.7**	**bhp**
Wire-to-Air Power @ Design Condition per Blower	**199.3**	**58.2**	**kW**
Discharge Temperature @ Design Condition	202.7	209.9	Deg. F
Maximum Discharge Pressure @ Reduced Flow Rate	10.02	10.27	PSIG
Total Rise-to-Sure Capability	2.02	2.27	PSIG
Notes			
Maximum Noise Level @ 3 feet	80	80	dBA
Dimensions per Blower, L / W / H	83/55/80	61/30/53	Inches
Weight per Unit	4268	1848	lbs
Heat Rejection inside Blower Room	0	0	kW
Cooling Requirements	0	0	kW
Inlet Flange Size (Optional)	20	10	Inches
Discharge Flange Size	14	8	Inches
Note: Output Power exceeding Rated Motor Output Power shall be allowed within the limit of the service factor and relevant conditions			
Tolerance of ± 5 % on flow and power values, 2 dB on noise			

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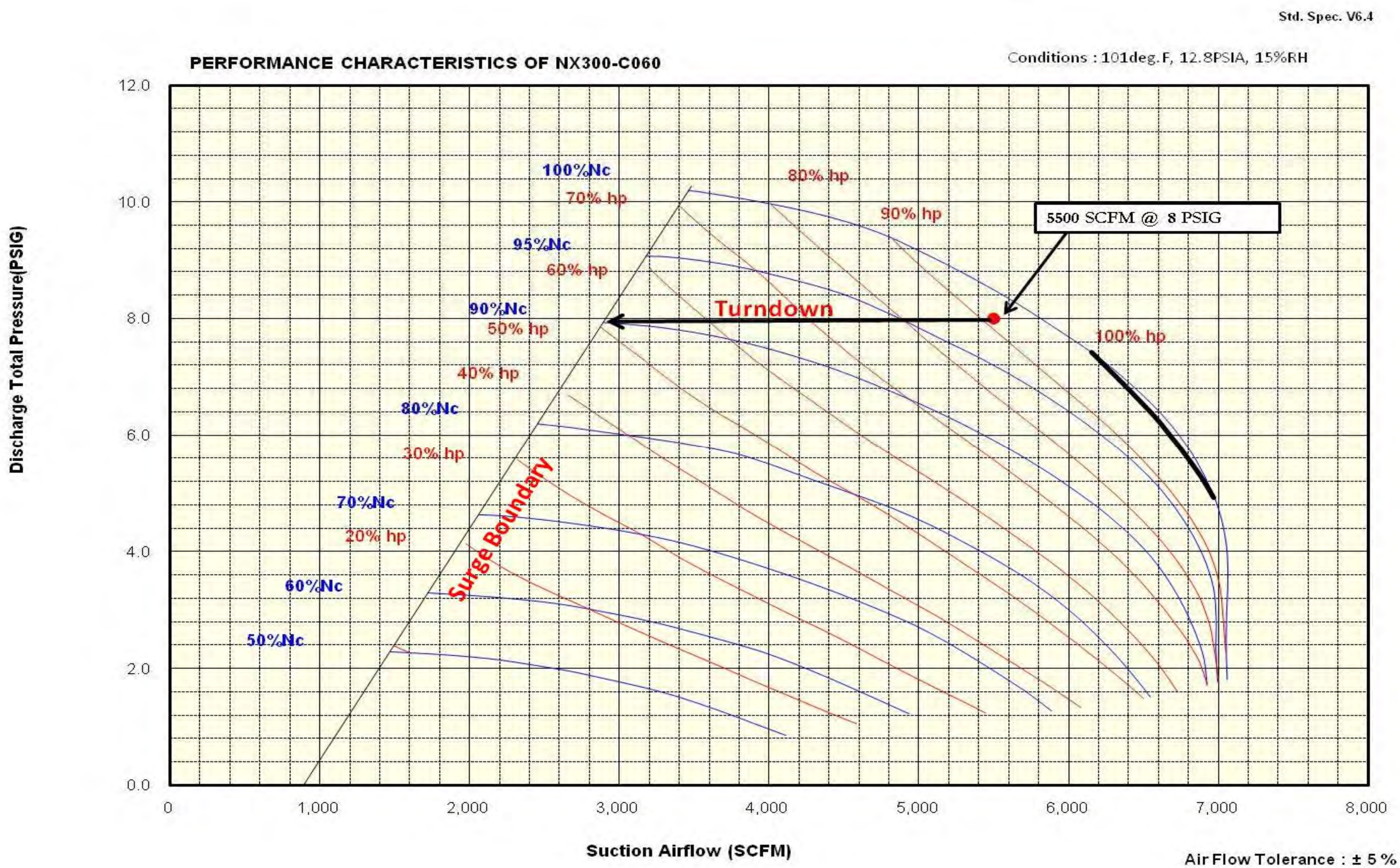
Bend Secondary Expansion - Neuros Turbo Blower - Performance Curves



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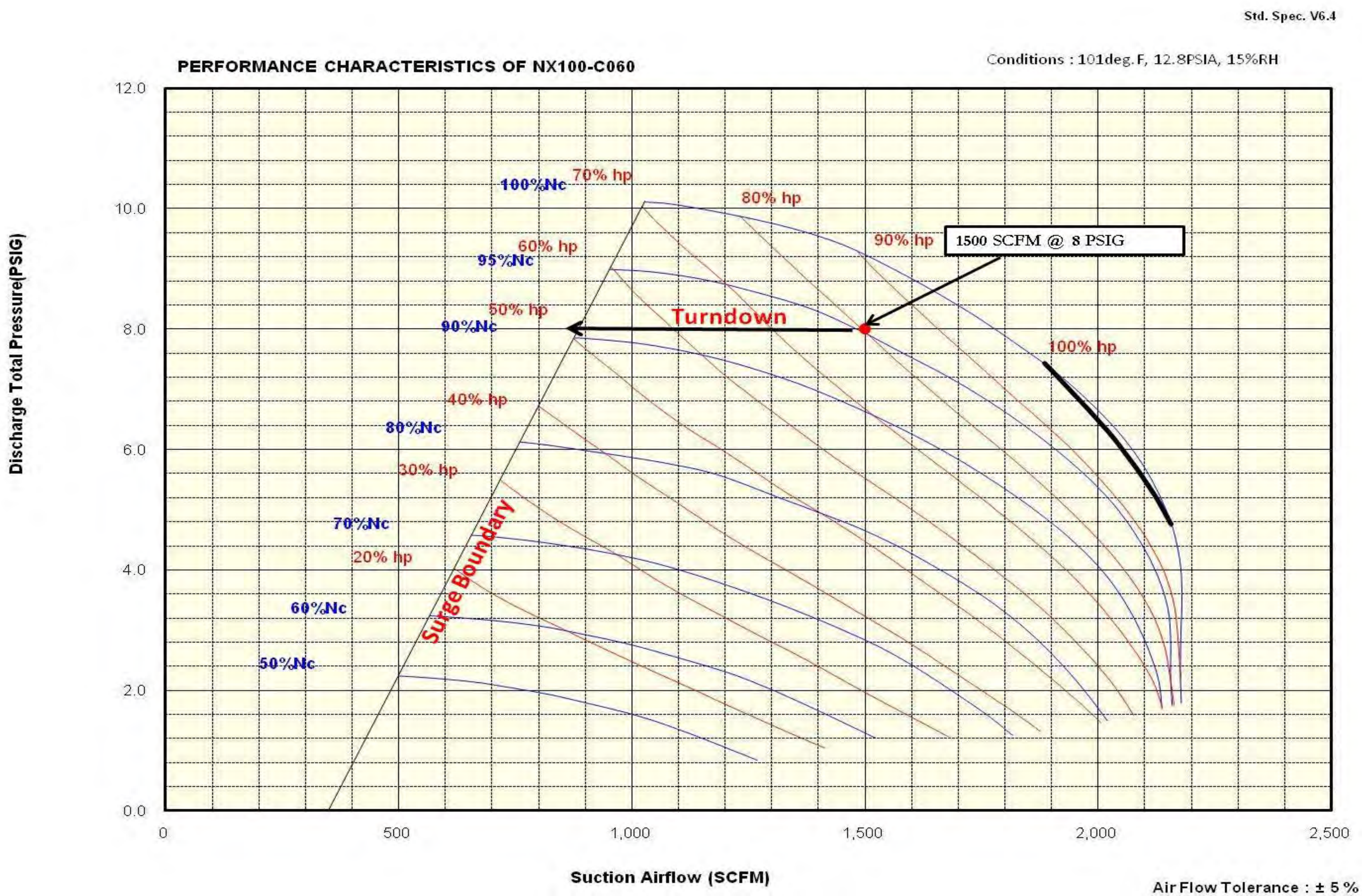
Bend Secondary Expansion - Neuros Turbo Blower - Performance Curves



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Bend Secondary Expansion - Neuros Turbo Blower - Scope of Supply

APG-Neuros Inc, agrees to sell to the Buyer, the equipment designated as included in the scope of supply below, subject to the Seller's General Terms and Conditions of Sales available upon request and special conditions outlined herein in this proposal.

1. Standard Neuros Turbo Blower Package ***(Included)***
Blower Core with Permanent Magnet Synchronous Motor
1. High Performance Variable Speed Drive & Inverter - Specially Tuned for High Speed Motor
2. Local Control Panel for Control and Monitoring, A-B MicroLogix PLC based
3. Remote Control capability via Ethernet, LAN or Hard wiring
4. Built in Sound Enclosure to below 80 dBA silence level
5. Blow off Valve to blow off air flow during start sequence
6. Blow off Silencer to silence air flow during start sequence
7. Temperature Sensors for motor, bearing, inlet and discharge air flow
8. Pressure Sensors for discharge conditions
9. Pressure Sensor and alert for air filter condition
10. Built in Flow Calculation
11. Built in Speed Measurement
12. Internal Expansion Joint
13. Internal vibration and dynamic effect Absorption Mounts
14. Optional Built in vibration sensor, transmitter and display
15. Electric Line Reactor to maintain a high power factor
16. Built in Air Filter to within ten micron filtration
17. Discharge Duct attached to Turbo Blower

2. Optional Computers and Software
(Not Included unless specified in Price sheet)
A. Master Control Panel to operate multi-blowers
1. Complete standalone computer system, built with its own state of the art technology microprocessor in a self contained enclosure.
2. MCP operates based on input and output signals to control on line blowers and other flow equipment based on DO or other operating parameter.

3. Standard Ship Loose Accessories ***(Included)***
1. Discharge Check Valve
2. Discharge Butterfly Valve
3. Discharge Duct Expansion Joint

4. Standard Documentation ***(Included)***
A. Submittal Information: PDF Electronic File
1. Bill of Material
2. Installation Drawings
3. Electrical and Control Drawings
4. Operation and Maintenance Manual
5. Commissioning Instructions

B. Standard Tests

1. Standard Blower Package Functional Acceptance Test	***included***
2. PTC-10 Factory Performance Test	- available for additonal cost upon request
3. Optional Functional tests with Plant LC	- available for additonal cost upon request
4. Optional Aeration Syatem Control functional system test	- available for additonal cost upon request

For any Factory witnessed testing or additional tests, please contact APG-Neuros for a price quote.

5. Spare parts (on site)
A. One set of spares
1. One (1) set of Air Filter Elements

6. Quality Assurance and Control and Product certification
A. Neuros Quality Assurance program is ISO 9001 certified
B. Neuros Turbo Blower is UL / CSA certified

Bend Secondary Expansion - Neuros Turbo Blower - Scope of Supply (continued)

7. Start-up and Factory Testing Service:
Start-up and operator training is available at US $1,200 per day plus travel and living expenses billed at cost, plus 10%. Advance notification of 15 working days is required for scheduling.

8. Proposal Validity and Seller Terms and Conditions
Unless otherwise specified elsewhere in the Sales Agreements, the prices in this proposal are valid for ninety (90) days from the issue date on the cover page.
This proposal, unless otherwise specified herein this document, is subject to the Seller's General Terms and Conditions of Sales available upon request.

9. Payment Terms:
Payments shall be made as follows:
15% upon issuance of Purchase Order
75% at delivery to Jobsite or offer to ship based on agreed upon schedule
10% upon Start-up, no later than 90 days after Delivery
Letter of Credit listing draw of payments against above deliverables will apply for Sales outside US and Canada.
100 % of invoice amount shall be payable by bank wire transfer without deduction and to be paid Net 30 days after invoice date.
Payment shal not be dependent on the buyer being paid by any third parties or equipment acceptnace by owner.

10. Submittals or Shop Drawings:
Submittal package will be provided wthin 4 to 6 weeks after acceptance of the Purchase Order by APG-Neuros.

11. Shipment:
Shipping terms, unless otherwise stated in price details, shall be ExWork Factory
Shipment will be made within 16 to 20 weeks after acceptance of Purchase Order by APG-Neuros or 16 weeks after after approval of Submittals, which ever occurs last.

Add Five percent (5%) escalation to Price for each partial or full quarter that shipment is extended beyond one year after order acceptance.

12. Warranty

A. Standard Warranty (INCLUDED)
Comprehensive non pro-rated One (1) year from commissioning date or Eighteen (18) months from delivery, whichever occurs first.
Warranty will begin upon successful completion of start-up and certification for full-scale operation by APG-Neuros, or Eighteen (18) months after shipment, whichever occurs first. Under no circumstances will the warranty begin upon "beneficial use", completion of the project, or acceptance of the equipment as determined by the Engineer or End User.

B. Extended Warranty (OPTIONAL - Not Included)
Warranty extension available included in Maintenance Cost Guarantee program described in Item C below.

C. Maintenance Cost Guarantee (OPTIONAL - Not Included)
All inclusive maintenance and warranty cost coverage beyond first year is available at additional cost.

13. Technical and Spares Support
Technical service persoonel as required to support start-up and technical service is available at additional cost.

14. Items Not Included:
Installation, main starters, anchor bolts, interconnecting pipe, Electrical & Control Items outside Blower Package, fittings, bolts, nuts, gaskets, wiring, valves, taxes and duties, or any other items not specifically listed above.

Bend Secondary Expansion - Neuros Turbo Blower - Price

Budgetary Price (U.S. Dollars, 2011 Economy Year)

Standard Equipment Scope of Supply Price:

Application	Aeration	Aeration
Total Quantity, Units	4	1
Model	NX300-C060	NX100-C060
Design Capacity, per Blower, SCFM	5500	1500
Design Discharge Pressure, PSIG	8	8
Motor Rating, hp	300	100
Total Base Price	**$784,000**	**$103,000**

Notes
Shipping and handling **ExWork Factory**
Taxes and Duties are **not included**
Start Up and Training **not included**

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Tel: 450-939-0799 Fax: 450 939 2115
www.apg-neuros.com

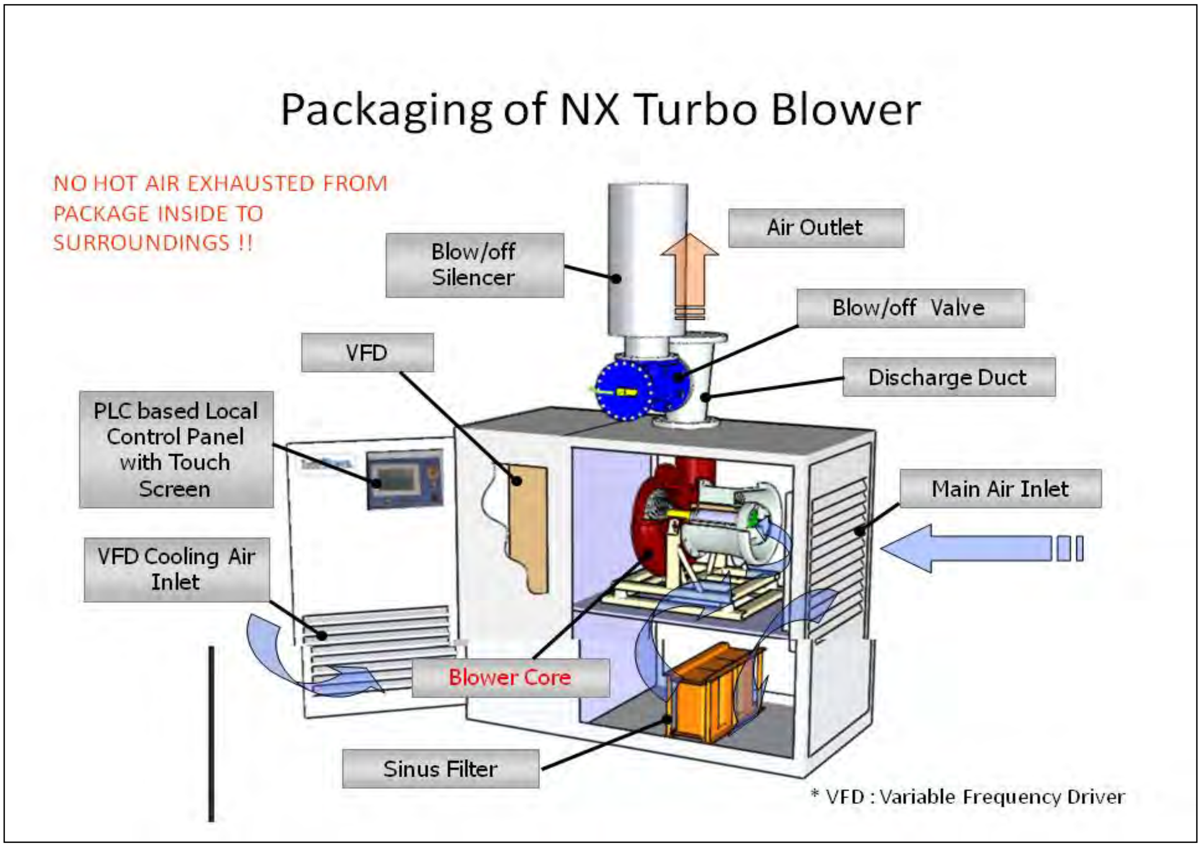
4. Technical Specification

- o Blower Layout
- o Components
- o Materials of Construction
- o Key Components Description

APG – Neuros Inc.
3200, Cours Le Corbusier, Boisbriand, Québec J7G 3E8, Canada, Tel : (450) 939-0799
www.apg-neuros.com

Blower Package

The Neuros Turbo Blower is provided in a “plug and play” package that combines the components, listed in the schematic below, in an enclosure that attenuates the sound to around 80 dBa. Neuros Turbo Blowers rated above 50 hp do not exhaust heat to the surroundings.



APG – Neuros Inc.
3200, Cours Le Corbusier, Boisbriand, Québec J7G 3E8, Canada, Tel : (450) 939-0799
www.apg-neuros.com

Models NX75 to NX150 Enclosure and Installation Layout

APG – Neuros Inc.
3200, Cours Le Corbusier, Boisbriand, Québec J7G 3E8, Canada, Tel : (450) 939-0799
www.apg-neuros.com

Primary Components

The Neuros Turbo Blower primary components comprise the list contained in the Table below. We have upgraded and replaced with US and Canada based components.

Component	Manufacturer	Location
Variable Frequency Drive Sine Filter Input line reactor	KEB	Minnesota / New York
Local Control Panel	Modicon	California
Harmonic Filter	Arteche	Wisconsin
Cooling Water Pump	Armstrong	New York
Control Transformer	Hammond Power Solutions	New York

APG – Neuros Inc.
3200, Cours Le Corbusier, Boisbriand, Québec J7G 3E8, Canada, Tel : (450) 939-0799
www.apg-neuros.com

Materials of Construction

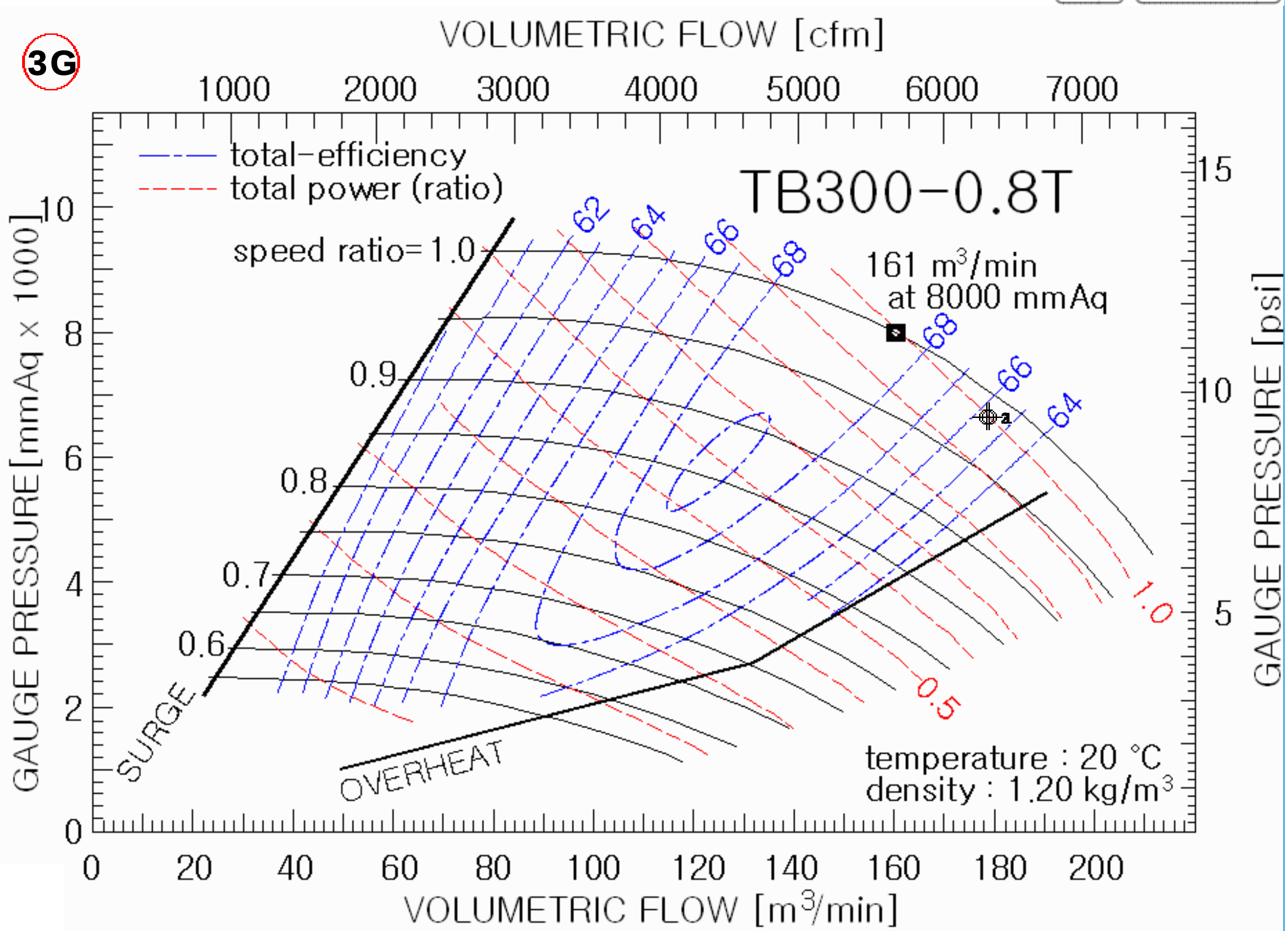
1	**High Speed Turbo Blower with High Speed Electrical Motor**		
	a.	*Impeller*	Aluminum (AL7075)
	b.	*Shaft*	Titanium Alloy (Ti-6AL-4V)
	c.	*Motor Casing*	Aluminum
	e.	*Motor Stator*	Copper
	f.	*Casing*	Aluminum (A356)
	g.	*Air Bearing*	Inconel (INCO718)
2	**Inverter/Variable Frequency Drive to Vary the Speed of the Motor/Blower**		
	a.	*VFD*	KEB (UL & CSA Certified)
	b.	*Sinus Filter*	KEB (UL & CSA Certified)
3	**Acoustic Sound Enclosure**		Carbon Steel Plate
4	**Inlet Silencer**		Install Noise Suppression Cover
5	**Inlet filter**		Efficiency of 90 percent by weight per ASHRAE 52-76
6	**Discharge Cone**		
	a.	*Flange*	Forged Steel
	b	*Body*	Carbon Steel
7	**Discharge Check Valve**		
	a.	*Body*	FC
	b.	*Disc*	BC6
	c.	*Seat*	Viton (Rated temperature @ 300 deg F)
8	**Blow-Off Valve and Silencer**		
	a.	*Type*	Electro-Pneumatic
	b.	*Flange*	Forged Steel
9	**Isolation Valve**		
	a.	*Operation*	Manual
	b.	*Body*	Cast Iron, Lug Style
	c.	*Disc*	Stainless Steel
	d.	*Stem*	Stainless Steel
	e.	*Seat*	EPDM, Rated Temperature up to 300 F
10	**Flexible Connections**		
	a.	*Flange*	Forged Steel
11	**Pressure and Temperature Monitoring Devices**		
	a.	*Pressure*	Filter pressure drop, Discharge pressure
	b.	*Temperature*	Suction, Discharge, Motor & Bearing
12	**Local Control Panel**		
	a.	Standard: Allen Bradley MicroLogix / CompactLogix	
	b.	Options: Siemens, Schneider Modicon, GE Fanuc, Cimon, Bristol Babcock	
13	**Transformers**		
	a.	Control Transformer	480 to 110 V
	b.	Auto Transformer	575 to 480 V

APG – Neuros Inc.
3200, Cours Le Corbusier, Boisbriand, Québec J7G 3E8, Canada, Tel : (450) 939-0799
www.apg-neuros.com

K Turbo Blower & Compressor Power Calculator(V2.0)

Shawn Clark : APSCO

3 G | TB300-0.8T



- TITLE: Bend IFAS 300 max
- UNIT SYSTEM: US (ft-lb)

* Typically 0%RH or 36%RH @ 68˚F(20˚C), 14.696psia(101.325kPa) for USA. 65%RH @ 20˚C, 101.325kPa for Japan

STANDARD CONDITION T_{st} [˚F]	$R.H_{st}$ [%]	P_{st} [psi(A)]	Altitude [ft]	Ambient Pressure [psi(A)]
68	36	14.696	3623	12.871

COMMENT

Save | Copy to my Account

* Built-in Filter : Fresh 0.03 psi / Dirty 0.22 psi

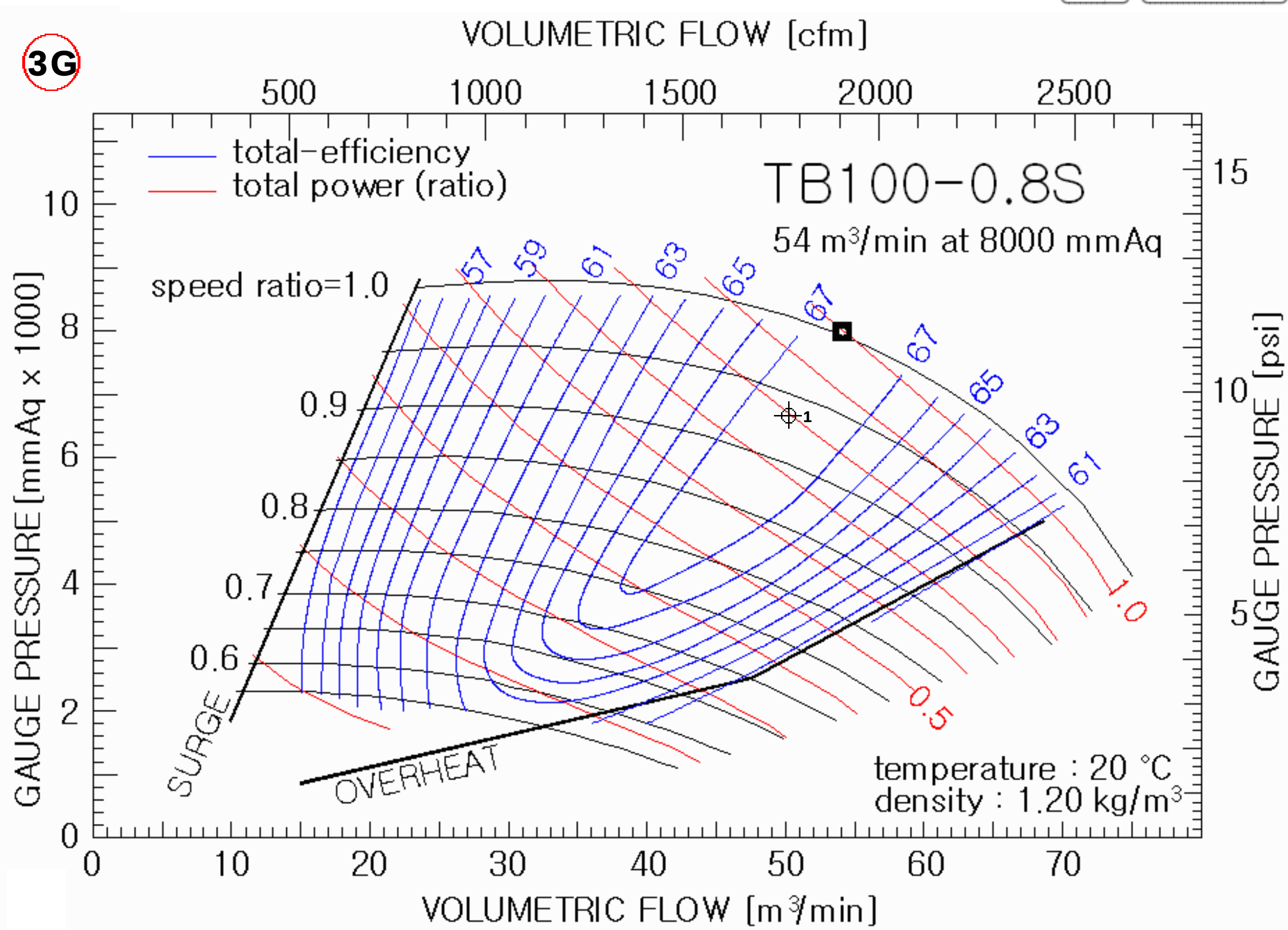
Pt	T_1 [˚F]	R.H [%]	Q_{std} [CFM]	# of Units	$P_{2(G)}$ [psi(G)]	$\triangle P_{filter}$ [psi]		$Q_{in/unit}$ [CFM]	$Q_{act/unit}$ [CFM]	$Q_{corr/unit}$ [CFM]	Mass Flow [lbm/s]	P_{corr} [psi]	η_{total} [%]		Total Input [kW] Unit	Total	remark	Del
1	90	36	16,000	3	8	0.11	▶	6,416.07	6,471.38	6,340.55	6.759	9.34	65.7	▶	216.0	648.1		X
2	56	36	16,700	3	8	0.11	▶	6,198.23	6,251.66	6,323.98	6.996	9.34	65.7	▶	208.7	626.1		X
3	10	36	17,600	3	8	0.11	▶	5,918.38	5,969.39	6,327.25	7.348	9.34	65.7	▶	199.3	597.8		X
+							▶							▶				

\+ : add additional line with copied data.

K Turbo Blower & Compressor Power Calculator(V2.0)

Shawn Clark : APSCO

3 G TB100-0.8S



- TITLE: Bend IFAS 100hp
- UNIT SYSTEM: US (ft-lb)

* Typically 0%RH or 36%RH @ 68˚F(20˚C), 14.696psia(101.325kPa) for USA. 65%RH @ 20˚C, 101.325kPa for Japan

STANDARD CONDITION

T_{st} [˚F]	$R.H_{st}$ [%]	P_{st} [psi(A)]	Altitude [ft]	Ambient Pressure [psi(A)]
68	36	14.696	3623	12.871

COMMENT

Save

Copy to my Account

* Built-in Filter : Fresh 0.03 psi / Dirty 0.22 psi

Pt	T_1 [˚F]	R.H [%]	Q_{std} [CFM]	# of Units	$P_{2(G)}$ [psi(G)]	$\triangle P_{filter}$ [psi]		$Q_{in/unit}$ [CFM]	$Q_{act/unit}$ [CFM]	$Q_{corr/unit}$ [CFM]	Mass Flow [lbm/s]	P_{corr} [psi]	η_{total} [%]		Total Input [kW] Unit	Total	remark	Del
1	90	36	1,500	1	8	0.11	▶	1,804.5	1,820.0	1,783.28	1.901	9.34	67.5	▶	59.1	59.1		X
+							▶							▶				

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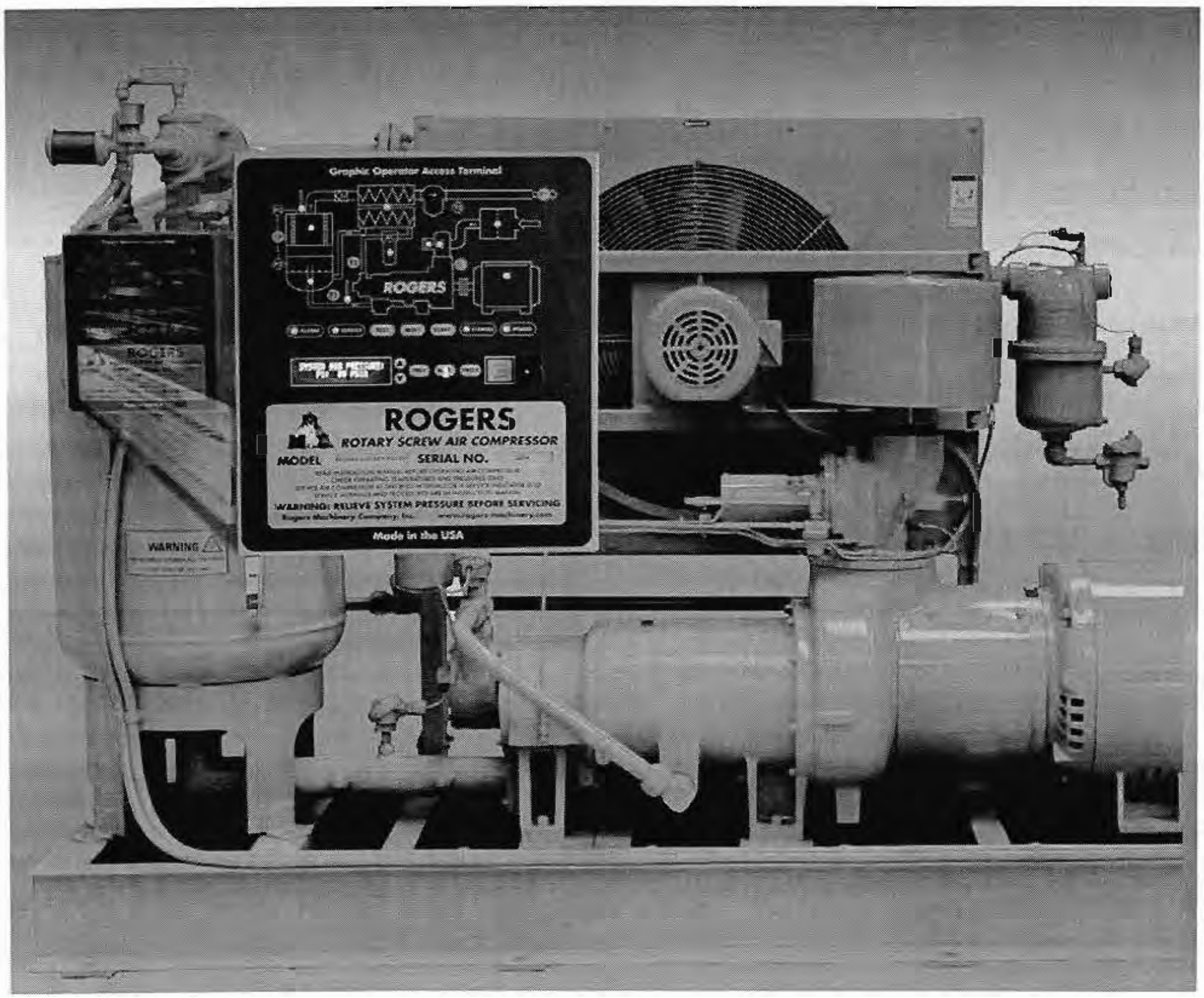
ROGERS

QNW G Series

Rotary Screw Air Compressors

40 – 350 HP
186 – 1521 SCFM
40 – 210 PSIG



Lubricant-Injected ▾ Single-Stage

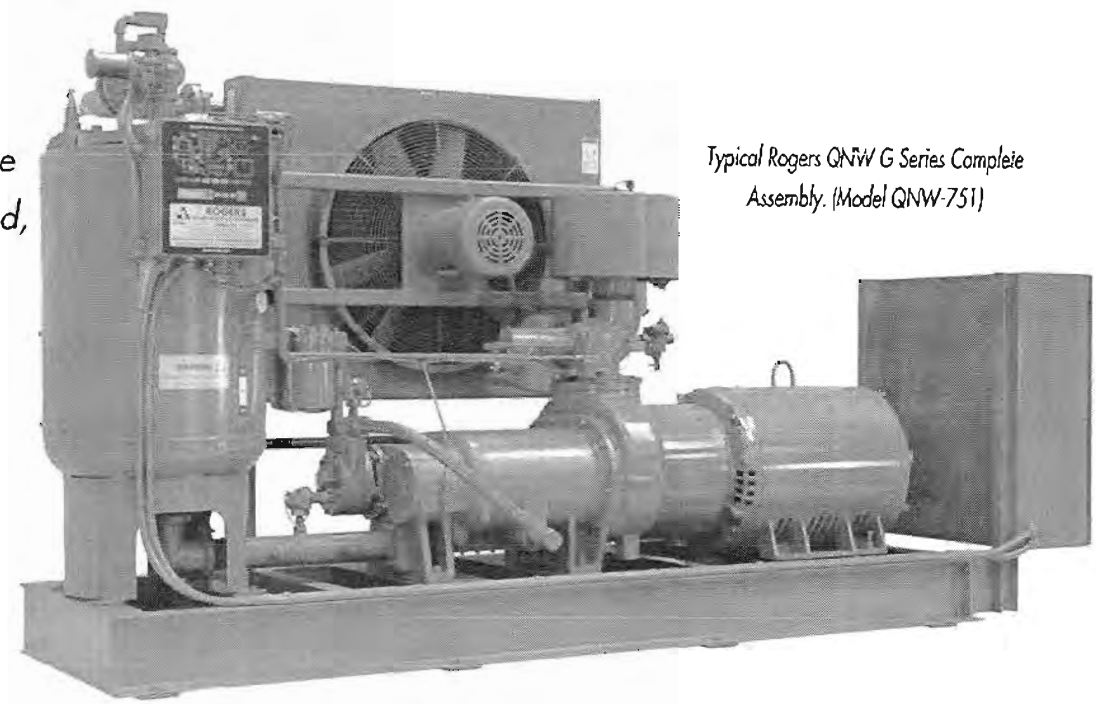
The Rogers QNW G Series is a state-of-the-art, single-stage, lubricant-injected, rotary screw air compressor assembly with Graphic Operator Access Terminal.

www.rogers-machinery.com

Inside the QNW G Series

When your production requirements are critical, you need the rugged QNW G Series compressor.

The Quincy Northwest G Series compressor assemblies represent the best of lubricant-injected, single-stage, rotary screw technology. The compressors are designed, assembled, and tested in our Centralia, Washington plant. Control panels are CSA listed.



Typical Rogers QNW G Series Complete Assembly. (Model QNW-751)

Quality Assembly Works For You

Flexible Configuration

An example of simplicity and reliability, the QNW G Series configuration is also flexible. An assembly can be customized to your specifications. Flange mounted air end available through 760 scfm.

Open Design

The open design of the G Series emphasizes function. The assembly is attractive and easy to inspect and service.

24-hour Production

The QNW G Series compressor has a rugged design, capable of operating fully loaded around the clock.

Oversized Heat Exchangers

Oversized heat exchangers, standard on all QNW G Series assemblies, result in lower operating temperatures and reduced maintenance costs.

Air/Lubricant Separation

High-efficiency, five-stage air/lubricant separation results in less than 2 PPM(W) lubricant carry over into the plant air system.

Rogers QNW Compressors Achieve The Lowest Energy Use In The Industry

Energy Efficient

High efficiency rotor design results in maximum air flow using minimum horsepower.

Air Capacity Display

Air capacity display is standard on all G Series assemblies. This allows measurement of how much compressed air the plant uses, how much air is lost through system leaks, and how much capacity remains to be utilized.

G Series Air Reheater (Optional)

Uses waste heat to improve air quality and quantity, improves overall compressor efficiency, and reduces cooling-water consumption by 20%.

G Series Air End

- Axial flow inlet (3–5% efficiency increase)
- No speed increasing gears (No parasitic losses)
- Precision rotor design and manufacture (3% efficiency increase)

Variable Speed Fan Drive Control (Optional)

Available on air-cooled models. Saves energy, reduces noise and prolongs equipment life.

QNW G Series Air End Is The Heart Of The Compressor's Reliability

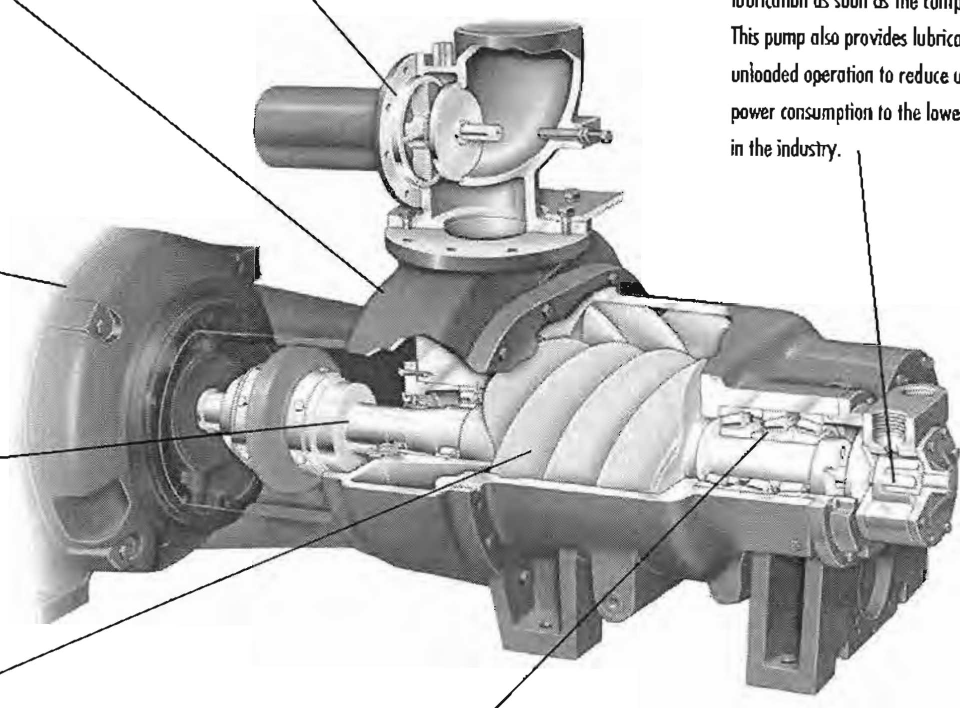
Positive closure inlet valve eliminates the need for a lubricant stop valve and reduces unloaded power consumption.

Axial flow inlet housing improves compressor efficiency by 3 – 5% over traditional radial flow designs. This results in lower power consumption to accomplish the job.

Gear-type lubricant pump provides lubrication as soon as the compressor starts. This pump also provides lubrication during unloaded operation to reduce unloaded power consumption to the lowest level in the industry.

C-face motor mount ensures longer coupling life and quieter operation. Standard through 760 SCFM.

Triple lip shaft seal provides unequaled reliability in this crucial area.



High-efficiency rotor design results in maximum air flow using minimum horsepower. Years of rotor profile development have improved efficiency more than 20% over earlier designs.

Triplex tapered roller bearings provide 30–100% longer life than competitive machines.

The assembly offers:

Triplex Bearings

The triplex tapered roller bearings are designed to ensure longer life. The B-10 life is rated at 130,000 hours of operation. This superior three bearing arrangement consistently provides longer life than competitive machines.

Shaft Seal

The G Series primary shaft seal is a triple-lip type design. This design is more reliable than a mechanical seal.

Lubricant

Rogers CLS46 synthetic compressor lubricant is scientifically formulated pecifically for Rogers QNW rotary screw air compressors. CLS46 lubricant provides superior lubricating qualities, assuring long air-end life and less frequent lubricant change intervals.

Positive Lubrication

The G Series uses a positive displacement lubricant pump to assure proper lubrication during startup, operation and shutdown. Unloaded brake horsepower is approximately 15% of full load, the lowest in the industry.

Slow Speed Rotors

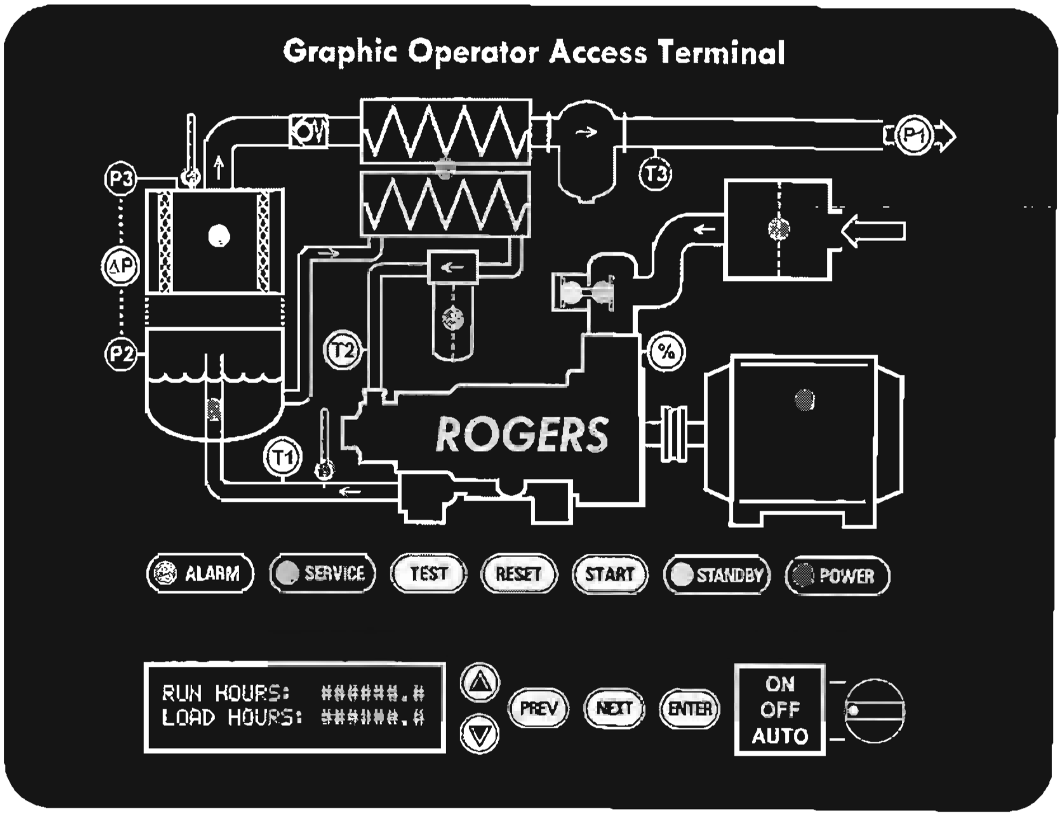
The male rotor is direct driven and non-geared. It runs at 1800 RPM motor speed, maximizing efficiency and minimizing wear while performing at a low noise level.

Warranty

The standard 5 year air end and motor warranty is the best in the industry.

Graphic Operator Access Terminal provides state-of-the-art compressor control

The Rogers Graphic Operator Access Terminal is a microprocessor control designed to monitor, regulate, and protect the compressor. Sensors continuously transmit temperature and pressure information to the processor. This data allows the most efficient compressor operation, annunciation of proper service intervals and alarms, and initiates shut down due to abnormal operating conditions.



Easy To Use Control Panel And Message Display Provides Complete Compressor Control

LED Indicators–Operating Status
- Power ON
- Standby (automatic operation)
- Service
- Alarm
- Compressor operating
- Compressor loading
- Compressor unloading

Service, With Displayed Message
- Air inlet filter ΔP
- Separator element ΔP
- Lubricant hours
- Lubricant filter ΔP

Pre-Alarm Warnings
- High air lubricant temperature
- High aftercooler discharge temperature
- Drive motor overload
- Fan motor overload (air-cooled)

Message Display–Operating Information
- Percent of compressor capacity (%)
- Delivered air pressure (P1)
- Separator differential pressure (ΔP)
- Discharge air temperature (T1)
- Lubricant injection temperature (T2)
- Aftercooler discharge temperature (T3)
- Total running hours
- Total loaded hours

Service Information
- Hours until next service, date of last service
- Air inlet filter
- Separator element
- Lubricant
- Lubricant filter
- Drive motor bearings
- Historical list of service dates

Shutdowns
- High air/lubricant temperature
- High air temperature (P3)
- Drive motor overload
- Fan motor overload (air-cooled)
- Starter fault
- Reverse rotation shutdown

Operators–Selector Switch Legend Insert
- ON/OFF
- ON/OFF/AUTO
- LOCAL/OFF/REMOTE

Keypads
- START - Run compressor
- RESET - Reset alarm
- TEST - Test indicators
- % - Show compressor capacity
- P1 - Show outlet air pressure
- ΔP - Show separator differential
- T1 - Show compressor temperature
- T2 - Show lubricant temperature
- UP arrow - display control
- DOWN arrow - display control
- PREV - Navigate display messages
- NEXT - Navigate display messages
- ENTER - Accept set point

Diagnostics
- Microprocessor power indicator
- Processor input status - 16 LED's
- Processor output status - 8 LED's
- Test key enables battery power for off-line display of information

G Series Equipment and Features

STANDARD EQUIPMENT AND FEATURES

All G Series assemblies include the following equipment and features:

- Control system capable of maintaining system pressure with ±2 PSI pressure differential
- Modulating inlet valve
- Heavy-duty fabricated steel base
- 1800 RPM motor, open drip-proof
- Jaw-type coupling
- OSHA type coupling guard
- Dual air/lubricant separator elements with scavenging sight glasses
- Spin-on full flow, 10μ lubricant filters with internal bypass valve
- Air-cooled or water-cooled with automatic temperature control
- Heavy duty, multi stage inlet air filter/silencer
- Air or water-cooled aftercooler, separator and automatic drain
- SAE O-ring fittings on all lubricant pipe joints larger than 1/4 inch in diameter (drains not included)
- Positive displacement lubricant pump
- ASME pressure relief valve
- Constant speed control
- Discharge air check valve
- Solenoid operated blowdown valve with muffler
- Two high temperature shutdown devices
- Lubricant level indicator
- All major components manufactured and assembled in the USA
- CSA listed
- Cast iron moisture separator with demand type drain valve
- CLS46 synthetic lubricant. Other lubricants available

OPTIONAL EQUIPMENT AND FEATURES

The following optional equipment and features are available on any G Series assembly:

Energy Conservation

- Air reheater
- Premium efficiency motor
- Variable speed cooling fan drive (air-cooled only)
- Heat recovery

Compressor Control

- Low unloaded horsepower with time delay shutdown is the most adaptable control available to achieve energy savings
- Load/unload control
- Duty sequencer provides the most efficient control for multiple compressor installations
- Electrical control interfaces
- Variable speed control options available
- Motor starters — all types and voltages

Additional Options

- Enclosure (partial or complete)
- Instrumentation and annunciation to meet your needs
- Pressure to 210 PSIG
- Remote run capability
- Auto restart after power failure
- Vertical discharge or remote cooler assemblies
- Real time communication for compressor condition
- Air inlet pre-separation
- High ambient air-cooled coolers

Contact Our Sales Department With Your Requirements

We offer the best selection of high-quality equipment you'll find anywhere, with a full range of services to back it up.

Cut-away of typical G-Series air end.

G Series Dimensions and Shipping Weights

QNW Model	Air-Cooled Compressor Dimensions (in inches)*			Shipping Weight	Water-Cooled Compressor Dimensions (in inches)*			Shipping Weight
	L	W	H**		L	W	H**	
191	89	40	57	2950	89	40	57	2800
192	89	40	57	2950	89	40	57	2800
241	89	40	57	3025	89	40	57	2875
242	89	40	57	3025	89	40	57	2875
244	89	40	57	3125	89	40	57	2975
271	95	43	60	4025	95	43	60	3775
273	95	43	60	4100	95	43	60	3850
371	95	43	60	4100	95	43	60	3850
372	95	43	60	4100	95	43	60	3850
373	99	44	62	4250	99	44	62	4000
501	99	44	62	4775	99	44	62	4575
502	99	44	62	4775	99	44	62	4575
503	99	44	62	4925	99	44	62	4725
641	114	50	72	5175	114	49	72	4975
642	114	50	72	5400	114	49	72	5200
751	114	50	72	5400	114	49	72	5200
752	114	50	72	5400	114	49	72	5200
753	114	50	72	5625	114	49	72	5425
1011	120	62	112	7200	120	60	112	7075
1013	121	62	112	7415	121	60	112	7365
1271	125	64	112	7750	125	63	112	7500
1273	128	64	112	7980	128	63	112	7730
1521	135	64	112	8500	135	63	112	8250
1523	135	64	112	8950	135	63	112	8700

* Typical – do not use for construction ** Includes required clearance for removal of separator element

Commitment to Quality and Service

The Rogers commitment to customer service is unequaled.

Engineering

Quincy Northwest rotary screw compressors are designed for all industrial users, large or small. QNW compressors are of the highest quality, efficiency and reliability.

Sales

Our experienced and professional sales staff will make recommendations based on your needs and specifications. The entire Rogers organization stands behind each recommendation, assuring everything will be done as requested.

Fabrication

Quincy Northwest compressors are assembled by expert technicians in our Centralia, Washington facility. These technicians interface directly with engineering, sales and application personnel involved with your order. This continuous communication at all levels is an important factor in delivering quality assemblies at the time you specify. Our quality assurance inspectors check each assembly before shipment to ensure the equipment delivered meets your requirements.

Service

After your compressor has been installed, one of our field service technicians will visit your plant to:

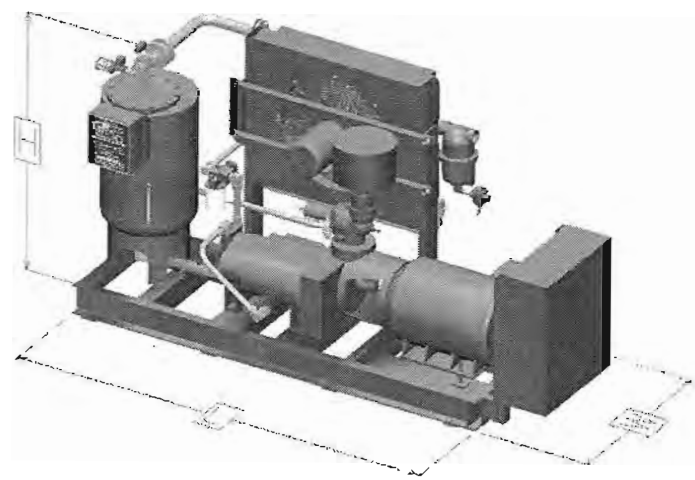
- Check the installation
- Start the compressor
- Ensure proper operation
- Train your personnel
- Service compressor as needed
- Service agreements

Our Service Department is available 24 hours a day, 7 days a week. We will meet your needs quickly and expertly.

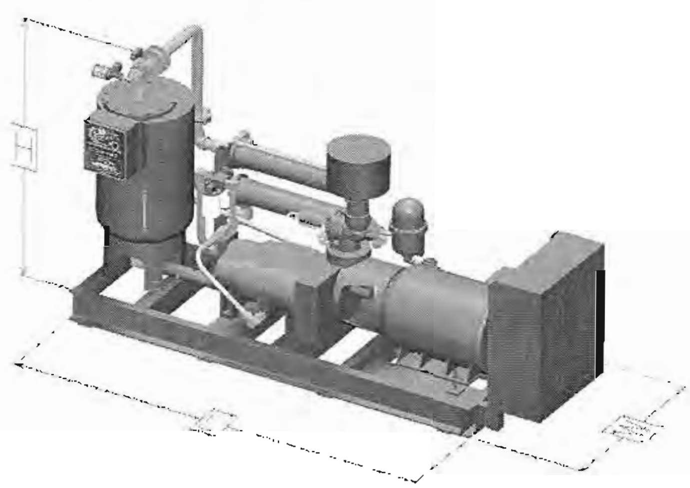
G Series Performance Data*

QNW Model	Capacity SCFM	Pressure PSIG	Motor HP
191	186	100	40
192	130	125	40
241	246	100	50
242	211	125	50
244	241	150	60
271	270	100	60
273	269	150	75
371	372	100	75
372	319	125	75
373	364	150	100
501	502	100	100
502	415	125	100
503	491	150	125
641	630	100	125
642	626	125	150
751	760	100	150
752	670	125	150
753	744	150	200
1011	1014	100	200
1013	1003	125	250
1271	1269	100	250
1273	1255	125	300
1521	1521	100	300
1523	1504	125	350

Air-Cooled Compressor



Water-Cooled Compressor



Reliability

There are good reasons why there are more Rogers QNW Series compressors in use in the Pacific Northwest than those from all other manufacturers combined. We would like to show you why.

*Performance notes:

- Male rotor speed 1780 RPM
  Female rotor speed 1190 RPM
- Maximum pressure on 100 PSIG models is 110 PSIG
- Maximum pressure on 125 PSIG models is 135 PSIG
- Maximum pressure on 150 PSIG models is 150 PSIG
- Higher pressures available, contact our sales department

Service Support

SERVICE COMMITMENT

We have maintained a commitment to provide immediate service of the highest quality, for over 55 years. What does this mean to you? A reliable compressed air system backed by the largest parts inventory in the Pacific Northwest!

When you calculate the cost of down-time and distraction of key people, we believe you will realize you can afford the best. When you purchase a Rogers assembly, you receive our 24-hour emergency parts and service shipment guarantee.

OUR GUARANTEE

If you notify us that you have an emergency and require a standard part or service for your Rogers compressor, we will ship the part and/or initiate the service within 24 hours or you will not have to pay for either or both.

AVAILABLE ANYTIME

We have a fleet of over 40 fully equipped service trucks staffed by experienced technicians. We can work on site and keep your downtime to a minimum.

WE ALSO OFFER:

- Start-up assistance
- Factory-monitored maintenance program
- Full factory service maintenance agreements
- Service reminder program
- Energy usage audits and energy saving equipment options
- User training classes held at our plant or customer site

FACTORY TRAINED TECHNICIANS

Our technicians receive year-round training. While specializing in servicing our air compressors, our technicians are trained to work on all system components, from air compressors and dryers, to blowers, vacuum pumps and generators.

FULL SERVICE LOCATIONS

24 hours a day / 7 days a week

- New and used equipment sales
- Repair and service
- Parts
- Rentals

RENTALS

We maintain a large selection of electric compressors and dryers, available 24 hours a day, ranging in size from fractional through 350 HP. Units are air-cooled with after-coolers and mounted starters.

ROGERS
MACHINERY
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Since 1949

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sales@rogers-machinery.com

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ZEKS
COMPRESSED AIR SOLUTIONS®

ECLIPSE™

DESICCANT AIR DRYERS

90-8000 scfm

ZPA *Heatless Regeneration*

ZHA *Heated Regeneration*

ZBA *Heated Blower Regeneration*

MADE IN USA

www.zeks.com

RELIABLE PERFORMANCE. DESIGN INNOVATION.

Before compressed air is used in production, finishing or sensitive research or manufacturing processes, it must be treated to remove moisture and contaminants. Without proper treatment, air may damage equipment and tools, reduce productivity and adversely affect the quality of finished goods.

Regardless of air compressor type, the compression process itself causes concentrations of water and airborne particulate to increase to damaging levels. Eclipse™ desiccant dryers from ZEKS effectively and reliably dry compressed air to extremely low moisture levels for use in applications where the presence of even minimal moisture can't be tolerated or where environmental conditions demand it.

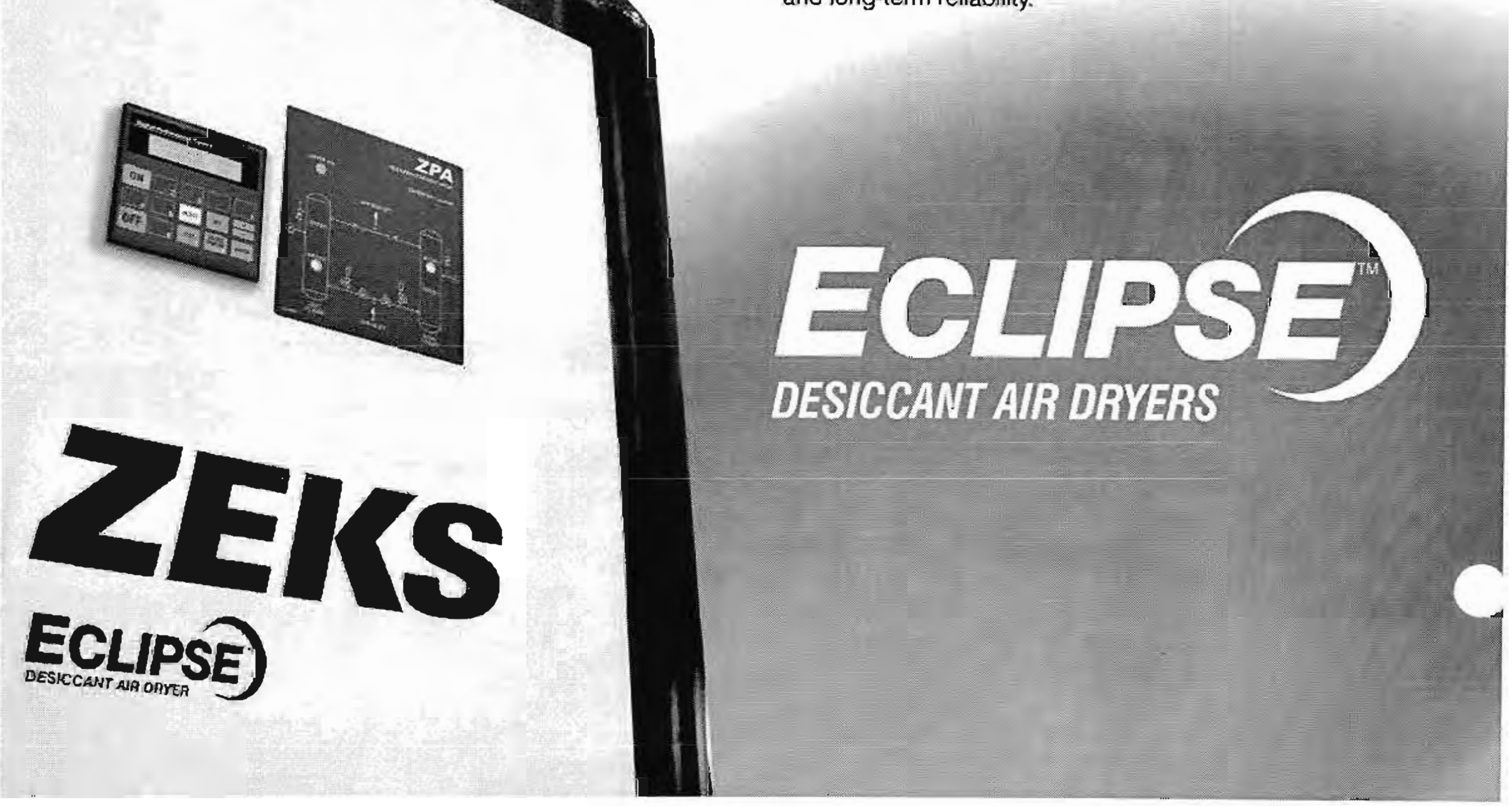
Eclipse™ desiccant dryers are engineered to deliver the operating and service benefits needed most:

- ***High Performance Valves*** - *Reliable operation plus reduced maintenance*
- ***Advanced Controls Group*** - *Digital performance control; Solid state heater control*
- ***Options For Energy Savings*** - *Minimize operating cost and optimize air system operation*
- ***Convenient Service Access*** - *Minimizes maintenance time requirement*
- ***Remote Communication Ready*** - *Multiple communication options*
- ***Low Profile Design*** - *Reduces shipping cost and simplifies installation*
- ***Comprehensive Warranty Coverage*** - *Standard warranty PLUS five years on flow valves and heater* +5

Three Eclipse™ models enable air treatment selection based on the unique requirements of the application:

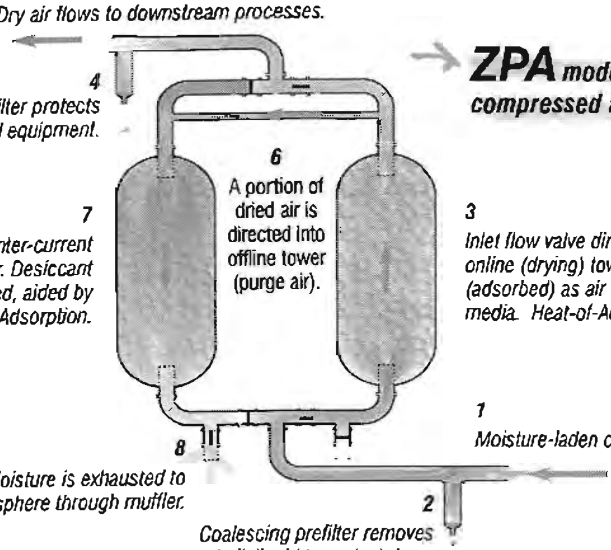
ZPA Heatless Regeneration
ZHA Heated Regeneration
ZBA Heated Blower Regeneration

Authorized ZEKS Distributors are trained to assist selection of the Eclipse™ model that will satisfy all application requirements and provide the most favorable energy use profile and long-term reliability.

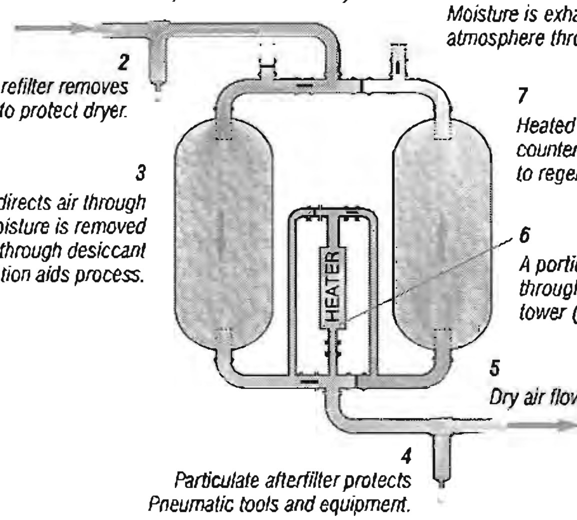


ECLIPSE™ DRYER OPERATION

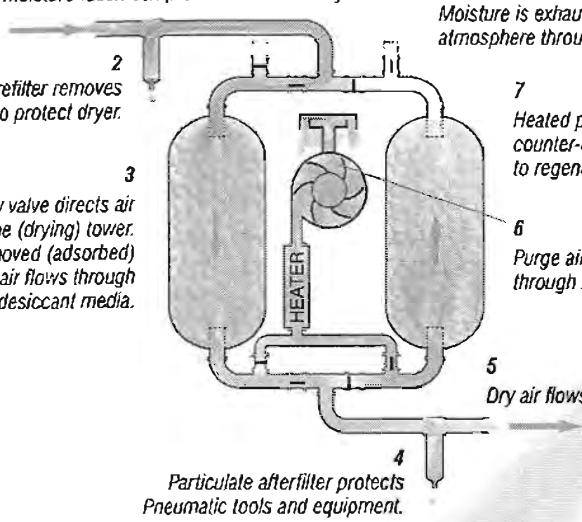
ZPA models use a portion of dry compressed air for desiccant regeneration.



ZHA models use a portion of dry compressed air that is heated for desiccant regeneration.



ZBA models use a dedicated blower to generate atmospheric air flow for desiccant regeneration.



ZPA
Heatless Regeneration

Eclipse™ ZPA models utilize a portion of the dried compressed air volume for regeneration of the desiccant media. Standard ZPA dryers deliver -40°F pressure dew point air while an optional -80°F or -100°F dew point is available for extremely critical applications. Dryers ordered with the NEMA 4/DPC™ option can be equipped with features that provide significant energy savings and optimize air system operation. ZPA models are available in a flow range from 90-5000 SCFM.

1200ZPA in NEMA 4/DPC™ Configuration

STANDARD FEATURES:

- **Dependable Valves:** Non-lubricated diaphragm valves engineered for trouble-free operation deliver higher flows with lower pressure drop than alternate valves. Internal components are easily accessed for routine maintenance without disconnection from pipework.
- **Reliable Solid State Timer:** Field-proven over time, this design and technology maintain precise control over all switching and purge valve functions.
- **Illuminated Status Indication:** All dryers feature Left and Right Tower operation lights, and Power On indication.
- **Prominent Purge Pressure Gauge:** Visual indication aids adjustment of purge flow rate for regeneration.
- **High Strength Desiccant:** Minimizes dusting, increases afterfilter element life and is unaffected by liquid water exposure.
- **Blue Moisture Indicator:** Continuously monitors outlet airstream for excessive moisture. Indicator turns from blue to gray in the presence of an elevated moisture content.
- **Control Air Filtration:** ZEKS ZTF™ particulate filter protects dryer operating controls.
- **ASME Coded Pressure Vessels:** Carbon steel towers constructed for 150 psig MAWP operation meet ASME Section VIII, Div. 1 requirements. Towers are sized to provide low air flow velocity and high contact time.
- **Tower Pressure Gauges:** Accurate indication of pressure within each tower.
- **Pressure Relief Valves:** Standard fire-rated relief valves per API RP-520. Optional flow-rated valves available.
- **Accessible Fill and Drain Ports:** Port locations on each vessel enable easy service access.
- **Removable Stainless Steel Diffuser Screens:** Distribute air evenly through desiccant beds.
- **Sound Attenuating Purge Mufflers:** Large mufflers minimize noise and include built-in relief valves to enhance safety.

+5

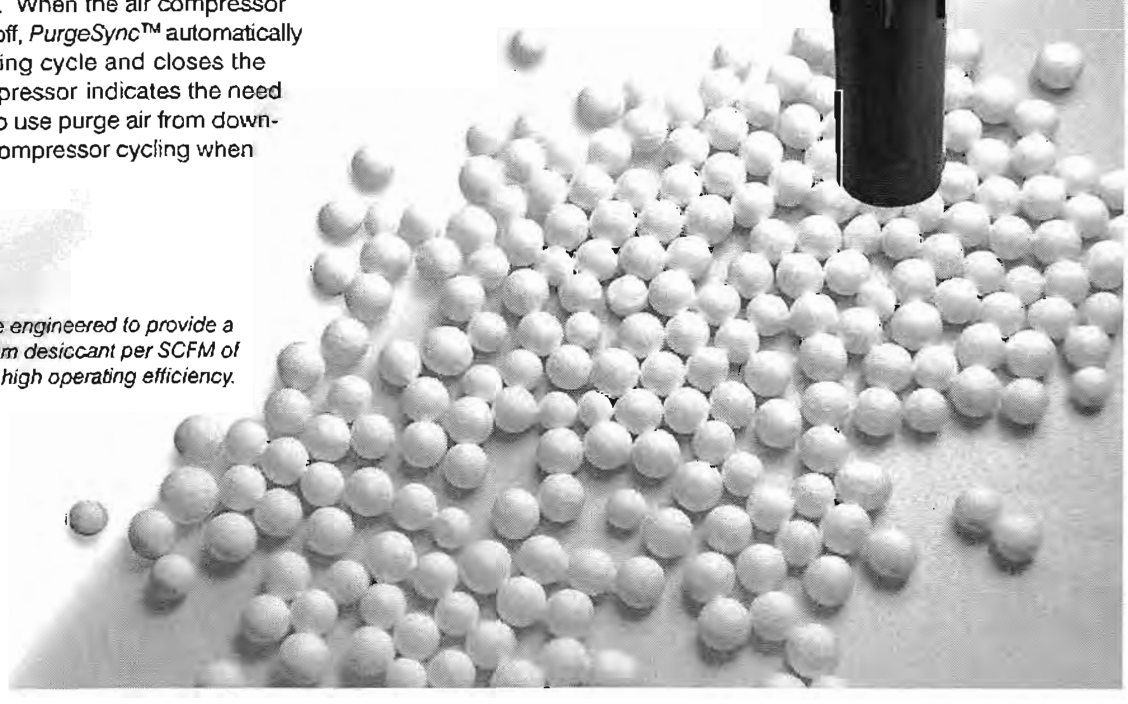
WARRANTY COVERAGE ON FLOW VALVES

OPTIONAL FEATURES:

- **NEMA 4/DPC™ Package:** Premium electrical package provides increased protection of electrical components and enhanced digital dryer controls and displays. The following features are included:
  - – **NEMA 4 Electrical Enclosure:** Type 4 enclosure protects against splashing, falling, and hose-directed water as well as severe external condensation.
  - – **UL/ULC Panel:** Electrical panel constructed in accordance with UL/ULC 508A.
  - – **DPC Controller:** Provides instant access to adjustable performance controls, executes all valve switching functions and monitors dryer operation. This fully-featured PLC with keypad interface includes the following:
    - *MODBUS Compatibility*
    - *Remote Alarm Contact*
    - *Failure Code Storage*
    - *Backlit LCD Display*

  - – **DynOptic™ Schematic:**
    - *Dryer On*
    - *Dryer Alarm*
    - *Left/Right Tower Drying*
    - *Left/Right Tower Regeneration*
  - – **Enhanced Dryer Operation Functions:**
    - *SelectDry™*- Permits user to select -40°F, -4°F or +38°F pressure dew point air.
    - *PurgeMizer™*- Allows the user to reduce the amount of purge air used for regeneration. Settings ranging from 30%-100% of purge flow in 10% increments can be selected. Ideally suited to low flow applications.
    - *PurgeSync™*- Enables dryer operation to "mirror" that of the main air compressor. When the air compressor either unloads or is turned off, *PurgeSync™* automatically completes the current drying cycle and closes the purge valves until the compressor indicates the need for more air. Allows dryer to use purge air from downstream storage, reducing compressor cycling when air demand is low.

- **Dew Point Display:** Monitors dryer dew point with a high accuracy ceramic-type moisture sensor. Reading is displayed on DPC Controller (required). A visual alarm is activated if a high dew point condition occurs.
- **Failure-to-Shift Alarm:** Monitors tower pressure for proper valve sequencing and operation.
- **High Humidity Alarm:** Monitors humidity level of the compressed air.
- **Moisture Load Control:** During periods of low air demand or low moisture loading, the purge valves remain closed while flow control valves cycle normally. When moisture loading increases, the purge valves automatically open and begin sequential desiccant regeneration. Minimizes purge air consumption and operating cost.
- **Downstream Purge:** Uses dry air from downstream storage, as well as from the drying tower for desiccant regeneration. This reduces compressor starts when air demand is low.
- **-80°F and -100°F Dew Points:** Specially designed dryers provide extremely low dew point air for critical applications.
- **250 psig and 300 psig MAWP:** High pressure dryer design for applications above 150 psig.
- **Filter Packages:** Factory installed prefilter and afterfilter available in several configurations. Also available with filter and dryer bypasses for ease of service.



Eclipse™ dryers are engineered to provide a high ratio of premium desiccant per SCFM of compressed air for high operating efficiency.

ZHA
Heated Regeneration

Eclipse™ ZHA models include an external heater to heat dry purge air for desiccant regeneration. Heating allows the dryers to consume only 7% of the dried compressed air volume for this purpose – significantly less than is required for heatless pressure swing type dryers. Available in sizes ranging from 150 – 8000 SCFM, ZHA dryers deliver -40°F pressure dew point air for critical drying applications.

ZBA
Heated Blower Regeneration

Eclipse™ ZBA models include a dedicated blower and external heater to produce purge air for desiccant regeneration. The blower develops atmospheric air flow through the heater, then through the desiccant media thereby regenerating it. With this design, no dried compressed air is consumed for regeneration, which maximizes the amount delivered to the air system. Dryer sizes from 150 – 8000 SCFM are available with each delivering -40°F pressure dew point air.

2100ZBA in standard configuration

STANDARD FEATURES:

- **High Performance Valves:** Non-lubricated ball and butterfly valves are designed specifically for high temperature applications and feature stainless steel internals and filled PTFE seats.
- **NEMA 4 Electrical Enclosure:** Protects electrical components against falling or hose-directed water and severe external condensation.
- **DPC™ Controller and DynOptic™ Display:** PLC Controller executes all dryer functions and monitors and displays dryer status. DynOptic™ Display provides schematic depiction of dryer status. This control panel with keypad interface includes the following:

  - *MODBUS Compatibility*
  - *Remote Alarm Contact*
  - *Failure Code Storage*
  - *Illuminated Display of:*
    - Dryer Alarm Annunciation/Cancellation
    - Heater Operation & Temperature Control
    - High Heater Temperature and Failure Alarm
    - Blower Operation Control
    - Regeneration Sequencing
    - Failure-to-Shift Alarm

- **Failure-to-Shift Alarm:** Monitors tower pressure for proper valve sequencing and operation.
- **Bi-Mode Operation:** Dryer can be switched to heatless regeneration mode if the heater or blower become inoperative.

+5

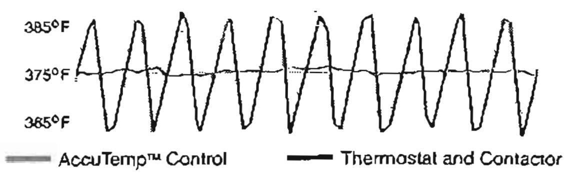
WARRANTY COVERAGE ON FLOW VALVES AND HEATER

ECLIPSE™

DESICCANT AIR DRYERS

RELIABLE PERFORMANCE. DESIGN INNOVATION.

- **AccuTemp™ Heater Control:** Unlike heater contactors that permit wide temperature swings, Solid State AccuTemp™ relay precisely monitors and controls heater temperature.



The result is longer valve life and extended heater life.

- **Incoloy Sheath on Heater Element:** Sheathing increases element life. External mounting outside of desiccant bed eliminates potential for desiccant scorching while low watt density design provides long service life.
- **Heater High Temperature with Interlock Alarm:** Provides continuous monitoring of heater sheath temperature. The heater will de-energize in a high temperature condition.
- **Compressed Air Cooldown:** For blower purge (ZBA) dryer applications requiring tighter dew point control and lower air temperature at switchover. Unheated, dry compressed air is used for the final stage of regeneration, thereby cooling the desiccant bed prior to tower switch over.
- **High Efficiency Blower** (ZBA Only): Reliable, quiet generation of purge air. Intake filter is positioned for convenient access to facilitate filter element changeout.

- **Pressure & Temperature Gauges:** Stainless steel gauges, located on each tower, provide visual indication of pressure and temperature during drying and regeneration processes.
- **High Strength Desiccant:** Minimizes dusting, increases afterfilter element life and is unaffected by liquid water exposure.
- **Control Air Filtration:** ZEKS ZTF™ particulate filter protects dryer operating controls.
- **ASME Coded Pressure Vessels:** Carbon steel towers constructed for 150 psig MAWP operation meet ASME Section VIII, Div. 1 requirements. Towers are sized to provide low air flow velocity and high contact time.
- **Pressure Relief Valves:** Standard fire-rated relief valves per API RP-520. Optional flow-rated valves available.
- **Accessible Fill and Drain Ports:** Port locations on each vessel enable easy service access for scheduled change of desiccant media.
- **Removable Stainless Steel Diffuser Screens:** Distribute air evenly through desiccant beds.
- **Sound Attenuating Purge Mufflers:** Large mufflers minimize noise and include built-in safety relief valves.

OPTIONAL FEATURES:

- **High Humidity Alarm:** Monitors humidity level of the compressed air.
- **Moisture Load Control with Dew Point Display:** Provides fully automated dryer operation based on continuous monitoring of outlet air moisture content. Timing of the regeneration sequence is adjusted to match the moisture loading. Includes dew point display, highly accurate ceramic dew point sensor and high dew point alarm.
- **Power Saver:** Reduces energy consumption by matching the regeneration heating cycle to the actual moisture loading of the regenerating bed. A sensor monitors the temperature of the outlet purge air stream and stops the heater when full regeneration of the offline tower is detected. Especially effective during times of low moisture loading.
- **-100°F Dew Point** (ZHA Only): Specially designed dryers provide extremely low dew point air for critical applications.
- **300 psig MAWP:** High pressure dryer design for applications above 150 psig.
- **Filter Packages:** Factory installed prefilter and afterfilter available in several configurations. Also available with filter and dryer bypasses for ease of service.
- **Tower Insulation:** Contains heat within towers to optimize regeneration efficiency. Provides contact barrier for safety.

800ZHA with factory installed filters

ECLIPSE™ SPECIFICATIONS

	MODEL	FLOW CAPACITY SCFM -40°F* PDP	FLOW CAPACITY SCFM -100°F* PDP	HEATER KW	BLOWER HP	AIR CONNECTION IN/OUT	DIMENSIONS** INCHES WIDTH	DIMENSIONS** INCHES DEPTH	DIMENSIONS** INCHES HEIGHT	SHIPPING WEIGHT LBS
ZPA	90 ZPA	90	72	–	–	1.0" NPT	40.5	30.0	63.0	475
Heatless Regeneration	120 ZPA	120	96	–	–	1.0" NPT	40.5	30.0	63.0	563
	160 ZPA	160	128	–	–	1.5" NPT	44.5	32.0	66.0	707
	200 ZPA	200	160	–	–	1.5" NPT	44.5	32.0	66.0	731
	250 ZPA	250	200	–	–	1.5" NPT	48.5	32.0	67.0	869
	300 ZPA	300	240	–	–	2.0" NPT	48.5	32.0	67.0	924
	400 ZPA	400	320	–	–	2.0" NPT	52.5	32.0	68.0	1115
	500 ZPA	500	400	–	–	2.0" NPT	56.5	33.0	82.0	1554
	600 ZPA	600	480	–	–	2.0" NPT	56.5	33.0	82.0	1664
	800 ZPA	800	640	–	–	3.0" NPT	64.0	42.0	88.0	2017
	1000 ZPA	1000	800	–	–	3.0" NPT	64.0	42.0	88.0	2237
	1200 ZPA	1200	960	–	–	3.0" NPT	64.0	42.0	88.0	2424
	1500 ZPA	1500	1200	–	–	4.0" FLG	78.5	55.0	81.0	2974
	1800 ZPA	1800	1440	–	–	4.0" FLG	84.0	61.0	92.0	3905
	2100 ZPA	2100	1680	–	–	4.0" FLG	84.0	61.0	92.0	4279
	2700 ZPA	2700	2160	–	–	4.0" FLG	84.0	61.0	92.0	4926
	3300 ZPA	3300	2640	–	–	6.0" FLG	96.0	66.0	100.0	6950
	4000 ZPA	4000	3200	–	–	6.0" FLG	96.0	66.0	100.0	7250
	5000 ZPA	5000	4000	–	–	6.0" FLG	102.0	72.0	92.0	9550
ZHA	150 ZHA	150	150	2.0	–	1.0" NPT	44.5	32.0	66.0	758
Heated Regeneration	200 ZHA	200	200	3.0	–	1.5" NPT	48.5	32.0	67.0	913
	250 ZHA	250	250	3.0	–	1.5" NPT	52.5	32.0	68.0	1119
	300 ZHA	300	300	3.0	–	1.5" NPT	52.5	32.0	68.0	1191
	400 ZHA	400	400	4.5	–	2.0" NPT	56.5	34.0	82.0	1539
	500 ZHA	500	500	4.5	–	2.0" NPT	56.5	34.0	82.0	1707
	600 ZHA	600	600	6.0	–	3.0" NPT	64.0	42.0	86.0	2369
	800 ZHA	800	800	9.0	–	3.0" NPT	64.0	42.0	86.0	2681
	1000 ZHA	1000	1000	9.0	–	3.0" NPT	78.5	46.5	80.0	3043
	1200 ZHA	1200	1200	12.0	–	3.0" NPT	78.5	46.5	80.0	3285
	1500 ZHA	1500	1500	15.0	–	3.0" NPT	84.0	55.0	92.0	4480
	1800 ZHA	1800	1800	18.0	–	4.0" FLG	84.0	60.0	92.0	4956
	2100 ZHA	2100	2100	18.0	–	4.0" FLG	84.0	60.0	92.0	5350
	3000 ZHA	3000	3000	30.0	–	4.0" FLG	96.0	68.0	100.0	7750
	4000 ZHA	4000	4000	36.0	–	6.0" FLG	102.0	80.0	92.0	10950
	5000 ZHA	5000	5000	50.0	–	6.0" FLG	CF	CF	CF	CF
	6000 ZHA	6000	6000	60.0	–	6.0" FLG	CF	CF	CF	CF
	8000 ZHA	8000	8000	75.0	–	8.0" FLG	CF	CF	CF	CF
ZBA	150 ZBA	150	–	3.0	1.0	1.0" NPT	44.5	33.5	66.0	874
Heated Blower Regeneration	200 ZBA	200	–	4.5	1.0	1.5" NPT	48.5	32.0	67.0	1136
	250 ZBA	250	–	6.0	1.5	1.5" NPT	52.5	32.0	68.0	1379
	300 ZBA	300	–	6.0	1.5	1.5" NPT	52.5	32.0	68.0	1477
	400 ZBA	400	–	9.0	2.0	2.0" NPT	56.5	33.0	82.5	1897
	500 ZBA	500	–	12.0	2.0	2.0" NPT	56.5	33.0	82.5	2111
	600 ZBA	600	–	12.0	5.0	3.0" NPT	64.0	47.0	88.0	2804
	800 ZBA	800	–	18.0	5.0	3.0" NPT	64.0	47.0	88.0	3198
	1000 ZBA	1000	–	24.0	7.5	3.0" NPT	78.5	49.0	80.0	3767
	1200 ZBA	1200	–	24.0	7.5	3.0" NPT	78.5	49.0	80.0	4091
	1500 ZBA	1500	–	30.0	15.0	3.0" NPT	98.0	55.0	92.0	5515
	1800 ZBA	1800	–	36.0	15.0	4.0" FLG	98.0	68.0	92.0	6113
	2100 ZBA	2100	–	45.0	15.0	4.0" FLG	98.0	68.0	92.0	6911
	3000 ZBA	3000	–	60.0	20.0	6.0" FLG	120.0	78.0	100.0	9730
	4000 ZBA	4000	–	80.0	25.0	6.0" FLG	126.0	83.0	92.0	12167
	5000 ZBA	5000	–	100.0	30.0	6.0" FLG	CF	CF	CF	CF
	6000 ZBA	6000	–	125.0	30.0	6.0" FLG	CF	CF	CF	CF
	8000 ZBA	8000	–	175.0	40.0	8.0" FLG	CF	CF	CF	CF

Performance data obtained and presented in accordance with CAGI Standard 200.
★ Pressure dew point (PDP) at 100 psig, 100°F inlet air, 100°F ambient air.
Pressure vessels are designed and constructed in accordance with ASME and CRN requirements.
Maximum working pressure is 150 psig.
Minimum working pressure is 75 psig.
Desiccant is factory-installed on models 90-2700 ZPA and 150-2100 ZHA/ZBA.
Desiccant ships loose on all other models.

** Dimensions shown are for base models only. Optional equipment may alter dryer dimensions. Dimensions and weights are approximate.
All ZPA dryers are supplied as 115V-1Ph-60Hz.
All ZHA and ZBA dryers are supplied as 460V-3Ph-60Hz
CF = Consult Factory

www.cagi.org

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 Eclipse 0810

Attachment C—Fact Sheets

Aeration System Blower Sizing

ATTACHMENT C TO: TM 5—Blower System Improvements

PROJECT: Schematic Design Report
Bend Water Reclamation Facility Secondary Expansion

Objective

Select blower sizes to provide adequate air to the new integrated fixed-film activated sludge (IFAS) basins while providing adequate minimum turndown.

Background

The Bend Water Reclamation Facility (WRF) is modifying the existing Modified Ludzack-Ettinger (MLE) aeration basins to IFAS basins. The IFAS process will require additional process air. A new blower building will be constructed to provide air to the new IFAS basins. The new blowers will be efficient, high-speed, direct-drive turbo blowers.

Design Criteria

Table 1 summarizes the air demands of the IFAS basins. Table 2 summarizes blower sizing data.

TABLE 1
IFAS Air Demand Design Criteria
City of Bend Water Reclamation Facility

	Air Demand Design Criteria (scfm)			
	Average Day Maximum Month Wastewater Flow			
Scenario Parameters	**Startup 6.0 mgd**	**Near-Term 8.5 mgd**	**Design 11.9 mgd**	**Buildout 17.5 mgd**
Scenario A[a]				
Minimum Week	5,949	8,910	18,214	17,144
Annual Average	9,098	20,676	27,450	39,371
Average Day Maximum Month	13,370	23,922	32,263	47,922
Maximum Week	20,555	34,182	33,570	60,067
Scenario B[b]				
Minimum Week	4,559	7,576	10,346	15,324
Annual Average	7,473	15,682	19,742	28,396
Average Day Maximum Month	10,490	17,834	24,137	35,866

TABLE 1
IFAS Air Demand Design Criteria
City of Bend Water Reclamation Facility

Scenario Parameters	Air Demand Design Criteria (scfm)			
	Average Day Maximum Month Wastewater Flow			
	Startup 6.0 mgd	**Near-Term 8.5 mgd**	**Design 11.9 mgd**	**Buildout 17.5 mgd**
Maximum Week	15,406	26,893	30,860	46,374
Scenario C[c]				
Minimum Week	4,681	7,531	9,285	13,753
Annual Average	7,582	13,305	15,715	22,968
Average Day Maximum Month	9,591	16,945	19,813	29,737
Maximum Week	12,423	23,063	25,977	39,058

[a]Within Scenario A, bulk-liquid DO varies from 4 mg/L to 6 mg/L depending on the influent conditions. Also, some conditions warrant the use of aeration in the swing zone to provide full nitrification.

[b]Within Scenario B, bulk liquid DO varies from 2 mg/L to 4 mg/L depending on the influent conditions.

[c]Within Scenario C, bulk liquid DO is held at 2 mg/L.

DO = dissolved oxygen; mgd = million gallons per day; mg/L = milligrams per liter; scfm = standard cubic feet per minute.

TABLE 2
Blower Sizing Data
City of Bend Water Reclamation Facility

Blower Parameters	Air (scfm)
300 hp blower	
Maximum air flow	5,800
Minimum air flow	3,500
100 hp blower	
Maximum air flow	1,700
Minimum air flow	1,000

Notes:

- All air flow rates are at 8 psig discharge pressure.
- Operation points for 300 hp unit are based on Neuros NX300-C060 performance curves.
- Operation points for 100 hp unit are based on Neuros NX100-C060 performance curves.

hp = horsepower; psig = pounds per square inch gauge; scfm = standard cubic feet per minute.

Evaluation of Alternatives

In order to meet the lower flow air flow rates associated with start up and the near-term conditions, a mixture of blower sizes will be required. The IFAS air demand and blower operation design criteria are summarized in Table 3.

TABLE 3
IFAS Air Demand and Blower Operation Design Criteria
City of Bend Water Reclamation Facility

Scenario Parameters	Average Day Maximum Month Wastewater Flow			
	Startup: 6.0 mgd		Near-Term: 8.5 mgd	
	Air Demand	**Blower Operations**	**Air Demand**	**Blower Operations**
Scenario A[a]				
Minimum Week	5,949 scfm	One 300 hp 95% speed One 100 hp 95% speed	8,910 scfm	Two 300 hp 95% speed
Scenario B[b]				
Minimum Week	4,559 scfm	One 300 hp 95% speed	7,576 scfm	One 300 hp 100% speed One 100 hp 100% speed
Annual Average	7,473 scfm	One 300 hp 100% speed One 100 hp 100% speed	15,682 scfm	Three 300 hp 97% speed
Scenario C[c]				
Minimum Week	4,681 scfm	One 300 hp 95% speed	7,531 scfm	One 300 hp 100% speed One 100 hp 100% speed
Annual Average	7,582 scfm	One 300 hp 100% speed One 100 hp 100% speed	13,305 scfm	Three 300 hp 93% speed

[a]Within Scenario A, bulk-liquid DO Varies from 4 mg/L to 6 mg/L depending on the influent conditions. Also, some conditions warrant the use of aeration in the swing zone to provide full nitrification.

[b]Within scenario B, bulk liquid DO varies from 2 mg/L to 4 mg/L depending on the influent conditions.

[c]Within scenario C, bulk liquid DO is held at 2 mg/L.

DO = dissolved oxygen; mgd = million gallons per day; mg/L = milligrams per liter; scfm = standard cubic feet per minute.

Recommendations

Install four 300 hp and one 100 hp high-speed, direct-drive turbo blowers.

TM 6—Plant Effluent Disinfection, Hypochlorite Facility, and Plant Water Pump Station

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DATE: October 3, 2011

PROJECT: Schematic Design Report
Bend Water Reclamation Facility Secondary Expansion

Background

This technical memorandum details the options that were evaluated for disinfection of the plant effluent, the chemical facilities associated with disinfection, and the new plant water pump station.

The Bend Water Reclamation Facility (WRF) currently uses gaseous chlorine and a chlorine contact basin to achieve disinfection for discharge and for Class A reuse.

The Project Definition Report documents the following decisions:

- Plant effluent primary and secondary disinfection of the plant effluent will be provided by 12.5 percent bulk sodium hypochlorite. (Decision modified during Schematic Design.)
- Primary disinfection of the Class A reuse water will be provided by in-vessel ultraviolet (UV) disinfection. Secondary disinfection will be provided by sodium hypochlorite.
- A new disinfection basin will be built for plant effluent. The existing CCB will be abandoned.
- A new plant water (PW) pump station will be provided. The existing PW pump station will be abandoned. A Parshall flume was selected as the element to be used to measure plant effluent flow rate. (Decision modified during Schematic Design.)

Design Criteria

Table 1 lists the design criteria for the plant effluent disinfection and PW systems. The discharge permit (Permit 101752 Outfall 001) requires that effluent meet the following E. coli measurements:

- Monthly geometric mean of E. coli shall not exceed 126 organisms per 100 milliliters (mL)
- No single sample shall exceed 406 organisms per 100 mL.

TABLE 1
Disinfection and Plant Water System Design Criteria
City of Bend Water Reclamation Facility

Criterion	Unit	AAF	MMF	Peak Hour
Plant Effluent Disinfection				
Flow	mgd	10.9	11.9	24.0[a]
UV Transmittance[b]	%	55	55	55
Plant Water Pump Station				
Plant Water Pressure	psi	90	90	90
Plant Water Flow	gpm	350	350	1000
Plant Water Flow	gpm	350	350	1000
Hypochlorite Dose for Plant Water	mg/L as Cl_2	3.0	3.0	3.0
Hypochlorite Storage				
Summer storage	Days	15	15	Not applicable
Winter Storage	Days	60	60	Not applicable

[a]Installed equipment for near-term flow. Hydraulic capacity for 29.1 mgd.
[b]City is collecting plant UV transmittance data to verify design criteria.

AAF = Average Annual Flow.
Cl_2 = chlorine.
mg/L = milligrams per liter.
MMF = Maximum Month Flow.
psi = pounds per square inch

Evaluations

The following items were evaluated during Schematic Design.

Plant Effluent Disinfection

During Schematic Design, the selection of sodium hypochlorite for plant effluent disinfection was again evaluated, taking into account capital costs, as well as life cycle costs, chemical delivery, facility footprint, and sensitivity to power costs and hypochlorite production costs. Two alternatives were considered during Schematic Design for disinfection of plant effluent flows:

- Alternative 1—Construct New chlorine contact basins

- Alternative 2—Construct new disinfection channels with in-channel Low Pressure High Output (LPHO) ultraviolet (UV) disinfection systems

The detailed plant effluent disinfection evaluation is included in Attachment C of this technical memorandum. Alternative 2, a LPHO in channel UV system, was selected as the disinfection system for plant effluent because:

- The two alternatives had similar present worth costs,
- A UV system allows less handling of sodium hypochlorite
- Power costs are relatively low and stable in Central Oregon
- The facility footprint for UV disinfection reduced the overall site impact at the plant

Hypochlorite Storage

There are multiple methods of transporting and storing sodium hypochlorite. Three methods for storing commercial sodium hypochlorite were evaluated during Schematic Design, including:

- Tote storage
- Mini-bulk storage
- Bulk storage

Mini-bulk storage was selected as the method of storing sodium hypochlorite as a good balance of costs effectiveness, safety, and hypochlorite age. The detailed evaluation is included in Attachment C of this technical memorandum.

Hypochlorite Metering Pumps

Three types of pumps were considered:

- Progressing cavity pumps
- Diaphragm pumps
- Peristaltic pumps

A linear-motion diaphragm pump was determined to be the most appropriate pump to meter sodium hypochlorite at this plant given the small flow rates, the low cost of the diaphragm pumps, and small footprint of an installed system.

Plant Effluent Flow Measurement

During Project Definition, a Parshall flume was selected as the element to be used to measure plant effluent flow rate. During Schematic Design, it was determined that a magnetic flow meter was appropriate for this application. The magnetic flow meter reduces the headloss associated with flow measurement, provides accurate flow measurement, and has less influence on the hydraulic gradeline of the plant than a Parshall flume.

Process Description

The WRF secondary expansion will include improvements to the disinfection system, the chemical building, and the PW pump station. The description o f the overall process is as follows:

- Ultraviolet disinfection: Provides inactivation of pathogens as the primary disinfection for plant effluent.
- Hypochlorite metering pumps: Provide a metered dose of sodium hypochlorite to the reuse disinfection system, the PW pump station, and into the return activated sludge (RAS) suction line for secondary biological control.
- Magnetic flow meter: Measures plant effluent flow.
- Drain pump: Drains plant effluent facility channels and floor drains.
- Hypochlorite storage: Storage of 12.5 percent sodium hypochlorite that is delivered from a tanker truck. The storage system will be designed to accept only partial loads of sodium hypochlorite.
- Hypochlorite transfer pump: Transfer hypochlorite between storage tanks or from the storage tank to totes or barrels for use in the water distribution system.
- Plant Water Pumps – Provide plant water (W4) to the plant water system including an automatic plant water strainer.

Design Data

Table 2 contains the design data for disinfection, chemical building, and the PW pump station.

TABLE 2
Disinfection, Chemical Building, and Plant Water System Design Data
City of Bend Water Reclamation Facility

Process	Unit	Existing Facilities	Secondary Expansion (11.9 mgd)
Ultraviolet Disinfection			
Channels	Each	Not applicable	Three
Type			In-channel
Output	mJ/cm^2		35
Hypochlorite Metering Pumps - Plant Water (assuming 3 mg/L at 1.5 mgd)			
Units	Each	Not applicable	Two
Type			Diaphragm
Capacity per unit	gph		2
Hypochlorite Metering Pumps – Reuse Residual (assuming 2 mg/L at 2.5 mgd)			
Units	Each	Not applicable	One
Type			Diaphragm
Capacity per unit	gph		2

TABLE 2
Disinfection, Chemical Building, and Plant Water System Design Data
City of Bend Water Reclamation Facility

Process	Unit	Existing Facilities	Secondary Expansion (11.9 mgd)
Hypochlorite Metering Pumps – RAS Control (assuming 350 ppd)			
Units	Each	Not applicable	One
Type			Diaphragm
Capacity per unit	gph		10
Hypochlorite bulk storage			
Units	Each	Not applicable	Two
Diameter	feet		8
Volume of each tank	gallons		3,000
Hypochlorite transfer pump			
Units	Each	Not applicable	One
Type	feet		Magnetically coupled centifugal
Capacity per unit	gpm		20
Head at capacity	feet		20
Plant Water Pumps			
Units	Each	Three	Four
Type		Vertical turbine	Vertical turbine
Capacity per unit	gpm	350	375
Head at capacity	feet	185	231

gph = gallons per hour.
gpm = gallons per minute.
mgd = million gallons per day.
mJ/cm^2 = millijoule per square centimeter.

Reliability/Redundancy

The U.S. Environmental Protection Agency (EPA) classifies wastewater treatment plants into three levels of system reliability. Based on November 2010 discussions with Oregon Department of Environmental Quality (DEQ), the Bend WRF requires the reliability and redundancy of a Class II facility for disinfection and reuse.

The criterion for chlorine contact basins requires treatment capacity for 50 percent of the design flow with the largest basin out of service (the 1972 EPA criteria assume chlorine disinfection); it is assumed that this same level of reliability and redundancy is also applicable to any UV components or chemical feed systems for the plant water disinfection system.

UV Disinfection units and hypochlorite metering pumps used to provide chlorine residual will be sized to provide firm capacity with the largest unit out of service to meet the reliability and redundancy criteria.

As a critical service, standby power is required for disinfection of effluent conveyed to the seepage ponds. This backup power requirement is the same for both Class I and Class II facilities. The plant effluent disinfection system and backup power will be sized to disinfect the entire design peak flow with one UV channel out of service. The design condition assumes end of lamp life and 55% UV transmittance.

No redundancy is required for the channel drain pump.

For the hypochlorite pumps feeding reuse and plant water, pumps will be provided to meet all design conditions. An extra swing pump will provide redundancy and a capacity safety factor. For hypochlorite metering pumps feeding the RAS pump, no redundancy will be provided. For hypochlorite, metering reliability at low flow is problematic. Pumping rates of hypochlorite can be reduced as hypochlorite degrades. The gaseous by-products can interfere with pump operation. While the condition is temporary, it can be Turndown will be limited to maintain proper flow through the pump. Additionally, the linearly-actuated diaphragm pump will improve turndown.

The PW pump station will be able to meet the peak plant water demand at a reduced pressure of 80 pounds per square inch (psi) with one unit (largest) out of service. A location for a fifth pump will be provided for future expansion. Plant water distribution piping changes may be required when additional pumps are added.

The motorized strainer will have no redundancy. During maintenance activities and mechanical failures, the strainer will be bypassed with manual valves.

Instrumentation and Control Strategy

Plant Effluent Disinfection (UV)

Disinfection of the plant effluent will be provided by a low pressure high output UV system installed in three channels. The numbers of channels operating will be based on flow rate. At least one UV channel will be operating at all times. The UV system will be operated by a package control system based on flow rate and transmittance feedback signals. The UV system flow rate is calculated by adding plant effluent flow rate and plant water flow rate. Flow rate through each UV channel is calculated by dividing the UV system flow rate by the number of operating UV channels.

Influent and effluent gates are provided at each UV channel for isolation. A self-contained level control gate in each channel will provide a constant level to keep the UV bulbs and sleeves submerged.

Hypochlorite System Overview

There are three applications for use of sodium hypochlorite:

- W4 (plant water) disinfection
- W3 (reuse) disinfection
- RAS filament control

Storage and feed for these applications are described below.

Hypochlorite Storage

There are two hypochlorite storage tanks, each with analog level sensing and separate high level detection. A common truck fill control panel is provided for the tanks. The truck fill panel includes analog level indication for each tank, a high level alarm for each tank, and a high-high alarm with horn and beacon to warn chemical delivery truck drivers of an approaching overflow condition.

Hypochlorite Containment Pumping

A constant speed pump is provided for removing liquid from the hypochlorite containment sump. Operators must choose the pumping destination using a manually-operated valve. The position of the valve will determine whether liquid is pumped to drain (for rainwater) or back into a storage tank (for spilled chemical that is to be recovered). The pump must be manually started and stopped from the local control panel.

Hypochlorite Area Eyewash

An eyewash station is located in the pump room. The control system will generate an alarm to notify plant staff when the eyewash station is IN-USE.

Hypochlorite Feed

There are four adjustable speed pumps that can deliver hypochlorite to the above feed point locations. Pump 4 is dedicated to RAS disinfection. The feed point locations for the three remaining pumps (either W3 or W4) will be chosen by operators using manually-operated valves. Each of the remaining three pumps is sized to handle either W3 disinfection or W4 disinfection independently, so one pump will be selected for W3 disinfection, one pump will be selected for W4 disinfection, and the last pump will be an installed spare (swing pump). Operators will identify the manually-valved feed application point via the HMI graphics.

The control strategies for hypochlorite feed to each feed point are described below:

- **W4 (plant water) disinfection.** The pump selected for W4 disinfection will be flow paced based on the flow rate measured at the W4 flow meter located on the discharge header of the W4 pumps and a dosing rate entered by operators via the HMI graphics. Hypochlorite is injected upstream of the W4 wet well. A chlorine analyzer will measure residual at a sample location off the W4 header. High and low chlorine residuals will be alarmed for plant notification and corrective action by operators.

- **W3 (reuse) disinfection.** The pump selected for W3 disinfection will be flow paced based on the flow rate measured at the existing low head reuse flow meter (FIT-52-040 in the low head reuse pump header located at the reuse facility) and a dosing rate entered by operators via the HMI graphics. Operators will use manually-operated valves to determine whether hypochlorite is injected upstream or downstream of the new UV chambers. A chlorine analyzer will measure residual at a sample location off the W3 header or pipeline, likely located near the PLE disinfection facility as the W3 line passes by to provide adequate mixing prior to measurement. High and low chlorine residuals will be alarmed for plant notification and corrective action by operators.
- **RAS filament control.** The pump selected for RAS filament control will be manually started and stopped by operators via the HMI graphics. Use of this pump will be on an as-needed basis. Pump speed will be based on a flow rate set point entered by operators via the HMI graphics.

Hypochlorite Transfer Pumping

The hypochlorite transfer pump is used to either transfer hypochlorite from one storage tank to another, or from a storage tank to a portable tote. Use of the pump requires a manual hose connection to be made to connect the pump discharge to the appropriate feed location. The constant speed pump will be manually started and stopped by operators using hand switches mounted on a local control panel (no SCADA interface). A pneumatic valve in the pump's discharge line prevents unintended tank emptying through the centrifugal pump when it is not running. Hardwired controls at the local control panel open the valve automatically when the pump is running.

Currently, the drinking water system uses around 720 gallons of hypochlorite each year. The hypochlorite transfer pump will be used to fill a portable tote that will be transported to the point of use such as a well pump.

Plant Water Pumping

Four adjustable speed pumps are provided for plant water pumping. The control system will control the pumps to maintain pressure at an operator-entered set point. The pumps will run in LEAD/LAG 1/LAG 2/LAG 3 sequence. The lead pump will run continuously. When the pressure controller's output exceeds 90% for a continuous 30 second period, the next lag pump in the sequence will be started to help meet the demand. When the pressure controller's output falls below 50% for a continuous 30 second period, the last started pump will be stopped.

The plant water strainer includes a package control panel that provides automated backwashing.

Drain Pumping

Two constant speed pumps are provided for drain pumping. The pumps will run in a LEAD/LAG sequence based on the liquid level measured in the drain wet well. Pump operation is based on the following set points, entered by operators via the HMI graphics:

- LSHH – Start LAG pump

- LSH – Start LEAD pump
- LSL – Stop both pumps

A low-low level switch (LSLL) provides a hardwired interlock for dry run protection.

Outstanding Issues

The in-channel UV equipment can be procured through several different mechanisms. The procurement method selected will impact the timing, the number of eligible vendors, and the approach to detailed design of the equipment. Common approaches for procuring this equipment are as follows:

1. Design Bid Build
2. Owner Purchase (Pre-Selection)
3. Owner Purchase (Pre-Selection) with Contract assigned to construction contractor

Evaluation and selection of a procurement approach for this equipment is being conducted in parallel to the Schematic Design, in coordination with the follow-on detailed design work.

Fire protection pumping: The existing plant water distribution system supplies plant water to the majority of fire hydrants at the plant. The domestic water system that supplies the plant is not sufficient to provide the instantaneous flow required for a fire flow condition. The new PW pump station must meet the needs as determined by the Fire Marshall who has jurisdiction over this facility.

Existing chlorine contact basin: The existing chlorine contact basins are not able to handle the future flow of the plant and will be replaced in the Secondary Expansion. The alternatives of abandoning or demolishing the existing disinfection facilities will be evaluated during Design Development.

Plant Water Strainer: The existing plant water pump station has a functional SP Kinney automatic strainer. During design development, the applicability of this strainer to the new facilities will be reviewed. If the existing strainer is reused, a manual strainer may be installed to facilitate startup of the system.

Attachments

Attachment A—Equipment Data Sheets

- In-Channel Low Pressure High Output UV
- Plant Water Pump
- Plant Water Motorized Strainer
- Hypochlorite Storage Tanks 1, 2
- Hypochlorite Metering Pumps 1, 2, 3
- Hypochlorite Metering Pumps 4
- Hypochlorite Transfer Pump

Attachment B—Vendor Catalog Cuts

- LPHO UV-Trojan UV3000Plus
- LPHO UV-Wedeco TAK 55
- Hypochlorite Metering Pump-Grundfos DME/DMS
- Hypochlorite Transfer Pump-Little Giant TE-6-MD-HC
- Plant Water Pump-Weir-Floway 11XKL
- Plant Water Pump-Flowserve 10ELM

Attachment C—Schematic Design Fact Sheets

- Fact Sheet 1—Plant Effluent Disinfection Alternatives
- Fact Sheet 2—Hypochlorite Storage

Attachment A—Equipment Data Sheets

Bend Water Reclamation Facility Secondary Expansion

EQUIPMENT DATA SHEET

SPEC SECTION: ______

LEAD ENGINEER: Thompson

FACILITY NAME: 43 - Plant Effluent Disinfection Facility

EQUIPMENT NAME: In-Channel Low Pressure High Output UV **QUANTITY:** 6

IDENTIFICATION NO.: ______

MATERIAL HANDLED: W3 - Reuse Water (Level 4/Class A)

CAPACITY: ______

LOCATION: ____ dry x wet x exterior ____ hazardous

POWER REQUIRED: ____ KW 480 volts 3 phase 184 kW

DRIVE: n/a
(Constant speed, 2 speed, variable speed)

ENCLOSURE TYPE: MOTOR: na CONTROL PANEL: ______

SYNCHRONOUS SPEED (rpm): ______

MOUNTING TYPE: ______
(Horizontal or Vertical):

SUPPORT UTILITIES REQUIRED: materials handling equipment, W4

EQUIPMENT DESCRIPTION: 2 banks per channel, 3 channels total
(Size, configuration)

MANUFACTURERS: **NO. 1:** Wedeco **NO. 2:** Trojan

MODEL: TAK 55 Series **MODEL:** TrojanUV3000Plus

EQUIPMENT WEIGHT: ____ lbs

EQUIPMENT COST: **QUOTE:** $1,345,680 **DELIVERY TIME:** 24 weeks

VENDOR: Goble Sampson - Wedeco
Wm H. Reilly & Co. - Trojan

MISCELLANEOUS COMMENTS, DATA, AND INFORMATION: ______

LOCATION OF EQUIPMENT: P&ID Sheet No. ____ Construction Sheet No. ____

REVISION	DATE	NO.	BY

Bend Water Reclamation Facility Secondary Expansion

EQUIPMENT DATA SHEET

SPEC SECTION: 44 42 56.03

LEAD ENGINEER: Thompson

FACILITY NAME: 43 - Plant Effluent Disinfection Facility

EQUIPMENT NAME: Plant Water Pump **QUANTITY:** 4

IDENTIFICATION NO.: PWP-1, PWP-2, PWP-3, PWP-4

MATERIAL HANDLED: W4 - Chlorinated Effluent (Plant Water)

CAPACITY: 375 gpm at 105 psi

LOCATION: ____ dry x wet x exterior ____ hazardous

POWER REQUIRED: 30 hp 460 volts 3 phase

DRIVE: Variable speed
(Constant speed, 2 speed, variable speed)

ENCLOSURE TYPE: MOTOR: TEFC CONTROL PANEL: ____

SYNCHRONOUS SPEED (rpm): 1,800

MOUNTING TYPE: Vertical
(Horizontal or Vertical):

SUPPORT UTILITIES REQUIRED: None

EQUIPMENT DESCRIPTION: 5 stage vertical turbine pump
(Size, configuration)

MANUFACTURERS: **NO. 1:** Flowserve **NO. 2:** Weir Floway

MODEL: 10ELM, 6 stage, 7.26 in. impellar **MODEL:** 11XKL, 5 stage, 7.94 impellar

EQUIPMENT WEIGHT: 4,500 lbs

EQUIPMENT COST: **QUOTE:** $320,000 **DELIVERY TIME:** 8 months

VENDOR: APSCO

MISCELLANEOUS COMMENTS, DATA, AND INFORMATION:
Plant Effluent has chlorine residual to 6 mg.

LOCATION OF EQUIPMENT: P&ID Sheet No. 08-N-032 Construction Sheet No. ____

REVISION	DATE	NO.	BY
Original	5/20/2011	0	Thompson

Bend Water Reclamation Facility Secondary Expansion

EQUIPMENT DATA SHEET

SPEC SECTION: 44 43 33.13

LEAD ENGINEER: Thompson

FACILITY NAME: 43 - Plant Effluent Disinfection Facility

EQUIPMENT NAME: Plant Water Motorized Strainer **QUANTITY:** 1

IDENTIFICATION NO.:

MATERIAL HANDLED: W4 - Chlorinated Effluent (Plant Water)

CAPACITY: 2,500 gpm @120 psi

LOCATION: x dry ____ wet ____ exterior ____ hazardous

POWER REQUIRED: 5 hp 480 volts 3 phase

DRIVE:
(Constant speed, 2 speed, variable speed)

ENCLOSURE TYPE: MOTOR: TEFC CONTROL PANEL:

SYNCHRONOUS SPEED (rpm): 1,800

MOUNTING TYPE: Vertical
(Horizontal or Vertical):

SUPPORT UTILITIES REQUIRED: Drain

EQUIPMENT DESCRIPTION:
(Size, configuration)

MANUFACTURERS: **NO. 1:** SP Kinney **NO. 2:**

MODEL: 8" Model "A-1" **MODEL:**

EQUIPMENT WEIGHT: ____ lbs

EQUIPMENT COST: **QUOTE:** **DELIVERY TIME:**

VENDOR:

MISCELLANEOUS COMMENTS, DATA, AND INFORMATION:
May use existing strainer

LOCATION OF EQUIPMENT: P&ID Sheet No. ____ Construction Sheet No. ____

REVISION	DATE	NO.	BY

Bend Water Reclamation Facility Secondary Expansion

EQUIPMENT DATA SHEET

SPEC SECTION: ____________________

LEAD ENGINEER: Thompson

FACILITY NAME: 42 - Hypochlorite Facility

EQUIPMENT NAME: Hypochlorite Storage Tanks 1, 2 **QUANTITY:** 2

IDENTIFICATION NO.: ____________________

MATERIAL HANDLED: NAOH - Hypochlorite

CAPACITY: 3,000 gallons

LOCATION: ______ dry ______ wet x exterior ______ hazardous

POWER REQUIRED: ______ hp 120 volts 1 phase

DRIVE: n/a
(Constant speed, 2 speed, variable speed)

ENCLOSURE TYPE: MOTOR: n/a CONTROL PANEL: ____________________

SYNCHRONOUS SPEED (rpm): ____________________

MOUNTING TYPE: ____________________
(Horizontal or Vertical):

SUPPORT UTILITIES REQUIRED: ____________________

EQUIPMENT DESCRIPTION: 3,000 gallons vertical fiberglass storage tank
(Size, configuration)

MANUFACTURERS: **NO. 1:** ____________________ **NO. 2:** ____________________

MODEL: ____________________ **MODEL:** ____________________

EQUIPMENT WEIGHT: ______ lbs

EQUIPMENT COST: **QUOTE:** ____________________ **DELIVERY TIME:** ____________________

VENDOR: ____________________

MISCELLANEOUS COMMENTS, DATA, AND INFORMATION:
Insulated and heat traced

LOCATION OF EQUIPMENT: P&ID Sheet No. ______ Construction Sheet No. ______

REVISION	DATE	NO.	BY

Bend Water Reclamation Facility Secondary Expansion

EQUIPMENT DATA SHEET

SPEC SECTION: 44 44 13.01

LEAD ENGINEER: Thompson

FACILITY NAME: 42 - Chlorination System

EQUIPMENT NAME: Hypochlorite Metering Pumps 1, 2, 3 **QUANTITY:** 3

IDENTIFICATION NO.: ______

MATERIAL HANDLED: CS - Chlorine Solution

CAPACITY: 3 gallons per hour at 30 psi

LOCATION: x dry ______ wet ______ exterior ______ hazardous

POWER REQUIRED: frac hp 120 volts 1 phase

DRIVE: ______
(Constant speed, 2 speed, variable speed)

ENCLOSURE TYPE: MOTOR: ______ CONTROL PANEL: ______

SYNCHRONOUS SPEED (rpm): ______

MOUNTING TYPE: ______
(Horizontal or Vertical):

SUPPORT UTILITIES REQUIRED: ______

EQUIPMENT DESCRIPTION: ______
(Size, configuration)

MANUFACTURERS: **NO. 1:** Grundfos **NO. 2:** ______

MODEL: DME 12-6 **MODEL:** ______

EQUIPMENT WEIGHT: ______ lbs

EQUIPMENT COST: **QUOTE:** $6,000 **DELIVERY TIME:** ______

VENDOR: TMG Services, Thomas Gazdik

MISCELLANEOUS COMMENTS, DATA, AND INFORMATION: ______

LOCATION OF EQUIPMENT: P&ID Sheet No. ______ Construction Sheet No. ______

REVISION	DATE	NO.	BY

Bend Water Reclamation Facility Secondary Expansion

EQUIPMENT DATA SHEET

SPEC SECTION: 44 44 13.01

LEAD ENGINEER: Thompson

FACILITY NAME: 42 - Chlorination System

EQUIPMENT NAME: Hypochlorite Metering Pumps 4 **QUANTITY:** 1

IDENTIFICATION NO.:

MATERIAL HANDLED: CS - Chlorine Solution

CAPACITY: 10 gallons per hour at 110 psi

LOCATION: x dry ____ wet ____ exterior ____ hazardous

POWER REQUIRED: frac hp 120 volts 1 phase

DRIVE:
(Constant speed, 2 speed, variable speed)

ENCLOSURE TYPE: MOTOR: ____ CONTROL PANEL: ____

SYNCHRONOUS SPEED (rpm):

MOUNTING TYPE:
(Horizontal or Vertical):

SUPPORT UTILITIES REQUIRED:

EQUIPMENT DESCRIPTION:
(Size, configuration)

MANUFACTURERS: **NO. 1:** Grundfos **NO. 2:**

MODEL: DME 60-10 **MODEL:**

EQUIPMENT WEIGHT: ____ lbs

EQUIPMENT COST: **QUOTE:** $2,000 **DELIVERY TIME:**

VENDOR: TMG Services

MISCELLANEOUS COMMENTS, DATA, AND INFORMATION:

LOCATION OF EQUIPMENT: P&ID Sheet No. ____ Construction Sheet No. ____

REVISION	DATE	NO.	BY

Bend Water Reclamation Facility Secondary Expansion

EQUIPMENT DATA SHEET

SPEC SECTION: ____________

LEAD ENGINEER: Thompson

FACILITY NAME: 42 - Chlorination System

EQUIPMENT NAME: Hypochlorite Transfer Pump **QUANTITY:** 1

IDENTIFICATION NO.: ____________

MATERIAL HANDLED: CS - Chlorine Solution

CAPACITY: 20 gpm at 20 feet

LOCATION: ______ dry ______ wet ______ exterior ______ hazardous

POWER REQUIRED: 0.5 hp 120 volts 1 phase

DRIVE: constant speed
(Constant speed, 2 speed, variable speed)

ENCLOSURE TYPE: MOTOR: ______ CONTROL PANEL: ______

SYNCHRONOUS SPEED (rpm): ____________

MOUNTING TYPE: ____________
(Horizontal or Vertical):

SUPPORT UTILITIES REQUIRED: ____________

EQUIPMENT DESCRIPTION: Magnetically coupled centrifugal pump
(Size, configuration)

MANUFACTURERS: **NO. 1:** Finish Thompson **NO. 2:** Little Giant

MODEL: DB6P-M226 (Grainger 3AZN4) **MODEL:** TE-6-MD-HC (4RL35)

EQUIPMENT WEIGHT: ______ lbs

EQUIPMENT COST: **QUOTE:** $1,000 **DELIVERY TIME:** n/a

VENDOR: Grainger Page 3861

MISCELLANEOUS COMMENTS, DATA, AND INFORMATION:
Run dry capability with magnetic drive. Capatible with Sodium Hypchlorite.

LOCATION OF EQUIPMENT: P&ID Sheet No. ______ Construction Sheet No. ______

REVISION	DATE	NO.	BY

Attachment B—Vendor Catalog Cuts

TROJANUV3000PLUS™

WASTEWATER DISINFECTION

TROJANUV3000PLUS™

The Reference Standard in UV

Proven, chemical-free disinfection from the industry leader

Trojan Technologies is an ISO 9001: 2000 registered company that has set the standard for proven UV technology and ongoing innovation for more than 25 years. With unmatched scientific and technical expertise, and a global network of water treatment specialists, representatives and technicians, Trojan is trusted more than any other firm as the best choice for municipal UV solutions. Trojan has the largest UV installation base – over 4,000 municipal installations worldwide – and almost one in five North American wastewater treatment plants rely on our proven, chemical-free disinfection solutions.

The TrojanUV3000Plus™ is one of the reasons why. This highly flexible system has demonstrated its effective, reliable performance around the world in over 400 installations. It is well suited to wastewater disinfection applications with a wide range of flow rates, including challenging effluent such as combined sewer overflows, primary and tertiary wastewater reclamation and reuse.

Following a review with Plant Operators and Engineers, the proven infrastructure of the TrojanUV3000Plus™ has been refined to make it even more operator-friendly. The result is more dependable performance, simplified maintenance, and maximized UV lamp output at end-of-lamp life. It also incorporates innovative features to reduce O&M costs, including variable output electronic ballasts and Trojan's revolutionary ActiClean™ system – the industry's only chemical/mechanical sleeve cleaning system.

TROJANUV3000PLUS™

Designed for efficient, reliable performance

System Control Center (SCC)

The SCC monitors and controls all UV functions, including dose pacing – the automatic, flow-based program that ensures proper disinfection levels while conserving power and extending lamp life. The microprocessor-based SCC is integrated onto one Power Distribution Center, and features a user-friendly, touch-screen HMI display with weatherproof cover, and Modbus Ethernet SCADA connectivity. For systems treating larger flows, or where more sophisticated control is desired, a PLC-based System Control Center is available. It features a separate wall-mount panel with colour, touch-screen HMI, Ethernet/IP SCADA connectivity, automatic slide/sluice gate control for multiple channels, and integrated Flash memory trend logging (flow, power, UVT, dose).

Alarms

Extensive alarm reporting system ensures fast, accurate diagnosing of system process and maintenance alarms. Programmable control software can generate unique alarms for individual applications.

Power Distribution Center (PDC)

The PDC powers each bank of modules. Its ergonomic, angled design provides easy access to module power cables and hoses for the ActiClean™ cleaning system. The robust stainless steel enclosure is mounted across the channel, with module fuses and interlock relays visually aligned with module receptacles for fast diagnostics. Modules are individually overload protected for safety. Like all TrojanUV3000Plus™ components, the PDC can be installed outdoors and requires no shelter or HVAC.

UV Intensity Sensor

The UV intensity sensor continually monitors UV lamp output. The ActiClean™ system automatically cleans the sensor sleeve every time lamp sleeves are cleaned.

Electronic Ballasts

The variable-output (60 - 100% power) electronic ballast is mounted in its own TYPE 6P (IP67) rated enclosure within the module frame. Features “quick connect” electrical connections. Cooling is by convection.

ActiClean™ Cleaning System

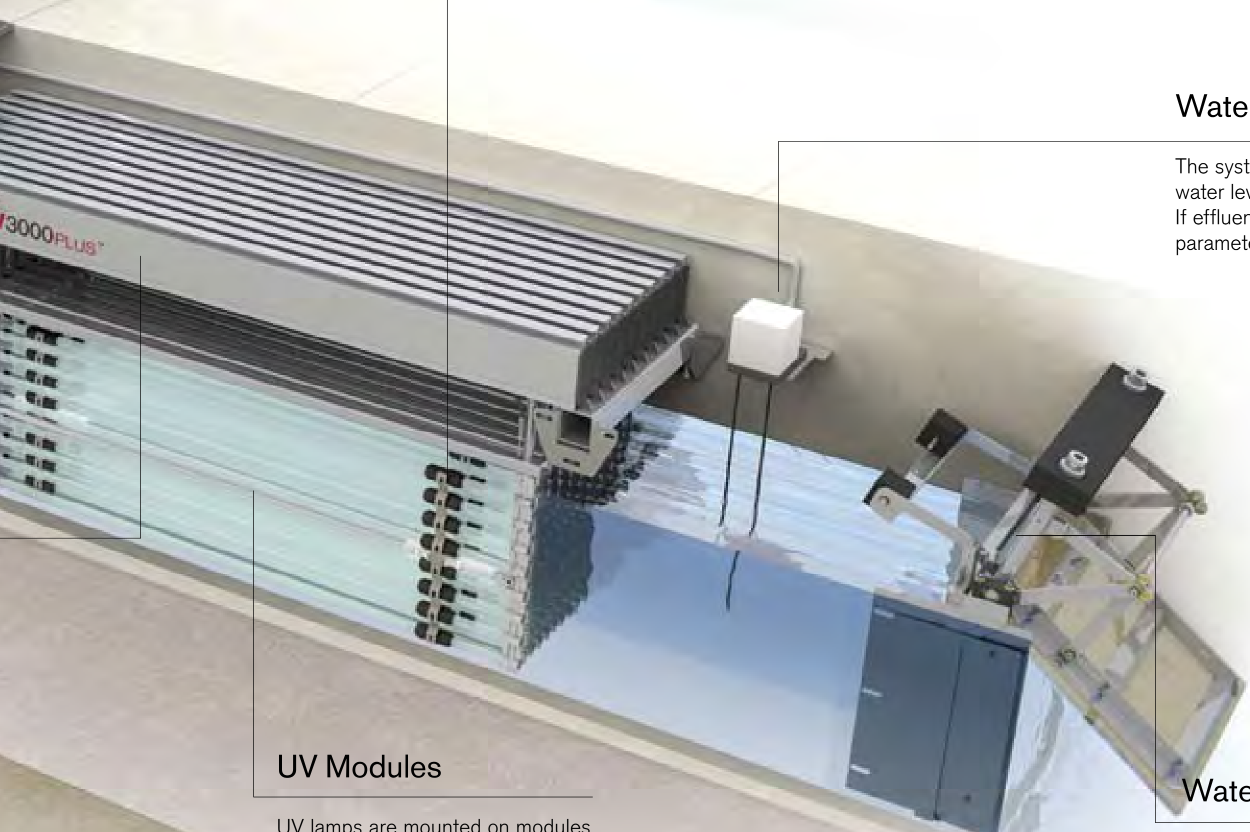
The system consists of two components:

1. Hydraulic System Center (HSC)

The HSC actuates the ActiClean™ cleaning system, and is mounted close to the channel in a stainless steel enclosure. It contains the pump, valves and ancillary equipment required to operate the cleaning system, and links to the extend/retract hoses of the module wiper drives via a manifold located on the underside of the PDC.

2. ActiClean™ Wiper Assembly

A submersible wiper drive on each UV module drives the wiper carriage assembly along the module. Attached wiper canisters surround the quartz sleeves, and are filled with Trojan's ActiClean™ Gel. The gel uses food grade ingredients and contacts the lamp sleeves between the two wiper seals. Cleaning takes place while the lamps are submerged and while they are operating.



Water Level Sensor

The system includes an electrode low water level sensor for each channel. If effluent levels fall below defined parameters, an alarm will be activated.

UV Modules

UV lamps are mounted on modules installed in open channels. The lamps are enclosed in quartz sleeves, and positioned horizontally and parallel to water flow. A bank is made up of multiple modules placed in parallel. All ballast and lamp wiring runs inside the module frame.

Water Level Controller

A fixed weir, motorized weir gate, or Automatic Level Control gate (shown), is required in the channel to maintain the appropriate water level over the lamps. Trojan engineers will work with you to select the appropriate level control device for your application.

Key Benefits
TrojanUV3000Plus™

Increased operator, community and environmental safety. The TrojanUV3000Plus™ uses environmentally-friendly ultraviolet light – the safest alternative for wastewater disinfection. No disinfection by-products are created, and no chemicals must be transported, stored or handled.

Well suited to changing regulations. Trojan UV systems do not have any negative impact on receiving waters and do not produce disinfection by-products, making them a strategic, long-term choice as regulations become increasingly stringent.

Most efficient UV system available versus competitive low-pressure, high-output (LPHO) or amalgam lamp-based systems.

Reduces operating costs by as much as 30% per year. Long-lasting amalgam lamps and variable-output ballasts optimize UV output to meet wastewater conditions and maximize system efficiency versus competitive UV systems.

Proven disinfection based on actual dose delivery testing (bioassay validation), and over 400 TrojanUV3000Plus™ installations worldwide. Real-world, field performance data eliminates sizing assumptions resulting from theoretical dose calculations.

Dual-action sleeve cleaning system improves performance and reduces labor costs. Automatic ActiClean™ chemical/mechanical cleaning system maintains sleeve transmittance of at least 95%, and works online – eliminating the need to remove modules from the channel.

Reduced installation costs. The compact TrojanUV3000Plus™ can be retrofitted into existing chlorine contact tanks, and comes pre-tested, pre-assembled and pre-wired to minimize installation costs.

Outdoor installation flexibility. The entire TrojanUV3000Plus™ system can be installed outdoors, eliminating the need and costs of a building, shelter, and HVAC for ballast cooling.

Guaranteed performance and comprehensive warranty. Trojan systems include a Lifetime Performance Guarantee, the best lamp warranty in the industry, and use lamps from multiple approved suppliers. Ask for details.

ActiClean™ Dual-Action, Automatic Cleaning System

Chemical/mechanical cleaning system eliminates sleeve fouling

Benefits:

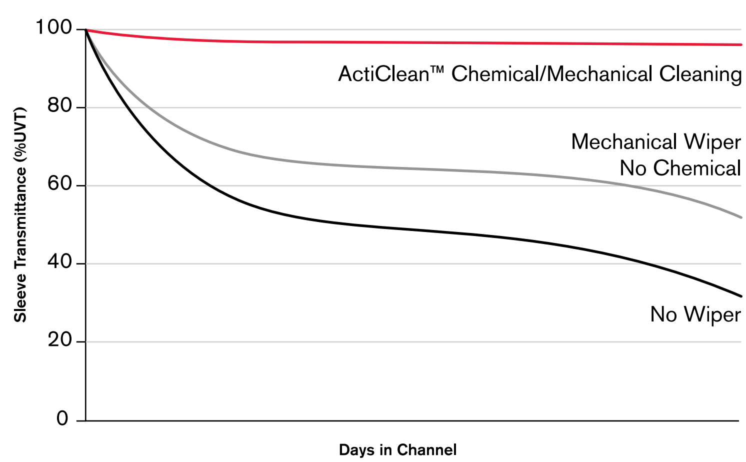
- Cleans 50% more effectively than mechanical wiping alone
- Improves lamp performance for more reliable dose delivery
- Elimination of fouling factor reduces equipment sizing requirements and power consumption
- Automatic, online cleaning reduces O&M costs associated with manual cleaning
- Combination of chemical and mechanical cleaning action removes deposits on quartz lamp and sensor sleeves much more effectively than mechanical wiping alone
- Innovative wiper design incorporates a small quantity of ActiClean™ Gel for superior, dual-action cleaning
- Cleans automatically while the lamps are disinfecting. There's no need to shut down the system, remove or bypass lamp modules for routine cleaning
- Proven in hundreds of systems around the world, including use in plants where heavy fouling had previously prohibited the use of UV disinfection technology
- ActiClean™ can be added to an installed TrojanUV3000Plus™ not originally equipped with a cleaning system

ActiClean™ Gel is Safe to Handle

- ActiClean™ Gel is comprised of food-grade ingredients
- Quick connect on cleaning system allows for easy refill of gel solution
- Lubricating action of ActiClean™ Gel maximizes life of wiper seals

The dual-action, chemical/mechanical cleaning with the ActiClean™ system provides superior sleeve cleaning and reduces maintenance costs. Fouling and residue build-up on quartz sleeves reduces system efficiency. ActiClean™ maintains at least 95% transmittance, ensuring sleeves are clean and the system is consistently delivering accurate dosing while reducing power consumption.

Efficacy of Cleaning Technologies to Control Sleeve Fouling



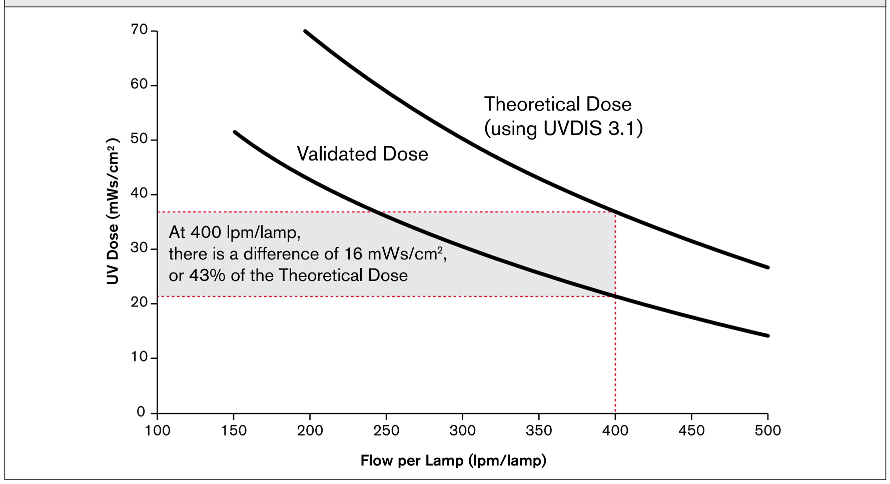
Regulatory-Endorsed Bioassay Validation

Real-world testing ensures accurate dose delivery

Benefits:

- Performance data is generated from actual field testing over a range of flow rates, effluent quality, and UVTs
- Provides physical verification that system will perform as expected; ensures public and environmental safety
- Provides accurate assessment of equipment sizing needs
- The TrojanUV3000Plus™ has been thoroughly validated through real-world bioassay testing under a wide range of operating conditions
- In-field bioassay testing offers the peace of mind and improved public and environmental safety of verified dose delivery – not theoretical calculations
- The USEPA has endorsed bioassays as the standard for assessment and comparison of UV technologies
- The disinfection performance ratings for the TrojanUV3000Plus™ are proof that what you see is what you actually get

Field Validated Dose vs. Theoretical Dose at 65% UVT
(Before Fouling & Lamp Aging Are Taken into Account)



This shows the validated dose of an actual working system and the theoretical dose calculated using UVDIS. Note that the UVDIS 3.1 dose calculation overestimates the system performance.

Amalgam Lamps Require Less Energy

Require fewer lamps and reduce O&M costs

Benefits:

- Draw less energy than competitive high-output systems – only 250 Watts per lamp
- Stable UV output over a wide range of water temperatures
- Fewer lamps are required to deliver the required dose, which reduces O&M costs
- Can treat lower quality wastewater such as primary effluents, combined sewer overflows, and storm water
- Fewer lamps allow systems to be located in compact spaces, reducing installation costs

Trojan's high efficiency amalgam lamps generate stable UV output in a wide range of water temperatures.

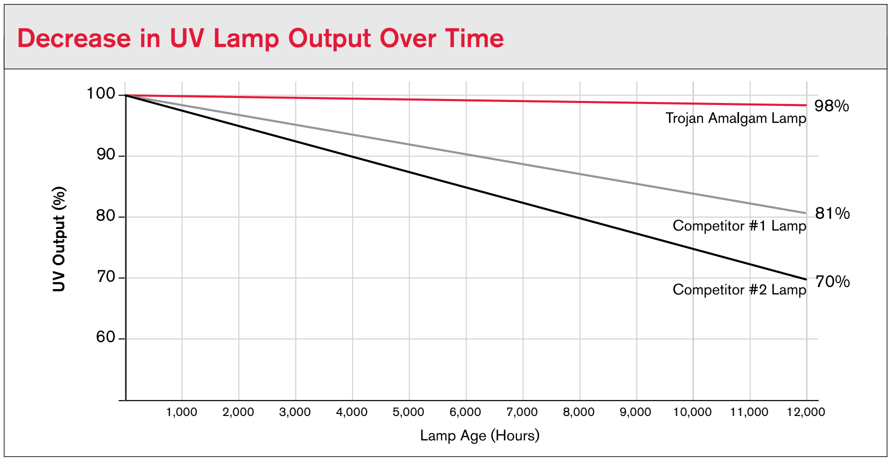
- Trojan's amalgam lamps produce significantly higher UV output than conventional low-output lamps
- Fast and simple lamp changeouts; replacing a 50-lamp system takes less than two hours and requires no tools
- The lamps are sealed inside heavy-duty quartz sleeves by Trojan's multi-seal system, maintaining a watertight barrier around the internal wiring while individually isolating each lamp and the module frame
- Lamps are pre-heated for reliable startup

Amalgam Lamps Maintain Maximum UV Output

Trojan lamps deliver 98% of full UV output after more than one year of use

Benefits:

- Trojan's high efficiency, amalgam lamps deliver the most consistent UV output
- Trojan lamps have 20% less decline in UV output after 12,000 hours of use compared to competitive UV lamps
- Validated performance assures you of reliable dose delivery and prolonged lamp life



The lamps used on the TrojanUV3000Plus™ system have been independently validated to maintain 98% of original output after 12,000 hours of operation.

Open-Channel Architecture Designed for Outdoor Installation

Cost-effective to install and expand

Benefits:

- Compact, open-channel design allows cost-effective installation in existing effluent channels and chlorine contact chambers
- System can be installed outdoors to reduce capital costs – no building, shelter or HVAC is required
- Gravity-fed design eliminates costs of pressurized vessels, piping and pumps
- Scalable architecture allows precise sizing – reduces capital and O&M costs associated with oversizing
- Modular design is readily expandable to meet new regulatory or capacity requirements
- Trojan's thorough design approach ensures that effluent quality, upstream treatment processes, and O&M needs are addressed in system configurations
- Horizontal lamp mounting delivers optimal hydraulic performance. This arrangement induces turbulence and dispersion, maximizing wastewater exposure to UV output

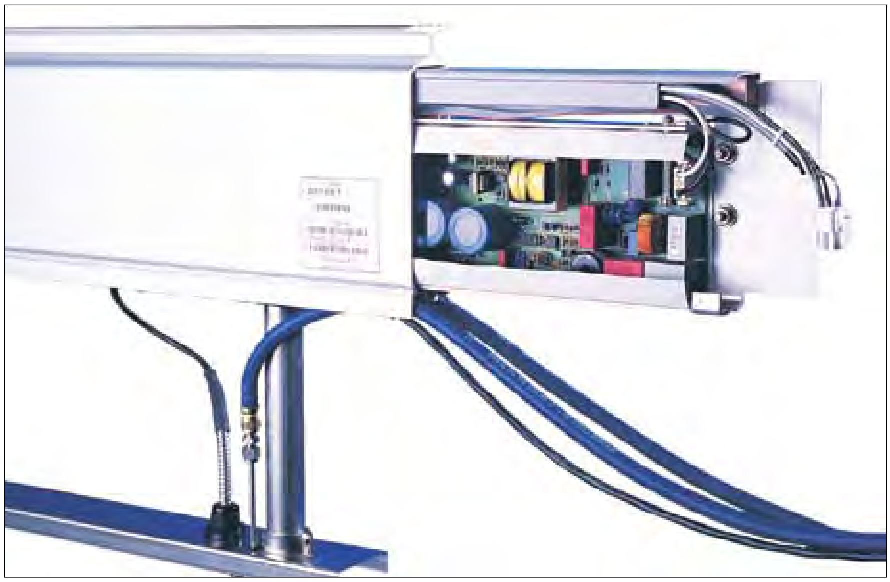
The TrojanUV3000Plus™ system delivers flexibility and cost savings through its simple installation in existing channels and chlorine contact chambers. The system can be situated outdoors with no additional building, shelter or cooling requirements.

Advanced, Self-Contained UV Module

Dramatically reduces footprint size and eliminates costs of air conditioning

Benefits:

- Lamps are protected in a fully submersible, 316 stainless steel frame
- Waterproof module frame protects cables from effluent, fouling and UV light
- Electronic ballasts are housed right in the module, reducing the system footprint, minimizing installation time and costs, and eliminating the need for separate external cabinets
- Ballast enclosures are rated TYPE 6P (IP67) – air/water tight
- Module leg and lamp connector have a hydrodynamic profile to reduce headloss
- The variable-output, electronic ballast is mounted in an enclosure integrated within the module frame
- Wiring is pre-installed and factory-tested

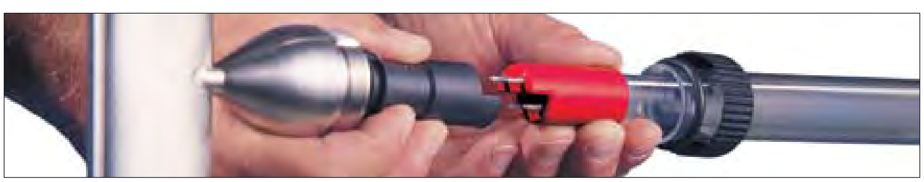


Module-mounted ballasts allow for compact installation, convection cooling, and protect wires and cables from exposure to effluent and UV light.

- Cooling ballasts by convection eliminates costs associated with air conditioning and forced-air cooling

Module leg and lamp connector have a hydrodynamic profile to reduce headloss and potential for debris fouling.

Designed for Easy Maintenance



Trojan UV lamps are easily replaced in minutes without the need for tools.

- TrojanUV3000Plus™ lamps are warranted for 12,000 hours
- Modular design allows for maintenance on one module without disrupting disinfection performance
- Maintenance limited to replacing lamps and cleaning solution
- Automated ActiClean™ cleaning system reduces manual labor associated with cleaning sleeves

Quick connect allows for easy refill of ActiClean™ Gel.

TROJANUV3000PLUS™

System Specifications

System Characteristics	TrojanUV3000Plus™
Typical Applications	Wide range of wastewater treatment plants
Lamp Type	High-efficiency Amalgam
Ballast Type	Electronic, variable output (60 to 100% power)
Input Power Per Lamp	250 Watts
Lamp Configuration	Horizontal, parallel flow
Module Configuration	4, 6 or 8 lamps per module
Level Control Device Options	ALC, fixed weir or motorized weir gate
Water Level Sensor	1 electrode low water level sensor per channel
Enclosure Ratings:	
Module Frame / Ballast Enclosure	TYPE 6P (IP68) / TYPE 6P (IP67)
All Other Enclosures	TYPE 4X (IP56)
Ballast Cooling Method	Convection; no air conditioning or forced air required
Installation Location	Indoor or outdoor
Sleeve Cleaning System:	
ActiClean™ Cleaning System	Optional Automatic Chemical/Mechanical Cleaning System
ActiClean™ Cleaning Gel	Non-corrosive, operator-friendly
Recommended Fouling Factor	1.0
System Control Center:	
Controller	Microprocessor or PLC-based
Analog Inputs (Typical)	Flow (4-20 mA) and UVT (4-20 mA)
Discrete Outputs (Typical)	Bank status, common alarms and SCADA communication
Maximum Distance from UV Channel	500 ft. (152 m)
Electrical Requirements:	
Power Distribution Center	208Y/120V, 3 phase, 4 wire + GND, 60 Hz (Max. 8 modules per PDC) 480Y/277V, 3 phase, 4 wire + GND, 60 Hz 380Y/220V, 3 phase, 4 wire + GND, 50/60 Hz 400Y/230V, 3 phase, 4 wire + GND, 50/60 Hz 415Y/240V, 3 phase, 4 wire + GND, 50/60 Hz
System Control Center (stand alone)	120V, single phase, 2 wire + GND, 60 Hz, 1.8 kVA 220/230/240V, single phase, 2 wire + GND, 50/60 Hz, 1.8kVA
Hydraulic System Center (for ActiClean™)	208V, 3 phase, 3 wire + GND, 60 Hz 380/400/415 V, 3 phase, 3 wire + GND, 50/60 Hz 480 V, 3 phase, 3 wire + GND, 60 Hz or 2.5kVA HSC powered from PDC
Water Level Sensor	24VDC powered from PDC

Find out how your wastewater treatment plant can benefit from the TrojanUV3000Plus™ – call us today.

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Trojan Technologies Deutschland GmbH (Germany): +49 6024 634 75 80
Hach/Trojan Technologies (China): 86-10-65150290

Products in this brochure may be covered by one or more of the following patents:
U.S. 4,872,980; 5,006,244; 5,418,370; RE 36,896; 6,342,188; 6,635,613; 6,646,269; 6,663,318; 6,719,491; 6,830,697; 7,018,975
Can. 1,327,877; 2,117,040; 2,239,925
Other patents pending.

MWW-003 (1108) TROW-1040

TROJANUV
WATER CONFIDENCE™

TAK 55 Series

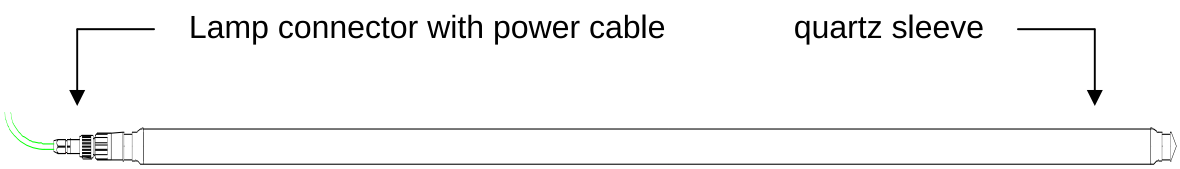
Wastewater UV Disinfection Systems

TAK 55 Wastewater UV Disinfection Systems

ITT Water & Wastewater has more than 25 years of experience in the development and application of WEDECO UV technology. The TAK series was specifically engineered for the disinfection of municipal wastewater. Several different TAK design configurations are available to meet worldwide regulatory requirements (e.g. USEPA requirements for discharge, NWRI guidelines for reuse, etc.) and cope with varying degrees of water quality depending on the level of pre-treatment (e.g. primary, secondary or tertiary). Installed in final effluent channels, the modular design of the TAK allows for practically unlimited flow capacities.

The number of lamps per bank and the total number of lamps in the system are dependent on several factors including the water flow rate, UV transmittance, suspended solids level, disinfection requirements, dose requirements, etc.

Each lamp is installed in a protective quartz "sleeve”. This sleeve, together with the lamp, electrical connector and water-tight tube end seal, make up a "UV lamp module".



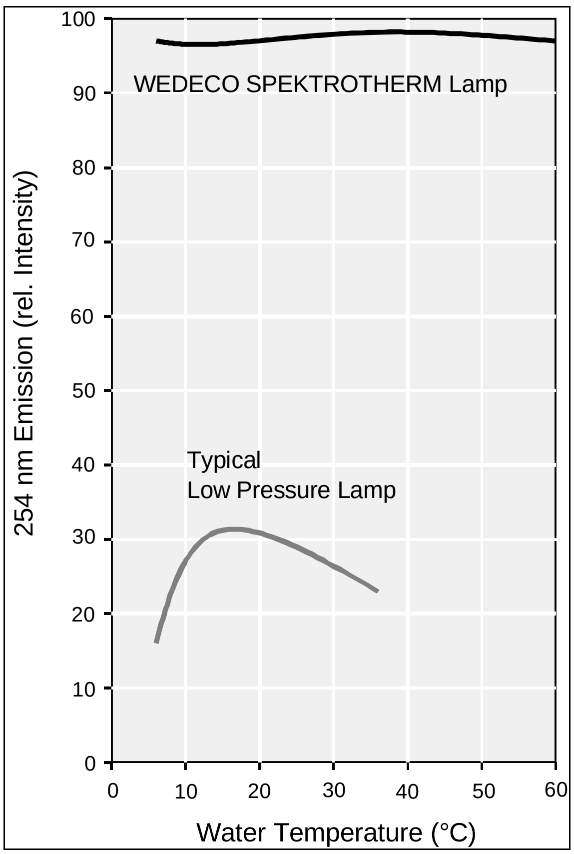
Lamp module

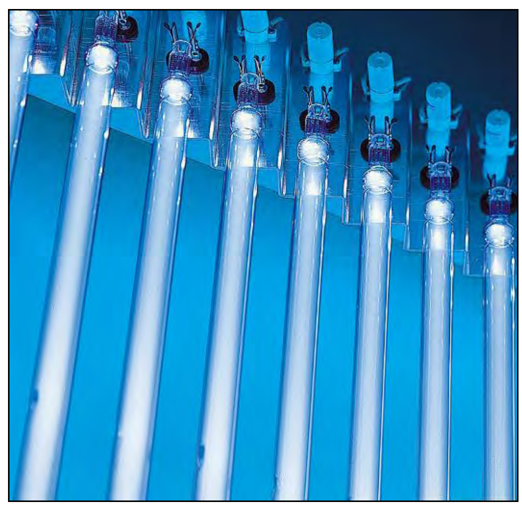
Low pressure – high intensity Spektrotherm® UV Lamps

Higher UV-C Output - Longer Lamp Life - Greater Temperature Stability

Spektrotherm® UV lamps are employed in most WEDECO UV disinfection systems. These lamps are the result of a concerted, long term R&D program aimed at increasing UV lamp performance and efficiency.

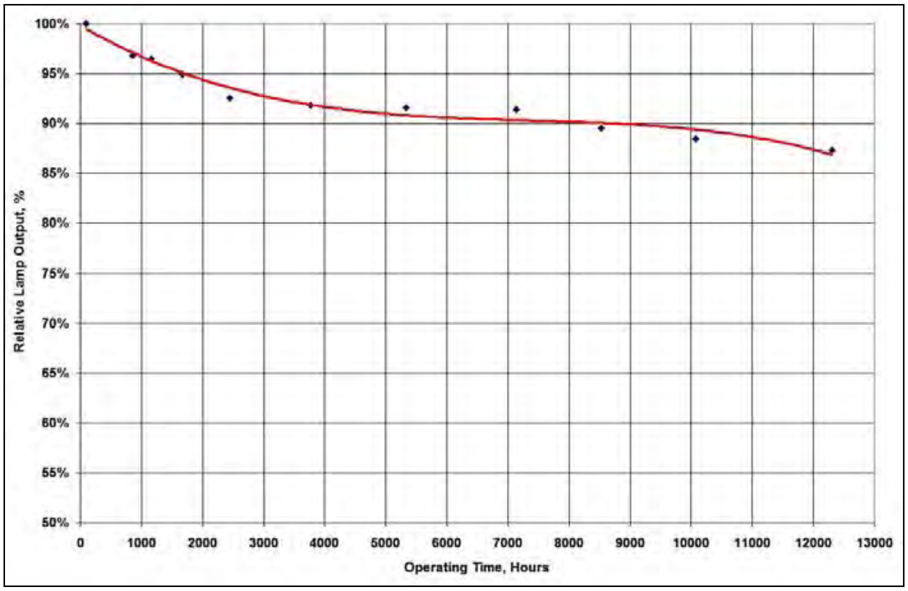
WEDECO Spektrotherm® UV lamps are low pressure high intensity mercury-indium amalgam type.





Lamp ageing

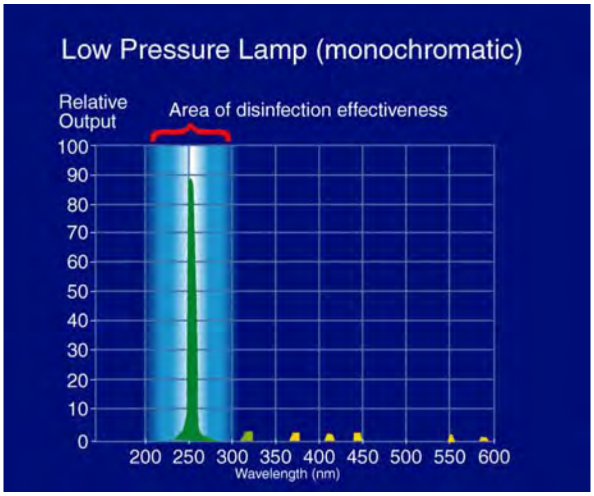
The WEDECO Spektrotherm lamp exhibits a slower ageing characteristic than competitive lamps and therefore has a guaranteed design life of 12,000 hours (pro-rata basis). The longer lamp life results in lower overall operating costs for the system due to the lower lamp replacement and consequent maintenance labor costs.

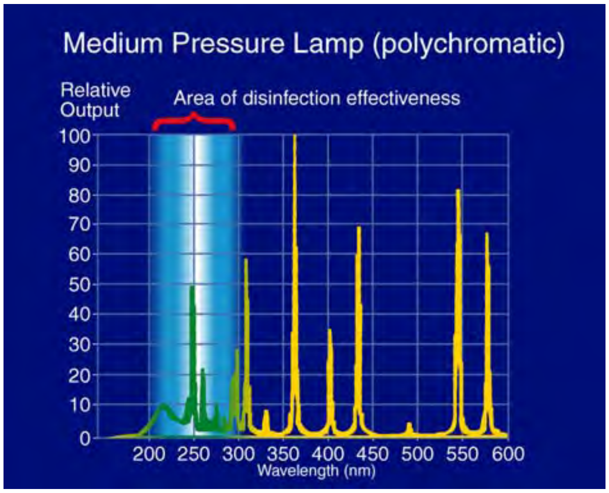


Advantages over standard low pressure and medium pressure UV lamps:

- **High intensity UV lamp with 5 times more UV-C output than standard low pressure lamps (see graph)**
  - fewer lamps required to disinfect a given flow
  - smaller equipment size
  - lower overall capital, maintenance, and lamp replacement costs
- **Higher operating efficiency versus medium pressure lamps**
  - lower operating costs due to decreased overall power consumption
  - no production of by-products in the water because of narrow UV output spectrum
  - less fouling because of low quartz surface temperature
- **Higher UV-C output stability with varying water temperature (see graph)**
  - no loss in performance with increased media temperatures
  - unaffected by seasonal water temperature changes
- **Longer lamp lifetime**
  - up to 25% longer guaranteed lifetime than other low pressure lamps
  - up to 150% longer guaranteed lifetime than medium pressure lamps
- **No danger for environment**
  - no liquid mercury inside SPEKTROTHERM® lamp
  - no pollution to the environment in case of lamp breakage (solid mercury can easily be collected in contrast to liquid mercury)

Comparison of Low Pressure, Spektrotherm and Medium Pressure Lamps





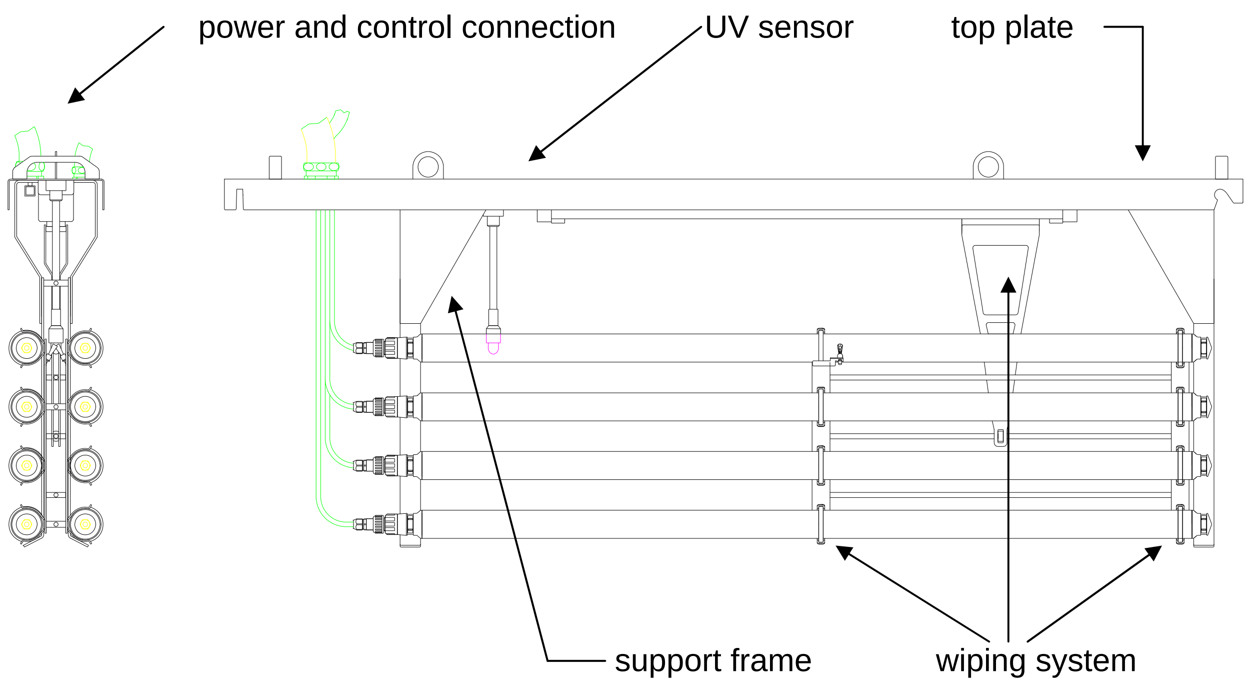
Attributes	Low Pressure	Spektrotherm HP	Medium Pressure
Mercury Capacity	liquid	solid (Amalgam)	liquid
Mercury Vapor Pressure [bar]	0.001	0.001	0.1-10
Mercury Vapor	saturated	saturated	unsaturated
Surface Temperature [°C]	40	120	600-900
Spectrum	quasi-monochromatic	quasi-monochromatic	broadband
Wavelength [nm] (in UV)	254	254	200-600
Power Consumption	85 Watt	360 Watt	2,800 Watt
UV-C output	26.7 Watt	150 Watt	420 Watt
UV-C-Output (%) based on the electrical connected load (new UV lamp)	30%	42%	9-15%

By means of a special amalgam dot in combination with gaseous mercury used by modern low pressure lamps, and among many improvements, it is possible to drastically increase UV output and overall efficiency. The result of a long time term development is the WEDECO Spektrotherm® lamp. This lamp, together with special adopted electronic ballast, achieves an efficiency of more than 40%, compared to the absorbed electrical power.

A further characteristic of low pressure UV lamps is that they do not cause solarisation of the quartz sleeves. This may cause medium pressure quartz sleeves to be replaced every 2 - 3 years which can be a substantial cost.

Lamp assembly in WEDECO TAK 55 systems

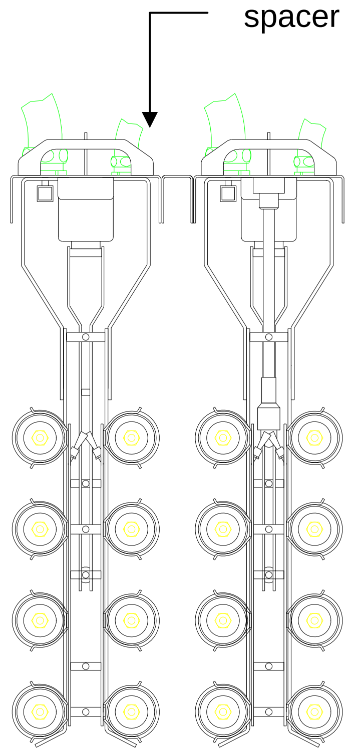
In WEDECO TAK UV disinfection systems, UV lamp modules are mounted on stainless steel frame structures known as "UV module rows". The UV lamp modules are positioned horizontally and parallel to each other on each UV module row. The number of UV lamp modules per module row is application specific. The UV module rows consist of a given number of UV lamp modules together with a stainless steel support frame and stainless steel UV light reflectors to prevent the escape of UV light from the channel.



UV module

A group of module rows forms a "UV bank". The lamp modules in each UV bank form a uniform array in the channel cross-section when viewed from the end of the channel (i.e., vertical plane cross-section). One module per bank is equipped with a UV intensity monitoring system.

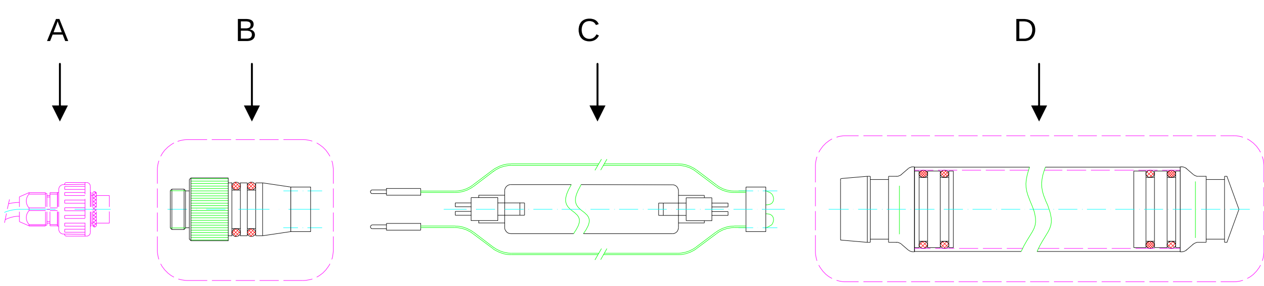
Each UV module row is connected by power and control cabling to the power supply electrical cabinet located beside the channel. The electrical cabinet contains the lamp power supply ballasts, UV sensor electronics, and instrumentation equipment. The complete system is powered and controlled by the central PC/PD station (process control and power distribution) which houses the PLC and the operator panel.



UV bank

Details of Lamp Removal

Each lamp is warranted for 12,000 hours of operation. Based upon our experience with the above described UV Disinfection Management System, a lamp lifetime of 15,000 hours of operation (almost 2 years) can be achieved. At the end of lamp lifetime the UV output reaches 87% of new lamps.
The replacement itself requires no special tools and takes less than a minute per lamp: the module is simply lifted out of the channels. A safety switch will immediately cut the power to the respective module when lifted up.
The operator simply disconnects the lamp connector / power cable (A), loosens the sealing plug / lamp head piece (B) by hand, disconnects lamp and wiring from the lamp head piece and can finally remove the used lamp (C) with the wiring from the quartz sleeve (D).



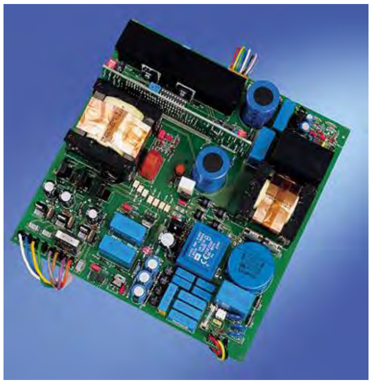
Ballasts & Control Panel

Electronic Ballast

Due to its high frequency operation (70 kHz), the WEDECO electronic ballast is able to operate the lamp at its optimum and therefore a lamp-life of 12,000 hrs can be guaranteed. The WEDECO electronic ballast is optimized to a power factor > 0.97.

The WEDECO electronic ballast is not only a ballast, but a digital controlled power supply. It is able to perform all monitoring tasks required by the lamps. Ignition and preheating are controlled by a micro-controller as well.

Constant output independent of common line voltage is ensured. The efficiency is above 92%. The lamp cable connecting the ballast to the lamp can have a length up to 82 feet / 25 m. Because of the compact design (“all components on board”) maintenance is very simple (”Plug-in-Board”).



Features:

- WEDECO Electronic Ballast
- Operation of 2 Lamps
- Fix and variable UV-C Output
- Lamp monitoring
- Preheating and ignition of lamps
- High frequency operation (70 kHz)
- Power factor > 0.97
- Voltage Stability
- Current Limitation
- Efficiency > 92%
- Low excess heat production
- Separation of mechanical and electrical components (ballast cabinets)
- Lamp cable up to 82 feet / 25 m long
- Easy replacement: max. 1 min (“Plug-in-Board”)
- Less cabling

Lamp Power Distribution

To distribute the electrical power to each of the UV banks, ITT Water & Wastewater has developed a particularly rugged UV bank services enclosure (junction box) designed to contain the individual lamp power and control cables, and the pneumatic lines for the lamp sleeve cleaning system if chosen. The junction box is a substantial rectangular section fabricated in 304 stainless steel which spans over the complete width of the channel. The electrical and pneumatic lines are terminated into heavy duty weatherproof sockets fixed to the side of the enclosure services. The cables entering the enclosure from the control panel are fully protected and sealed against ingress of water and are mechanically protected against accidental damage.

An important feature of the WEDECO TAK system is the adoption of a conventional panel configuration with the UV lamp control equipment being included in the panel assembly. Each lamp module has two flexible stainless steel armored conduits containing the interconnecting cable and pneumatic lines for that module. These terminate in the matching female plug for connection with the socket mounted on the enclosure. The plugs and sockets are mechanically locked into position to prevent accidental disconnection. As an additional safety feature, an interlock is provided to isolate the electrical supply should an attempt be made to withdraw a plug whilst still electrically alive. The overall design of the UV junction box provides the highest level of mechanical and electrical security whilst maintaining a straight forward access for maintenance of lamp module assemblies.

The size of the junction box is a function of channel width and number of lamps connected.

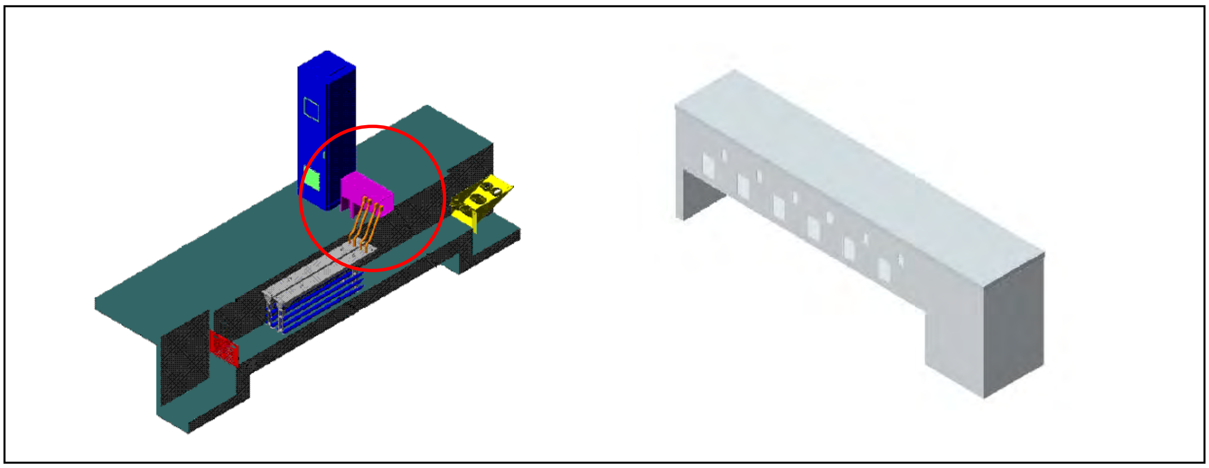


Fig. 1 Schematic of a junction box

WEDECO UV Disinfection Management System

Any UV disinfection system is designed to apply a given UV dose in the “worst possible case”, which will generally mean at the maximum design flow, at design UV transmission and at the end of lamp lifetime. This means that at all times, except at the “worst possible case”, there exists a certain amount of redundancy in the UV system.

A variety of control philosophies are applied to achieve this.

Non Variable Power Lamp Systems:

- **“All Lamps On / All Lamps Off”**

This system control is typical for single bank systems. It offers no variation. Even for flows far below the design flow the whole system has to be employed.

- **“Flow Pacing”**

One way of managing the UV disinfection system more effectively, is to control the various banks (e.g. switching on and off) in response to increase or decrease in volume flow. This control philosophy is called “flow pacing”.

The above can offer some financial benefits in reducing power costs and extending the life of the UV lamps. However, it is based purely on the volumetric flow passing through the system and makes no allowance for any improvement in UV transmission rate or the reduction of UV light due to the ageing effect of the lamps.

- **“Dose Pacing”**

WEDECO’s UV Disinfection Management System takes all important parameters into account and controls the UV disinfection system based upon the Applied UV Dose:

The WEDECO UV Disinfection Management System is to be fitted to an open channel system, generally based upon the proven WEDECO TAK design. A minimum of one (1) highly selective UV sensor will be installed in each bank. The installation of the optional automatic wiping system is recommended to ensure regular cleaning of the sensors.
The UV sensors will be calibrated to give a specified output in mW/cm^2 and will accurately reflect any change in the UV transmission rate as well as indicating any reduction in the UV-C output due to lamp ageing. The output of the sensors will be in analogue form (4 - 20 mA) and is the input to the PLC controlling the UV plant. The signals derived from the UV sensors and the flow meter (by others), are used to calculate the Empirical UV Dose which, at any given time, is applied to the waste water passing through the UV system.

Variable Power Lamp Systems:

- **Variable Power Lamp Systems**

The latest development regarding the Spektrotherm lamp technology is lamps with variable output. These lamps not only have an enhanced UV-C output but also allow the continuous variation of the lamp output from 50 – 100%. With these new lamps the above described control philosophies can therefore be improved. Even one bank systems can now be modified to employ the above described “Dose Pacing”. While including all the benefits of “Dose Pacing” these lamps allow an even more optimized adjustment of the UV output according to the water characteristics.

Lamp life Management

Depending on the customers requirements the PLC-program will manage the lamp life by switching on and off preferably either a few banks often or all banks in nearly equivalent time intervals. These alternatives allow to concentrate the ageing on few lamps or to distribute lamps ageing in the same form over all lamps installed.

Recycling of WEDECO Spektrotherm® UV Lamps

In order to protect our environment, ITT Water & Wastewater in cooperation with its suppliers undertake great efforts to minimize and control the release of residues.

For the recycling of the UV-lamps, the following treatment system has been established:

- The lamps are being crushed by a hammer mill

- The small particles are being sieved in several steps and divided in two fractions:

  - Metal and bigger glass particles; to be reused in the metal production
  - Smaller glass particles; to be reused in the glass industries.

The whole recycling plant is protected in order to inhibit the release of mercury.

Automatic Wiping System

The TAK 55 system is equipped with an automatic wiping system to prevent fouling and scaling of the quartz sleeves and the UV sensor window.

WEDECO's automatic wiping system employs PTFE/Viton sandwich wipers which avoid formation of organic and inorganic deposits on the protective quartz tubes while being unaffected by the high intensity UV light at the lamp surface. Each tube has a total of two wipers whose wiping ranges overlap to ensure total tube cleaning. The UV sensor window is cleaned by two brushes. The wiping frequency is variable and adjustable using the PLC to reflect actual operational requirements. The wiping system is pneumatically powered. Each module is equipped with one wiping system. The wiping system is available only if ordered at the same time as the TAK system and supplied with the corresponding pressured air system.

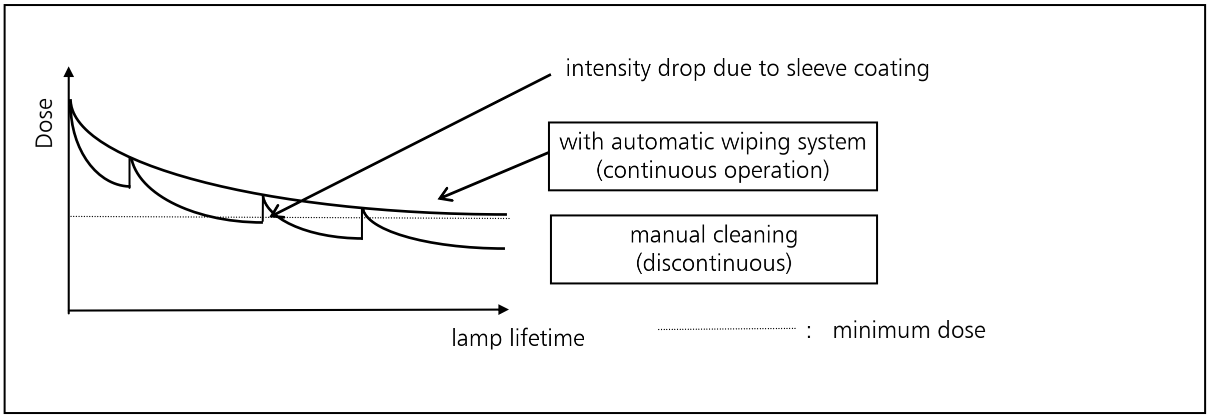
Fig. 2 Wiper rings and sensor cleaning brushes

Advantages of the automatic wiping system:

- No operation breaks due to lamp cleaning (no isolation of the channel, no switching on and off, no handling of lamps or aggressive chemicals)
- Less operation costs
- Increased operation safety, because the maximum intensity is maintained continuously and because the system automatically takes into account changes in water characteristics
- Continuous cleaning not only of the lamps, but also of the UV sensor
- No monitoring and refilling of chemical cleaning agents required
- No contamination of the treated effluent by cleaning agents

In case that the automatic wiping system is not installed, a conventional chemical cleaning system needs to be employed which requires the removal of the UV module by a davit. The module needs to be hosed down prior to placing it into a tank filled with cleaning solution (typically based upon phosphoric acid). Especially at larger systems with several channels/banks, the turned-down banks can be heavily fouled with biological coating so that a frequent cleaning cycle can be expected.

The diagram below shows the effect of fouling and scaling which can be compensated by chemical cleaning or the automatic, pneumatically driven WEDECO TAK wiping system.



Graph 1 Decrease of the UV intensity due to ageing and fouling / scaling effects of the lamps

The intensity decrease is a general physical effect and occurs due to ageing of every lamp. For the advanced WEDECO Spektrotherm® SLR32143HP lamp this effect amounts to 20% of the original performance and is taken into consideration for the dimensioning of the WEDECO TAK systems.

The manual cleaning of the sleeves means a less constant intensity compared with the use of the automatic wiping system (see graph 1). The constant and computer-controlled wiper activity maintains the intensity on the maximum level corresponding to the ageing of the lamps (solid line). Manually executed chemical cleanings are undertaken in intervals, which means that the average performance of the lamps is lower compared to lamps operated with the automatic wiping system in place (dotted line).

GRUNDFOS **DME/DMS**

DIGITAL DOSING

BE > THINK > INNOVATE >

GRUNDFOS



Digital Dosing represents innovation in its purest form!

No more complicated calculations
In the past, traditional dosing equipment forced you to resort to complicated calculations to find the right setting. The exact dosage required to ensure that your dosing system was economical and safe had to be found by trial and error. And you would have to do it all over again whenever you needed to make adjustments. That all changed when Grundfos brought you Digital Dosing. Now, you simply specify the dosage you want and let the pump do the rest – with perfect confidence that you will get what you want.

Digital Dosing represents innovation in its purest form. This patented Grundfos solution uses new principles and methods to set an entirely new standard for dosing technology. It makes your job a lot easier and your results a lot better.

Focus on user-friendliness
Digital Dosing is about complete precision combined with complete user-friendliness. It is made possible through the use of an innovative drive principle in a diaphragm dosing pump. More technical information can be found elsewhere in this brochure, but all you really need to concern yourself with is the easy-to-use control panel. Just push the buttons a few times to specify the dose you want, and the pump will take care of the rest. Quite simply, Digital Dosing means that what you set is what you get.

Proven technology
Ever since Digital Dosing was introduced, enthusiastic customer responses have shown that there was a real demand for better dosing technology. Aside from the obvious advantages of precise, trouble-free dosing, many customers point to the remarkable reliability of Grundfos Digital Dosing as a key benefit. This is technology you can trust.

We have always been confident that Digital Dosing was the way to go, and satisfied users worldwide now support this conviction. In effect, Grundfos has set the agenda for the future of dosing. And you can trust us to remain ahead of the game.

To give even more enterprises the chance to benefit from Digital Dosing, we have expanded the product family to cover the full range from 2,5 ml/hour to 150 l/hour – all handled by just a few highly versatile and efficient models. So if you haven't gone digital yet, we urge you to try it out. You will never want to go back.

Your benefits

Digital Dosing is the result of true Grundfos innovation. We are always working with new methods, materials and technology with a specific goal in mind: to bring you products that make a difference. To use technological advances to bring you real benefits, not just features that may seem impressive but have limited true value.

- **Fast, simple and accurate dosing**
- **Be your own dosing specialist**
- **Reduction in logistics costs**
- **Easy installation, priming and calibration**
- **Optimal dosing of difficult liquids**

The DME 150-10 with side mounted control panel.

Accurate dosing -

cutting line only

cutting line only

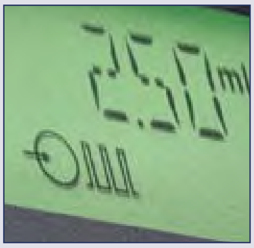
Grund

The large Digital Dosing range comprises two pump models housed in the same size cabinet. Both are equipped with brushless DC motors.

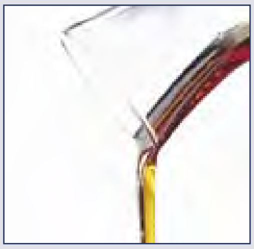
The smaller Digital Dosing range comprises five pump models housed in two cabinet sizes. These use a stepper motor to ensure precise dosing.

fos Digital Dosing -

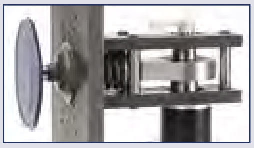
What you set is what you get
The push-button control panel lets you set the pump to deliver exactly the dosage you need. Simply decide how many millilitres or litres of dosing additive you want, punch in the numbers, and let your Digital Dosing pump do the rest. If you need 4.67 l/h, you use the control panel to set 4.67 l/h, and you get 4.67 l/h. With Grundfos, nothing but real precision is good enough.



Smooth and gentle dosing
Grundfos dosing pumps give you full control over the speed, acceleration, and position of the diaphragm. The gentle and steady connecting rod movement minimises pressure peaks in the dosing head and discharge line and eliminates the vibrations associated with traditional dosing pumps. This all means that the additive is discharged more evenly, ensuring precise dosing.



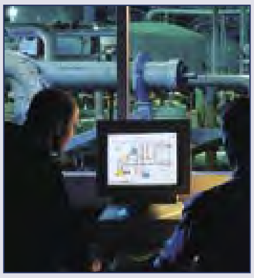
Full stroke length
The full stroke length is an important part of the Digital Dosing approach to optimum performance. It makes the pump less vulnerable to build-up of gases in the dosing head, thereby ensuring maximum precision and optimal stroke length.



Easy priming
You can make your Grundfos dosing pumps run at full capacity by pressing the 100% key. This ensures that the pump is fully primed with additive before a new process begins. Once priming is complete, the pump automatically returns to the previous setting. Easy!

- what you set is w

Fieldbus
Grundfos dosing pumps can be equipped with a fieldbus communication module. This lets you benefit from many types of information sharing. For example, the Digital Dosing pump can supply performance data and status information to be used for quality control, preventive maintenance, and future reference. You can monitor and control pumps from your PC, and you will receive immediate on-screen warnings if something should go wrong in the system.

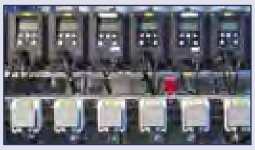


Fewer models cover all needs
Grundfos covers the vast majority of all dosing needs with just seven Digital Dosing models. Capable of supplying from 2.5 ml/hour to 150 l/hour, the range is sure to include a solution for you. It also allows for significant savings on logistics.

Impressive range of features
The standard features of the Digital Dosing pumps reflect Grundfos standards, which makes them quite impressive in their own right. All pumps feature manual operation, full pulse control, analog 4-20 mA control, timer-based batch control, pulse-based batch control, and switch-mode power supply (100-240 V, 50–60 Hz). Even more features are available as options if you need them.

Many mounting options
Grundfos dosing pumps are easily adapted to your placement requirements. You can choose between pumps with a side-fitted or front-fitted control panel to ensure that you have unobstructed access to the panel and display.

hat you get

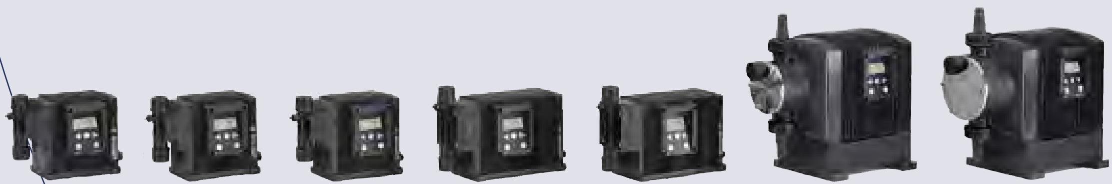


Trouble-free installation
Reflecting the Grundfos approach to user-friendliness, a Digital Dosing pump takes only a moment to install: just place it where you want it and plug it in. Going digital couldn't be simpler.

Wide range of accessories
Digital Dosing is supported by a large selection of accessories to meet your system requirements. Unlike the "options" offered by many other pump suppliers, these accessories are not necessary for precise pump operation. They simply ensure that the Digital Dosing pump is fully compatible with the rest of your installation.

Simple calibration
The Digital Dosing pump lets you be your own dosing specialist! It features special software to make calibration as easy as possible. Just place a graduated glass under the pump and activate the program. The pump will then perform 100 strokes and indicate how much it thinks it has pumped. Adjust the figure as necessary, and you're done.

The Digital Dosing range gives you complete flexibility and precision with just seven models.



cutting line only

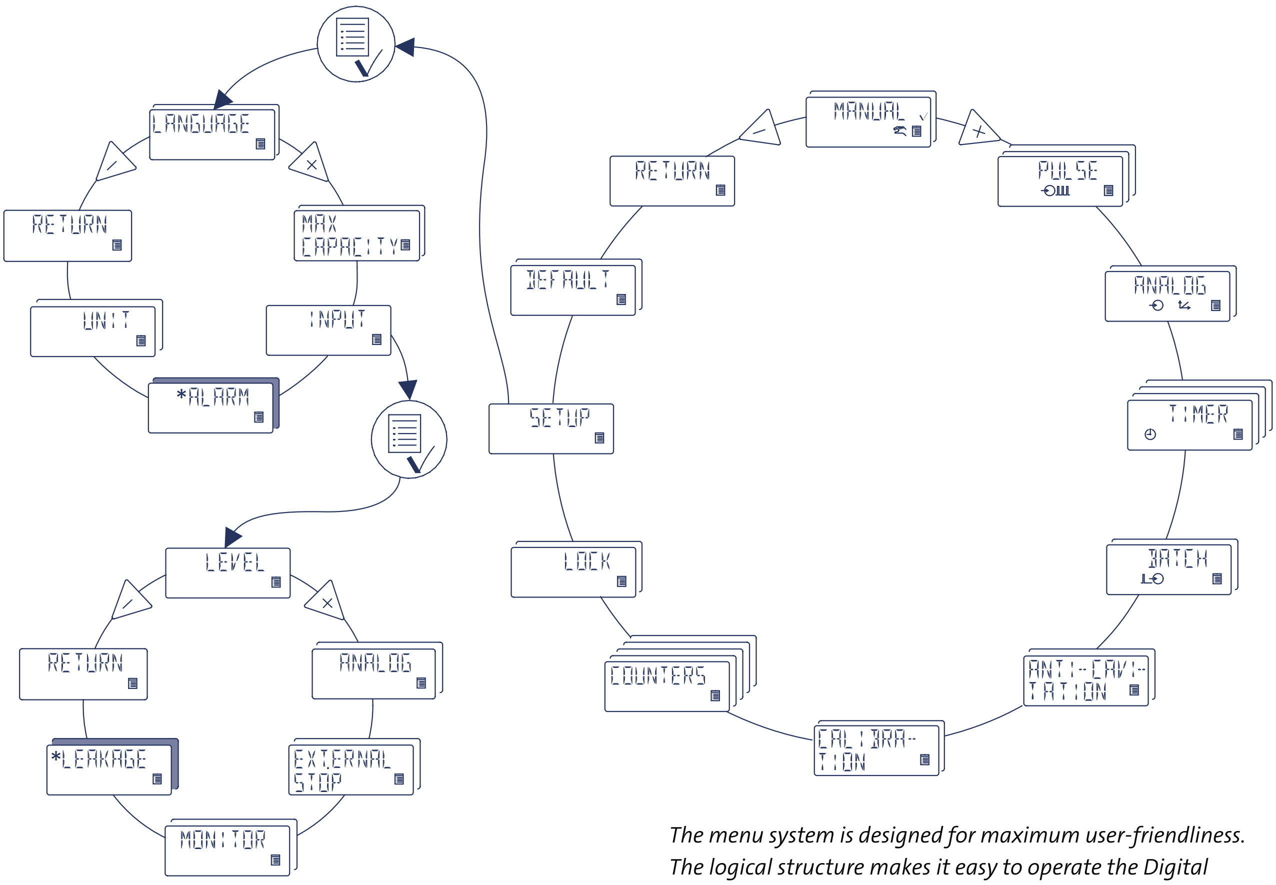
- from 2.5 ml/h to 150 l/h

Sophisticated technology for simple operation

Grundfos dosing pumps are based on innovative technology. New principles and methods have been employed to create patented solutions you won't find anywhere else.

Motor-driven connection rod
The motor-driven connection rod remains in contact with the diaphragm throughout the discharge/suction cycle. This keeps the diaphragm under control at all times.

Full stroke length
The Digital Dosing pumps give you the optimal stroke length every time. The amount of additive discharged through the dosing head is always the maximum possible in each cycle. This makes the pump much less vulnerable to build-up of gases in the dosing head, thereby improving precision and priming capabilities.



The menu system is designed for maximum user-friendliness. The logical structure makes it easy to operate the Digital Dosing pump.

***Only DME model 60-10 and 150-4**

Technical specifications

Product range and performance data DME 2.5 ml/h - 48 l/h

Pump type		DME 2-18	DME 8-10	DME 12-6	DME 19-6	DME 48-3
Capacity at max. pressure	[l/h]	2.5	7.5	12	18.5	48
Max. pressure	[bar]	18	10	6	6.2	2.6
Setting range		1:1000	1:1000	1:1000	1:1000	1:1000

Stroke frequency	[min⁻¹]	180	
Suction lift	[m]	6	
Viscosity*	[mPa]	500	100
Power supply	[V], [Hz]	1×100-240, 50-60 Hz	
Accuracy	[%]	±1% repeatability	

Product range and performance data DME 75 ml/h - 150 l/h

Pump type		DME 60-10	DME 150-4
Capacity at max. pressure	[l/h]	60	150
Max pressure	[bar]	10	4
Setting range		1:800	1:800

Stroke frequency	[min⁻¹]	160
Suction lift	[m]	6
Viscosity*	[mPa]	3000 at 50% capacity
Power supply	[V], [Hz]	1×100-240V, 50-60 Hz
Accuracy	[%]	±1% repeatability

Product range and performance data DMS 25 ml/h - 12 l/h

Pump type		DMS 2-11	DMS 4-7	DMS 8-5	DMS 12-3
Capacity at max. pressure	[l/h]	2.5	4	7.5	12
Max pressure	[bar]	11	7	5.4	3.4
Setting range		1:100	1:100	1:100	1:100

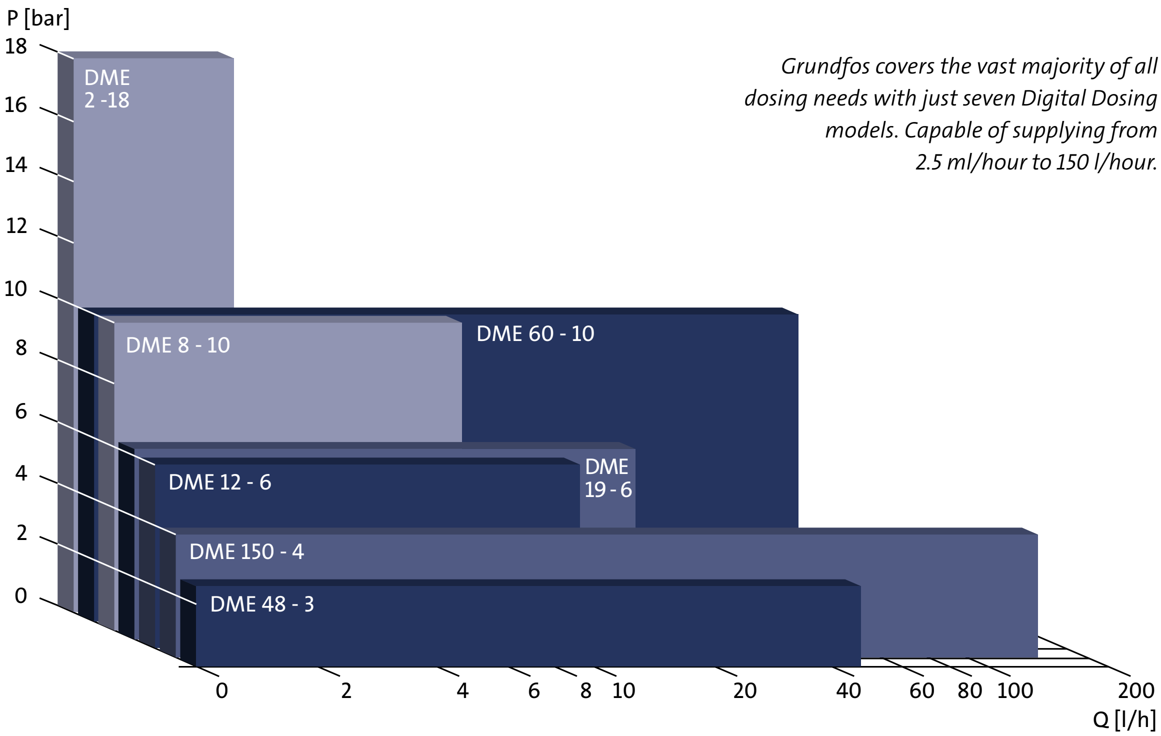
Stroke frequency	[min⁻¹]	180
Suction lift	[m]	6
Viscosity*	[mPa]	500
Power supply	[V], [Hz]	1×230, 50 Hz - 1×120, 60 Hz - 1x100, 50 Hz
Accuracy	[%]	±1% repeatability

**Spring-loaded valves*

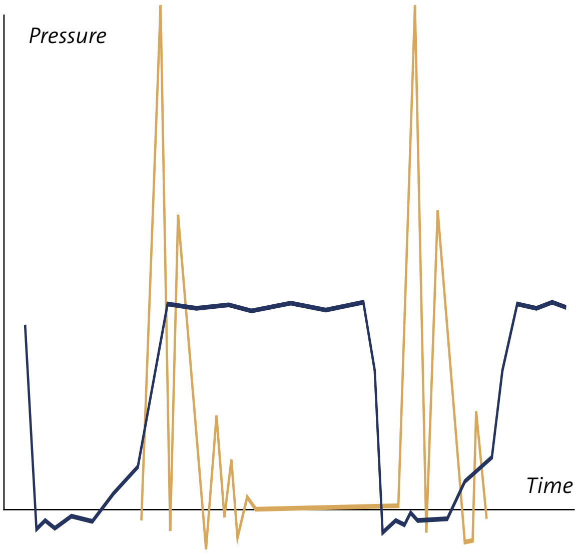
The Grundfos Digital Dosing range

	**DME 2.5 ml/h to 12 l/h** **Cabinet size 1**, consisting of 3 stepper motor driven models. Max. pressure rate: 18, 10 and 6 bar
	**DME 19.5 ml/h to 48 l/h** **Cabinet size 2**, consisting of 2 stepper motor driven models. Max. pressure rate: 6.2 and 2.6 bar
	**DME 75 ml/h to 150 l/h** **Cabinet size 3**, consisting of 2 brushless DC motor driven models. Max. pressure rate: 10 and 4 bar

	**DMS 25 ml/h to 12 l/h** An excellent alternative to the Digital Dosing DME range consisting of 4 synchronous motor driven models. Max. pressure rate: 11, 7, 5.4 and 3.4 bar



Grundfos covers the vast majority of all dosing needs with just seven Digital Dosing models. Capable of supplying from 2.5 ml/hour to 150 l/hour.



The advantages of the variable speed motor used in Grundfos dosing pumps are immediately evident when you compare them with standard pumps. The gold curve shows the pressure conditions in a traditional solenoid pump. Here, pressure peaks can be as high as 2.5 times the counter-pressure.

Grundfos dosing pumps give you far better control of the process. As shown by the blue curve, pressure in a Digital Dosing unit builds up to the level of the counter-pressure and is controlled throughout the suction and discharge phases.

Variable speed for smooth dosing
The variable speed motor used in the DME series maintains full control over the diaphragm through-out the suction and discharge phases. The result? A better, more even mix. Also, a unique anti-cavitation function makes it possible to extend the suction phase for extra protection. The slower suction phase ensures correct additive intake every time – even when dosing high-viscosity liquids.

The best dosing solution on the market
With Digital Dosing, Grundfos brings you the best dosing solution on the market. Customers all over the world appreciate the advantages of Digital Dosing: No more complicated calculations, high installation costs, or expensive accessories – just perfect precision with complete ease.
Why settle for less?

“The new technology behind the stepper motor that makes precise dosing possible is what really convinced us to choose Grundfos as a dosing pump supplier. Our investment has resulted in highly precise dosing, improved product quality, and higher productivity.” Ralf Kammerer, Technical Manager at Wisthoff Glassworks, Group Gerresheimer

Innovation in its purest form

Grundfos created digital dosing – both as a concept and by developing the world's first ever digital dosing pump range. Our digital dosing pumps represent innovation in its purest form, and this patented new method sets an entirely new standard for dosing technology. It enables our customers to achieve extreme accuracy literally at the touch of a button.

Ongoing research and development

The digital dosing pump range is only one example of how Grundfos remains at the forefront of pumping technology. At Grundfos, research and development is an ongoing process, and a very large proportion of our annual earnings is channelled straight back to developing new innovative pump solutions.

Committed to our customers

Grundfos offers a full range of pumps and pumping solutions with more than 170,000 product variants to choose from. With Grundfos as your partner you can be sure of 100% commitment, before and after the sale, backed by an efficient global service network, 24 hours a day.

VENTURE I/S
96530572 0905

GRAINGER
FOR THE ONES WHO GET IT DONE

printed May 11, 2011

Pump, Mag Drive, 1/3 HP, 115/208-230VV

Pump, Magnetic Drive, 1/3 HP, Voltage 115/208-230, Full Load Amps 5.70/2.70-2.85, Motor Type Induction, Motor Enclosure TEFC, 39 GPM @ 1 Ft. of Head, Length 17 13/32 In., Width 7 1/2 In., Height 8 19/64 In., Inlet 1 FNPT In., Outlet 1 MNPT In., Temp (F) @ 0 PSIG 180, Temp (F) @ 10 PSIG 180, Temp (F) @ 20 PSIG 180, Temp (F) @ 30 PSIG 180, Operating Pressure 14.2 PSI

Grainger Item #	3AZN4
Price (ea.)	**$834.00**
Brand	FINISH THOMPSON
Mfr. Model #	DB6P-M224
Ship Qty.	1
Sell Qty. (Will-Call)	1
Ship Weight (lbs.)	40.5
Usually Ships	1-3 Days
Catalog Page No.	3861

Price shown may not reflect your price. Log in or register.

Additional Info

Magnetic Drive, Corrosives-Handling Pumps

Sealless mag-drive design eliminates the need for mechanical seals; prevents shaft leaks and reduces maintenance costs. Polypropylene units are generally used for caustic liquids and feature polypropylene impellers and Viton® O-rings. Carbon bushings permit extended run-dry capability. PVDF units mount horizontally and are generally used for strong acids. Feature PVDF impellers, Viton O-rings, and PTFE bushings. Not capable of running dry. Pumps can handle strong acids, caustics, and toxic solutions, such as sodium hypchlorite, HCL, potassium hydroxide, phosphoric acid, sulfuric acid, plating solutions, DI water, brine solutions, and fume scrubbers.

- TEFC motors
- Max. temp.: 180°F (polypropylene); 220°F (PVDF)
- Run-dry capability

Flooded Suction

Close-coupled to standard NEMA motors for installation flexibility. High-efficiency impeller design allows a smaller pump to be used in many applications. Max. viscosity: 100 cps. 5-yr. warranty.

Tech Specs

Item: Centrifugal Magnetic Drive Pumps
Type: Flooded Suction
HP: 1/3
Voltage: 115/208-230
Full Load Amps: 5.70/2.70-2.85
Motor Type: Induction
Motor Enclosure: TEFC
GPM @ 1 Ft. of Head: 39
GPM of Water @ 3 Ft. of Head: 39
GPM of Water @ 6 Ft. of Head: 39
GPM of Water @ 9 Ft. of Head: 37
GPM of Water @ 15 Ft. of Head: 34
GPM of Water @ 18 Ft. of Head: 31
GPM of Water @ 24 Ft. of Head: 23
Max. Head (Ft.): 33
Length (In.): 17-13/32
Width (In.): 7-1/2
Height (In.): 8-19/64
Temp (F) @ 0 PSIG: 180
Temp (F) @ 10 PSIG: 180
Temp (F) @ 20 PSIG: 180
Temp (F) @ 30 PSIG: 180
Operating Pressure (PSI): 14.2

Optional Accessories

There are currently no optional accessories for this item.

Alternate Products

There are currently no alternate products for this item.

Repair Parts

A Repair Part may be available for this item. Visit our Repair Parts Center or contact your local branch for more information.

Housing: Polypropylene

Impeller: Polypropylene w/Carbon Bushing

Max. Specific Gravity: 1.2

Max. Viscosity: 100 CPS

Mounting: Horizontal

Bearings: Thrust & Radial

Design: Centrifugal

Gasket: Viton

Series: DB6

For Use With: Chemicals and Water

Application: Acids, Caustics, Plating Solutions, DI-Water

Notes & Restrictions

There are currently no notes or restrictions for this item.

MSDS

This item does not require a **Material Safety Data Sheet (MSDS).**

Required Accessories

There are currently no required accessories for this item.

GRAINGER
FOR THE ONES WHO GET IT DONE

printed May 11, 2011

Pump, Magnetic Drive

Magnetic Drive Pump, Power Rating 1/2 HP, Voltage @ 60 Hz 115/230, Current Rating 11.6/5.8 Amps, Outlet 3/4 Inch MPT, Inlet 1 Inch FPT, Maximum PSI 22, Maximum Head 51 Feet, Motor Enclosure TEFC, Maximum Temperature 200 F @0 PSI, 150 F @ 40 PSI, Water Flow @ 6 Foot of Head 38.0 GPM, @ 9 Feet of Head 36.2 GPM, @ 15 Feet of Head 34 GPM, @ 18 Feet of Head 33.1 GPM, Height 7 Inches, Length 15 1/4 Inches, Width 8 3/4 Inches

Grainger Item #	4RL35
Price (ea.)	**$740.00**
Brand	LITTLE GIANT
Mfr. Model #	TE-6-MD-HC
Ship Qty.	1
Sell Qty. (Will-Call)	1
Ship Weight (lbs.)	31.0
Usually Ships	Today
Catalog Page No.	3861

Price shown may not reflect your price. Log in or register.

Additional Info

Magnetic Drive Pumps

Eliminate seal-caused friction loss, wear, contamination, and leakage. All are nonsubmersible, except No. 4RL36 can be used submersible or inline. Mount horizontally.

- Max. specific gravity: 1.1
- Max. viscosity: 100 SSU

MD-HC Series—For Highly Corrosive Chemicals

Pumps handle liquids such as photographic and plating solutions, acids, alkalies, brines, and distilled water. Ryton® pump housing and impeller, Viton® O-ring gasket, and encapsulated ceramic magnet. Motors have 6-ft., 3-conductor SJO cords with 3-prong plugs, except Nos. 4RL34, 4RL35, and 2P044 which must be field-wired.

Tech Specs

Item: Pump
Type: Magnetic Drive
HP: 1/2
Voltage: 115/230
Full Load Amps: 11.60/5.80
Motor Type: PSC
Motor Enclosure: TEFC
GPM of Water @ 6 Ft. of Head: 38.0
GPM of Water @ 9 Ft. of Head: 36.2
GPM of Water @ 15 Ft. of Head: 34.0
GPM of Water @ 18 Ft. of Head: 33.1
GPM of Water @ 24 Ft. of Head: 30.5
GPM of Water @ 40 Ft. of Head: 21.6
GPM of Water @ 50 Ft. of Head: 2.0
Max. Head (Ft.): 51
Length (In.): 15-1/4
Width (In.): 8-3/4
Height (In.): 7
Temp (F) @ 0 PSIG: 180
Temp (F) @ 10 PSIG: 175
Temp (F) @ 20 PSIG: 170
Temp (F) @ 30 PSIG: 165
Operating Pressure (PSI): 22.0
Housing: Ryton
Impeller: Ryton
Max. Specific Gravity: 1.1
Max. Viscosity: 100 SSU

Optional Accessories

Nipple, Hose, 1 In

Item #: 3LZ93
Brand: APPROVED VENDOR
Usually Ships: Today
Price (ea): $4.27

Braided Tubing, PVC, Flexible, 3/4 In ID

Item #: 4HM06
Brand: KURIYAMA
Usually Ships: Today
Price (ea): $230.75

Braided Tubing, PVC, Flexible, 1 In ID

Item #: 4HM07
Brand: KURIYAMA
Usually Ships: Today
Price (ea): $295.75

Alternate Products

Pump, Magnetic Drive

Item #: 2P044
Brand: LITTLE GIANT
Usually Ships: Today

Mounting: Horizontal
Bearings: Thrust
Cord Length: 6
Cord Type: 3-conductor SJO
Design: Gravity-feed, Requires the Pump Inlet to be Lower than Liquid Level
Gasket: Viton
Series: MD-HC
For Use With: Highly Corrosive Chemicals
Application: For Highly Corrosive Chemicals, Eliminates Seal-caused Friction Loss, Wear, Contamination and Leakage

Notes & Restrictions

California Proposition 65
Warning: This product contains a product known to the State of California to cause cancer.
Warning: This product contains a chemical known to the State of California to cause birth defects or other reproductive harm.

MSDS

This item does not require a **Material Safety Data Sheet (MSDS).**

Required Accessories

There are currently no required accessories for this item.

Price (ea): $1,025.00

Repair Parts

Repair Parts Information is available for this item.

Pump Performance Datasheet

Customer	: TRIANGLE PUMP & EQUIP. CO.	Quote number	: 160399
Customer reference	: CH2M Hill	Size	: 11XKL
Item number	: 002	Stages	: 5
Service	: Plant Effluent Pump	Based on curve number	: 11XKL 1770 Rev. 0
Quantity	: 1	Date last saved	: 11 May 2011 12:44 PM

Operating Conditions

Flow, rated	: 375.0 USgpm
Differential head / pressure, rated (requested)	: 243.0 ft
Differential head / pressure, rated (actual)	: 243.2 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: Ample
Frequency	: 60 Hz

Performance

Speed, rated	: 1,767 rpm
Impeller diameter, rated	: 7.94 in
Impeller diameter, maximum	: 8.15 in
Impeller diameter, minimum	: 7.00 in
Efficiency (bowl / pump)	: 79.42 / 78.16 %
NPSH required / margin required	: 10.80 / 0.00 ft
Ns (imp. eye flow) / Nss (imp. eye flow)	: 1,675 / 5,790 US Units
MCSF	: 102.8 USgpm
Head, maximum, rated diameter	: 345.5 ft
Head rise to shutoff	: 42.16 %
Flow, best eff. point (BEP)	: 349.0 USgpm
Flow ratio (rated / BEP)	: 107.46 %
Diameter ratio (rated / max)	: 97.39 %
Head ratio (rated dia / max dia)	: 89.03 %
Cq/Ch/Ce [ANSI/HI 9.6.7-2004]	: 1.00 / 1.00 / 1.00
Selection status	: Acceptable

Liquid

Liquid type	: Water - Clean
Additional liquid description	:
Solids diameter, max	: 0.00 in
Temperature, max	: 68.00 deg F
Fluid density, rated / max	: 0.998 / 0.998 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.00 psi.a

Material

Material requested	: Auto
Material selected	: Cast Iron/Bronze

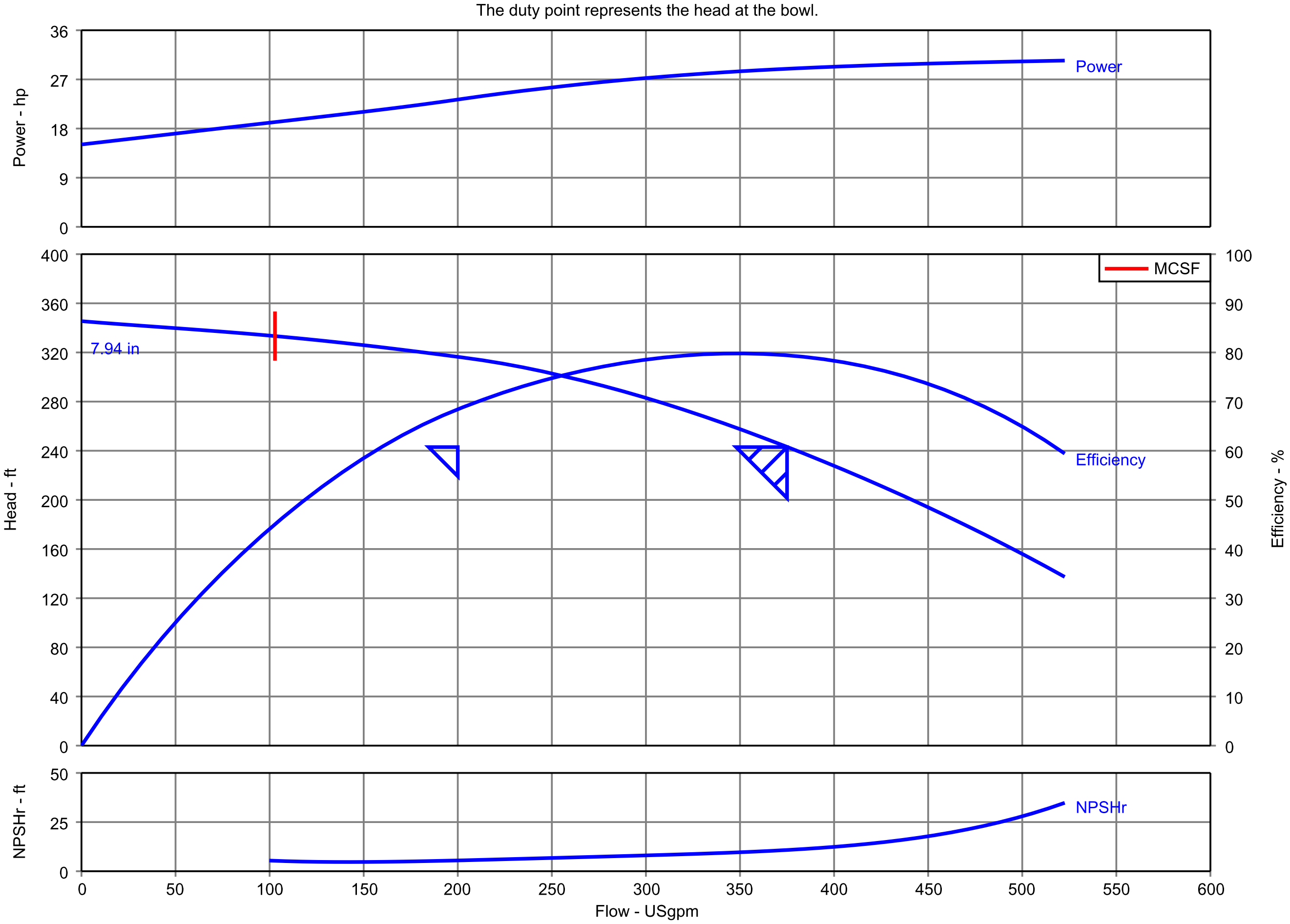
Pressure Data

Maximum working pressure	: 149.5 psi.g
Maximum allowable working pressure	: 649.0 psi.g
Maximum allowable suction pressure	: N/A
Hydrostatic test pressure	: N/A

Driver & Power Data

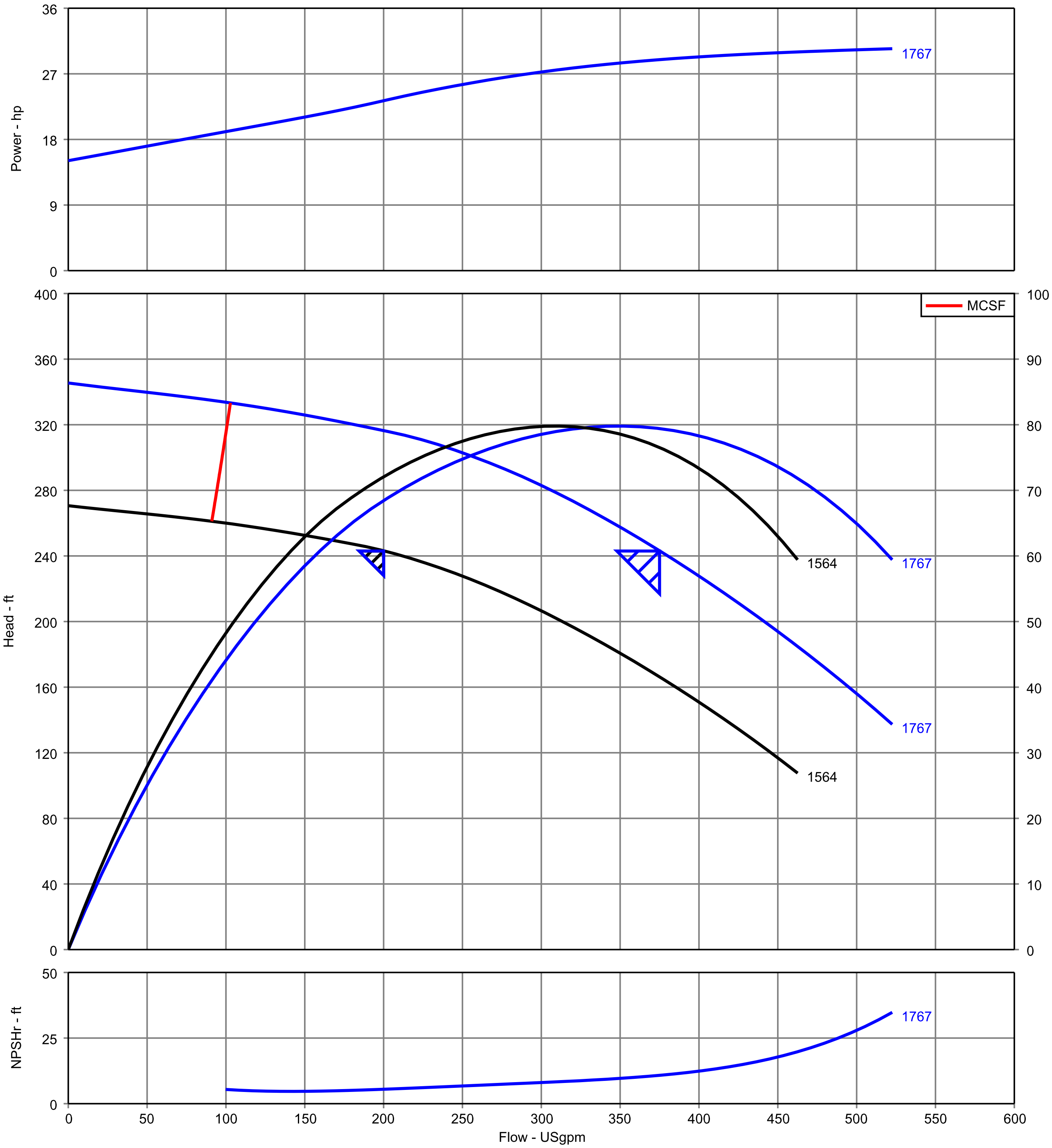
Driver sizing specification	: Maximum power
Margin over specification	: 0.00 %
Service factor	: 1.15
Power, hydraulic	: 22.99 hp
Power (bowl / pump)	: 28.95 / 29.24 hp
Power, maximum, rated diameter	: 30.74 hp
Minimum recommended motor rating	: 40.00 hp / 29.83 kW

Bowl performance. Adjusted for construction and viscosity.
The duty point represents the head at the bowl.



Multi-Speed Performance Curve

Bowl performance. Adjusted for construction and viscosity.
The duty point represents the head at the bowl.



Customer	: TRIANGLE PUMP & EQUIP. CO.	Pump Type	: 11XKL	Quote number	: 160399
Address	: 7509 S FIFTH ST SUITE 103 , RIDGEFIELD, WA 98642	# of Stages	: 5	Customer PO #	:
Location	:	Quantity	: 1	CO #	:
Project	: Bend	Flow	: 375.0 USgpm	Item #	: 002
Tag	:	Head	: 243.0 ft	JOL #	:
Bowl/Pump	:	Speed	: 1,767 rpm	Serial #	:
Eff (bowl / pump)	: 79.42 / 78.16 %	Fluid Density	: 0.998 / 0.998 SG	Drawing #	:
Power (bowl / pump)	: 28.95 / 29.24 hp	Viscosity	: 1.00 cP	Drawn By	:
NPSH required	: 10.80 ft	Impeller Trim	: 7.94 in	Last Modified	: 11 May 2011 12:44 PM

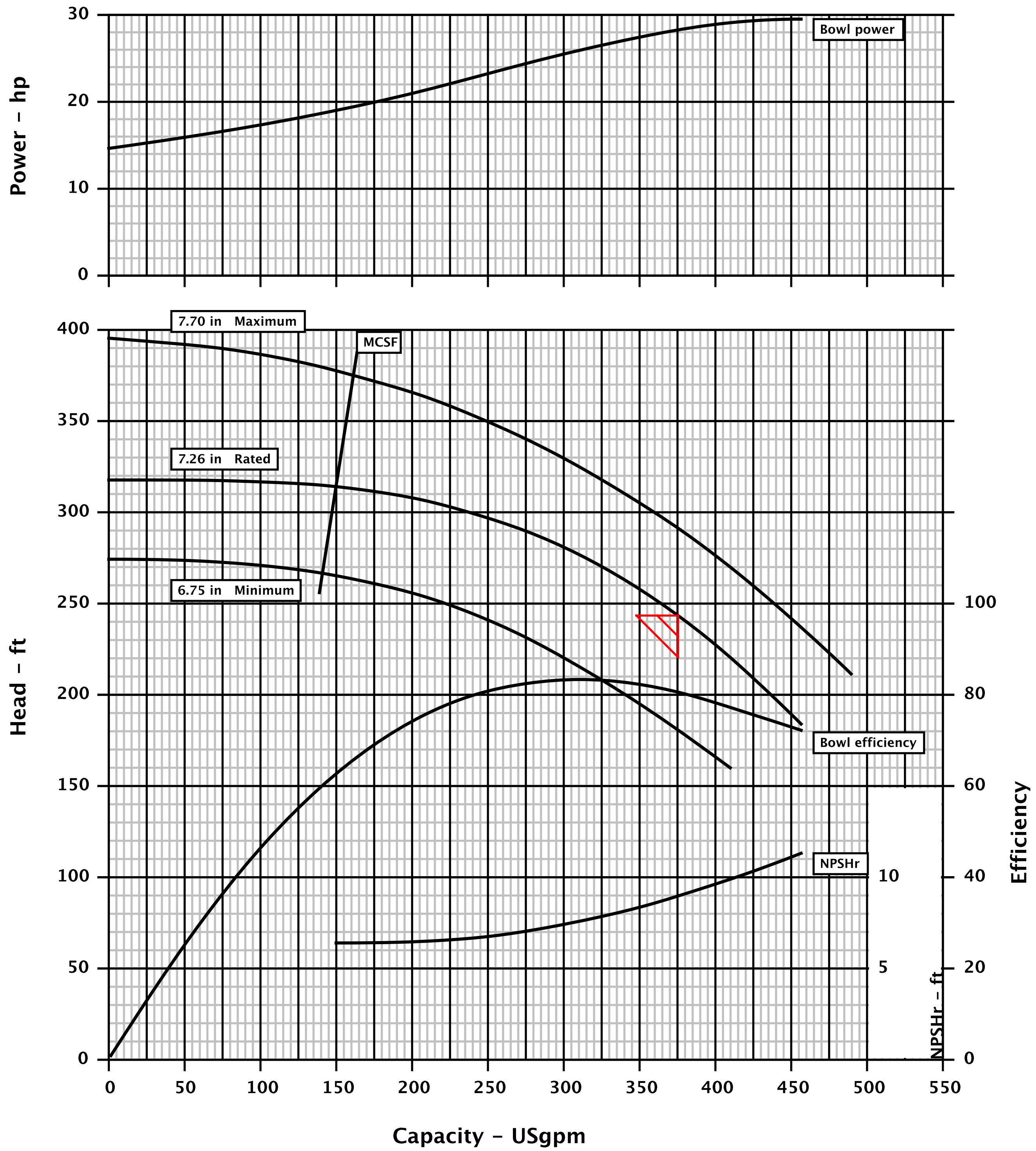
The head and power may be different than that shown in accordance with Hydraulic Institute / API 610 Standards

Additional Notes:

FLOWSERVE		Pump size & type	: 10ELM
		Based on curve no.	: EC-2357
		Number of stages	: 6
Customer	: Customer	Capacity	: 375.0 USgpm
Item number	: -	Head	: 243.00 ft
Service	:	Specific gravity	: 1.000
Vendor reference	: Default Project 0.1	Pump speed	: 1775 rpm
Date	: May 11, 2011		

CURVES ARE APPROXIMATE, PUMP IS GUARANTEED FOR ONE SET OF CONDITIONS, CAPACITY, HEAD, AND EFFICIENCY.

Bowl performance shown below is corrected for materials, viscosity and construction.



Bowl head of 243.35 ft corresponds with 243.0 ft head at low liquid level adjusted for elevation and friction losses.

 FlowSelex v2.2

FLOWSERVE

Hydraulic Datasheet

Customer	: Customer	Pump / Stages	: 10ELM / 6
Customer reference	: Default Project	Based on curve no.	: EC-2357
Item number	: -	Vendor reference	: Default Project 0.1
Service	:	Date	: May 11, 2011

Operating Conditions

Capacity	: 375.0 USgpm
Water capacity (CQ=1.00)	: 375.0 USgpm
Normal capacity	: -
Total Developed Head	: 243.00 ft
Water head (CH=1.00)	: 243.00 ft
NPSH available (NPSHa)	: Ample
NPSHa less NPSH margin	: -
Maximum suction pressure	: 0.0 psig

Liquid

Liquid type	: Other
Liquid description	:
Temperature	: 60 F
Specific gravity / Viscosity	: 1.000 / 1.0 cSt

Materials / Specification

Material column code	: B30
Pump specification	: -

Other Requirements

Hydraulic selection : No specification
Construction : No specification
Test tolerance : Hydraulic Institute Level A
Reduced speed application
Driver Sizing : Max Power(MCSF to EOC)with SF
Performance data based on standard impeller

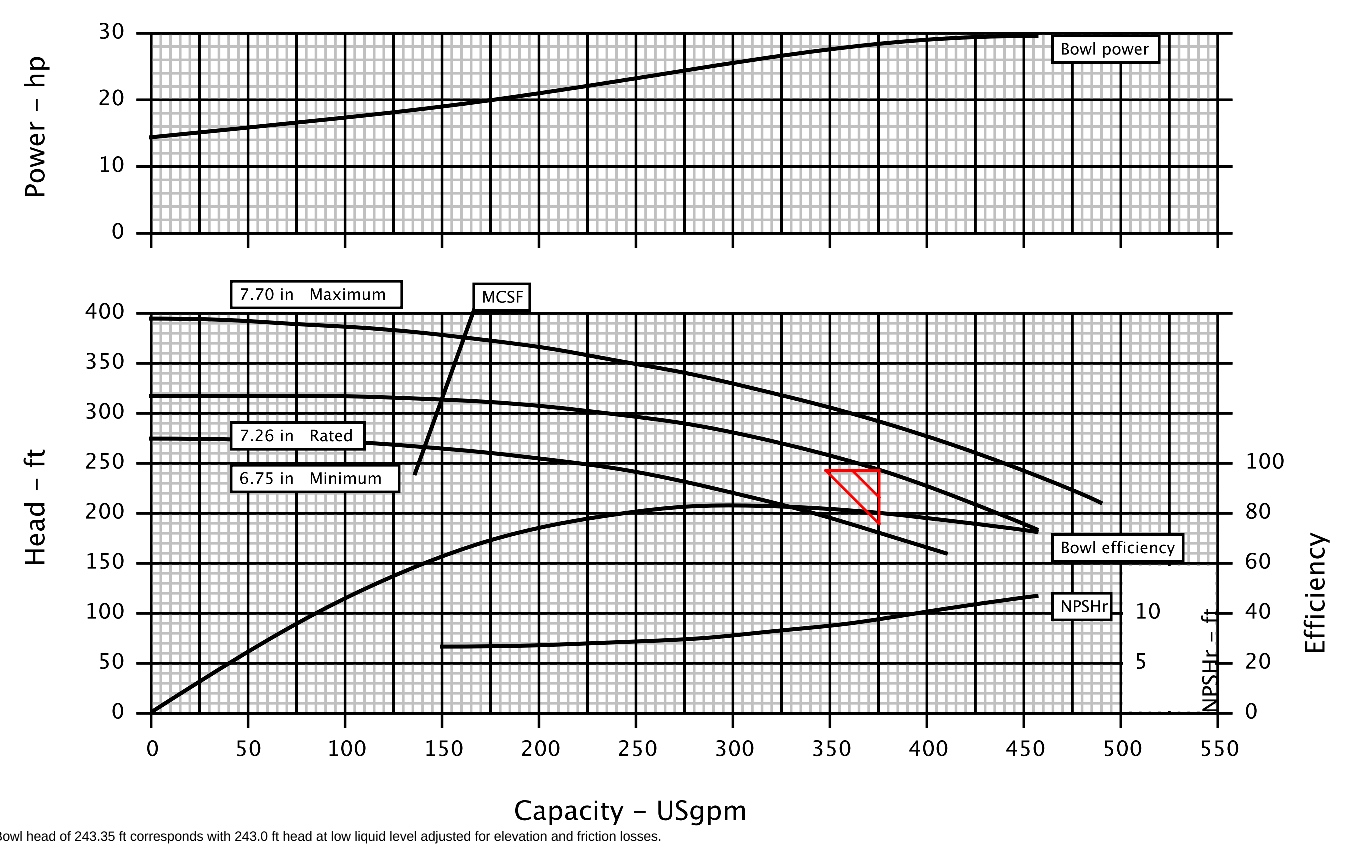
Performance

Hydraulic power	: 23.0 hp
Pump speed	: 1775 rpm
Efficiency (CE=1.00)	: 80.1 %
NPSH required (NPSHr)	: 8.6 ft
Rated power	: 28.7 hp
Maximum power	: 29.9 hp
Driver power	: 30.0 hp / 22.4 kW
Casing working pressure	: 137.6 psig
(based on shut off @ cut dia)	
Maximum allowable	: 136.0 psig
Bowl & column hydrotest	: 172.0 psig
Minimum submergence	: 21.00 in
Pump thrust at rated flow	: 662.4 lbf

Impeller diameter	
Rated	: 7.26 in
Maximum	: 7.70 in
Minimum	: 6.75 in
Suction specific speed	: 7050 US units
Minimum continuous flow	: 151.5 USgpm
Maximum head @ rated dia	: 317.89 ft
Flow at BEP	: 307.1 USgpm
Flow as % of BEP	: 122.1 %
Efficiency at normal flow	: -
Impeller dia ratio (rated/max)	: 94.3 %
Head rise to shut off	: 30.6 %
Total head ratio (rated/max)	: 83.6 %

CURVES ARE APPROXIMATE, PUMP IS GUARANTEED FOR ONE SET OF CONDITIONS, CAPACITY, HEAD, AND EFFICIENCY.

Bowl performance shown below is corrected for materials, viscosity and construction.



Bowl head of 243.35 ft corresponds with 243.0 ft head at low liquid level adjusted for elevation and friction losses.

FLOWSERVE

Construction Datasheet

Customer	: Customer	Pump / Stages	: 10ELM / 6
Customer reference	: Default Project	Based on curve no.	: EC-2357
Item number	: -	Vendor reference	: Default Project 0.1
Service	:	Date	: May 11, 2011

Construction

Bowl construction / lined	: Flanged / Lined bowls
Impeller type	: Enclosed
Impeller fastening	: Colleted
Suction strainer	: Basket
Column construction	: Threaded
Column flange spec'n	: Taneytown Specification
Column dia (nominal)	: 6.00 in
Column pipe length	: 9.58 ft
Column section length	: 120.00 in
Lineshaft brg spacing	: 120.00 in
Lineshaft diameter	: 1.00 in
Lineshaft coupling type	: Threaded coupling
Lineshaft bearings, qty	: 1
Lineshaft construction	: Open
Lineshaft lubrication	: Pumpage
Enclosing tube diameter	: -
Disch size/rating/face	: 6.00 / : - / : -
Pump/driver coupling	: No coupling - hollow shaft
-	

Materials

Bowl	: -
Impeller	: -
Bowl bearing	: -
Bowl shaft	: -
Bowl wear ring	: -
Impeller wear ring	: -
Suction strainer	
Column	: -
Lineshaft	: Carbon steel
Enclosing tube	
Bearing retainer	
Lineshaft bearing	: -
Lineshaft sleeve	
Discharge head	: -
Head shaft	
Support plate	: -

Weights (Approx.)

Complete pump	: -
Mounting plate	: -
Driver(nett)	: -

Testing

Hydrostatic test	: None
Performance test	: -
NPSH test	: -

Driver Information

Manufacturer	: -
-	: - 1.0
Vertical shaft type	: Hollow
Hollow shaft coupling	
Driver Type	: -
Frame size / Base dia	: -
Enclosure	: -
Duty type	
Efficiency type	
Hazardous area class	: -
Explosion 'T' rating	: -
Volts / Phase / Hz	: - / - / -
Amps-full load/locked rotor	: - / -
Motor starting	: Direct on line (DOL)
Insulation	: -
Temperature rise	: -
Bearings / Lubrication	: - / -
Motor mounted by	: Customer
Thrust rating down/up	: - / -

Seal Information

Arrangement	: -
Size	: -
Manufactur / Type	: - / -
Material code (Man'f/API)	: - / -
Gland material	: -
Auxiliary seal device	: -
Seal flush plan	: -
Seal flush construction	: -

Paint and Package

Pump paint	: -
Support plate paint	: -
Shipment type	: -

-

Pit / sump depth	: 15.00 ft
Pump length (mounting	
-	: 14.88 ft
Available well diameter	: 100.00 in
Max dia below mtg	: 13.50 in

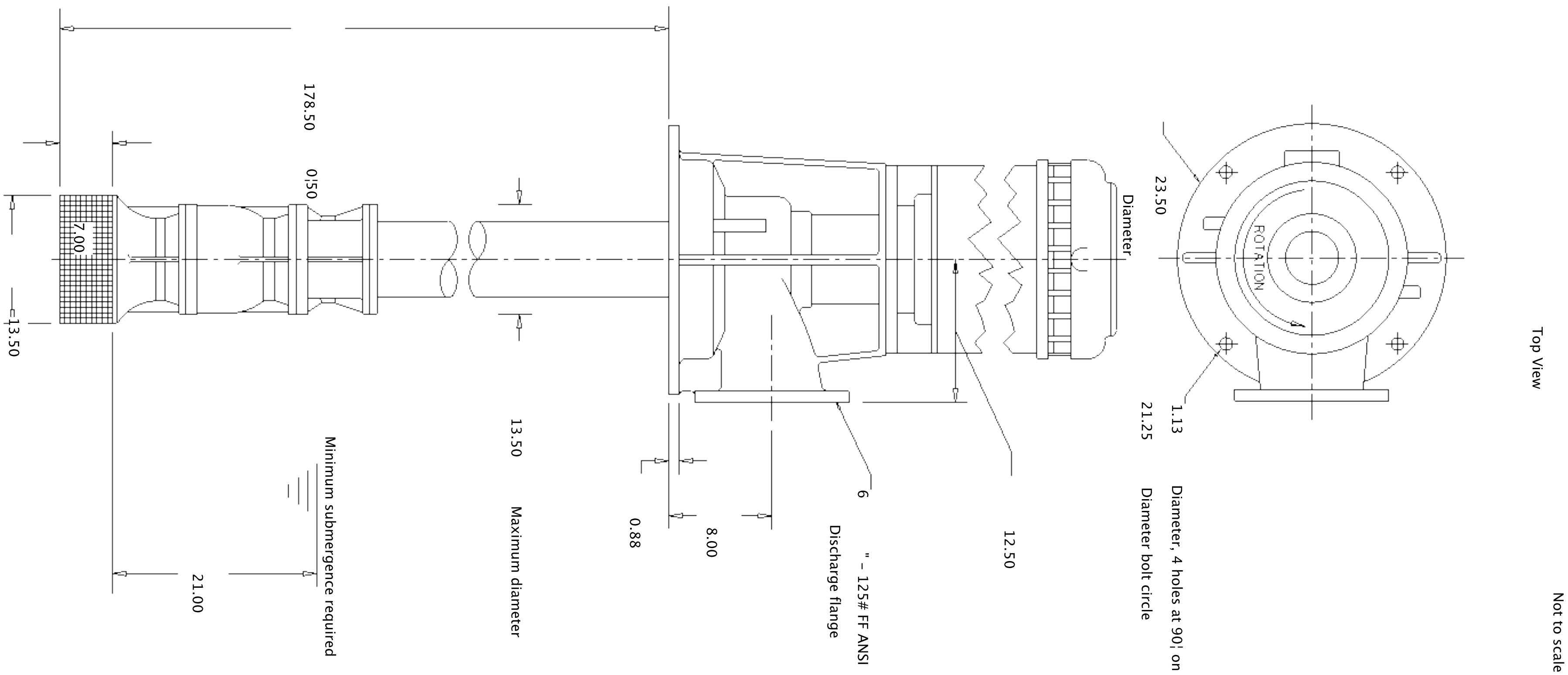
Notes

-

Discharge flange is designed only to bolt up to an ANSI 125# flange but is not fully ANSI compliant.

-

-



All dimensions are in inches unless otherwise specified

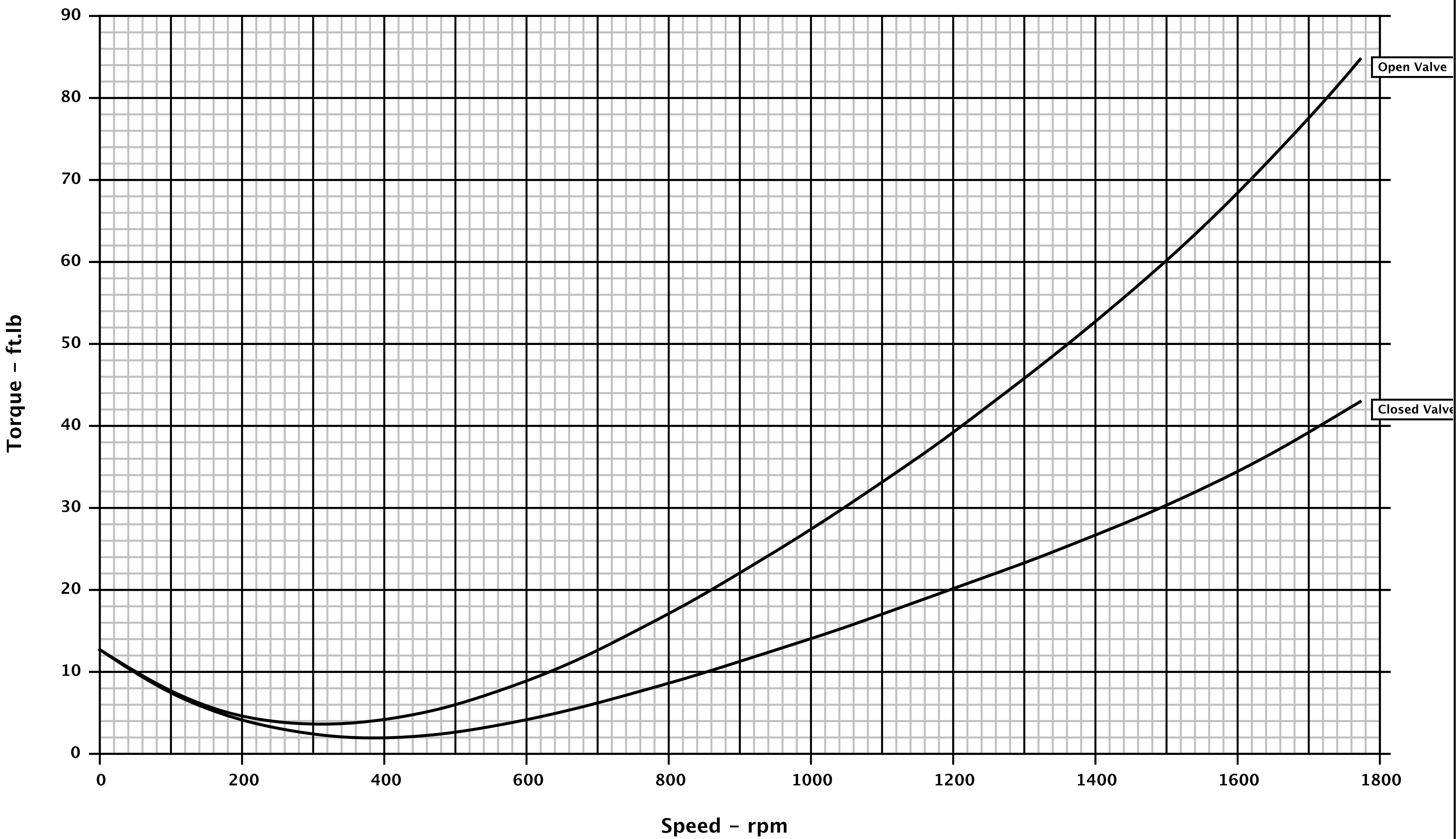
Customer	: Customer	Pump size & type	: 10ELM	Drawing number	: -
Item number	: -	Pump speed / Stages	: 1775 rpm / 6	Date	: May 11, 2011
Service	:	Flow / Head	: 375.0 USgpm / 243.00 ft	Certified by / Date :	: -
Customer PO #	: -	Driver power / Frame	: 30.0 hp / 22.4 kW /	Seal type	: -
Vendor reference	: Default Project 0.1	Volts / Phase / Hz	: - / - / -	Seal flush plan	: -

Customer	:	Customer
Item Number	:	-
Service	:	
Vendor Reference	:	Default Project 0.1
Date	:	May 11, 2011

FLOWSERVE

Capacity	:	375.0 USgpm	Specific gravity	:	1.000
Head	:	243.00 ft	Pump speed	:	1775 rpm

Pump size & type	:	10ELM
Based on curve no.	:	EC-2357
Number of stages	:	6



FlowSelex v2.2

KINNEY

AUTOMATIC SELF-CLEANING STRAINERS

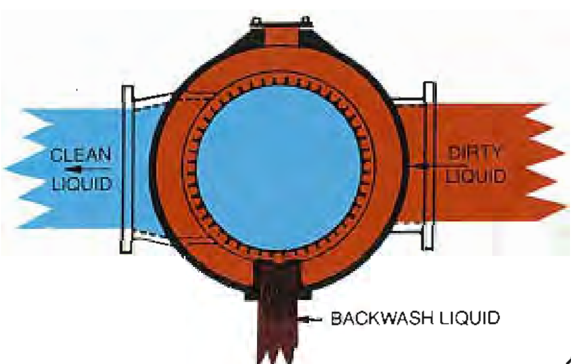
S.P.KINNEY

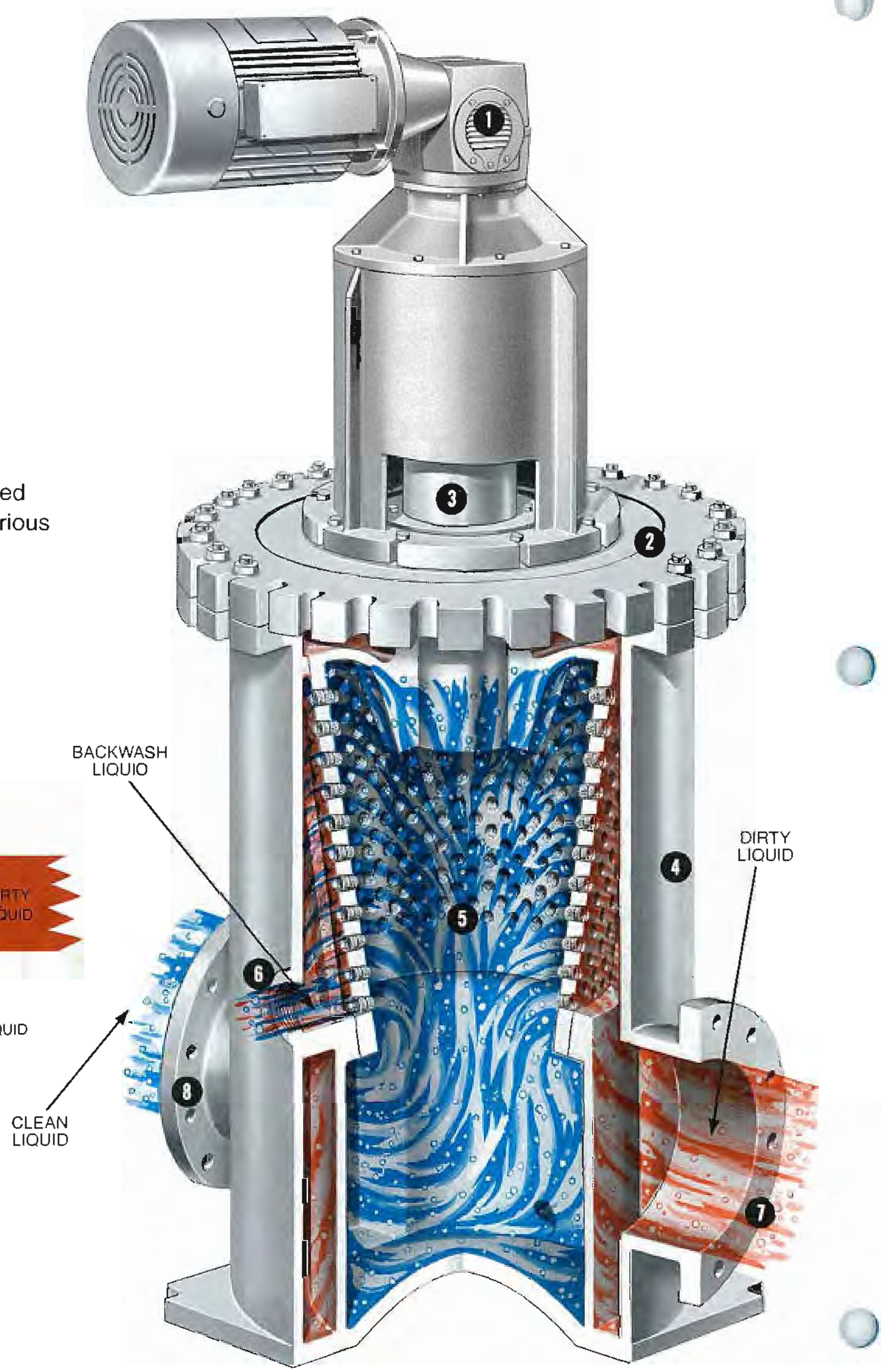
OVER 10,000 SATISFACTORY INSTALLATIONS - WORLDWIDE

MODEL A
for operation under positive pressure

1. strainer drive
2. cover
3. shaft
4. body
5. drum . . . tapered for vertical adjustment—drilled and tapped to receive various types of straining media
6. backwash outlet
7. inlet
8. outlet

TOP VIEW





APPLICATION

Designed for continuous removal of suspended particles from all types of liquids. Applications are in industrial plants using river, lake, well, or sea water for cooling, descaling, bearing lubrication, spraying, quenching, and similar purposes. Pipeline sizes: 2" - 60" & larger.

Liquids other than water, such as chemicals, acids, white water (paper mills), sewage, and ammonia flushing liquor (coke plants) can also be effectively strained.

INSTALLATION

Installation is made on the discharge side of a pump or in any piping system operating under a positive pressure. The minimum working pressure required to effectively clean the straining media is 20 psi. The strainer is compact with small face-to-face, width, and height dimensions.

DESIGN

The strainer consists of a cylindrical drum with a number of threaded holes containing one of many types of straining media. The drum is supported on a rotating shaft fitted with bearings and is contained in a body having a vertical backwash slot opening adjacent to the drum surface.

OPERATION

The liquid to be strained enters the inlet connection located in the lower portion of the body and flows around the outer surface of the drum. The suspended particles are retained in the media pockets and the clean liquid passes through the media to the inside and bottom opening of the drum—leaving the body at the outlet connection located diametrically opposite the inlet.

BACKWASH

As each row of straining media passes the backwash slot, a reversal of flow occurs, flushing the suspended particles from the media pockets. This reversal of flow is caused by a pressure differential between the interior of the strainer and atmosphere. The backwash flow rate is exceptionally low and will vary, depending on the amount of suspended particles in the liquid. The backwash piping should discharge into an open funnel immediately after the backwash valve.

AUTOMATIC BACKWASH CONTROL

In lieu of a manually operated valve on the backwash outlet line, an automatic control can be furnished to permit intermittent backflushing. This control consists of a motor or pneumatic cylinder operated ball valve, actuated by a timer or a pressure differential switch (or both).

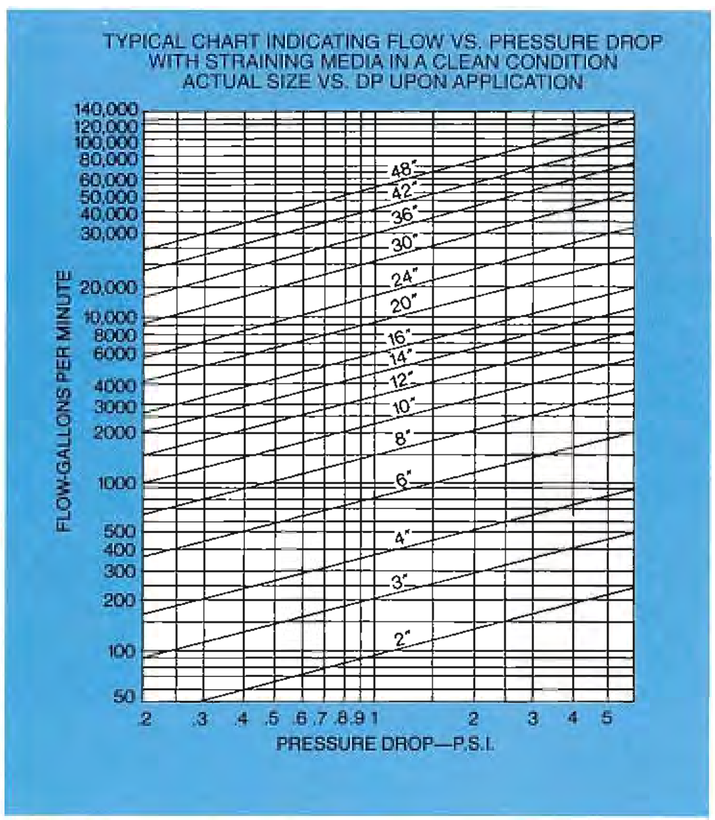
ADJUSTMENT AND SHEARING ACTION

The clearance between the backwash slot and the drum is equal to or smaller than the opening presented in the media—and can be adjusted easily by two locknuts on the threaded part of the top section of the shaft. The backwash slot contains a knife-like edge which enables the strainer to shear debris such as wood, shells, fish, and other suspended materials which may extend beyond the surface of the drum—with no resultant damage to the drum, straining media, or drive unit.

INSPECTION

The straining media can be easily inspected or changed through an opening in the side of the strainer body. The cover of this inspection opening can be furnished with the same material as the body construction - or with a transparent cover to permit visual inspection of the straining media while the strainer is in operation. Or the entire drum assembly can be lifted from the body for inspection or changing of media.

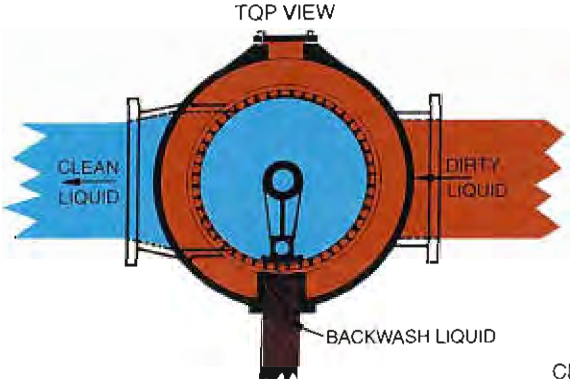
MODEL A

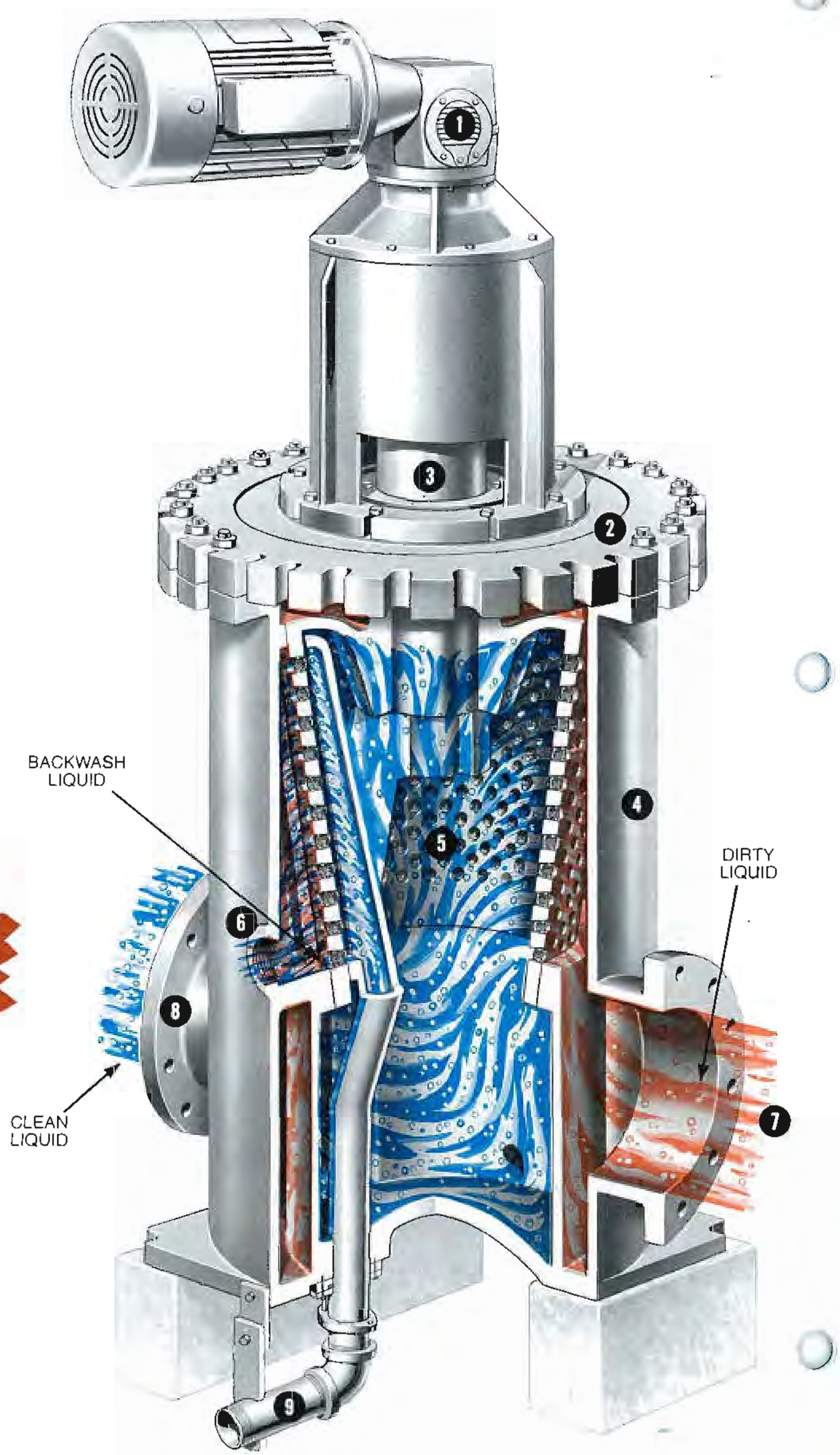


MODEL AP

for low working pressures

1. strainer drive
2. cover
3. shaft
4. body
5. drum . . . tapered for vertical adjustment—drilled and tapped to receive various types of straining media
6. backwash outlet
7. inlet
8. outlet
9. backwash shoe inlet





APPLICATIONS

Designed for continuous removal of suspended particles from all types of liquids. Applications are in industrial plants using river, lake, well, or sea water for cooling, descaling, bearing lubrication, spraying, quenching, and similar purposes. Pipeline sizes: 2" - 60" & larger.

Liquids other than water, such as chemicals, acids, white water (paper mills), sewage, and ammonia flushing liquor (coke plants) can also be effectively strained.

INSTALLATION

Used when working pressure is low. The strainer is compact —with small face-to-face, width, and height dimensions.

DESIGN

The strainer consists of a cylindrical drum with a number of threaded holes containing one of many types of straining media. The drum is supported on a rotating shaft fitted with bearings and is contained in a body having a vertical backwash slot opening. A pressure backwash shoe is inserted inside the drum, directly opposite the backwash slot.

OPERATION

The liquid to be strained enters the inlet connection located in the lower portion of the body and flows around the outer surface of the drum. The suspended particles are retained in the media pockets and the clean liquid passes through the media to the inside and bottom opening of the drum—leaving the body at the outlet connection located diametrically opposite the inlet.

BACKWASH

High pressure liquid from the discharge side of the pump or from some other source is diverted to the backwash shoe. As each row of straining media passes between the backwash shoe and the backwash slot, the high pressure liquid flushes the suspended particles from the media. The amount of high pressure liquid needed to effect proper backflushing is low and will vary, depending on the amount of suspended particles in the liquid being strained. The inlet and outlet valves are kept open partially in order to obtain a minimum pressure drop across the strainer with low wastage. Periodically, these valves should be opened all the way to obtain a more thorough cleaning action. The backwash piping should discharge into an open funnel immediately after the backwash outlet valve.

AUTOMATIC BACKWASH CONTROL

In lieu of manually operated backwash valves, an automatic control can be furnished to permit intermittent backflushing. This control consists of motor or pneumatic cylinder operated ball valves (one at the backwash inlet and one at the backwash outlet), actuated by a timer.

ADJUSTMENT AND SHEARING ACTION

The clearance between the backwash slot and the drum and the clearance between the drum and the backwash shoe is equal to or smaller than the opening presented in the media. Adjustment of the clearance between the backwash slot and the drum is accomplished by two locknuts on the threaded part of the top section of the shaft. The clearance between the drum and the backwash shoe is adjusted at the bottom of the backwash shoe.

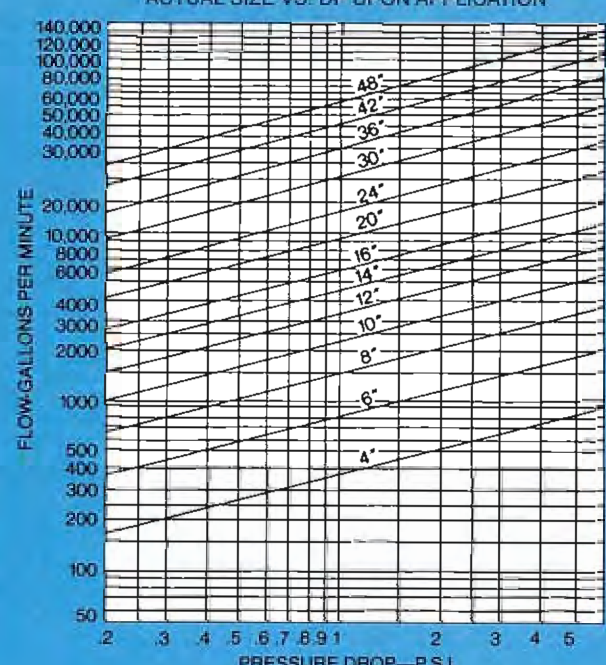
The backwash slot contains a knife-like edge which enables the strainer to shear debris such as wood, shells, fish, and other suspended materials which may extend beyond the surface of the drum—with no resultant damage to the drum, straining media, or drive unit.

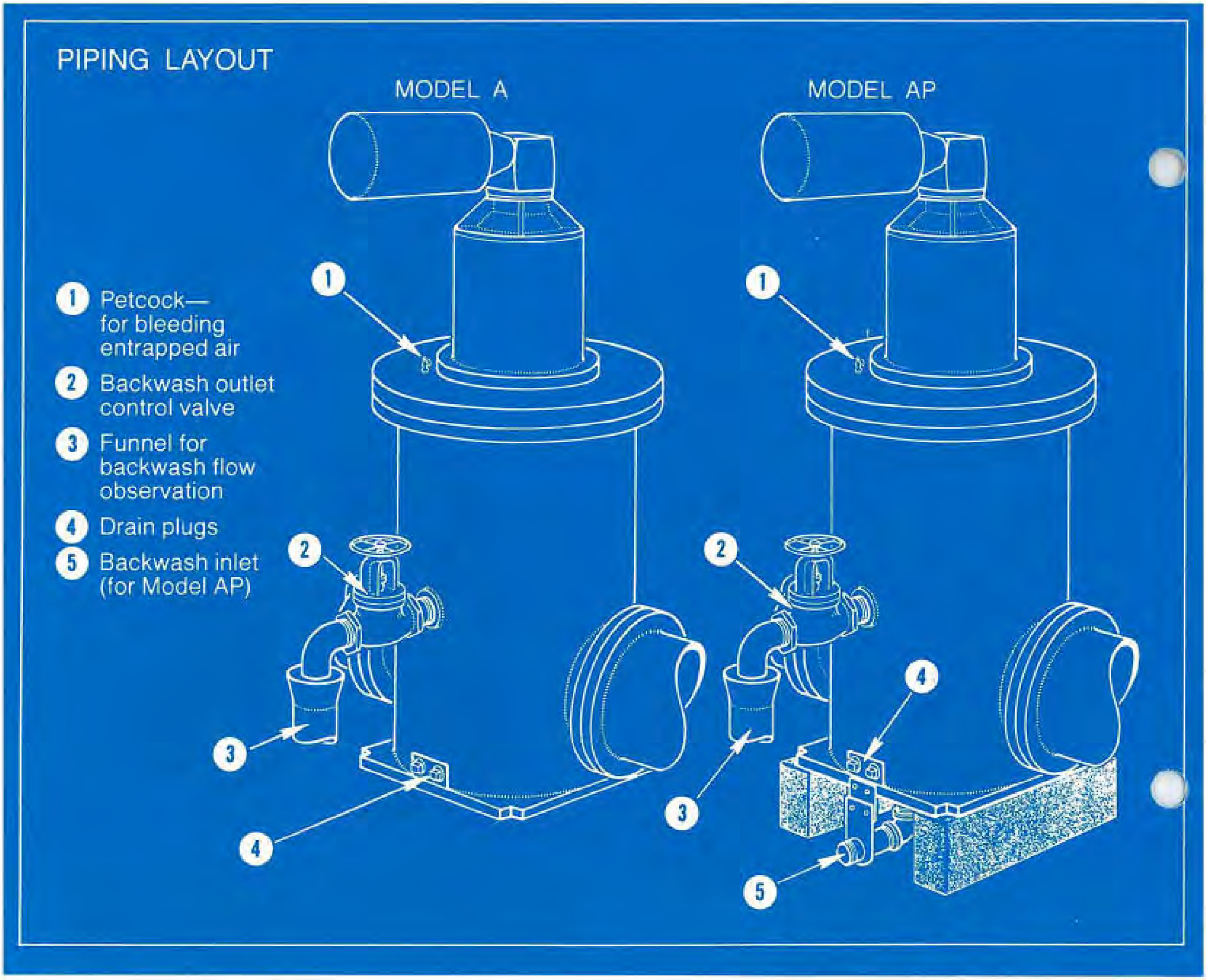
INSPECTION

The straining media can be easily inspected or changed through an opening in the side of the strainer body. The cover of this inspection opening can be furnished with the same material as the body construction - or with a transparent cover to permit visual inspection of the straining media while the strainer is in operation. Or the entire drum assembly can be lifted from the body for inspection or changing of media.

MODEL AP

TYPICAL CHART INDICATING FLOW VS. PRESSURE DROP
WITH STRAINING MEDIA IN A CLEAN CONDITION
ACTUAL SIZE VS. DP UPON APPLICATION





CONSTRUCTION

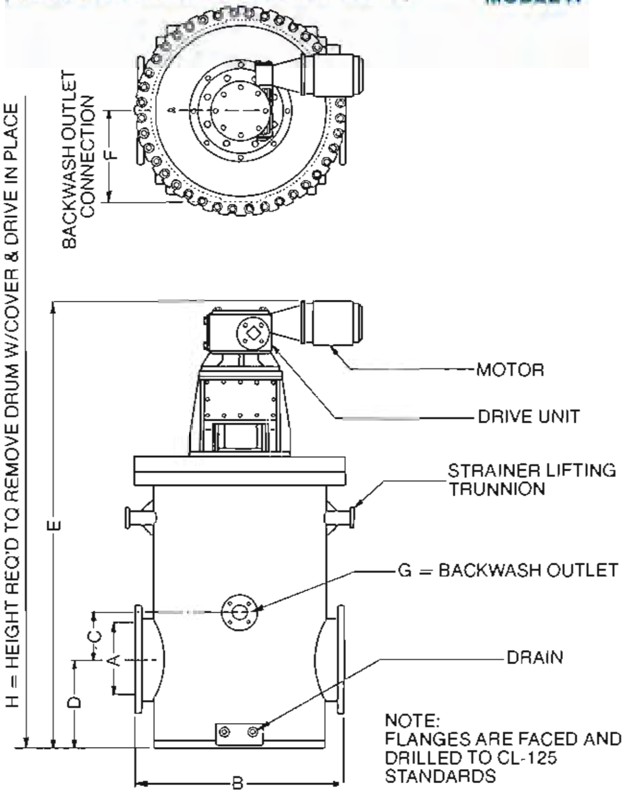
MODEL A				
PART	STANDARD	SEA WATER	WHITE WATER	AMMONIACAL LIQUOR
BODY	Cast Iron	Cast Iron	Cast Iron	Cast Iron
DRUM	Cast Iron	Aluminum Bronze	Stainless Steel	Cast Iron
MEDIA	As Specified	As Specified	As Specified	As Specified
MEDIA RETAINERS	Delrin	Delrin	Delrin	Stainless Steel
SHAFT	Steel	Stainless Steel	Stainless Steel	Stainless Steel

MODEL AP				
PART	STANDARD	SEA WATER	WHITE WATER	AMMONIACAL LIQUOR
BODY	Cast Iron	Cast Iron	Cast Iron	Cast Iron
DRUM	Cast Iron	Aluminum Bronze	Stainless Steel	Cast Iron
MEDIA	As Specified	As Specified	As Specified	As Specified
MEDIA RETAINERS	Delrin	Delrin	Delrin	Stainless Steel
SHAFT	Steel	Stainless Steel	Stainless Steel	Stainless Steel
BACKWASH SHOE	Cast Iron	Aluminum Bronze	Stainless Steel	Cast Iron

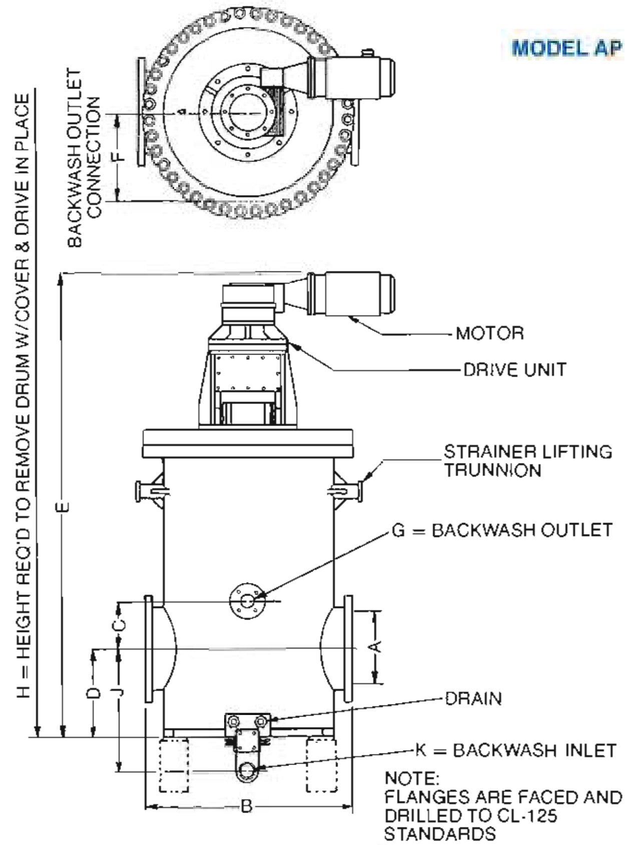
DIMENSIONS (CAST IRON UNITS)

(FABRICATED DIMENSIONS UPON REQUEST)

MODEL A



MODEL AP



MODEL A

STRAINER SIZE-A	DIMENSIONS (INCHES) B	C	D	E	F	G	H	MOTOR H.P.	APPROX. SHIP. WT. LBS.
2 ▲	18	1	4	36	6¾	1¼ ▲	42	½	460
3 ▲	18½	1	4½	38½	6¾	1½ ▲	45½	½	525
4	18½	1¼	5	37	6¾	2 ▲	49	½	625
6	21	5	9	49	8⅝	2 ▲	60¾	¾	1,100
8	26	6⅛	9½	58½	10½	2 ▲	80¼	¾	1,800
10	31	8¼	11	65⅛	13	3 ▲	89⅜	¾	2,500
12	36	9¾	12½	81⅛	14¾	3 ▲	111⅞	1	4,500
14	41	10½	14½	83⅞	17⅝	3*	115	1	6,100
16	45	10½	19¼	101¾	19⅛	3*	139¾	1½	8,300
20	52	13	20	106½	22⅜	4*	148	1½	11,200
24	62	11⅝	23¾	120¾	26⅝	4*	174¾	3	16,800
30	72	12½	20	115¾	31	6*	169¾	3	23,250
36	86	32½	25	165¼	37½	6*	224¼	5	38,500
42	100	36	27	189¼	39½	6*	259¼	5	46,750
48	120	45	55½	227	52¾	8*	336	7½	58,000

MODEL AP

STRAINER SIZE-A	DIMENSIONS (INCHES) B	C	D	E	F	G	H	J	K	MOTOR H.P.	APPROX. SHIP. WT. LBS.
4	18½	1¼	5	37	6¾	2 ▲	49	7	1½	½	645
6	21	5	9	49	8⅝	2 ▲	67⅞	6⅝	1½	¾	1,140
8	26	6⅛	9½	58½	10½	2 ▲	97¼	15½	1½	¾	1,890
10	31	8¼	11	65⅛	13	3 ▲	108⅛	16¼	2	¾	2,600
12	36	9¾	12½	81⅜	14¾	3 ▲	128⅜	18½	2	1	4,625
14	41	10½	14½	83⅞	17⅝	3*	140	21 3/16	2½	1	6,260
16	45	10½	19¼	101¾	19⅛	3*	169¼	26½	3	1½	8,775
20	52	13	20	106½	22⅜	4*	192½	28⅛	4	1½	11,830
24	62	11⅝	23¾	120¾	26⅝	4*	209½	32	4	3	17,400
30	72	12½	20	115¾	31	6*	210 7/16	27½	6	3	24,000
36	86	32½	25	165¼	37½	6*	281¼	39	6	5	39,950
42	100	36	27	189¼	39½	6*	305¼	41	6	5	48,500
48	120	45¼	31¼	202¾	52¾	8*	336	36	4	7½	57,000

*Two backwash openings ▲ Pipe tap Do not use for construction—certified prints will be furnished

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A LARGE VARIETY OF STRAINING MEDIA IS AVAILABLE FOR EVERY CONCEIVABLE APPLICATION. ALL THE FOLLOWING TYPES AND SIZES ARE THE SAME DIAMETER TO PERMIT RAPID INTERCHANGEABILITY SHOULD A DIFFERENT RANGE OF STRAINING BE DESIRED. BOTH OF THESE FEATURES ARE UNIQUE WITH THE KINNEY AUTOMATIC STRAINER.

WIRE MESH CONES (STAINLESS STEEL)

Ideal for removal of granular materials such as dirt, sand, silt, gravel, and stones. Available in meshes of 10 x 10, 20 x 20, 40 x 40, 60 x 60, Micron Ranges 178, 152, 95, 75 and 40. Other sizes available upon request

SLOTTED CONES (DELRIN, STAINLESS STEEL, OR BRONZE)

Suitable for removal of fibrous materials such as grass, roots, twigs, and fibre. There are no sharp edges for entanglement of debris. Size of slots range from .375" to .010".

PERFORATED DISCS (DELRIN)

Also suitable for removal of fibrous materials. Tapered holes and smooth surface repels matting of debris. Sizes: 1/8", 1/16", 1/32" and 1/64".

PERFORATED CONES (STAINLESS STEEL)

An all purpose media for removal of either granular or fibrous materials. Sizes: 1/8", 1/16" and 1/32".

RETAINER RINGS (DELRIN, STAINLESS STEEL, OR BRONZE)

Threaded retainer rings securely hold straining media in place in the drum.

QUALITY CONSTRUCTION ALL STRAINERS ARE DESIGNED, CONSTRUCTED AND HYDROSTATICALLY TESTED - TO ASSURE ABSOLUTE SATISFACTORY PERFORMANCE. OUR SHOPS ARE ALSO CERTIFIED TO FURNISH SPECIAL QUALITY STRAINERS TO SECTION VIII (U STAMP) AND TO SECTION III (N STAMP - NUCLEAR) OF THE ASME BOILER AND PRESSURE VESSEL CODE.

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Attachment C—Schematic Design Fact Sheets

Plant Effluent Disinfection Alternatives

ATTACHMENT C TO: TM 6—Plant Effluent Disinfection, Hypochlorite Facility and Plant Water Pump Station

PROJECT: Schematic Design Report
Bend Water Reclamation Facility Secondary Expansion

Objective

Evaluate the present worth of disinfection alternatives for plant effluent for the Bend Water Reclamation Facility (WRF). The options to consider include chemical disinfection with hypochlorite and in-channel low pressure high output (LPHO) ultraviolet (UV) disinfection.

Background

The WRF currently uses gaseous chlorine and a chlorine contact basin to achieve disinfection for plant effluent. During the reuse season, the entire plant flow is dosed with reuse levels of chlorine due to the facility's configuration. To improve overall safety and risk, an alternative to gaseous chlorine is being considered.

Design Criteria

Table 1 lists the design criteria specific to addressing the selection of disinfection alternatives for plant effluent.

TABLE 1
Plant Effluent Disinfection Design Criteria
City of Bend Water Reclamation Facility

Criterion	Unit	AAF	MMF	Peak Hour
Total Plant Flow	mgd	10.9	11.9	29.5
Plant Effluent, Fecal Coliform	MPN/100 mL	200	200	Not applicable

AAF = Average Annual Flow.
mgd = million gallons per day.
mL = milliliter.
MMF = Maximum Month Flow.
MPN = most probable number.

Evaluation of Alternatives

For plant effluent disinfection, two alternatives were considered. Alternative 1 included a chlorine contact basin with liquid hypochlorite as the disinfectant. Alternative 2 included an open-channel LPHO UV disinfection system. In-vessel UV systems were not considered because plant effluent is not filtered, causing maintenance difficulties with in-vessel systems. Debris from clarifiers can be difficult to clear from closed vessel systems. At this facility, open channel is compatible with the gravity outfall.

Alternative 1— Construct New CCB

Alternative 1 is to construct a new CCB for disinfecting plant effluent and includes yard piping and miscellaneous demolition. Operations and maintenance (O&M) costs consist of delivered sodium hypochlorite use and some electrical costs.

Advantages

- Lowest capital cost
- Familiar process for operators.
- Simple to operate.

Disadvantages

- Highest disinfection chemical costs
- Must manage larger quantity of hypochlorite

Alternative 2 –In channel LPHO UV

Alternative 2 is to construct new channels with roof structure for new LPHO UV in-channel equipment, enclosed electrical room for UV, and additional backup power generation capacity. O&M costs consist of delivered sodium hypochlorite for reuse season reuse residual, estimated power usage for UV usage for plant effluent discharge, and estimated UV equipment replacement costs.

Advantages

- Smallest footprint
- Minimum requirements for sodium hypochlorite
- Low energy requirements
- Simple to operate

Disadvantages

More manpower and attention required.

Present Worth Analysis

Table 2 provides the relevant basis of present worth analysis. Table 3 summarizes the capital, O&M, and life cycle costs used in the UV equipment evaluation. For this analysis, it is assumed that the reuse system will operate for 153 days (May to September) of each year.

The O&M costs are relative, order-of-magnitude estimates and should be used to compare the alternatives. For example, none of the O&M present worth costs include the additional hypochlorite costs for offsite usage since these costs would be the same for all alternatives. O&M costs consist of delivered sodium hypochlorite use for disinfection at the CCBs and/or reuse water residual with UV alternatives during the reuse season, estimated UV power consumption for the reuse system and/or for the plant disinfection system, and estimated UV equipment replacement costs.

TABLE 2
Basis of Present Worth Analysis Factors
City of Bend Water Reclamation Facility

Factors	Unit	Value
Power Cost	$/kWh	$0.041
Labor Cost	$/hour	50
Inflation	Annual %	Not used
Discount Rate	Annual %	1%
Time Length	Years	20

kWh = kilowatt-hour.

TABLE 3
Present Worth Cost Estimates of Alternatives
City of Bend WRF Secondary Expansion Project

Item	Alternative 1 New CCB	Alternative 2 In-channel LPHO
Relative Capital Cost	$4.6	$7.4
Present Worth of Annual O&M Costs*	$3.9	$1.4
Total Present Worth	$8.5	$8.8

*Present worth based on a 20 year life and 1% discount factor.

Sensitivity

The present worth analysis can be sensitive to different factors based on the differences in each of the alternatives. For this analysis, both the cost of power and the discount rate were reviewed to determine if they would impact the decision.

Cost of Power

Figure 1shows the sensitivity of the present worth analysis to changes in the cost of power at the Bend WRF. Alternative 1 is not significantly impacted by the cost of power because of the relatively low power use of a chlorine contact basin. The present worth of Alternative 4 rises because of full reliance on electrical power for disinfection.

Discount Factor

Figure 2 show the sensitivity to changes in the discount factor. The net present worth of the Alternative 2 does not drop as fast as Alternative 1 with increasing discount factor because the annual operating costs of Alternative 2 are low compared to Alternative 1. Specifically, as the discount rate rises, the economic evaluation indicates a stronger preference for Alternative 1.

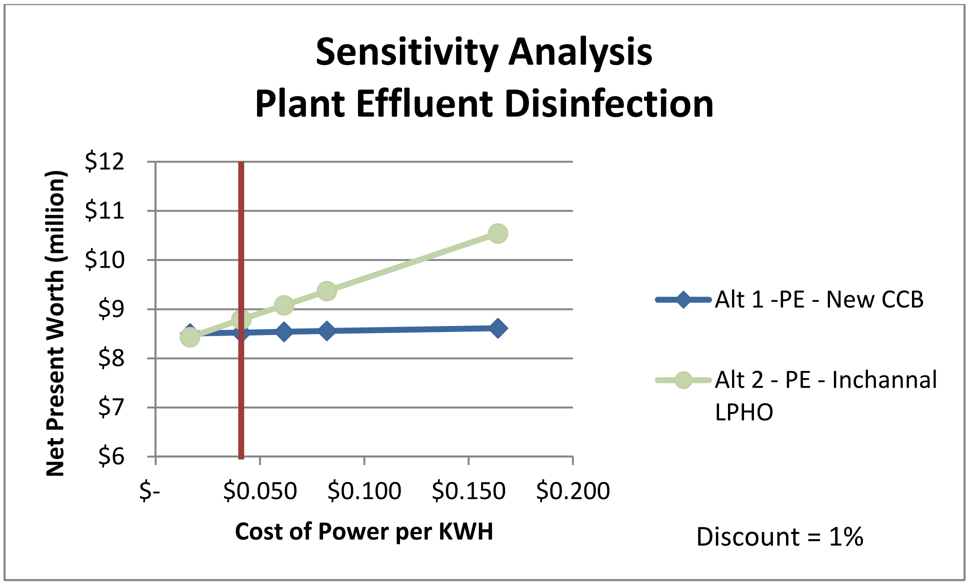


FIGURE 1
Sensitivity to the Cost of Power at Bend WRF
Based on a discount rate of 1%

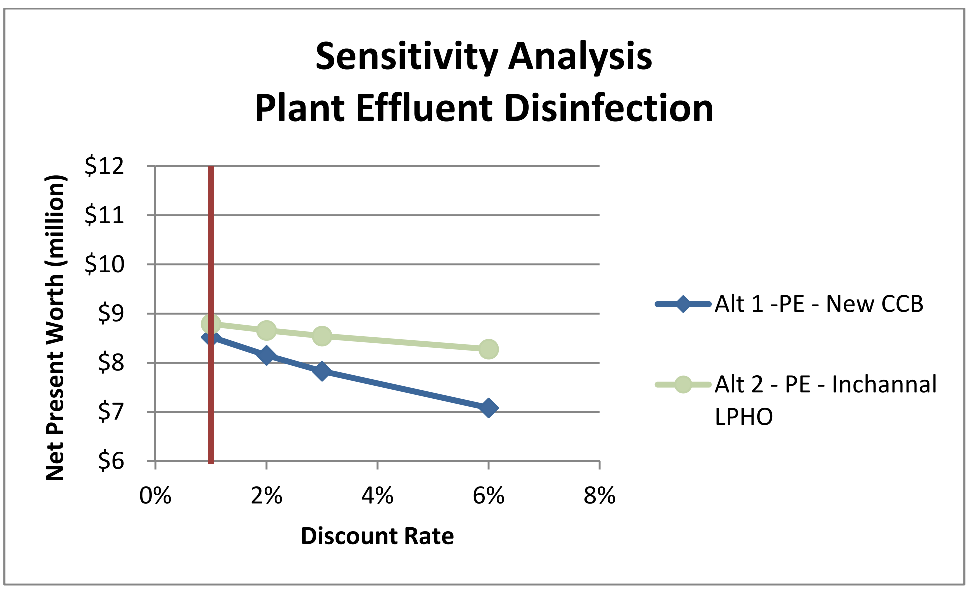


FIGURE 2
Sensitivity to the Discount Rate
Based on a electricity cost of $0.041/kwh

Recommendations

Hypochlorite disinfection of plant effluent has a small economic advantage according to this analysis. The advantage is small and sensitive to the final construction costs. Because of this small difference, other non-economic factors should be considered. Specifically, operator safety and corrosion are important factors. Safety is the primary reason for eliminating the existing gaseous chlorine system.

Handling of hypochlorite creates some concerns for the Bend WRF staff related to exposure of operators to chemicals. Hypochlorite has a very high pH and is an oxidant. These items can contribute to premature corrosion around hypochlorite systems. An LPHO system can address these concerns.

Footprint of the overall facility is also a concern. The current Environmental Review (conducted as part of the 2007 Facilities Plan) does not address the area required for new chlorine contact basins and begins to encroach on the right of way for high voltage transmission lines. The UV facility footprint fits within the area designated during Facility Planning.

A low pressure high output UV disinfection system will be used as the primary disinfectant for plant effluent.

Attachments

Attachment 1 – Vendor Catalog Cuts

- Low Pressure Ultraviolet Disinfection (WEDECO)

Hypochlorite Storage

ATTACHMENT C TO: TM 6—Plant Effluent Disinfection, Hypochlorite Facility, and Plant Water Pump Station

PROJECT: Schematic Design Report
Bend Water Reclamation Facility Secondary Expansion

Objective

Determine the approach for storage of commercial grade sodium hypochlorite for use in disinfection.

Background

The Project Definition Report described a chlorine contact basin for plant effluent and required a large hypochlorite storage facility. During schematic design, ultraviolet disinfection was again considered for disinfecting plant effluent, based on overall present worth costs. With a low pressure high output (LPHO) ultraviolet (UV) system for plant effluent, a smaller hypochlorite storage system would be required.

Hypochlorite is still required for the following uses:

- Reuse Water (W3) - chlorine residual
- Plant Water (W4) - chlorine residual
- Return Activated Sludge (RAS) – biological control (700 gallons over a two day event)
- Offsite - drinking water point uses (724 gallons per year)

This fact sheet presents the options for hypochlorite storage, assuming that plant effluent is disinfected using an LPHO UV system.

Design Criteria

Table 1 shows the basic criteria for sizing the hypochlorite storage system.

Table 2 shows the hypochlorite storage requirements using an applied chlorine dose of 2-3 milligrams per liter (mg/L) for both reuse and plant water lower dosage. This reduced chlorine dose is based on similar operations to the Bend WRF and is only used to calculate hypochlorite storage. Metering equipment and pumps will be designed to the higher Project Definition dose. With this reduced dose, the total required storage is about 3,000 gallons based on a winter storage requirements of 60 days. Hypochlorite for reuse water was not considered in calculating storage during the winter. The winter storage could likely be reduced when the wintertime plant water demands are refined.

TABLE 1
Hypochlorite Storage Design Criteria at Design Condition
City of Bend Water Reclamation Facility

Criterion	Unit	MMF
Class A Reuse flow	mgd	2.5
Reuse Chlorine Residual	mg/L as Cl_2	2
Plant Water flow	mgd	1.5
Plant Water Residual	mg/L as Cl_2	3
RAS chlorine usage	ppd	350
RAS event length	days	2
Offsite usage	gallons per year	724
Summer Storage	days	15
Winter Storage	days	60

Cl_2 = chlorine.
mgd = million gallons per day.
mg/L = milligrams per liter.
MMF = Maximum Month Flow.
ppd=pounds per day

Evaluation of Alternatives

Alternative 1—Tote Storage

Operations

Totes contain 275 to 330 gallons of chlorine. Plant staff members are familiar with handling totes, but the frequency of handling will be significantly higher for hypochlorite than chemicals currently in use at the plant in a tote. During the reuse season, this could be every 3-6 days (estimated 4 days). Totes require more handling than alternative hypochlorite systems. Offloading of totes requires a forklift. As the individual totes of chemical are consumed, they must be swapped with a full tote and then need to be rinsed. Totes provide an adaptable approach and are likely to lead to better management of hypochlorite storage to minimize the age of hypochlorite. RAS chlorination can be provided by hypochlorite tote that is stored inside or adjacent to the RAS pump station during the infrequent requirement.

Appendix A is a layout for chemical storage facility for tote delivery. Totes are stored under a roof. The totes in use are placed on elevated stands in a heated room to improve the properties of the sodium hypochlorite and to keep the connection piping from freezing. Providing a firewall between the totes allows indoor usage without providing fire sprinklers or hoods.

TABLE 2
Operation Dosage – Disinfection Rates
City of Bend Water Reclamation Facility Secondary Expansion

Usage	Dose	Flow	Storage	Mass Flow	Effective Dose	Daily Flow	Storage	Tanks	Totes
	mg/L	*mgd*	*days*	*ppd*	*ppg*	*gpd*	*gallons*	*#*	*#*
Reuse	2	2.5	15	41.7	1.26	33	496	0.1	1.8
Plant Water - Summer	3	1.5	15	37.53	1.26	30	447	0.1	1.6
RAS Control					1.26		556	0.1	2.0
Drinking Water System							362	0.1	1.3
SUMMER TOTAL						63	1,861	0.3	6.7
Plant Water - Winter	3	1.5	60	37.53	1.0	38	2,252	0.4	8.2
Drinking Water System							362	0.1	1.3
RAS Control					1.26		556	0.1	2.0
WINTER TOTAL						38	3,170	0.6	11.5

Assuming tote size of 275 gallons.

Cost

Although a detailed construction estimate has not been completed, the totes and mini-bulk storage facilities would have similar construction cost. The tote storage option has a moderate construction cost. Totes will be provided by supplier. Delivered hypochlorite is estimated to cost $2.10/gallon including estimated shipping costs.

Advantages

- Totes are a familiar operation to facility operations staff
- Lowest capital cost
- Better management of hypochlorite age
- No ownership of totes/storage tanks, so nothing to replace/reline

Disadvantages

- Frequent handling of hypochlorite.

Alternative 2—Mini-Bulk Storage Tanks

Operations

Assume two 3, 000 gallon tanks for offloading 2,000 to 3,000 gallons at each delivery. A mini-bulk tank system requires minimal handling of hypochlorite. The tanker truck will fill the storage tank where it can be metered to the final usage. Mini-bulk storage can be managed to minimize the hypochlorite age, but cost sensitivity may lead to slightly older hypochlorite.

Attached is a potential layout for a chemical storage facility for mini-bulk delivery (8 foot diameter tanks). Tanks are kept under a cover to reduce heating. The tanks and piping are insulated and heat traced to keep the sodium hypochlorite from freezing during extreme weather.

Cost

The mini-bulk storage facility has a moderate construction cost. Tanks can be provided through the hypochlorite vendor or through the construction contractor. Assuming that the construction contract will provide the tank, replacement of fiberglass tank is required every 8 years. Delivered hypochlorite is estimated to cost $2.00/gallon including shipping costs.

Advantages

- Minimal handling of hypochlorite
- Good management of hypochlorite age

Disadvantages

- More costly hypochlorite than full bulk tanker delivery.
- Some risk of hypochlorite degradation prior to usage

- Deterioration of bulk storage tanks requires relining/replacement every 6-8 years

Alternative 3—Bulk Storage Tanks

Operations

Assume two 6,000 gallon tanks for off loading an entire semi-truck load of hypochlorite (5,000 gallons). A bulk storage tank system requires the least handling of hypochlorite. Layout for chemical storage facility for bulk delivery would be similar to mini bulk storage tanks but with larger tanks (10 foot diameter tanks).

Cost

The bulk storage facility has a slightly higher construction costs than the other alternatives. Replacement of fiberglass tank is required every 8 years.

Hypochlorite price per gallon for this alternative will be the most cost effective base cost but with losses of chemical due to degradation. With this alternative, plant staff can choose the most cost effective method depending on current hypochlorite usage, hypochlorite degradation, and the chemical costs. Loss of chemical strength requires increasing pumping rate over time. SCADA controls can be programmed to adapt. Delivered hypochlorite is estimated to cost $1.42/gallon including shipping costs for a full tanker truck.

Advantages

- Least handling of hypochlorite
- Allows the most cost effective purchasing of hypochlorite (bulk or mini-bulk)

Disadvantages

- High degradation of chemical due to high age of hypochlorite with full loads
- Effective cost of hypochlorite much higher than purchase cost because of degradation
- Most expensive facility construction cost
- Dosing rates will change depending on the strength of chemical
- Deterioration of bulk storage tanks requires relining/replacement every 6-8 years

Chlorine Degradation

Chlorine degrades at different rates depending on the batch and temperature. It is generally recommended to retain less than 15 days of storage during warm weather. A batch may lose 50% strength in 30 days. After the facility is operating, the facility staff will be able to better predict the stability of hypochlorite and reliability of delivery.

Present Worth Analysis

Table 3 provides the relevant project factors used in the present worth analysis. Table 4 summarizes the present worth analysis used to evaluate the hypochlorite storage alternatives.

TABLE 3
Present Worth Analysis Approach
City of Bend Water Reclamation Facility

Factors	Unit	Value
Power Cost	$/kWh	$0.041
Labor Cost	$/hour	50
Inflation	Annual %	Not used
Discount Rate	Annual %	1%
Time Length	Years	20

kWh = kilowatt-hour.

TABLE 4
Present Worth Analysis—Hypochlorite Storage
City of Bend Water Reclamation Facility

	Alternative 1 Tote Storage	Alternative 2 Mini-Bulk Storage	Alternative 3 Bulk Storage
Capital Cost (Storage only)	$540,000	$540,000	$680,000
Present Worth of O&M	$912,000	$835,000	$633,000
Total Net Present Worth	$1,500,000	$1,400,000	$1,300,000

Notes:
Cost calculated using hypochlorite degradation estimates.

Recommendations

The present worth shows very similar costs for all alternatives. Schematic design will include the use of a mini-bulk storage system for hypochlorite with two 3,000 gallon tanks. This approach provides a low capital costs and encourage good management of sodium hypochlorite age. The total storage allows the system to meet the winter requirement of storing at least 60 days of hypochlorite.

Design Data

Table 5 contains the design data for hypochlorite storage. Appendix B is a possible site plan that accommodates UV disinfection and tote hypochlorite storage.

TABLE 5
Hypochlorite Storage Design Data
City of Bend Water Reclamation Facility

Process	Unit	Design Phase (8.5 mgd)	Buildout (11.9 mgd)
Hypochlorite Storage			
Tanks	each	2	2
Volume per tank	gallons	3,000	3,000

mgd = million gallons per day.

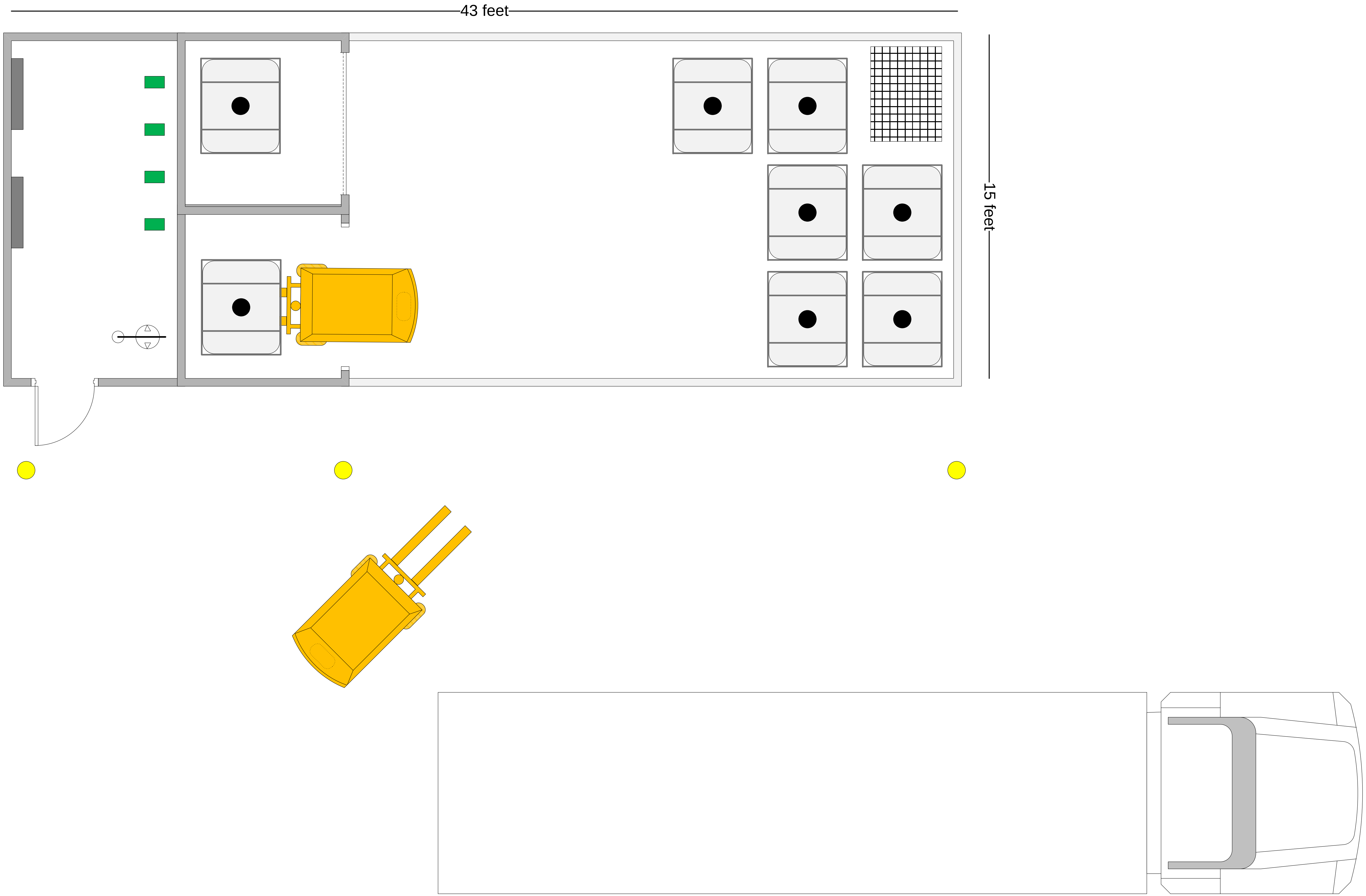
Appendixes

Appendix A—Alternative Layouts

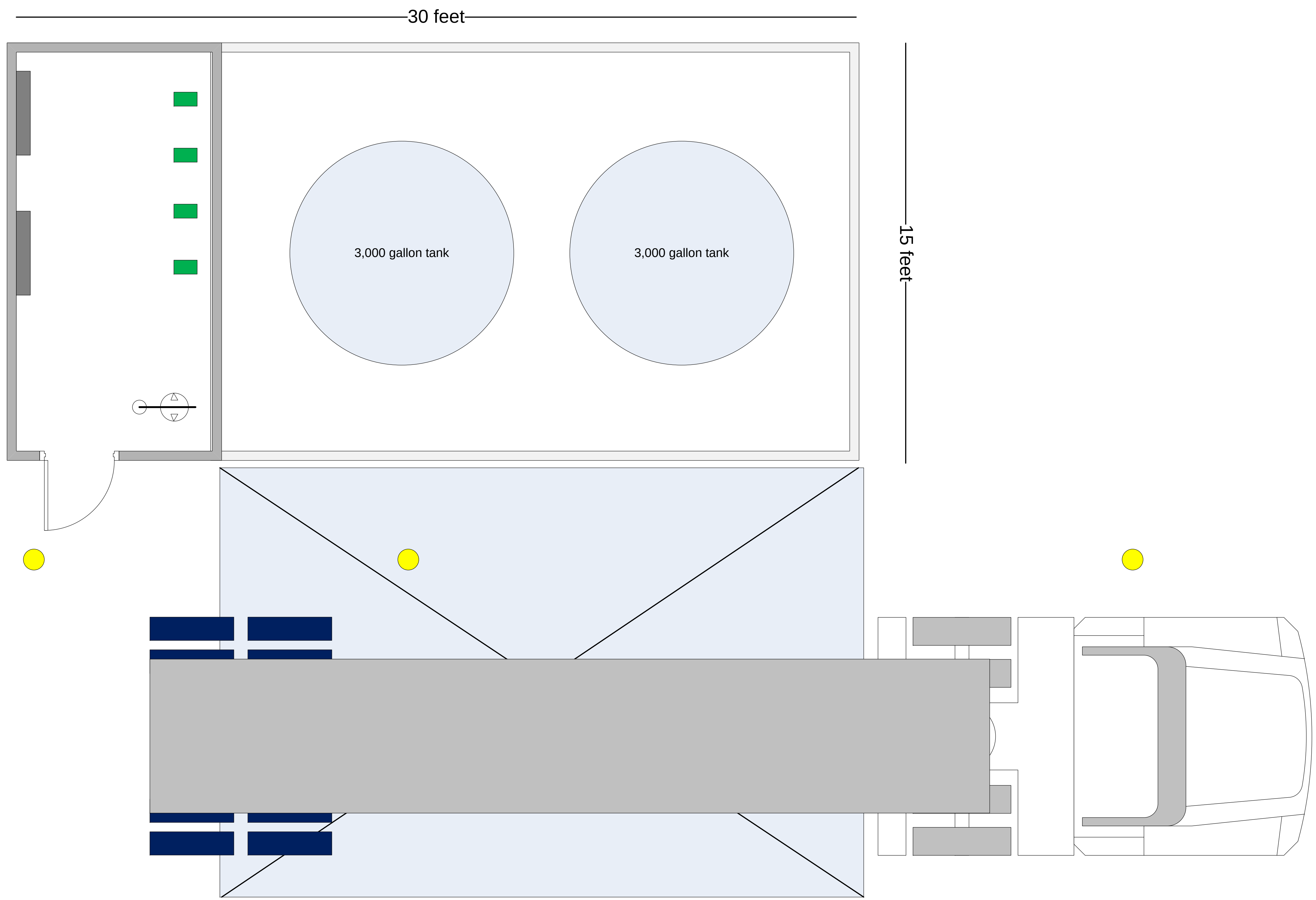
- Alternative 1 – Tote Storage – Hypochlorite Storage Layout
- Alternative 2 – Mini-Bulk Storage – Hypochlorite Storage Layout
- Alternative 3 –Bulk Storage – Hypochlorite Storage Layout

Appendix B—Site Plan for UV Disinfection for Plant Effluent

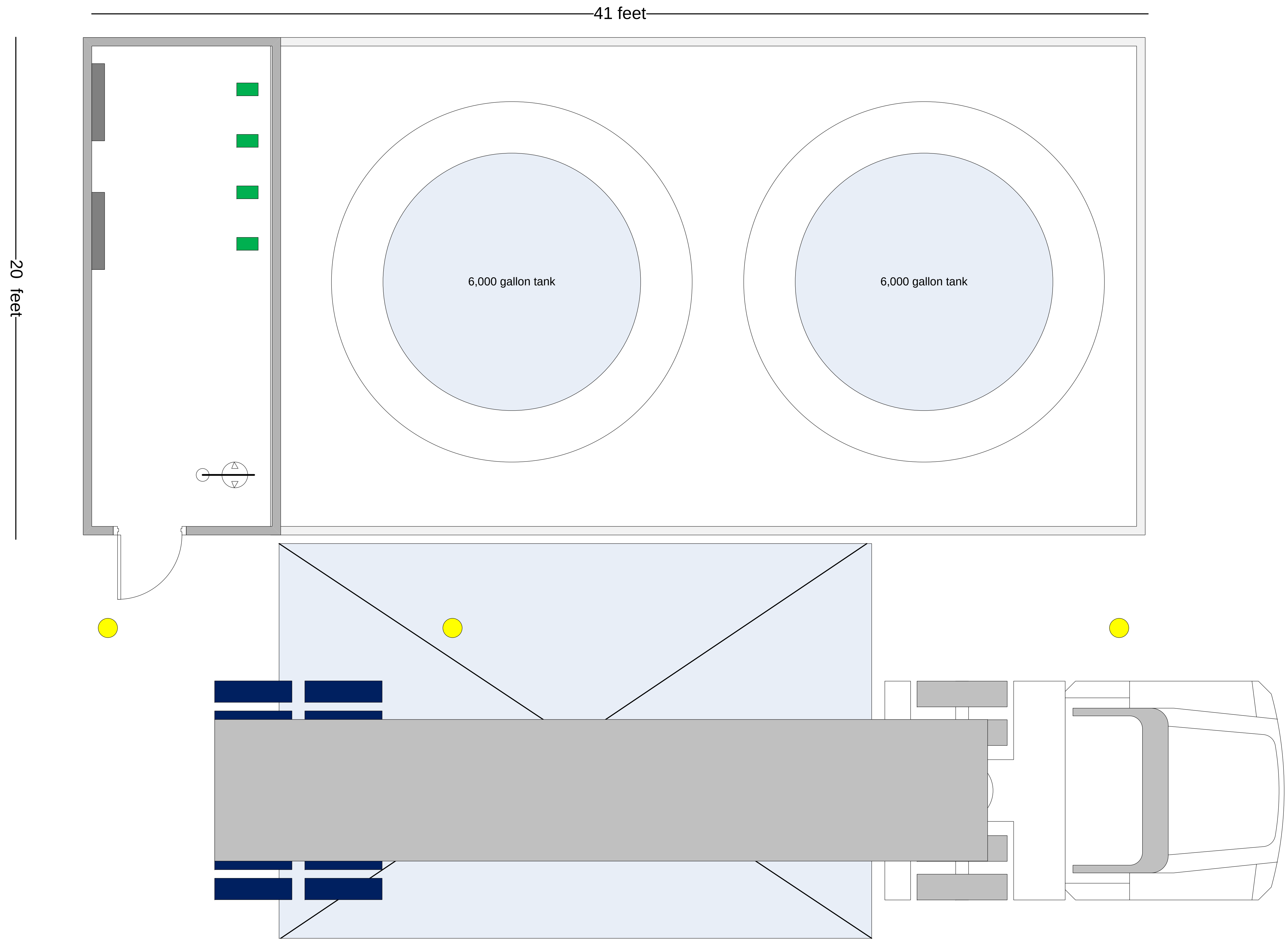
Appendix A—Alternative Layouts



Alternative 1 – Tote Storage

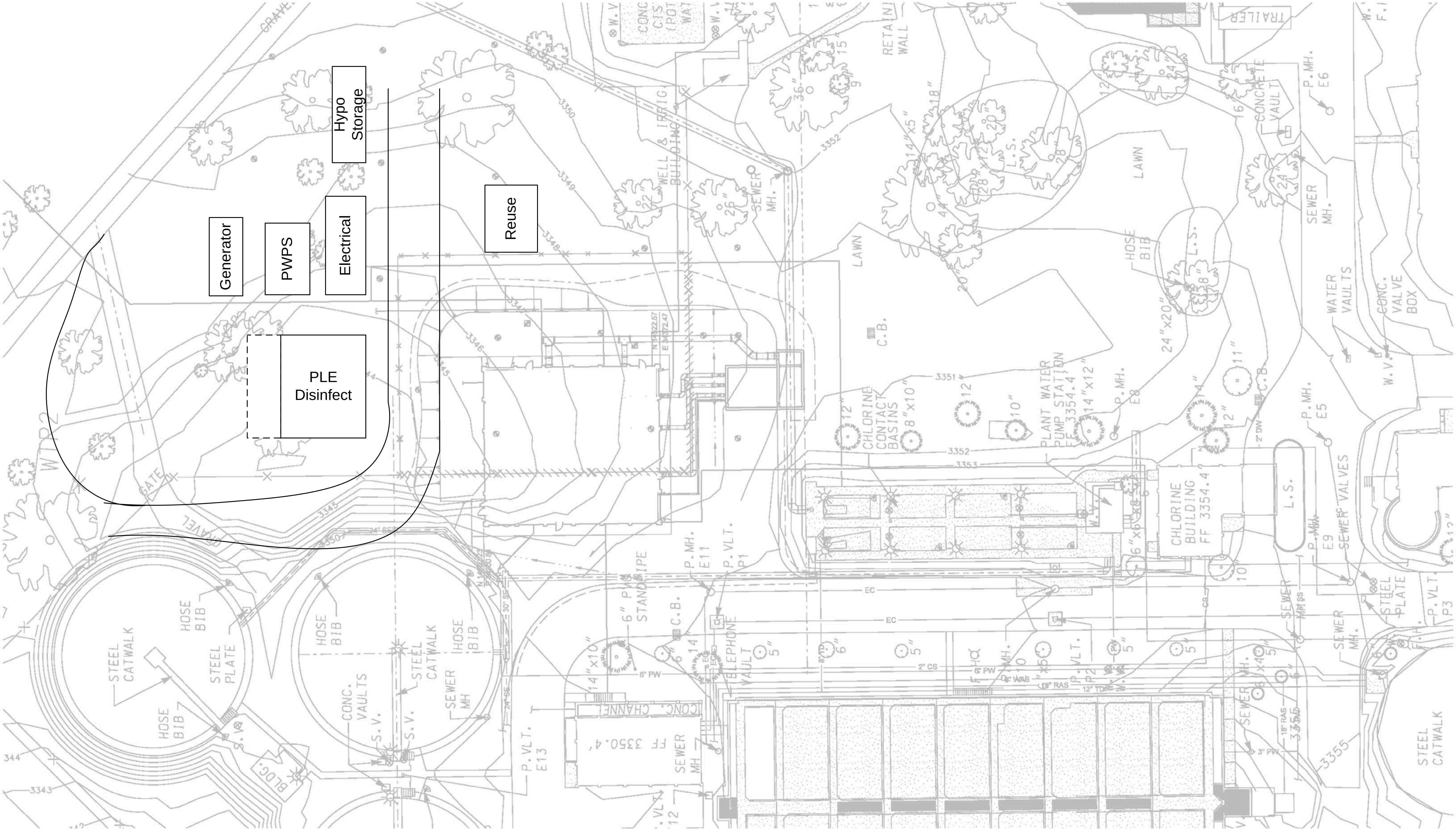


Alternative 2 – Mini-Bulk Storage



Alternative 3 – Bulk Storage

Appendix B— Site Plan for UV Disinfection for Plant Effluent



N

PARTIAL SITE PLAN
1"=20'

Onsite Hypochlorite Generation

ATTACHMENT C TO: TM 6—Plant Effluent Disinfection, Hypochlorite Facility, and Plant Water Pump Station

PROJECT: Schematic Design Report
Bend Water Reclamation Facility Secondary Expansion

Objective

Evaluate the differences of the present worth between onsite hypochlorite generation and the partial bulk delivery of commercial grade hypochlorite.

Background

The Project Definition Report described a chlorine contact basin for plant effluent and required a large hypochlorite storage facility. During Schematic Design, ultraviolet (UV) disinfection was again considered for disinfecting plant effluent, based on overall present worth costs. With a low pressure high output (LPHO) UV system for plant effluent, a smaller hypochlorite onsite generation and storage system would be required.

Hypochlorite is still required for the following uses:

- Reuse water (W3): chlorine residual
- Plant water (W4): chlorine residual
- Return activated sludge (RAS): biological control (gallons over a 2 day event)
- Offsite: drinking water point uses (gallons per year)

Onsite hypochlorite generation (OSHG) was considered during Project Definition, but was determined to be expensive compared to the alternatives. When the total chlorine demand was reduced, OSHG was reevaluated because the smaller demand may make the system more attractive. This fact sheet presents the economic evaluation between mini-bulk storage of commercial grade hypochlorite and hypochlorite onsite generation and storage.

Design Criteria

Table 1 shows the basic criteria for sizing the hypochlorite delivery and storage systems.

TABLE 1
Hypochlorite Onsite Generation Design Criteria at Design Condition
City of Bend Water Reclamation Facility

Criterion	Unit	MMF
Class A reuse flow	mgd	2.5
Reuse chlorine residual	mg/L as Cl_2	2
Plant water flow	mgd	1.5
Plant water Residual	mg/L as Cl_2	3
RAS chlorine usage	ppd	350
RAS event length	days	2
Offsite usage	pounds per year	913

Cl_2 = chlorine.
mgd = million gallons per day.
mg/L = milligrams per liter.
MMF = Maximum Month Flow.
ppd = pounds per day

Evaluation of Alternatives

Alternative 1—Mini-Bulk Storage Tanks

Operations

Mini-bulk storage is based on delivery of commercial grade sodium hypochlorite (12.5 percent as chlorine). The hypochlorite will be delivered by a tanker truck. It is assumed that two 3,000-gallon tanks will be used to offload 2,000 to 3,000 gallons at each delivery. A mini-bulk tank system requires limited handling of hypochlorite. The tanker truck will fill the storage tank where it can be metered to the final usage. Mini-bulk storage can be managed to minimize the hypochlorite age, but cost sensitivity may lead to slightly older hypochlorite.

Tanks will be kept under a cover to reduce heating. The tanks and piping will be insulated and heat traced to keep the sodium hypochlorite from freezing during extreme weather.

Cost

The mini-bulk storage facility has a moderate construction cost. Tanks can be provided through the hypochlorite vendor or through the construction contractor. Assuming that the construction contract will provide the tank, replacement of fiberglass tank is required every 8 years. Delivered hypochlorite is estimated to cost $2.00/gallon including shipping costs.

Facility costs are updated to match the Schematic Design cost estimate for the hypochlorite storage facility (mini-bulk storage tanks).

Advantages

- Minimum equipment to maintain.
- Smaller storage volume than onsite generation.

Disadvantages

- More costly hypochlorite.
- Some risk of hypochlorite degradation before usage.
- Additional exposure to high concentrations of oxidant.

Alternative 2—Onsite Hypo Generation

Operations

The onsite hypochlorite generation system produces a hypochlorite solution (0.08 percent as chlorine) from salt and electricity. Salt will be delivered to the site in 1-ton bulk sacks and loaded into a brine saturator. A water softener provides soft water to the saturator and generator.

The onsite hypochlorite generation system will require a 150 pounds per day (ppd) generator, a brine tank, a water softener and two 6,500-gallon tanks. Storage for hypochlorite is based on the volume required for 24-hour operation of the system during the reuse season including intermittent chlorination of RAS. The required storage is 12,800 gallons to allow for 1 day of disinfection and 2 days accumulation of RAS chlorination. The majority of the required installed storage is based on the RAS chlorination volume of 11,600 gallons.

When RAS chlorination is required, the system will be operated at 150 ppd approximately 6 days before expected RAS chlorination to allow for generation of sufficient volume for 2 days of hypochlorite application.

Offsite application of hypochlorite will also be served by the onsite generation system. The daily requirement is low and does not affect sizing or operation of the system.

Cost

Although a detailed construction estimate has not been completed, the onsite generation and storage facilities have higher construction costs than the mini-bulk storage facility. Salt for brine generation is estimated to cost $0.06 per pound including estimated shipping costs. Three pounds of salt are required to make a pound of chlorine. Approximately 2 kilowatt-hours (kWh) of electrical power will be required for each pound of chlorine. The onsite equipment is estimated to cost $190,000 (delivered) based on vendor price quotes.

Advantages

- Lower concentration of hypochlorite reduces safety hazards.
- Limited degradation of hypochlorite due to low concentration.
- Improved hypochlorite metering pump reliability (e.g., limited off-gas)

- Storage could be installed indoors (increases costs).
- Increased shelf life of salt reduces the delivery risk posed by winter weather.

Disadvantages

- Salt handling and manual unloading into brine tank for onsite generation system.
- Higher electrical operating costs than the delivered hypochlorite option.
- Larger building footprint to accommodate hypochlorite and electrical equipment.
- Hypochlorite required for RAS chlorination would have to be anticipated well in advance (6 days) in order to generate enough hypochlorite to address 2 days of demand.
- Offsite drinking water point uses could be impacted by the larger fluid volume of the low strength hypochlorite.

Chlorine Degradation

Delivered chlorine degrades at different rates depending on the batch and temperature. It is generally recommended to retain less than 15 days of storage during warm weather. Onsite generation is a low concentration hypochlorite solution with minimal degradation.

Present Worth Analysis

Table 2 provides the relevant project factors used in the present worth analysis. Table 3 summarizes the present worth analysis used to evaluate the hypochlorite storage alternatives.

TABLE 2
Present Worth Analysis Approach
City of Bend Water Reclamation Facility

Factors	Unit	Value
Power cost	$/kWh	$0.041
Labor cost	$/hour	50
Inflation	Annual %	Not used
Discount rate	Annual %	1%
Time length	Years	20

kWh = kilowatt-hour.

TABLE 3
Present Worth Analysis—Hypochlorite Storage
City of Bend Water Reclamation Facility

	Alternative 1 Mini-Bulk Storage Tanks	**Alternative 2 Onsite Hypochlorite Generation**
Capital cost (generation system storage only)	$641,000	$1,357,000
Present worth of O&M	$1,000,000	$513,000
Total net present worth	$1,641,000	$1,870,000

Notes:

Cost for generation calculated using 3 lb salt/lb Cl_2 and 2 kWh/lb Cl_2.

Recommendations

The present worth analysis indicates similar costs for the two alternatives. The analysis indicates that mini-bulk storage is the least cost alternative.

Appendixes

Appendix A—Vendor Catalog Cuts

- ClorTec Onsite Hypochlorite Generation System
- Process Solutions, Inc. Onsite Hypochlorite Generation System
- Wallace and Tiernan Onsite Hypochlorite Generation System

Appendix A—Vendor Catalog Cuts

SEVERN TRENT SERVICES

Disinfection Products

ClorTec™

Skid Mounted On-Site Sodium Hypochlorite Generation Systems

Midsize systems for 75 to 300 lb/day (34 to 136 kg/day)

Severn Trent Services offers the ClorTec™ On-site Hypochlorite Generating Systems, that easily produce 0.8% sodium hypochlorite by combining three common consumables: salt, water and electricity, to provide a powerful disinfection method for any application; food and beverage, potable water, wastewater, odor and corrosion control, cooling towers, oxidation and swimming pool disinfection.

The ClorTec systems are skid mounted and consist of electrolytic cell(s), power supply/rectifier, control panel/PLC, water softener, brine proportioning pump, hydrogen dilution blower and an optional water chiller/heater, all in one compact unit design conducive to easy installation and start-up. The simple-to-install skid-mounted systems can be fully operational and generating hypochlorite in less than 24 hours.

Features:

- **Compact, skid-mounted system**
- **Hypochlorite produced on-site, on demand**
- **Superior Warranty**
- **NSF 61, ETV certification**
- **Eliminates need to store hazardous chemicals onsite**
- **Eliminates handling and transportation of hazardous materials**

NSF REGISTERED ETV

Benefits:

- **Eliminates dependence on chemical suppliers**
- **Easy to install and operate**
- **Reduced disinfection by-product formation**
- **Improved water quality**
- **On-demand sodium hypochlorite production**
- **Reduced maintenance**
- **Exempt from Process Safety Management**
- **Exempt from Risk Management Planning**

Severn Trent Services
2660 Columbia Street
Torrance, CA 90503
Tel 310 618 9700
Toll Free 800 524 6542
Fax 310 618 1384
info@severntrentservices.com
www.severntrentservices.com

SYSTEM SPECIFICATIONS

Capacities: 75-300 lb/day (34-136 kg/day). Free available chlorine.

Control: Automatic batch, regulated by storage tank status.

Hypochlorite: 0.8% ± 0.05%.

Raw Materials: Per pound of chlorine produced 3 lbs. salt, 2 kwh (DC), 15 gal. (57 L) water.

Water Supply: Potable water @20-50 psi (1.4-3.5 bar) temperature range 65°F-80°F (18°C-27°C).

Salt Quality: 99.7% pure dry weight Morton White Crystal or equivalent.

Electrical Power: 480 VAC 3 Ø, 60 Hz to rectifier, 240 VAC 1 Ø phase 60 Hz to controls. (Other voltages available as an otion)

Control Panel: Grey polyester coated NEMA 12 welded steel enclosure.

Operator Interface:
Standard: LCD touchscreen

Optional: Color LCD touchscreen industrial computer with data logging and communications capability.

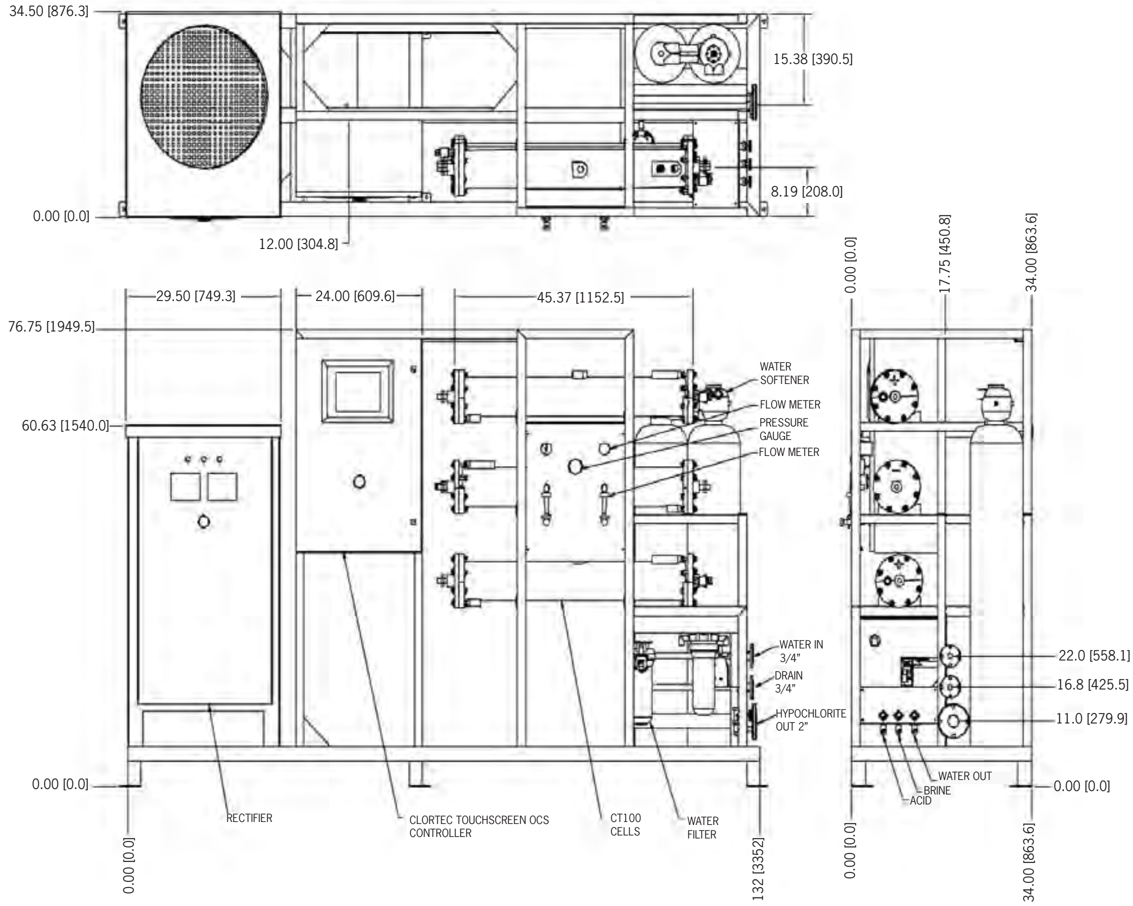
Programmable Logic Controller: Expandable from 8 to 32 discrete I/O channels, 4 to 16 analog inputs and 2 to 8 analog outputs.
Full custom integration available.

Salt Dissolver: HDPE or FRP tank to store minimum of 1 weeks salt supply. (lb/day x 3 x 7 days min).

SODIUM HYPOCHLORITE TANK

Material: HDXLPE or equivalent
Size: Two days storage recommended (lb/day x 15 gal x 2)

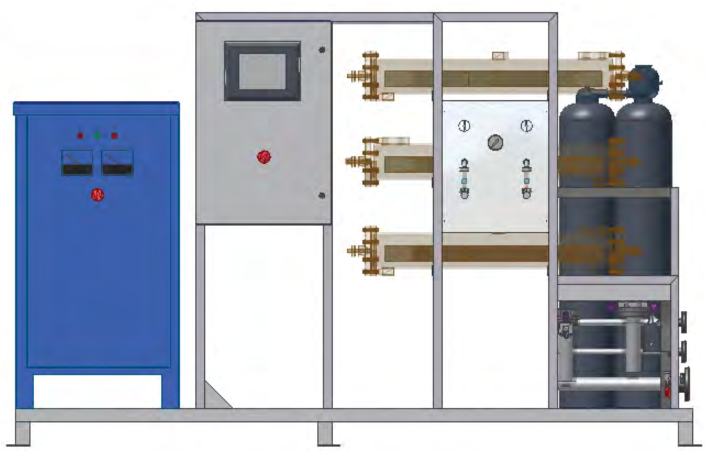
Level Control: Ultrasonic or Mechanical level sensor in tank controls start/stop function of system.



Hydrogen Vent: Waste hydrogen is vented to atmosphere by an active air dilution blower system.

Optional Water Chiller: Air cooled design. Classified by Underwriters Laboratories in accordance with ANSI/NSF 61, 1997b.

Optional Water Heater: UL® and CSA recognized and listed unitized assembly.



Model	Cell Configuration	Output		Flow		Water		Salt		Power DC/kWh/day	AC Amp 480 V 3 Ø Draw	Circuit Capacity
		lb/day	kg/day	gal/hr	L/hr	gal/day	L/day	lb/day	kg/day			
CT-75	1 x 75	75	34	47	177	1,125	4,258	225	102	150	15	20
CT-100	1 x 100	100	45	63	237	1,500	5,676	300	136	200	20	30
CT-150	2 x 75	150	68	94	355	2,250	8,516	450	204	300	30	40
CT-200	2 x 100	200	91	125	473	3,000	11,355	600	272	400	40	60
CT-225	3 x 75	225	102	141	532	3,375	12,774	675	306	450	45	70
CT-300	3 x 100	300	136	188	710	4,500	17,033	900	408	600	60	90

* Ready for use containerized packages available.

Use of the ETV Name or Logo does not imply approval or certification of this product nor does it make any explicit or implied warrantees or guarantees as to product performance.

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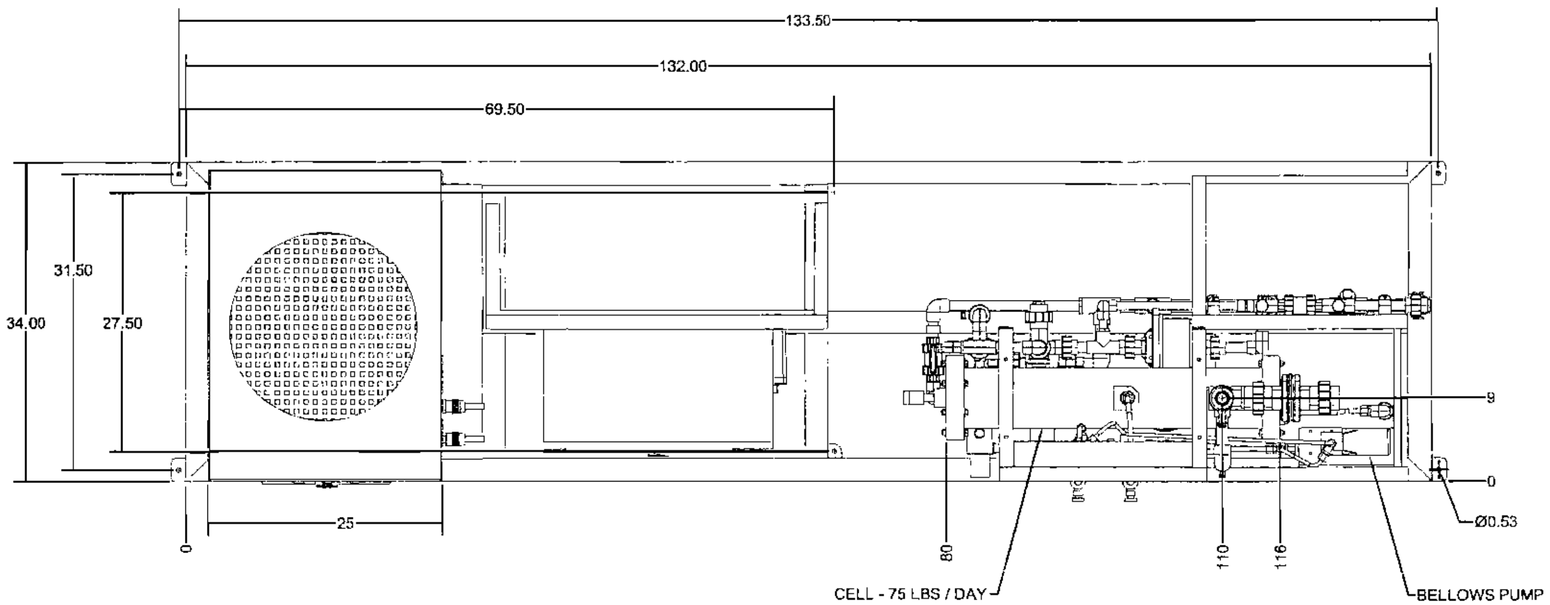
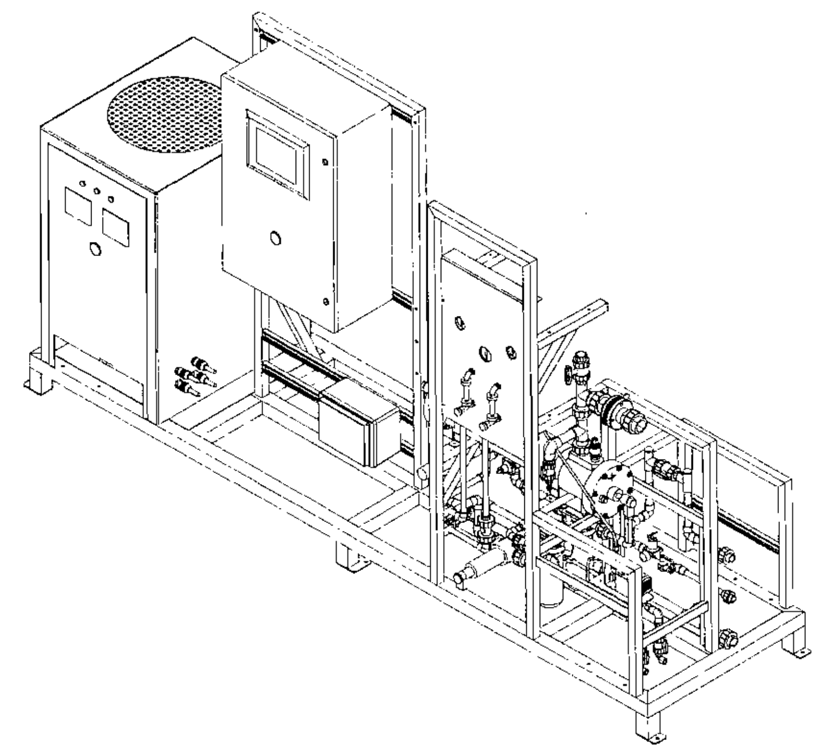
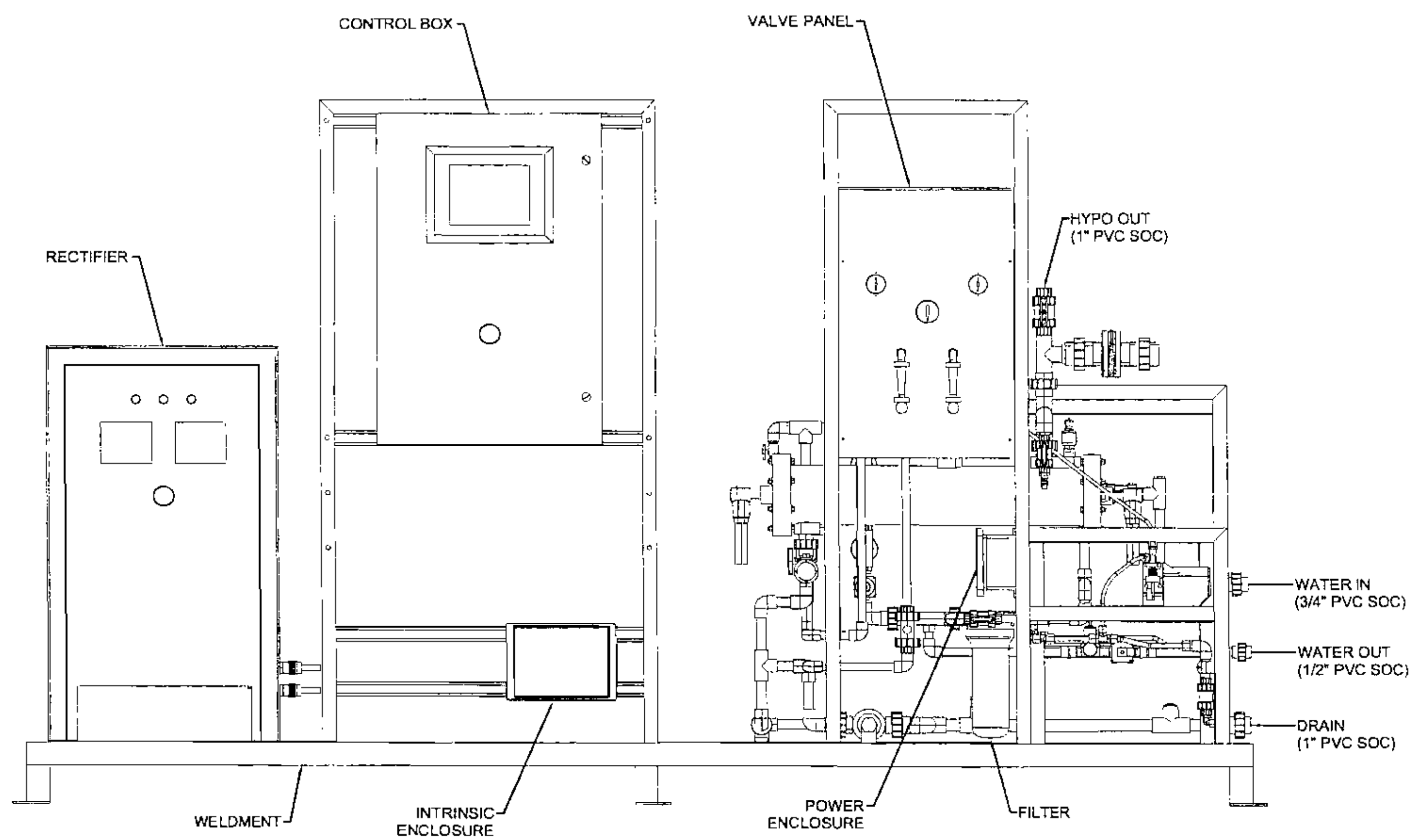
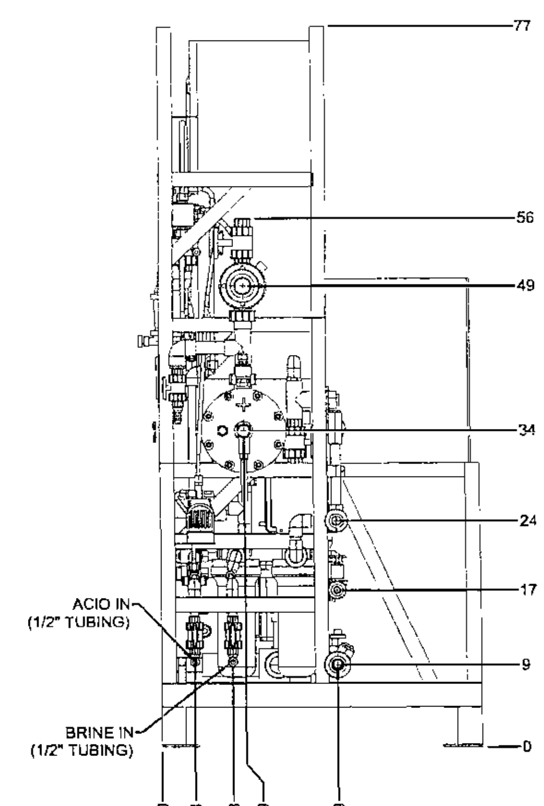
REV	DATE	DESCRIPTION	DRAWN BY	CHECKED BY	APPROVED BY
01	1.13.06	ISSUED FOR APPROVAL	BCW	JPM	JPM









Parts List

ITEM	QTY	DESCRIPTION	VENDOR
1	1	PANEL.VALVE,SS,CT75 -CT300	CLORTEC
2	2	BRACKET,FILTER ASSY	CLORTEC
3	1	BRACKET,BELLOWS PUMP	CLORTEC
4	2	SADDLE,CELL 100	EXCELTEC #CT3-0356
5	1	SOLENOID VALVE,1/2"	BC VALVE #2106X-402CN-A210-DC
6	1	SOLENOID VALVE,3/4"	BC VALVE #2108X-482CN-A210-DC
7	2	FLOWMETER,0.1-1 GPM	BLUEWHITE #F-44375LKEA-8
8	1	SWITCH,FLOW,150PSI,1"	DWYER # FLOTEC V6
9	1	VALVE,BALL,TU,MTM,1",PVC,SCH 80	G. FISCHER #800.016.011
10	2	FLOW SENSOR,PP,1/2",0-10VDC,0.1-1	GEMS #170290
11	1	PUMP,BELLOWS,45 rpm 115 v	GRI #16001-002 H8 F9 T7
12	1	GAUGE,PRESS,SS,0-60,2 1/2,1/4 NPT,LBM	JENSEN INSTR #P552L-153104
13	1	RUPTURE DISK,1 1/2",35 PSI	OSECO
14	1	VALVE,PRESSURE RELIEF,1"	PLAST-O-MATIC #RVDT100V-PV
15	1	SWITCH,PRESSURE,1/2"	PLAST-O-MATIC #SWT050T-3A-PV
16	2	GASKET,RUPTURE DISK.1 1/2"	RYAN HERCO #3867-005
17	2	HOUSING,FILTER,CLR,3/4" NPT,10" LG	PENTAIR #150436
18	1	VALVE,LABCOCK,1/4",KIT,PVC	SPEARS #1539-002
19	3	VALVE,CHECK,1/2",PVC,SCH 80	SPEARS #2239-005
20	4	VALVE,BALL,TU,1/2",PVC,SCH 80	SPEARS #3639-005
21	3	VALVE,BALL,TU,3/4",PVC,SCH 80	SPEARS #3639-007
22	1	VALVE,BALL,TU,1",PVC,SCH 80	SPEARS #3639-010
23	1	VALVE,PRESSURE REGULATOR,3/4"	WATTS # N35BU
24	1	REGULATOR,PRESSURE,1/2"	WATTS #263AB
25	1	GAUGE,PRESS,SS,0-160,1 5/8,1/4 NPT,BM	WIKA #4233395

SEVERN TRENT SERVICES **CLORTEC**

DO NOT SCALE DRAWING

CT75 (75LBS/DAY) ON SITE HYPOCHLORITE GENERATOR
SKID ASSY,132"Wx34"Dx77"H

bworsley 1/13/2006

CTSA-75-01 01

SHEET 1 OF 1

N:\PROJECT-Pre Released\SKID-CT0075 WASHOE (CPG0405)\CTSA 075-01.iam

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1/20/05

ClorTec®
CASE STUDY

"Exactly as Advertised": On-site System Increases Safety, Reduces Costs

Sodium hypochlorite disinfection

The City of Gastonia, N.C., water treatment plant was constructed in 1922 near what is now the center of the city. Gastonia, a city of 70,000 residents, is located 20 miles west of Charlotte in the state's southern Piedmont region. Its 25.2-mgd water treatment facility uses a traditional disinfection / coagulation / flocculation / sedimentation / filtration process to treat surface water drawn from Mountain Island Lake. The man-made lake is fed by the Catawba River and is the primary source of drinking water for residents of Gaston County.

Using gaseous chlorine for disinfection at the water treatment facility, the City had developed an efficient evacuation plan in the event of a large scale gas leak as required by its USEPA risk management plan. However, in the 1990s a three-story courthouse, a jail and a social services building were built near the plant, with the jail and courthouse adjacent to the chlorine storage building. With an evacuation plan now affecting thousands of residents — including inmates — rather than just hundreds, the City knew it was time to either move the plant or change disinfection methods.

For more information on ClorTec® on-site sodium hypochlorite generation systems
visit **www.severntrentservices.com**

UNDERSTANDING
A VALUABLE RESOURCE

SEVERN
TRENT
SERVICES

WE UNDERSTAND SODIUM HYPOCHLORITE GENERATION

Considering the switch from gaseous chlorine

Even before the construction of the courthouse, jail and social services building, the City's public works and utilities department had been considering a switch to an alternative means of disinfection. And when the 9/11 terrorist attacks took place in 2001, increasing awareness of the potential hazard of transportation and storage of high-pressure chlorine cylinders, the City redoubled its efforts to secure funding for the disinfection switch over. With funding finally assured in 2007, the City began investigating two alternatives: bulk sodium hypochlorite and on-site sodium hypochlorite generation.

"Under the direction of our design engineer, CDM (Charlotte), we performed a fairly sophisticated analysis using different price points for the cost of bulk sodium hypochlorite," said Ed Cross, division manager, water supply and treatment for the City of Gastonia. "At the time of the analysis, the cost of bulk was relatively low — but now costs have risen again. The operational considerations were significant, too. With on-site generation, a shipment of salt would be delivered every six weeks affording uninterrupted service in between. However, with bulk, shipments would be received every few days. The frequency of shipments would have required a lot of extra labor to coordinate and physically handle the incoming material."

An additional benefit of on-site generation over the use of bulk sodium hypochlorite is that because the unit produces sodium hypochlorite on demand, the technology alleviates the problem of chlorate by-product generation that typically results from the storage of bulk material.

After analyzing the two disinfection methods, Laurin Kennedy PE, CDM's principal design engineer on the project, recommended the selection of the ClorTec® on-site sodium hypochlorite generating system from Severn Trent Services. Two 750-lb generating units were installed in January 2010 along with four 12,500-gallon storage tanks. The equipment was provided by Premier Water in Charlotte. Max Foster, the company's sales representative who worked with the City, also provided timely technical information and support.

The ClorTec technology came highly recommended by another local water utility. The City of Hickory, N.C., had installed the state's first ClorTec system in 2003, and the system has provided ongoing operational efficiencies with low, predictable maintenance, increased safety and demonstrable cost savings. "When we checked with other water utilities using various on-site systems, the ClorTec system had the best reputation and history of long-term performance," Cross said.

Advantages of on-site generation

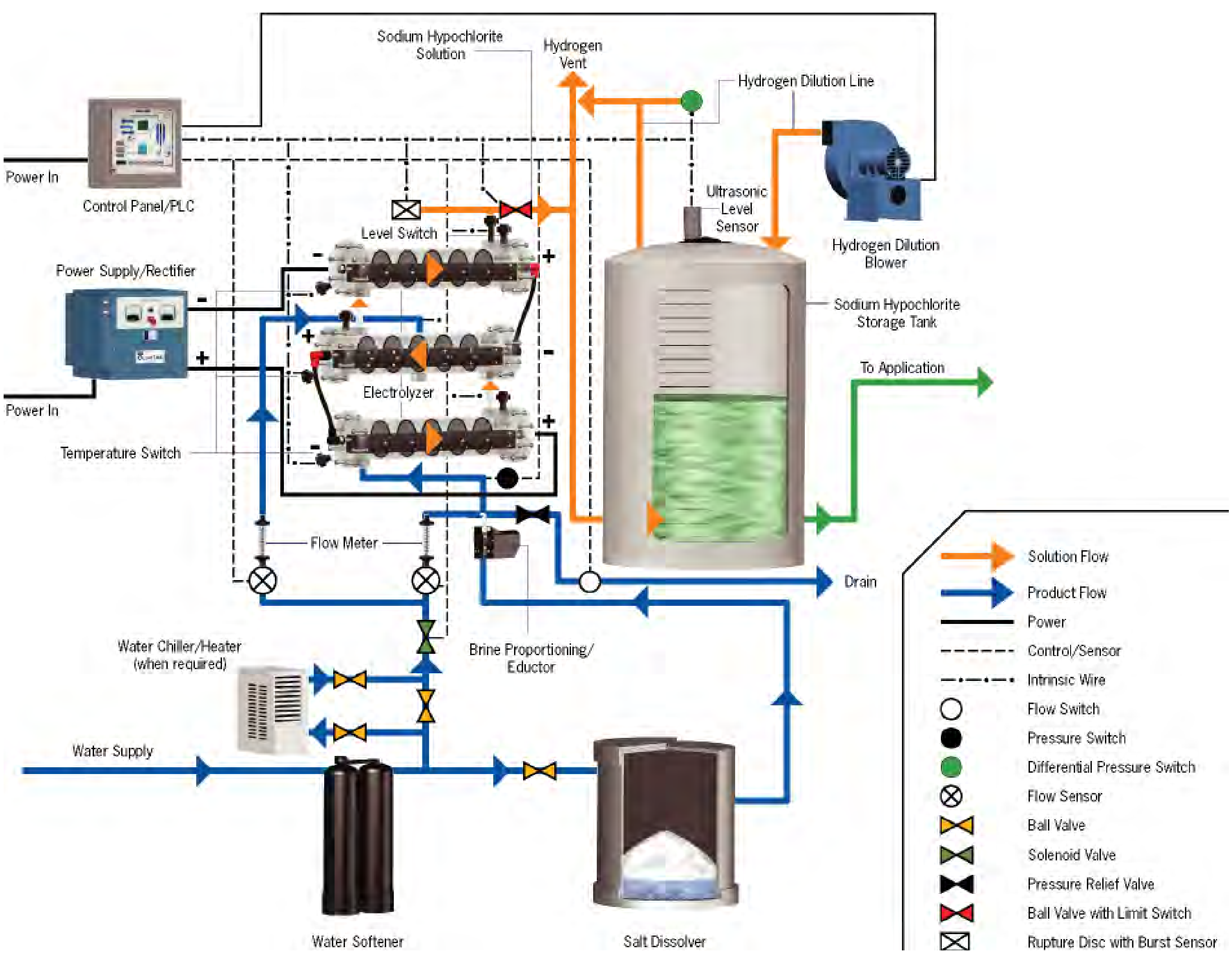
The use of on-site sodium hypochlorite generation offers several advantages over gaseous chlorine for disinfection. The disinfectant is produced and stored in liquid form. Therefore, there is no danger of leaks from chlorine gas cylinders. It is also not necessary for facilities using on-site sodium hypochlorite generating systems to develop and maintain a risk management plan. HAZMAT training is not required for handling the disinfectant; nor is there any need for the use of self-contained breathing apparatuses. In addition, on-site sodium hypochlorite disinfection systems do not suppress finished water pH to the extent that gaseous chlorine disinfection does. Therefore, the amount of pH adjustment chemical (i.e., lime or caustic) necessary before distribution of finished water is reduced.

The on-site generation process is simple, as three common consumables are used in sodium hypochlorite generation: salt, water and electricity. The system operates by feeding softened water into a brine dissolver. The salt dissolves to form a brine solution, which is further diluted to the desired salt solution and then passed through electrolytic cells. The cells apply a low-voltage DC current to the brine to produce the sodium hypochlorite. The solution is then safely stored in two of the 12,500-gal storage tanks. When it reaches the low-level set point, the system automatically restarts to replenish its supply. The 0.8 percent sodium hypochlorite solution is non-hazardous; the only by-product is hydrogen gas, which is safely vented to the atmosphere.

Safety of on-site generation

"From the beginning, safety was the driving force behind eliminating the use of gaseous chlorine at our facility" said Cross. "When the chlorine gas cylinders were being hauled away, we were jumping for joy. Choosing on-site generation for our disinfection needs was in line with our safety requirements and the switch provided us with cost savings, too. When we applied for deregistration from our risk management plan and no longer had to perform HAZMAT training, we realized how significant the savings were. We haven't completed a full cost analysis yet, but we are certain the ClorTec system is providing long-term savings. We have also been impressed with the intuitiveness of the system's software package too. When there is an operational issue, the system tells you what's wrong, and our staff has been able to handle every maintenance issue. The system has performed exactly as advertised, and that's a testament to the technology and to the Severn Trent Services sales and technical team."

ClorTec® PROCESS DIAGRAM



MICROCLOR
The Next Generation

It is well known that chlorine is a powerful disinfectant used in water treatment and plays a vital role in controlling bacteria and viruses that can cause human illness.

More stringent regulations for transportation and storage of bulk chlorine or pressurized chlorine gas have required many to search for alternative methods of disinfection.

Onsite generation of sodium hypochlorite alleviates the safety concerns associated with storing and using bulk sodium hypochlorite or chlorine gas.

300 PPD

Systems Capable of 20 to 3600 Pounds per Day Chlorine Equivalent

The MicrOclor vertical cell array (V-Ray) allows for the instantaneous passive removal of all hydrogen produced.

Making Bleach Made Easy

- Low Cost Hypochlorite
- Enhanced Performance
- Small Footprint
- 24 Hour Service
- Safe
- Vertical V-Ray Cell Design
- Immediate Hydrogen Removal
- Reduce Scaling
- Low Maintenance

psi process solutions, inc.

NSF

PSI's MicrOclor Onsite Hypochlorite Generator is certified by NSF to NSF/ANSI Standard 61

40 PPD

MICROCLOR

The state of the art patent pending MicrOclor onsite hypochlorite generation system is a brand new design built upon twenty years of dedicated research and development in the field of onsite hypochlorite generation.

The design incorporates all of the advantages of current industry standards while radically improving all safety aspects of the process. Specifically, the manner in which hydrogen is removed from the electrolytic cell is a huge improvement over more conventional horizontal tubular designs.

The MICROCLOR onsite hypochlorite generation system incorporates a multitude of unique features that are now patent pending. The most significant features are as follows:

1. Passive hydrogen removal.
2. Brine conductivity control.
3. Full wave D.C. rectification.
4. No cell electrode penetrations.
5. High velocity electrolyte flow.
6. Higher performance level.
7. Recirculating cell loop.
8. No internal cell baffles or gasketing.

There is no other onsite hypochlorite system in the marketplace today that possesses even one of the above advantages, no less all eight.

A brief discussion of each feature follows:

Passive Hydrogen Removal

The V-Ray cells are configured in a vertical format with a recirculation loop on each cell that allows for optimized brine utilization and passive release of the hydrogen gas from each cell. Hydrogen gas is not allowed to pass from cell to cell. This design radically increases operator safety and substantially reduces the possibility of hydrogen gas build-up in the cell and the potential of catastrophic failure. Immediate hydrogen removal at the top of each cell loop greatly reduces electrode blinding and associated heat buildup.

Brine Conductivity Control

Constant current is achieved via a current feedback loop where the brine pump speed is controlled by the system programmable logic controller. This feedback loop accounts for variations in temperature, conductivity and water flow. The titanium, Teflon impregnated gear pump is attached to a variable speed drive that continually provides a consistent blended electrolyte flow to the cells maximizing salt efficiency.

Full Wave D.C. Rectification

The DC Rectifier design consists of a fully isolated step-down transformer and bridge rectifier. DC voltage is fixed with primary taps for + 5, 10% voltage correction. DC ripple is less than 4.0% with a power factor of 99% or better. Switching rectifier or phase angle fired SCR voltage correction technology is not utilized as this twenty year old technology has an excessively high failure rate.

No Cell Electrode Penetrations

The V-Ray cells consist of thirteen internal bipolar electrodes while the cell outer plates serve as both terminating anode and cathode. All anodic surfaces are coated with DSA catalytic coating. The design of the cell precludes the need for wet D.C. cable connections or problematic O-ring seals.

High Velocity Electrolyte Flow

The passive hydrogen gas removal provides a hydraulic lift within the V-Ray cell loop which causes a high velocity flow through the recirculation loop and across the V-Ray cell plates. This high velocity flow results in a scouring action between the vertically mounted V-Ray cell plates. This novel self cleaning feature virtually eliminates the need for acid cleaning of the electrolytic cells and reduces heat build up.

Higher Performance Level

PSI's proprietary patent pending vertical V-Ray cell design provides for a far more efficient generation platform than the industry standard of 3.5 pounds salt and 2.5 KWH per pound chlorine equivalent.

The MICROCLOR vertical V-Ray cell produces hypochlorite at 0.8% while consuming less than 3 pounds of salt and 2.0 AC KWH per pound of equivalent chlorine.

There is no competitive open cell process available which is more efficient than the MICROCLOR System.

PSI welcomes a side by side comparison with any manufacturer claiming higher performance levels than MICROCLOR.

No Internal Cell Baffles or Gasketing

There are no internal cell baffles, gaskets or fasteners found inside the cell. The cells are built with clear acrylic guides that support the internal bi-polar plates that allows for direct visual inspection of the plates. Anode and Cathode mono-polar plates are surface mounted to the outside of the acrylic guides.

V-Ray Cell maintenance and replacement

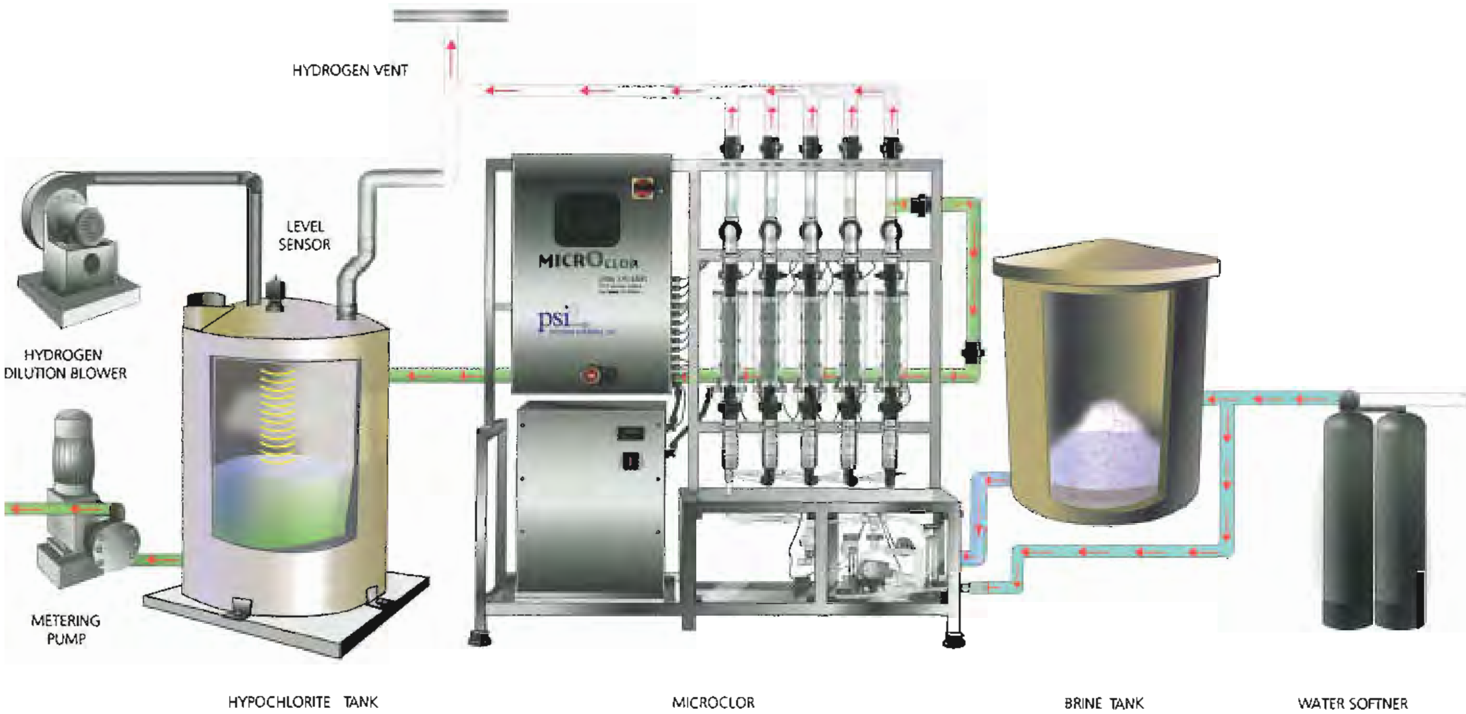
The MicrOclor vertical V-Ray cell design allows for the cell to easily be removed from the cell carrier piping by simply breaking two unions. This makes for simple cell maintenance and or replacement.

The MicrOclor design has taken into account every imaginable failure scenario including direct operator error in the handling of the process equipment.

Sequential operations logic is provided for all process variables where the change from standby to process is confirmed for all sensor locations at each start sequence. This auto diagnostic routine locks out generation in the event of sensor failure or electrical bypass.

MicrOclor hypochlorite systems meet requirements for 20 to 3600 pounds per day chlorine equivalent.

The Next Generation Onsite Hypochlorite Generator



The MicrOclor is modular in design and based on standard components. These components may be customized to meet a wide range of requirements.

Standard components for the MicrOclor system include:
Stainless Steel Skid Assembly
Water Softener
Brine Tank
Brine Pump
Electrolytic Cells
Skid mounted PLC Control Panel
D.C. Rectifier
Hypochlorite Storage Tank
Hypochlorite Metering Pump
Hydrogen Dilution Blower

Model/Capacity	Cell Size W X H	# of Cells	H20 GPM	Brine GPM	DC Amps	KVA	FLA 208/240 1PH	FLA 480 3 PH
20	2 x 12	1	0.2	0.02	40	2.4	11.5/11	-
40	2 x 12	2	0.4	0.03	80	4.8	23/22	-
60	2 x 12	3	0.6	0.05	120	7.2	35/33.5	-
80	2 x 12	4	0.8	0.07	160	9.6	46/44	13
100	2 x 12	5	1	0.08	40	12	-	16
200	4 x 12	5	2	0.17	80	24	-	32
300	6 x 12	5	3	0.25	120	36	-	48
600	12 x 12	5	6	0.50	240	72	-	96
900	18 x 12	5	9	0.75	320	96	-	128
1200	24 x 12	5	12	1.00	480	144	-	192
1800	24 x 18	5	18	1.50	720	216	-	288

Note: Typical Nominal Operating Amperage is 75% of Full Load Amperage

Capacities: 20-3600 pounds per day free available chlorine.
Control: Automatic, regulated by storage tank level.
Percentage Sodium Hypochlorite: 0.8 + 0.05
Consumables per pound of chlorine produced:
3lbs salt, 2KWH (AC), 15 gallons water.
Water Input: Potable water, 30-80 PSI, 40°F-80°F (5°C-27°C)
Salt: 99.7% pure dry weight Morton White Crystal or equivalent.

Power: 20-80ppd systems - 208V or 240V AC, 1PH, 60HZ
80-1800ppd systems- 480V, 3PH, 60HZ
Control Cabinet: 304 stainless steel NEMA 4X
Operator Interface: 6" Color Touchscreen
Programmable Logic Controller: Allen Bradley 1200
Brine Tank & Hypochlorite Storage Tank shall be appropriately sized for each application.

MICROCLOR
The Next Generation

Comprehensive Warranty
It is our policy to provide every customer with a state of the art, fully tested system. Each MicrOclor Hypochlorite Generation System carries a full three-year support agreement covering all parts and labor. In addition, the electrolytic cells and cell housings are warranted on a prorated basis for years 4-7.

Service & Support
PSI prides itself on our service and technical support. We offer complete support for your MicrOclor Hypochlorite Generation System including all peripheral components. 24-7 phone support and next day parts are available for your MICROCLOR System. PSI guarantees next day field service, 7 days a week, with technicians located in all major markets plus an extensive factory trained representative network. If you need assistance, we're here to help.

1200 PPD

Represented by:

psi process solutions, inc.

WATER AND WASTEWATER TREATMENT TECHNOLOGIES

1077 Dell Avenue, Suite A, Campbell, CA 95008
Toll Free: (888) 774 4536 (PSI Help)
Telephone: (408) 370-6540 Fax: (408) 866-4660
Email: mail@4psi.net www.4psi.net
with offices in Clearwater, FL, Mesa, AZ, and Temecula, CA.

Wallace & Tiernan® On-Site Hypochlorite Generation System OSEC® B1-200 System

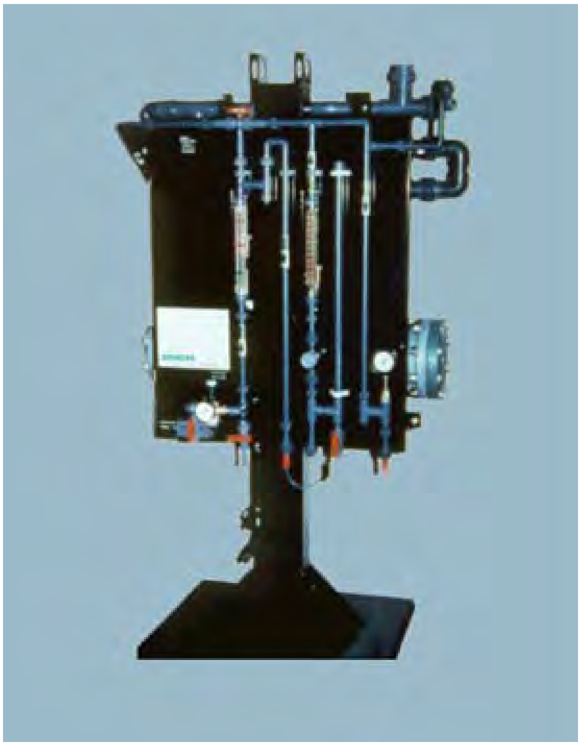
OSEC® Systems provide for on-site, on-demand production of sodium hypochlorite solution from salt, water, and electricity. This eliminates dependence on commercial chlorine suppliers and the problems inherent in the transport and handling of bulk hypochlorite. Additionally, OSEC® Systems can significantly lower operating costs, as well as disinfection by-products compared to the use of bulk hypochlorite. Operation is completely automatic, making the B1-200 system ideally suited for remote or unmanned locations.

System Components

The B1-200 OSEC® System can produce up to 113 kgs (250 lbs) per day of equivalent chlorine. The system includes all of the components to automatically generate sodium hypochlorite. This includes a salt saturator, water softener (if required), electrolyzer, transformer/rectifier, product storage tank and system control panel. To complete the disinfection process, Siemens Water Technologies offers a complete line of chemical metering pumps and packages to deliver the sodium hypochlorite to the point of application. Continuous, on-line residual analyzers for both free and total chlorine are available to measure chlorine levels in the treated water and compound-loop controllers to maintain the desired disinfectant level regardless of flow or water quality changes.

Key Benefits

- Economical, reliable, low maintenance operation
- Automatic, on demand production of sodium hypochlorite
- Major components mounted and pre-piped on a common pedestal
- Flexible installation configurations
- Positive Hydrogen gas dilution and removal



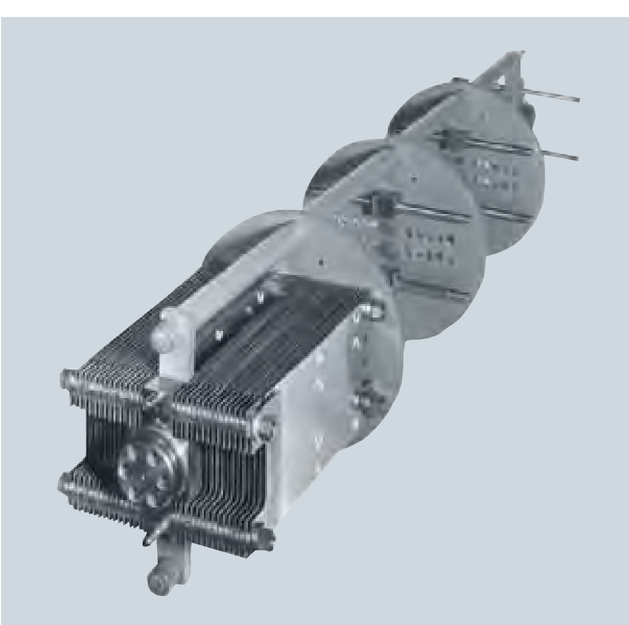
Product Sheet

Generator

The key component in any on-site electrochlorination system is the electrolyzer. This is where the salt or brine solution, water and power are combined to produce sodium hypochlorite. This critical function requires the latest anode technology and electrolyzer design to achieve consistent, reliable operation with efficient use of power and salt. As specialists in anode technology, Siemens Water Technologies maintains a complete "in-house" R & D facility for custom anode design, testing and evaluation of the optimum performance requirements for any application. In addition, a complete anode fabrication plant produces the OSEC® anodes in every configuration and size. Combined with the cell manufacturing and assembly expertise, Siemens offers complete system responsibility without the need to rely on sub-vendors for critical components.

The B1-200 OSEC® System consists of a single tubular electrolyzer casing, mounted on a sturdy, freestanding pedestal. This casing houses a titanium chassis to which the anodes and cathodes are fixed in a configuration that ensures maximum operational efficiency by providing simple, single-pass flow operation. The anodes are DSA-type and manufactured from a titanium substrate with a precious metal oxide coating. The cathodes are fitted with PVDF spacers that maintain a critical, uniform distance from the anode. The electrolyzer contains four cells electrically connected in series, containing sufficient anodes and cathodes to produce the desired quantity of chlorine 97 or 113 kgs/day (215 or 250 lbs/day.)

The internal electrolyzer design and vertical orientation of the anode and cathode plates provide for the quick removal of hydrogen from the inter electrode gap to ensure maximum efficiency. The partition discs have gas ports that pass the hydrogen through the compartments. Baffling effectively eliminates mixing between cells, thereby reducing competing electrochemical reactions. This design provides an efficient release of hydrogen, which results in electrical power and salt savings.



OSEC® Systems include a number of design features, which optimize operating efficiency, including:

Heat Exchanger

Reaction efficiency is greatly affected by the operating water temperature. Systems operating with incoming water temperatures below 7.2°C (45° F) often require electrically powered pre-heaters to elevate the water temperature to optimal conditions. OSEC® generators are offered with a heat exchanger, which is integrally mounted to the generator assembly. The optional heat exchanger uses the hypochlorite solution exiting the generator, which has been elevated in temperature due to the heat of reaction of the generation process, to heat the incoming cold water. When conditions dictate, the heat exchanger can be valved in service to allow the cold water to be heated in a counter-flow exchange manner with the warmer outlet solution. The use of the heat exchanger in typical installations results in a 2.8°C (5° F) increase in incoming water temperature, without any electric power consumption. With the piping manifold supplied, the heat exchanger can be bypassed during warm-season operation.

Split Flow Regime

OSEC® B-Series Generators employ a split-flow arrangement to further optimize overall process efficiency. The incoming dilution water is split into two streams before entering the electrolyzer. This provides a favorable brine concentration and enhanced operating temperature in the first cells allowing it to operate more efficiently. The rest of the cool dilution water is added to the downstream cells, which serve to maintain the operating temperature within the most efficient range, and achieves the final product concentration.

To maintain proper conditions for safe and efficient operation, OSEC® generators include sensors for brine flow, water flow, and electrolyzer level and inlet and outlet temperatures.

Control Panel

For supervision and monitoring of the safe generation of sodium hypochlorite, the entire OSEC® System is automatically operated by a central PLC-based control panel. The control panel includes an HMI (Human/Machine Interface) with an LCD screen to allow for immediate visual indication of complete system status and parameters. Status indications include rectifier on, water supply on, blower running, brine pump on, electrolyte inlet and hypochlorite outlet temperature, and storage tank level. There is a comprehensive list of alarms including storage tank overflow, high electrolyte temperature, improper voltage, and low brine flow. Any alarm condition that affects the consistent production of sodium hypochlorite shuts the system down. A last-200-event logger tracks all operating conditions and maintains a record for troubleshooting.

Transformer / Rectifier

Power for the electrolysis of brine is provided by a solid-state controlled, force-air-cooled transformer/rectifier. This unit takes the incoming AC power and converts it to the 32-volt DC power required for the electrolysis process. The rectifier is self-monitoring for cell voltage, thermal overload and internal faults. An alarm contact interfaces with the OSEC® System control panel to maintain proper system operation.

Product Tank

The freshly produced sodium hypochlorite solution is stored in a totally enclosed FRP tank. Storage is generally provided for 24 hours of operation, although this can be increased or decreased depending on site conditions. Level probes or transducers in the tank provide start/stop control of the OSEC® System to maintain a continuous supply of hypochlorite. A primary air dilution blower and a complete redundant standby blower is provided to force ventilate the product storage tank to reduce the concentration of hydrogen gas in the tank and the gas discharged from the system vent to 25% of the LEL, which is 1% in air. A differential pressure switch monitors the operation of the blower. If a decrease in air flow is detected, the standby blower is activated. Unless airflow is maintained, the OSEC® System is shutdown to prevent the accumulation of hydrogen above the LEL.

Salt Saturator

The salt saturator creates the brine solution that feeds the OSEC® electrolyzer. The saturated brine tank is constructed from FRP and features an automatic level control system to maintain a constant liquid brine level. The brine solution is made by passing the make-up water through the salt bed forming a saturated brine solution, which is then fed by a brine dosing pump to the electrolyzer. The saturator is typically sized for 30 or more days production to ensure sufficient salt quantity to provide production continuity and economical refill cycles.

Softener

The make-up water used for the salt saturator and the feed water used for the dilution of the brine must have less than 17 mg/l of calcium hardness, otherwise operating efficiency and maintenance-free operation will be compromised. For water supplies exceeding this hardness limit, a water softener is required. The softener is a twin tank design with automatic changeover for regeneration. One tank is in service while the other is regenerating or in standby-mode to assure a continuous, uninterrupted supply of softened water.

Anode Warranty

The anodes are warranted for seven years (two full years and five years prorated). This warranty is based on installation and start-up provided that the correct operating conditions of the OSEC® System are maintained.

Technical Specifications

Capacity: Two sizes available:
97 kgs/day (215 lbs/day) of chlorine equivalent
113 kg/day (250 lbs/day) of chlorine equivalent

Housing: Single 152.4 mm (6”) casing, nominal diameter tube with PVC end flanges

Anodes: DSA type with precious metal oxide coating

Cathode Spacers: Surface-mounted PVDF bushings

Chassis: Titanium construction

Dilution Water Flowmeter: Variable-area flowmeter with integral, adjustable alarm proximity switch

Brine Water Flowmeter: Variable-area flowmeter with integral, adjustable alarm proximity switch

Salt Requirements: Common solar grade salt. Salt usage is approx. 3 kgs per kg (3 lbs per lb).

Supply Water Requirements: Max. water hardness not to exceed 17 mg/l of $CaCO_3$ at the electrolyzer inlet

Water Pressure: 1.9 bar (29 psi) min.; 4.96 bar (72 psi) max.

Electrolyzer Inlet Temperature: Min. 7.2°C (45°F); max. 26.7° C (80°F)

Electrical Requirements: Main Control Panel 120/230 V 1 phase or 230/460 V 3 phase; Transformer Rectifier 230/460 V 3 phase

Electrical Power Consumption: 2.0 kWh AC per lb. of Cl_2 per day

Hypochlorite Strength: 0.7% to 0.85% concentration by weight

Pipe Connections: Inlet Water ¾”, Inlet Brine ½”, Outlet Product 1½”

Brine Pump: Premia® 75 ME 38 (See WT.460.150.003.UA.PS)

Generator Dimensions: 1.5m x 0.7m x 2.0m (3’9” x 2’4” x 6’6”)

Weight: 91 kgs (200 lbs)

Optional Equipment: Hydrogen Detector, Titrator, Acid Cleaning Kit, Integral Heat Exchanger

Siemens
Water Technologies

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wtus.water@siemens.com

Literature No.: WT.085.030.000.UA.PS.1008
Subject to change without prior notice.

The information provided in this literature contains merely general descriptions or characteristics of performance which in actual case of use do not always apply as described or which may change as a result of further development of the products. An obligation to provide the respective characteristics shall only exist if expressly agreed in the terms of the contract.

TM 7—Reuse System Improvements including UV

PREPARED FOR: Jim Wodrich, P.E./City of Bend

PREPARED BY: Gregg Thompson, P.E./CH2M HILL

REVIEWED BY: Dave Green, P.E./CH2M HILL
Brady Fuller, P.E./CH2M HILL
Jim Griffiths, P.E./CH2M HILL

DATE: October 3, 2011

PROJECT: Schematic Design Report
Bend Water Reclamation Facility Secondary Expansion

Background

This technical memorandum details the schematic design for the reuse system improvements including ultraviolet (UV) disinfection.

The Bend Water Reclamation Facility (WRF) currently uses gaseous chlorine and a chlorine contact basin to achieve disinfection for plant effluent and for Class A reuse water.

The Project Definition Report documents the following decisions:

- Primary disinfection of the Class A reuse water will be provided by in-vessel UV disinfection.
- Secondary disinfection (and maintenance of a chlorine residual) will be provided by sodium hypochlorite.

Design Criteria

Table 1 lists the design criteria for the disinfection and plant water (PW) systems.

The UV system will be at-grade and under a roof with no walls. The electrical room will be a block building with heating and ventilation. The design of the UV chamber and piping will accommodate draining of the pipelines during the winter or other idle periods. To control scaling, fouling, and algae growth, a chemical cleaning system will be integrated into the design of the UV system.

TABLE 1
Disinfection and Plant Water System Design Criteria
City of Bend Water Reclamation Facility

Criterion	Unit	AAF
Ultraviolet (UV) disinfection		
Design flow	mgd	2.5
Peak flow	mgd	5.0
Water quality		
Chlorine dose for disinfection	mg/L as Cl_2	
Chlorine residual for disinfection	mg/L as Cl_2	2
Chlorine dose for reuse	mg/L as Cl_2	4
Chlorine residual for reuse	mg/L as Cl_2	2

AAF = Average Annual Flow.
Cl_2 = chlorine.
mg/L = milligrams per liter.
MMF = Maximum Month Flow.
psi = pounds per square inch.

Evaluations

The type of UV equipment was evaluated during Schematic Design. The evaluation is documented in *Fact Sheet 1 – Ultraviolet Disinfection: Low Pressure vs. Medium Pressure* (provided in Attachment C to this technical memorandum).

UV disinfection for reuse and plant effluent can be impacted by water quality characteristics. Potential fouling of UV systems was evaluated and documented in *Fact Sheet 2 – Fouling of Ultraviolet Disinfection* (also provided in Attachment C).

Ultraviolet Disinfection: Low Pressure High Output versus Medium Pressure High Output

Two UV system types were considered for the primary disinfection system for the Class A reuse:

- Low pressure high output in-vessel UV systems
- Medium pressure high output (MPHO) in-vessel UV systems

A medium pressure in-vessel UV system was determined to be the best equipment for this application based on present worth analysis and the compact size and fewer components of MPHO systems.

Fouling of Ultraviolet Disinfection

UV disinfection for reuse and plant effluent can be impacted by water quality characteristics. Ferric, alum, hardness, and polymers were reviewed for impact on the Bend WRF. Water hardness (due to the addition of the lime in the primary clarifier) will impact

UV disinfection. A chemical cleaning system should be included in the design to address concerns related to hardness fouling.

Process Description

The facility secondary expansion will include the addition of a UV disinfection system downstream of the reuse filters. The UV disinfection will provide primary disinfection for the Class A reuse system. Sodium hypochlorite will be added as a secondary disinfectant to provide a residual when the water is delivered to the reuse customer (currently Pronghorn golf course).

The primary measurements required for proper UV disinfection are the flow rate and the UV transmittance. Flow rate will be measured using the existing magnetic flow meters installed downstream of the low head reuse pumps in the reuse facility. Transmittance will be measured with a flow through UV transmittance element sampled between the reuse pumps and the UV chambers.

National Water Research Institute (NWRI) standards are commonly used to define testing and treatment requirements for reuse water. For this project, those standards will generally serve as a guideline for design and specification of the UV system.

Design Data

Table 2 contains the design data for reuse disinfection.

TABLE 2
Disinfection, Chemical Building, and Plant Water System Design Data
City of Bend Water Reclamation Facility

Process	Unit	Existing Facilities	Secondary Expansion (11.9 mgd)
UV Disinfection			
Type		Not applicable	MPHO
Trains	each		Two
Chambers per train	each		Two
Design flow	mgd		2.5
Peak flow	mgd		5.0
Hypochlorite metering pumps – reuse residual			
Units	each	Not applicable	Two
Type			Diaphragm
Capacity per unit	gph		2
Pressure at capacity	psi		30

gph = gallons per hour.
mgd = million gallons per day.

Reliability/Redundancy

The U.S. Environmental Protection Agency (EPA) classifies wastewater treatment plants into three levels of system reliability. EPA standards do not apply to the reuse system at the Bend WRF since the system can be taken offline during power failures and mechanical failures. All flow would then be routed through the plant effluent disinfection system, which is designed to meet the EPA standards for reliability.

The reuse disinfection system is sized to disinfect the design flow with a single chamber out of service. No backup power will be provided for the reuse systems because the current power reliability meets the service standard. No installed redundancy will be provided for the master UV controller. An uninterrupted power supply will be provided for the programmable logic controller.

For hypochlorite metering pumps, a swing pump will be provided to dose chlorine to either the plant effluent or W4 reuse water. The metering pumps will be sized to meet the peak flow requirement with two pumps.

Instrumentation and Control Strategy

W3 Reuse Water Disinfection (UV)

Disinfection of the reuse water will be provided by a medium pressure high output UV system installed in two in-line trains. Each train is sized to handle the design flow rate for delivery to Pronghorn (2.5 mgd), so there is currently no need to run both trains simultaneously. Influent and effluent valves are provided at each UV train for isolation. A UV train will only operate when the low head reuse pumps are running.

The UV system will be operated by a package control system based on flow rate and transmittance feedback signals. The UV system flow rate is measured at the existing low head reuse flow meter (FIT-52-040 in the low head reuse pump header located at the reuse facility).

W3 Reuse Water UV System Chemical Cleaning

Operators will manually start and stop the chemical cleaning system on an as-needed basis. When operating, the chemical tank mixer and the feed pump will run continuously. A hardwired interlock is provided to stop the feed pump when a low chemical level is detected in the tank.

Outstanding Issues

The in-vessel UV equipment can be procured through several different mechanisms. The procurement method selected will impact the approach to procurement of the UV equipment. Common approaches for procuring unique equipment are as follows:

1. Design Bid Build
2. Owner Procured (Pre-Selection)
3. Owner Procured and Assigned to Construction Contractor

Attachments

Attachment A—Equipment Data Sheets

- In-Vessel Medium Pressure High Output Ultraviolet

Attachment B—Vendor Catalog Cuts

- Medium Pressure High Output Ultraviolet – Aquionics Inline W 16000plus

Attachment C—Schematic Design Fact Sheets

- Fact Sheet 1—Ultraviolet Disinfection: Low Pressure High Output versus Medium Pressure High Output
- Fact Sheet 2—Fouling of Ultraviolet Disinfection

Attachment A—Equipment Data Sheets

Bend Water Reclamation Facility Secondary Expansion

EQUIPMENT DATA SHEET

SPEC SECTION:

LEAD ENGINEER: Thompson

FACILITY NAME: 44 - Reuse Disinfection Facility

EQUIPMENT NAME: In-Vessel Medium Pressure High Output UV **QUANTITY:** 4

IDENTIFICATION NO.:

MATERIAL HANDLED: W3 - Reuse Water (Level 4/Class A)

CAPACITY: 2.5 mgd

LOCATION: x dry ___ wet ___ exterior ___ hazardous

POWER REQUIRED: ___ hp 480 volts 3 phase 108 kW

DRIVE:
(Constant speed, 2 speed, variable speed)

ENCLOSURE TYPE: MOTOR: na CONTROL PANEL:

SYNCHRONOUS SPEED (rpm):

MOUNTING TYPE:
(Horizontal or Vertical):

SUPPORT UTILITIES REQUIRED:

EQUIPMENT DESCRIPTION:
(Size, configuration)

MANUFACTURERS: **NO. 1:** Aquionics **NO. 2:**

MODEL: InLine W 16000+ **MODEL:**

EQUIPMENT WEIGHT: 530 lbs

EQUIPMENT COST: **QUOTE:** $371,404 **DELIVERY TIME:** 12-18 weeks

VENDOR: Treatment Equipment Company - Dean Wood

MISCELLANEOUS COMMENTS, DATA, AND INFORMATION:

LOCATION OF EQUIPMENT: P&ID Sheet No. ___ Construction Sheet No. ___

REVISION	DATE	NO.	BY

Attachment B—Vendor Catalog Cuts

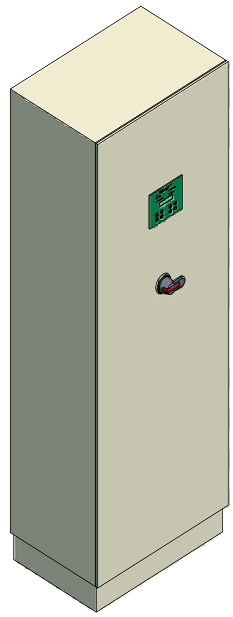
InLine™ W 16000+

AQUIONICS UV That Works!

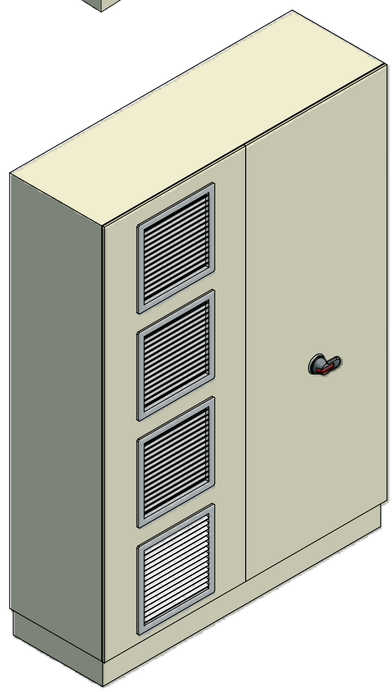
Specifications UV unit

Material	Stainless Steel, 316L
Internal finish	Ra_{max} 0.8 µm
Degree of protection	NEMA 12 (IP 54)
Flange connections	20” ANSI 150 lbs
Dimensions	See drawing next page
Weight dry	530 lbs (260 kg)
Weight wet	990 lbs (450 kg)
Lamp type	B5050H
Number of lamps	12
Temperature sensor	PT 100
UV sensor	UVector MPI
Nominal pressure	102 psi (7 bar)*
Test pressure	160 psi (11 bar)
Maximum hydraulic flow	11.4 MGD (1800 m^3/h)

* Higher pressures on request



Specifications	Control Cabinet	Power Cabinet
Cabinet type / QTY	Floor standing / 1	Floor standing / 2
Dimensions	74.8 x 23.6 x 15.75 inch 1900 x 600 x 400 mm	74.8 x 47.25 x 15.75 inch 1900 x 1200 x 400 mm
Weight	330 lbs (150 kg)	1015 lbs (460 kg)
Material	Painted steel	Painted steel
Color	RAL 7035	RAL 7035
Degree of protection	NEMA 12 (IP 54)	NEMA 12 (IP 54)
Ambient temperature	40 - 95 F (5 - 35 °C)	40 - 95 F (5 - 35 °C)
Ambient humidity	15 - 90 % rel.	15 - 90 % rel.
Maximum cable length	160 ft (50 m)	160 ft (50 m)

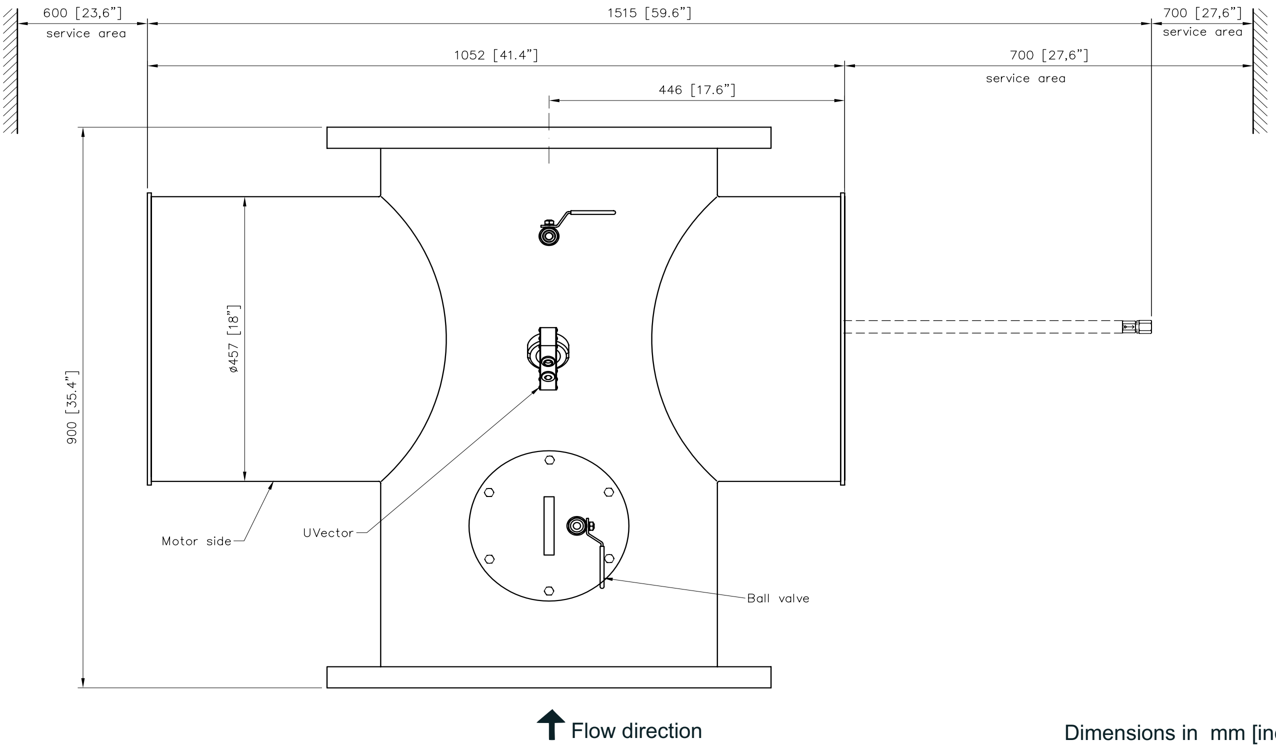


Electrical Specifications (Build according IEC 60204-1)

Input Voltage	120 V, 60 Hz, 1L+N	480 V, 60 Hz, 3L
Average power consumption	1.0 kW (± 5%)	2 x 22.0 kW (± 5%)
Total connected power	1.0 kW (± 5%)	2 x 30 kW (± 5%)
Size of customers breaker (D type tripping characteristic)	> 10A (120 V)	>2 x 63A (480 V)

Standard features	Optional features
ECtronic+ controller	Allen Bradley Compact Logix PLC / HMI
Automatic cleaning system	Ultrawipe™ (chemical assisted) cleaning system
Energy control, 3 power levels	NEMA 4x cabinet with cooler
Drain tap (BSP or NPT)	Stainless Steel AISI 304 cabinet
Air release valve	Bleed valve control
Access hatch	Dose output signal (4 - 20 mA)
Door safety switch	

InLine™ W 16000+



Dimensions in mm [inch]

Aquionics InLine+ W series

- InLine W 36000+
- InLine W 33000+
- InLine W 30000+
- InLine W 18000+
- InLine W 17000+
- *InLine W 16000+*
- InLine W 15000+
- InLine W 7500+
- InLine W 5000+
- InLine W 4750+
- InLine W 4500+
- InLine W 4250 +
- InLine W 1250+
- InLine W 1000+
- InLine W 400+
- InLine W 250+
- InLine W 100+
- InLine W 40+

Notes

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Phone (800) 925-0440
E-mail sales@aquionics.com
www.aquionics.com

Attachment C—Schematic Design Fact Sheets

Ultraviolet Disinfection for Reuse Water

ATTACHMENT C TO: TM 7—Reuse System Improvements Including Ultraviolet

PROJECT: Schematic Design Report
Bend Water Reclamation Facility Secondary Expansion

Objective

Ultraviolet (UV) radiation (using in-vessel equipment) will be used for primary disinfection of the Class A reuse water. Select the appropriate UV type, evaluating both Medium Pressure and Low Pressure UV systems.

Background

The Bend Water Reclamation Facility (facility) currently uses gaseous chlorine and a chlorine contact basin to achieve disinfection for Class A reuse.

Design Criteria

Table 1 lists the design criteria specific to addressing the selection of medium- versus low-pressure UV disinfection of the Class A reuse water.

TABLE 1
Class A Reuse Disinfection Design Criteria
City of Bend Water Reclamation Facility

Criterion	Unit	AAF	MMF	Peak Hour
Class A Reuse flow	mgd	2.5	5	5
Chlorine Residual	mg/L as Cl_2	.5	2	2
Total Coliform per 100 ml	mpn	2.2	2.2	23
UV Transmittance	/cm	65%	65%	65%
UV dose	mJ/cm^2	80	80	80

AAF = Average Annual Flow.
Cl_2 = chlorine.
mgd = million gallons per day.
mg/L = milligrams per liter.
ml = milliliter.
MMF = Maximum Month Flow.
mpn = most probable number

Evaluation of Alternatives

Two in-vessel alternatives were considered for UV disinfection of the reuse flow stream. Other UV arrangements that required an open water surface were not considered because additional pump stations would be required given the current arrangement of the plant.

Alternative 1—Low-Pressure Ultraviolet Disinfection

Advantages

- Lower power consumption (more efficient)
- Lower bulb temperature
- Auto wiper system

Disadvantages

- More expensive initial cost
- More bulbs to maintain
- Larger building footprint

Alternative 2 – Medium-Pressure Ultraviolet Disinfection

Advantages

- Less expensive initial cost
- Fewer bulbs to maintain
- Smaller building footprint
- Auto wiper system

Disadvantages

- Higher power consumption
- Higher bulb temperature
- Visible light from bulbs promotes algae growth

Present Worth Analysis

Table 2 provides the relevant project factors used in the present worth analysis. Table 3 summarizes the present worth analysis used in the UV equipment evaluation. Table 3 shows that a medium pressure system has a smaller present worth cost than the low pressure system. In analyses at other facilities, low pressure systems may have a lower cost because of the low power consumption of a low pressure system. The power cost is not a deciding factor in the analysis because the system is operated for part of a day and for less than half of the year and because the cost of power is very low compared to other plants in the United States.

TABLE 2
Present Worth Analysis Approach
City of Bend Water Reclamation Facility

Factors	Unit	Value
Power Cost	$/kWh	$0.041
Labor Cost	$/hour	50
Inflation	Annual %	Not used
Discount Rate	Annual %	1%
Time Length	Years	20

kWh = kilowatt-hour.

TABLE 3
Ultraviolet Equipment Evaluation Present Worth Analysis Cost Estimates
City of Bend Water Reclamation Facility

Type of Cost	Alternative 1 Low-Pressure Ultraviolet Disinfection ($ millions)	Alternative 2 Medium-Pressure Ultraviolet Disinfection ($ millions)
Capital Cost	$2.4	$1.5
Annual Maintenance Costs	$0.03	$0.01
Annual Operations Cost	$0.23	$0.23
Net Present Worth	$7.0	$5.9

Recommendations

The present worth analysis indicates an economic advantage to medium-pressure UV. The small footprint of medium-pressure systems is an added advantage in the expected location of the UV building. The smaller size and fewer bulbs will be an advantage to operations staff.

There are a limited number of vendors for in-vessel medium pressure systems. Aquionics has a good track record with owners. Trojan also has a good reputation for its UV products.

The facility secondary expansion will include a medium-pressure UV disinfection system for the Class A reuse system.

Appendix A—Vendor Catalog Cuts

- Low Pressure Ultraviolet Disinfection (WEDECO)