APPENDIX F4

WASTEWATER MANAGEMENT PLAN

(Pages F4-1 to F4-486)

BAFFINLAND IRON MINES CORPORATION
MARY RIVER PROJECT

WASTEWATER MANAGEMENT PLAN

Rev. No.	Revision	Date	Approved
0	Issued in Final	September 15, 2007	DC
1	Issued in Final	March 31, 2009	JM
2	Issued in Final	March 31, 2010	JM
3	Issued in Final	March 31, 2012	JM

TRACK CHANGES TABLE

An annual routine review and update of the Wastewater Management Plan (WWMP) has been undertaken, with the following salient revisions to the March 2010 WWMP:

Revision 3: March 2012

Modifications/Additions	Where they appear in the document	
	Section	Page number
Section 1.0 was updated to reflect the new Water Licence.	1.0	1-2
Section 1.1 and 1.2 was updated to reflect the 2010 and 2011 activities at the Mary River and Milne sites, as well as the planned activities for 2012.	1.1 and 1.2	2-4
Section 2 was revised to remove the historical 2007 and 2008 responses to regulatory and government agencies. These responses are historic and no longer relevant. The chronology was also brought up to date.	2.1	5-6
The previous Appendix A containing historical responses to regulatory and government agencies has been removed and the remaining appendices renumbered.	N/A	N/A
Section 3.0 was updated to reflect the 2011 activities and plans for 2012.	3.0	7
Section 4.1 was updated to include the effluent filtration process present as part of the sewage treatment system.	4.1	12
Sections 4.2 and 4.3 were updated to reflect operational experience with the discharge and outfall management.	4.2 and 4.3	14
Section 5.3 was updated to reflect experience associated with system start-up.	5.3	17
Section 6.0 and Appendix F has been updated to reflect practical experience gained during the 2011 season. Appendix F has been renumbered to Appendix E.	6.0 Appendix E	18-19
Section 7 was updated to reflect the results of the sludge inventory monitoring work performed n 2011.	7.0	20-21
Section 10 was updated to reflect the results of the 2010 and 2011 monitoring data.	10.0	24-29
The previous Appendix G containing historical assessment database and interpretation of potential effects of sewage effluent discharge on Sheardown Lake has been removed. A summary of this information remains in Section 10.	N/A	N/A

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This Wastewater Management Plan has been prepared by Baffinland Iron Mines Corporation with the technical assistance, support, and review services of various consulting engineers and scientists. The consulting companies involved, and the specific areas of technical expertise provided, are listed below:

Seprotech Systems Inc. (Seprotech) of Ottawa, ON - Wastewater Treatment Plant Design Development, Installation, Maintenance, Technical Support, and Operator Training.

Genivar Consultants PL (Genivar) of Timmins, ON - Polishing Waste Stabilization Ponds (PWSPs) and Piping/Outfall Design, Construction QA/QC and As-Built Drawings, Author of September 15, 2007, Version of the Wastewater Management Plan.

AMEC Environment & Infrastructure (AMEC) of Cambridge, ON - Treatment Plant Design Review, 2010 Sludge Management Plan, PWSP Effluent Discharge Plan, and general review.

BAFFINLAND IRON MINES CORPORATION
MARY RIVER PROJECT

WASTEWATER MANAGEMENT PLAN

TABLE OF CONTENTS

PAGE

SECTION 1.0 - INTRODUCTION 1
1.1 MARY RIVER CAMP WWTF OVERVIEW 2
1.2 MILNE INLET CAMP WWTF OVERVIEW 4

SECTION 2.0 - WASTEWATER REGULATORY BACKGROUND AND CHRONOLOGY 5
2.1 WASTEWATER MANAGEMENT CHRONOLOGY 5

SECTION 3.0 - DESIGN CRITERIA, CAPACITY, AND PROCESS REVIEW 7
3.1 DESIGN BASIS 7
3.2 MARY RIVER RBC DESIGN PROCESS EVALUATION 9
3.3 PROVISIONAL OPTION - ADDITIONAL RBC MEDIA 10

SECTION 4.0 - SEWAGE TREATMENT AND DISCHARGE 12
4.1 TREATMENT 12
4.2 MARY RIVER DISCHARGE 13
4.3 MILNE INLET DISCHARGE 14

SECTION 5.0 - OPERATIONS AND MAINTENANCE (O&M) 16
5.1 TRAINING 16
5.2 ROUTINE O&M 16
5.3 NON-ROUTINE O&M 17

SECTION 6.0 - PWSP EFFLUENT RELEASE WORK PLAN 18

SECTION 7.0 - ROUTINE SLUDGE MANAGEMENT AND LONG TERM TECHNICAL STRATEGY AND WORK PLAN 20
7.1 ROUTINE SLUDGE MANAGEMENT 20
7.2 2009 AND 2011 SLUDGE MONITORING 20
7.3 SLUDGE MANAGEMENT AND TECHNICAL STRATEGIES – 2012 WORK PLAN 20

SECTION 8.0 - CONTINGENCY MEASURES 22

SECTION 9.0 - SAMPLING, MONITORING, AND REPORTING 23

SECTION 10.0 - EFFLUENT EFFECT ON RECEIVING WATERS 24
10.1 EFFLUENT TOXICITY 24

10.2 EFFECTS OF SEWAGE EFFLUENT DISCHARGES TO SHEARDOWN LAKE 25
10.3 EFFECTS OF SEWAGE EFFLUENT DISCHARGES AT MILNE INLET 27

SECTION 11.0 - REFERENCES 30

LIST OF FIGURES & DRAWINGS

Figure 1 Project Location Map
Figure 2 Existing Site Layout at Mary River
Figure 3 Existing Site Layout at Milne Inlet
Figure 4 Acute Toxicity of Ammonia with pH
Figure 5 Sheardown Lake NW Bathymetry
Figure 6 Sheardown Lake NW Water Quality Sites

Drawing 002 As Constructed Mary River Site Plan
Drawing 003 Milne Inlet As Constructed Site Plan
Drawing 004 Mary River Camp Sewage Discharge Profile & Details
Drawing 005 As Constructed PWSP 1 – Plan and Sections
Drawing 006 As Constructed PWSP 2 and 3 – Plan and Sections
Drawing 007 Milne Inlet – As Built Sewage Lagoon – Plan and Profiles

LIST OF APPENDICES

Appendix A Tables from Cold Regions Utilities Monograph
Appendix B Seprotech Design Briefs For Models N70 (Mary River Camp) and N30 (Milne Inlet Camp) RBC Units
Appendix B.1 - Model N70 - Mary River Camp RBC
Appendix B.2 - Model N30 - Milne Inlet Camp RBC
Appendix C Mary River RBC Process Design Evaluation
Appendix D Seprotech RBC Installation, Operation, and Maintenance Manuals
Appendix D.1 - RBC Wastewater Treatment Inspection Logs
Appendix D.2 - Model N70 - Mary River Camp
Appendix D.3 - Model N30 - Milne Inlet Camp
Appendix E PWSP Effluent Discharge Plan
Appendix E.1 – PWSP Effluent Discharge Plan
Appendix E.2 – PWSP Effluent Polishing System Operation and Maintenance Manual

BAFFINLAND IRON MINES CORPORATION
MARY RIVER PROJECT

WASTEWATER MANAGEMENT PLAN

SECTION 1.0 - INTRODUCTION

Genivar Consultants PL (Genivar) was retained by Baffinland Iron Mines Corporation (Baffinland) in 2007 to design the sewage works for the Mary River Project (the Project), specifically for Mary River and Milne Inlet Camps on Baffin Island, Nunavut, to support the Bulk Sampling Program. As a requirement under Baffinland's historical Water Licence 2BB-MRY0710 issued by the Nunavut Water Board (NWB) on July 27, 2007, and in accordance with Part D, item 13, BIM was required to submit a Wastewater Management Plan (WWMP).

On September 15, 2007, Baffinland submitted a Wastewater Management Plan (WWMP) to the NWB that addressed the key elements related to sewage works and management at the Mary River and Milne Inlet Camps (refer to Figure 1 for location map).

The September 2007 WWMP was subsequently revised by Baffinland in March 2009 (Revision 1, approved August 2009) and again in March 2010 (Revision 2, approved April 2011). These revisions to the WWMP included the following items:

- Changes to sewage infrastructure including the construction and commissioning of two additional Polishing/Waste Stabilization Ponds (PWSPs) at the Mary River Camp.
- Revisions to operating manual documentation, maintenance, and monitoring practices to reflect enhancements that have been implemented since start-up of the wastewater treatment facilities (WWTFs).
- Review and revision of the design basis of the sewage treatment systems in consideration of actual monitoring/operational/performance data.
- Presentation of a provisional option to provide additional RBC media to the Mary River Camp sewage treatment system to address current and unexpected throughput limitations resulting from higher than anticipated average nitrogen loading.
- Proposed management and disposal technical strategy for the effluent residing in three (3) PWSPs at Mary River and one (1) PWSP at Milne Inlet.
- Proposed management and disposal technical strategy for sludge currently stored in the PWSPs and technical work plan.
- Review and validation of the prediction for no adverse impacts to the receiving environment associated with the discharge of treated sewage effluent.

The Wastewater Management Plan revised and submitted herein (Revision 3) is in accordance with the current Water Licence 2BB-MRY1114 issued by the Nunavut Water Board (NWB) on April 5, 2011, Part D, item 16,

> *"The Board approved the Plan entitled "Waste Water Management Plan," dated March 31, 2010. The Licensee is required to update the plan annually and submit any changes, in the form of an addendum complete with a record of revision, to the Board for review by March 31st of the year following the update."*[1]

Minor revisions have been made throughout this document but the key revisions include the following:

- The previous Appendix A containing historical 2007 and 2008 responses to regulatory and government agencies has been removed and the remaining appendices renumbered.
- Section 6.0 and Appendix E.1 (PWSP Effluent Discharge Plan), Appendix E.2 (PWSP Effluent Polishing System Operation and Maintenance Manual) have been updated to reflect practical experience gained during the 2011 season.

An overview and chronology of the sewage works at the Mary River and Milne Inlet Camps are provided in Sections 1.1 and 1.2, below. A location plan showing the two camps is provided as Figure 1.

1.1 MARY RIVER CAMP WWTF OVERVIEW

The existing camp at Mary River currently has a potential capacity for 200 persons. This capacity consists of a 100 person seasonal camp, originally set up and used for the exploration work prior to 2007, plus an adjacent all-season camp with a nominal design capacity of 100 people that was constructed in late 2007 and early 2008. The all-season camp consists of predominantly Weatherhaven™ tents, two steel Quonset huts as maintenance facilities, and numerous small wooden outbuildings, situated approximately 200 meters from the shores of Camp Lake (refer to Figure 2 and Drawing 002).

The current WWTF, consisting of a Rotating Biological Contactor (RBC), effluent filter, and ultra-violet light (UV) disinfection (manufactured and installed by Seprotech), was designed to achieve tertiary levels of treatment with the potential for piped, year-round, discharge to Sheardown Lake.

With the design basis that was adopted, the RBC WWTF was sized for a nominal occupancy of 150 persons. Since, October 2008, the camp occupancy at Mary River has declined from previous levels with very low numbers (less than 10 personnel) during the off-season period (October to April) and increased numbers (50-120 personnel) during the field season to support exploration drilling, geotechnical drilling, site reclamation programs, and baseline data collection programs. During the upcoming 2012 field season the occupancy numbers in camp are expected to be fewer than 100 persons to support a small drill program (one drill), site reclamation efforts, and site baseline data collection programs that are supporting current permitting efforts.

[1] Note that although the licence calls for a submission of an addendum, Baffinland has concluded that from an environmental management perspective, an addendum is a confusing way to proceed and that a single revised document, rather than the original document plus an addendum, has more utility.

In 2008, BIM conducted a review of the design basis for the wastewater treatment facility, its standard operating procedures for operations and maintenance, and monitoring requirements, with the aim of consistently meeting discharge requirements thereby reducing the dependency on the use of the PWSPs. Since the implementation of the recommendations from this review, water licence effluent requirements have largely been met (since December 2008).

Although effluent produced from the Mary River RBC WWTF has been compliant for most effluent parameters, there have been problems with the WWTF consistently meeting the total phosphorous criterion. Because of this inconsistency in achieving the target total phosphorus concentration in the WWTF effluent, BIM has recognized the need for a conservative approach and has discharged all treated effluent to the PWSPs for further testing and treatment, as required, prior to final discharge to Sheardown Lake. During 2009, an appropriate polishing treatment, discharge, and monitoring plan for treated sewage effluent stored in the PWSPs was developed and implemented at the Mary River site.

The 2,858 m^3 of polished effluent that was discharged to Sheardown Lake during the 2009 program met or exceeded applicable effluent criteria, including total phosphorus, and was not acutely toxic. Due to the discharge of treated effluent from the PWSPs during 2009, there was sufficient storage capacity for 2010 and winter 2011. During the 2011 summer season 5,287 m^3 of polished effluent was discharged to Sheardown Lake. The 2011 PWSP discharge met or exceeded applicable effluent criteria, including total phosphorus, and was not acutely toxic.

In response to ongoing operating experience since 2008, Baffinland continues to optimize the Mary River WWTF design and operation with the aim of consistently meeting discharge requirements for all parameters, thereby reducing or eliminating the need for additional polishing treatment within the PWSPs prior to discharge. Operational experience has shown that at the low flows experienced during the winter months, freeze protection of the discharge line to Sheardown can be problematic. Storage of the winter effluent in the PWSPs prior to seasonal discharge in the spring has been effective at managing the operation of the discharge. Baffinland recognizes that an appropriate storage, discharge, and monitoring plan for treated effluent was effectively developed and executed during 2009, 2010, and 2011. Continuation of this plan is an appropriate and protective method for ongoing treatment and discharge of treated effluent at the Mary River camp.

During June 2011, the RBC WWTF was temporarily shut-down for approximately 2 weeks to make repairs to the rotating disk assembly. During the repair period sewage was diverted to PWSP No. 1. During the remainder of the 2011 operating season Baffinland continued to work to reduce total phosphorus concentrations in the treated effluent from the WWTF with the intention of direct discharging to Sheardown Lake. However, testing results remained inconsistent for total phosphorus concentrations, resulting in our utilization of the PWSPs for treated effluent storage.

During the 2012 operating season our intention will be to discharge compliant melt water from the PWSPs during the spring and continue utilization of the PWSPs for treated effluent storage.

1.2 MILNE INLET CAMP WWTF OVERVIEW

The Milne Inlet site is the shipping point for materials and supplies to and from the Mary River Operations (refer to Figure 3 and Drawing 003). An all-season trailer camp was installed in 2007 to support the annual re-supply and Bulk Sample Program operations. The camp facilities at Milne consist of a Shanco™ accommodation complex with a RBC WWTF (complete with UV disinfection). The Milne facilities and WWTF are sized for a nominal capacity of 60 workers to support peak periods of activity, primarily during the initial mobilization and final ore shipment stages of the Bulk Sample Program.

The RBC WWTF was commissioned in October 2007. During the start-up period, effluent and sludge were disposed of in a PWSP, constructed on site for that purpose. Treated effluent from this facility first met the water license discharge requirements in January 2008 and was directed to the approved receiving ditch upstream of Milne Inlet. Compliance with the water license criteria enabled direct discharge to the receiving environment for the majority of 2008, with intermittent periods where effluent not meeting discharge criteria was directed to the PWSP

Since the completion of the Bulk Sample Program in October 2008, the Milne Inlet Camp population has declined to two persons during the off-season (October to April) and increased numbers (6-60 personnel) during the open water field season.

During the off-season, the RBC is shut down and winterized while the toilet wastes at Milne Inlet are managed through use of latrines and the incineration of latrine waste. Small quantities of grey water are discharged to a leach pit located adjacent to the camp. During the active field season the RBC may be operated depending on the level of activity and camp population.

During 2009 and 2010 the RBC WWTF was not operated and wastes were managed similar to the off-season. During 2011 the Milne RBC WWTF was restarted, which required mechanical repairs to equipment after approximately 30 months of inactivity. Afterwards, the WWTF was started, operated, and treated effluent was discharged to the approved receiving ditch upstream of Milne Inlet. To facilitate easier discharge of compliant water from the RBC effluent storage tank, a temporary pipeline was installed between the tank and the receiving ditch.

At different times the Milne PWSP has received sludge from the RBC WWTF and/or non-compliant effluent.

During June 2009 the volume of effluent stored in the Milne PWSP was substantially reduced. Approximately 331 m^3 of treated effluent stored in the Milne PWSP was discharged to the approved receiving ditch that drains directly into Milne Inlet during June 2009. Further treatment prior to discharge was not required since the stored effluent met effluent requirements and was acutely non-toxic.

There was no further discharge from the Milne PWSP to the receiving environment during the 2010 and 2011 field seasons. Discharge of compliant treated sewage residing the Milne PWSP is anticipated for the spring/summer of 2012.

SECTION 2.0 - WASTEWATER REGULATORY BACKGROUND AND CHRONOLOGY

2.1 WASTEWATER MANAGEMENT CHRONOLOGY

This section presents, in the following Table 2-1, a chronological listing of key regulatory submissions/approvals and key activity/milestones related to wastewater treatment and management from September 2007 to March 2012.

Table 2-1 Wastewater Management Chronology

Date	Activity/Milestones and Regulatory Submissions/Approvals
September 2007	Submission of Wastewater Management Plan
October 2007	Commissioning of Milne Inlet Rotating Biological Contactor (RBC) and Polishing / Waste Stabilization Pond (PWSP)
November 2007	Commissioning of 'Tanks-a- Lot' Wastewater Treatment Facility (WWTF) at Mary River
January 2008	As-Built submission for Milne Inlet RBC Facility
January 2008	As-Built submission for the Mary River 'Tanks-A-Lot' sewage system
January 2008	Treated effluent from Milne RBC meets Water Licence criteria and is discharged to the Milne Inlet
February 2008	Installation of all-season tent camp at Mary River
February 2008	Construction completion and commissioning of Mary River RBC facility
March 2008	Submission of Water Licence Annual Report (2007)
April 2008	Submission of Waste Disposal Facilities Modification Request for PWSP No. 2 and No. 3 at Mary River and an additional PWSP at Milne Inlet
May 2008	Construction completion and commissioning of Mary River PWSP No. 2
May 2008	Water License Modification granted - Waste Disposal Facilities
July 2008	As-built submission for Mary River RBC and PWSP No. 1 and No. 2
August 2008	Milne effluent tested for acute toxicity and passes
October 2008	Shut-down of Milne Inlet RBC due to low population numbers in camp
November 2008	Submission of Annual Geotechnical Inspection Report
December 2008	Construction completion and commissioning of Mary River PWSP No. 3
December 2008	Effluent from Mary River RBC starts meeting Water Licence Criteria
March 2009	Submission of revised WWMP (rev. 1)
March 2009	As-built submission for Mary River PWSP No. 3
June 2009	Discharge of Milne PWSP (no pre-treatment required)
June 2009	Submission of schedule of activities for Summer 2009 as related to treatment and discharge of the PWSPs
July 2009	Submission of response to reviewer's comments on the WWMP
August 2009	Approval received for WWMP (Rev. 1)
August 2009	Treatment and discharge of effluent from PWSP Nos. 2 and 3.

Table 2-1 Wastewater Management Chronology

Date	Activity/Milestones and Regulatory Submissions/Approvals
November 2009	Submission of Annual Geotechnical Inspection Report
March 2010	Submission of revised WWMP (Rev. 2)
November 2010	Submission of Annual Geotechnical Inspection Report
April 2011	New Water Licence received (2BB-MRY1114) and approval of 2010 WWMP (Rev. 2).
June 2011	Submission of schedule of activities for Summer 2011 as related to treatment and discharge of the PWSPs
June 2011	Discharge of Mary River PWSPs (no pre-treatment required)
August 2011	Treatment and discharge of effluent from PWSP Nos. 2 and 3.
November 2011	Submission of Annual Geotechnical Inspection Report
March 2012	Submission of revised WWMP (Rev. 3)

SECTION 3.0 - DESIGN CRITERIA, CAPACITY, AND PROCESS REVIEW

This section presents the original design basis for the Mary River and Milne Inlet RBC WWTFs and presents the results of a process design review that was performed that focused on the Mary River RBC system in particular. This review was undertaken due to the longer-than-anticipated time that it has taken to achieve water licence criteria for treated effluent. The objective of the review was to provide recommendations on the actual treatment capacity of the Mary River sewage treatment system. As a follow-up to this review work, a provisional option to install additional RBC media in the Mary River WWTF is provi ded as a means of eliminated nitrogen removal as a current limitation on the ability of the facility to meet its original design throughput.

Through 2011, the Mary River RBC system was considered to be generally performing within its expected operational limits and successfully treating the wastewater for all parameters, with the notable exception of phosphorus. During 2012, Baffinland will continue to work to reduce total phosphorus concentrations in treated effluent from the Mary River WWTF.

The treated effluent from the Milne Inlet RBC first met the water licence discharge requirements in January 2008 and, since then, there was direct discharge to the receiving environment for the majority of 2008, with intermittent short periods where effluent not meeting discharge criteria was directed to the PWSP. These periods resulted from minor upset conditions in the RBC related to mechanical or process maintenance, and intermittent spikes in camp occupancy that resulted in higher than design loadings. Following mechanical repairs to the Milne WWTF during 2011, the Milne RBC treatment system is considered to be generally performing within its expected operational parameters.

3.1 DESIGN BASIS

Prior to construction of the Milne and Mary River camps the per capita sewage flows and strengths were originally estimated based on the typical values found in Tables 10.3, 10.4 and 13.1 of the 1996 “Cold Regions Utilities Monograph, Third Edition”, a publication highly respected and used in Canada and USA for the design of infrastructure in the arctic regions. Copies of these Tables are included in Appendix A to this report.

The characteristics of sewage in remote/cold regions, depend on the type of work being performed, work schedules, facilities provided, and the type and capacity of the water supply. These factors directly affect the flow rates and the amount of dilution seen in the wastewater.

For design of the freeze protection of the forcemain, the minimum ambient temperature was assumed to be -45 degrees C and wind speed was assumed to be 40.3 kph. The heat tracing on the forcemain was designed to keep the pipe contents at 5 degrees C.

The sewage at both camps was expected to be a ‘moderately diluted wastewater’ as defined in Table 10.4 in Appendix A. The average BOD_5/TSS concentrations for this type of wastewater were expected to be 460 mg/L BOD_5 and 490 mg/L TSS. In addition, a loading of 65 mg/L TKN and

10 mg/L phosphorus was assumed by Seprotech, the manufacturer of the RBC units, derived from their experience with similar operating facilities.

Average flow rates for similar camps have been recorded in the range of 132 to 220 litres per capita per day (Lpcd). For design purposes, sewage generation was conservatively assumed to be 225 Lpcd, with a maximum loading of 460 mg/L BOD_5, 490 mg/L TSS, 65 mg/L TKN and 10 mg/L phosphorus.

The following tables 3-1 and 3-2 provide a summary of the original design sewage flows and strengths, the discharge requirements of the water licence, and the original design basis of the pre-engineered RBC units. Note the original Water Licence requirements are stated as maximum average concentrations whereas the current Water Licence (April 2011) is stated as maximum of any grab sample. The original design briefs and loading calculations completed by Seprotech are provided in Appendix B to this WWMP.

Table 3-1 Original Design Sewage Flows and Strengths

Facility Type	Water/Sewage Quantity (Lpcd)	BOD_5/TSS (Avg. - mg/L)	No. of Persons (Capita)	Total Daily Flow (L/d)	Total Flow 400 days (m^3)
Drilling Camp	83 to 227	460/490	-	-	
Average Work Camp	170	460/490			
Average Construction Camp	220		-	-	
Design Criteria for Mary River Camp	**225**	**460/490**	**150**	**33,750**	**13,500**
Design Criteria for Milne Inlet Camp	**225**	**460/490**	**60**	**13,500**	**5,400**

Table 3-2 Original Water License Discharge Requirements and the Original Design Basis

Parameter	Water License Requirements Maximum Average Concentration		Wastewater Treatment Plant Design Effluent Concentrations	
Location	Milne Inlet WWTF	Mary River WWTF	Milne Inlet WWTF	Mary River WWTF
BOD_5	100 mg/L	30 mg/L	20	10
TSS	120 mg/L	35 mg/L	20	10
Faecal Coliform	10,000 CFU/100mL	1,000 CFU/100mL	Less than 200 Counts per 100 m L	Less than 200 Counts per 100 m L
Oil and Grease	No visible sheen	No visible sheen	Removed by grease traps	Removed by grease traps
pH	Between 6.0 and 9.5	Between 6.0 and 9.5	Between 6.0 and 9.5	Between 6.0 and 9.5
Toxicity	Final effluent not acutely toxic	Final effluent not acutely toxic	Not acutely toxic due to nitrification	Not acutely toxic due to nitrification
Ammonia	N/A	N/A	2 mg/L NH3-N	2 mg/L NH3-N
Total Phosphorus	N/A	N/A	N/A	0.5 mg/L target level**

** Note: The 0.5 mg/L phosphorus target level is considered to be conservative based on anticipated overall phosphorus loadings to Sheardown Lake and modeling results. It also needs to be recognized that because these target levels are very close to what is technically achievable, that levels may on occasion may range between 0.5 to 1.0 mg/L, especially as related to discharge from the PWSPs. The modeling takes this 0.5 to 1.0 mg/L range into consideration when calculating loadings for discharge from the PWSPs.

3.2 MARY RIVER RBC DESIGN PROCESS EVALUATION

Due to the poorer than expected performance of the Mary River RBC sewage treatment system in 2008, a review was performed by AMEC Geomatrix Limited (AMEC). The AMEC review compared the original design basis to actual 2008 operating conditions with the aim of identifying the actual treatment capacity of the system. The treatment capacity recommendation is based on an independent review of the design parameters, the estimated original design capacity, and the actual loading data recorded during the 2008 operating season. AMEC's technical memorandum, Mary River RBC Process Design Evaluation, provided in Appendix C to this report, contains the technical details of the evaluation. A summary of this work including key results is provided below.

For general background, it is important to understand that RBC design is based on both hydraulic and organic loading rates across a surface area and that increases or decreases in surface area increase the fundamental treatment capacity of the system. The variability in surface area is provided by the configuration of the media (spacing and diameter of the RBC discs) and promotes biofilm growth on the rotating discs. The biofilm is responsible for removal of organic and nutrient constituents. Once the biofilm sludge reaches a certain thickness, it sloughs off of the media for removal.

AMEC conducted an independent review of the design parameters used by Seprotech against accepted published values. Based on the results of this review, in terms of the design flowrates and

the organic loading capacity of the system, it was concluded that the system has been designed to be within published loading criteria, however, little flexibility or safety factor has been designed into the system. It is possible that small changes in wastewater characteristics could have a significant impact on treatment efficiency.

AMEC also compared the actual 2008 measured wastewater loading data with the design basis for the system. The results of this comparison was that the actual flowrates were lower than the design basis (26 m^3/day actual compared with 33.75 m^3/day in the design basis). It is suspected that the daily habits of camp crews have impacted the overall flowrates to the wastewater treatment system in that some flows of dilute wastewater have not been entering the system. The higher concentration material has continued to enter the system which has resulted in overall wastewater concentrations that are higher (particularly nitrogen, measured as total Kjeldahl nitrogen (TKN)) than in the original design basis. The resulting mass loading rates were similar to design mass loading rates although BOD_5 and TSS loadings were less than estimated while the TKN loading was higher than original estimates.

It has been identified that TKN is the limiting design parameter for the RBC system currently operating at Mary River. The treatment system was designed with a maximum TKN loading of 2194 grams of nitrogen per day (g N/day). To produce effluent consistently meeting the water license criteria in the current configuration (one shaft, four stages) the number of staff on-site at any one time would be limited to 123 people based on the per capita loading rates of 16.9 g of nitrogen per person per day observed in 2008 in order to provide sufficient surface area for nitrification.

The key tables summarizing these results are provided in AMEC's technical memorandum found in Appendix C to this report.

3.3 PROVISIONAL OPTION - ADDITIONAL RBC MEDIA

A treatment option has been developed to enable the Mary River RBC to treat sewage at the originally designed hydraulic throughput. By adding additional growth media to the RBC, the sewage system will be capable of treating the higher than expected nitrogen levels while preserving the design hydraulic throughput.

In late 2008, anticipating a potential treatment bottleneck, Baffinland purchased from Seprotech a stand-alone RBC media unit. This unit has not been installed, but consists of a tank assembly complete with 3,038 m^2 of high density packaged media designed specifically for nitrification. Seprotech has provided a design basis for this system and design brief which is provided in Appendix C to this report. AMEC conducted a review of the provisional system including development of a conceptual process flow diagram for the proposed configuration (also provided in Appendix C).

The suggested layout would consist of adding the new media in series with the existing four (4) stages of media contained within the existing RBC facility. By adding an additional four (4) stages of media, the surface area available for treatment would increase to 5,382 m^2. Connecting

the existing 4- stage Shaft #1 in series with the new 4 stage shaft Shaft #2 would provide a total of two (2) shafts and eight (8) stages.

In the proposed configuration, the first four media stages would be used for BOD removal and the remaining 4 stages would be used for nitrification. Although the additional media will not increase the existing hydraulic capacity, it will allow the existing system to operate at the original design capacity instead of the current "TKN limited" capacity. The maximum hydraulic loading would be limited by the system hydraulic loading of 33.75 m^3/day. The additional shaft and discs would increase the existing treatment capacity and result in a more robust system capable of treating wastewater from a maximum of 236 people at 143 L/person/day. The tanks, pumps, alum system and filter systems will not need to be upgraded as the hydraulic capacity will not change.

For the purposes of determining a maximum number of staff that the Mary River facility can support, the sizing calculations were based on calculated mass loading and available surface area. This analysis and results are presented in the AMEC Technical Memorandum in Appendix C.

SECTION 4.0 - SEWAGE TREATMENT AND DISCHARGE

4.1 TREATMENT

Treatment of sewage at the Mary River Site is by a ROTORDISK®; N-70 packaged RBC System by Seprotech Systems Inc. Effluent from the sewage treatment system has the potential to be transmitted directly to the submerged outlet at Sheardown Lake via an insulated 75 mm forcemain. Since start-up in February 2008, treated effluent has been discharged to the three PWSPs constructed for that purpose.

The fully contained RBC system is comprised of a raw sewage equalization tank equipped with submersible pumps, a primary settlement tank, a Rotating Biological Contact (RBC) tank, and a final settling tank. Raw sewage is pumped into the primary settlement tank, where heavy solids are retained through gravity settling and thickening. Supernatant from the primary settlement tank enters the RBC tank through an inlet slot located at the front section of the RBC tank. The RBC tank is made up of four stages, or disk banks. The four separate disk banks are mounted on a common rotating shaft. As the disk banks are partially submerged, the rotation serves to provide continual aeration for the fixed film biological growth and filtering process (which occurs on the disk banks).

The first disc bank represents 40% of the total RBC surface area and is responsible for the most significant reduction in BOD. Subsequently, the accumulation of biological growth will be the greatest on the first disc bank and gradually decrease through subsequent sections. The growth will be generally thick and often filamentous on the 1st disk bank, becoming thinner and more compact on stages 2 through 4. Under certain operating conditions, nitrifying bacteria may become dominant in the 3rd and 4th disc banks. The 4th disc bank has a circulation device that allows well-treated liquid to be recycled to the primary settling tank. Treated water from the RBC enters the final settlement tank, whereby biomass sloughed from the disks and other suspended solids settle through gravity.

The existing RBC system uses aluminum sulphate (commonly called “alum”) to precipitate dissolved phosphorus thereby forming insoluble aluminum phosphate. This insoluble aluminum phosphate settles in the RBC tankage and is periodically removed along with the accumulated biological solids sloughed off from the rotating media. Thus, phosphorus removal is a 2-stage process whereby the dissolved phosphorus is first precipitated to form a solid, and secondly those solids are then removed from the treated water. For systems that experience occasionally high suspended solids concentrations in the effluent, meeting low phosphorus concentrations can be problematic. To ensure the Mary River WWTF is able to consistently meet a 0.5 mg/L phosphorus discharge target concentration, the existing alum addition program can be combined with effluent filtration.

The effluent from the final settling tank can be filtered, if required, and then passed through an ultraviolet light disinfection system before entering the effluent holding tank. The fully treated water in the effluent holding tank can then be pumped to the PWSP or discharge pipe.

The dimensions and sizes of the system can be seen in the Seprotech drawings provided in Appendix B.

Treatment of sewage at Milne Inlet is by a ROTORDISK®; B-30 packaged RBC System by Seprotech Systems Inc. This system is similar to the N-70 unit. In order to meet the requirement of the water license for a non-acutely toxic effluent, this unit was modified as part of its original installation to promote nitrification.

The B-30 system operation is similar to the N-70 as discussed above except that there is no phosphorus removal equipment (i.e. alum dosing and effluent filtration system).

4.2 MARY RIVER DISCHARGE

Since start-up, all effluents have been directed to the PWSPs. The location of the three PWSPs relative to the RBC system is shown in Figure 2 and Drawing 002.

The as-built report for the sewage treatment system including the RBC, PWSP No. 1 and No. 2, and associated piping and outfall was submitted to the NWB in July 2008. The as-built report for PWSP No. 3 was submitted to the NWB in March 2008. These reports contain detailed design and as-constructed survey information. Drawings Nos. 002, 004, 005, and 006 provide as-built plans and profiles for the Mary River Camp sewage treatment infrastructure including piping, outfall, and PWSPs. In general, the designs of the PWSPs consist of cells lined with a 1.0mm (40 mil) HDPE liner. The slopes of the PWSPs designed to be a minimum of 2H: 1V with allowance for 0.3m of sludge, 1.5 m of water, and 0.6m of free board. The total operating volume for the combined volume of the three PWSPs at Mary River is approximately 9,400 m^3.

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Freeze protection has been designed by Urecon Limited. The 75 mm DR 26 HDPE pipe is fitted with 50 mm of polyurethane insulation and a PVC jacket. Inside the insulation, an integral conduit houses a Thermocable C13-240-COJ heating cable with an output of 13 watts/meter controlled by an electronic thermostat set at 5 degrees C with a high limit of 65 degrees C for protection of the HDPE pipe. Operating experience has shown that due to the harsh climate and irregular topography along the pipeline route, that it is risky and difficult to keep the line from freezing during winter conditions because the pipe is not self draining and the low winter flow rates are insufficient to prevent freezing. Therefore, during the winter it is recommended that all discharge be directed to PWSP No. 2 and 3, rather than attempting to utilize the effluent discharge pipeline all the way to Sheardown Lake.

Since December 2008, the treated effluent from the Mary River RBC system has met effluent requirements with the exception of total phosphorus. During the open water season in 2009 and 2011, the partially treated effluent contents of PWSP No. 2 and 3 were further treated and discharged to the receiving environment based on the strategy as presented in Revision 2 of the WWMP and in accordance with water licence requirements. Since the discharge event in August 2011, the effluent criteria from the RBC has been mainly within discharge criteria (including total phosphorus). Therefore, it is anticipated that the stored effluent in the PWSPs will be tested in May or early June 2012 and, if all regulatory criteria are met and the effluent is non-acutely toxic, then

the pond can be direct discharged to the receiving environment without further treatment via the existing pipeline.

Due to ice damage to the outfall piping in Sheardown Lake, the discharge pipe is removed each fall. For the early season discharge, while ice cover remains on Sheardown, a hole must be augered through the ice and a temporary discharge pipe installed. The temporary discharge pipe conducts the effluent to a point below the ice to prevent erosion or sediment entrainment due to the discharge flow. At the completion of the spring discharge, the temporary pipe is removed from Sheardown.

For discharge to Sheardown Lake later in the operating season the outfall must be placed in Sheardown. The outfall consists of a steel structure which holds the discharge pipe above the lake floor to prevent erosion or sediment entrainment due to the discharge flow. The outfall pipe and structure are removed late in the season to prevent them from being damaged by ice.

4.3 MILNE INLET DISCHARGE

During the RBC start-up at Milne Inlet (from November 2007 to January 2008), treated effluent from the plant was transported to the PWSP via vacuum truck. The location of the PWSP relative to the RBC and other camp infrastructure is shown on Figure 3 and Drawing 003. Commencing in January 2008, treated effluent was discharged to the receiving environment with the exception of short periods when water licence criteria were not, or not likely, being met. During normal operation, treated effluent can be transported regularly from the RBC via vacuum or tanker truck to the local drainage ditch (non-fish bearing) where the effluent is released to the ditch that flows to the receiving environment. During 2011 a 2-inch diameter pipeline was installed between the RBC effluent tank and the ditch. The dimensions of the ditch are as follows: average width of the drainage ditch is 15 m, average depth relative to surrounding land is 1.9 m and approximate length of the ditch 275 m. The ditch discharges to Milne Inlet.

The Milne Inlet RBC was shut down and winterized in October 2008 and not operated during 2009 or 2010 due to the low camp occupancy. Based on an occupancy level of less than five (5) persons, latrines are to be used and the collected waste incinerated. During 2011 the Milne RBC WWTF was restarted, which required repairs to equipment after approximately 30 months inactivity. Afterwards, the WWTF was started, operated, and treated effluent was discharged to the approved receiving ditch upstream of Milne Inlet.

The as-built drawings for the Milne RBC and PWSP was submitted to the NWB in December 2007. The PWSP consists of a cell lined with a 1.0mm (40 mil) HDPE liner. The slopes of the PWSP are 2H: 1V with allowance for 0.3m of sludge, 1.5 m of water, and 0.6m of free board. Total operating volume of the PWSP at Milne Inlet is approximately 575 m^3. Detailed as-constructed drawings and profiles of the PWSP at Milne is presented in Drawings 003 and 007.

The effluent from the RBC System is transferred to a holding tank with a capacity of two days of average flow. The effluent holding tank is housed adjacent to the RBC System to protect the tank from freezing. Inside temperature is normally kept at a minimum of 10 degrees C.

The discharge location along the drainage ditch is protected by means of an energy dissipater to prevent erosion. Silt fences have been maintained downstream from the discharge location as an additional protective measure.

In June 2009, the PWSP at Milne was partially discharged (without pre-treatment) as the effluent met water licence effluent requirements and was acutely non-toxic. Similar to 2009, the residual effluent remaining in the PWSP will be retested in May 2012 and further discharged if criteria are met.

SECTION 5.0 - OPERATIONS AND MAINTENANCE (O&M)

Both routine and non-routine O&M procedures are described in detail in the Installation, Operation, and Maintenance Manuals provided in Appendix D. They are briefly summarized in the subsections below.

5.1 TRAINING

The manufacturer of the RBC WWTFs (Seprotech) provides training to BIM managers and RBC facility operators during routine periodic visits to the Project site, as well as providing a training program at their Ottawa offices. Seprotech have provided the level of training to BIM supervisors and operators that it recommends to clients of their equipment. To enhance management capabilities and enable continuity of operation, BIM designates specific contract operators for its WWTFs. These operators have undergone on-site training by the manufacturer, Seprotech, as described above. Seprotech is also available to provide on-call expert advice, as required. BIM is currently developing in-house training capabilities for its WWTF operators.

5.2 ROUTINE O&M

BIM have developed a checklist for routine inspections that occur on a daily basis. A copy of the checklist that is used is provided in Appendix D.1. When the checklist is completed, it is provided to the BIM Camp Manager where the results of the inspection are reviewed and any actions taken as required. The record is safely stored in a record filing system developed for the purpose. In addition to reviewing the daily checklists for upset conditions that might require action, the treatment plant operators are instructed to immediately notify the Camp Manager as soon as an atypical condition is observed.

The following procedures associated with operation and maintenance of the sewage facilities are performed on a scheduled basis while the Mary River and Milne Inlet Camp RBCs are in operation:

- Visual inspection of the RBC unit to detect any leaks, malfunctions, discoloration, foul odours (refer to checklist for complete list)
- Monitoring for indicator parameters such as pH and temperature
- Visual inspection of camp kitchen grease traps to ensure proper operation
- Visual inspection of effluent pipeline and heat trace checks along the pipeline to detect any leaks, damage or malfunction of the heat tracing system
- Visual Inspection of the pump station at the camp to verify the liquid levels, and detect any system blockages
- Visual inspection of the discharge outfall to ensure continuous discharge and detect any leaks in the embankment

Prior to inspecting the RBC unit, the operator must ensure that the unit is well ventilated and appropriate personal protective gear is worn, including disposable gloves. During routine visual inspection of the RBC unit, attention will be paid to the nature of the biological growth on the disk media. The colour of the growth will typically be dark brown to black on the 1st disk stage. The

growth on disks 2-4 will typically range between medium brown to tan on the final section. Unusual discoloration/texture of the disk media growth or strong sour odours could be indicative of process malfunction. Full details of the routine inspections and troubleshooting guidelines are provided in the Seprotech O&M Manual. These conditions are also noted on the daily checklists.

5.3 NON-ROUTINE O&M

Non-routine O&M procedures will be performed associated with the following system needs:

- Unit Start up
- Unit Shutdown
- Sewage sludge management (discussed in Section 6 of this report)
- Special start-up procedures must be followed if the RBC unit has been out of operation. These procedures are outlined in detail in Appendices D.2 and D.3, and are briefly summarized below:
  - Support bearings on shaft and coupling re-lubricated;
  - Primary settling tank should be filled with fresh water;
  - While the RBC is rotating, introduce wastewater at design or less than design loading rates; and
  - Unit start-up normally requires 3 to 6 weeks, with 50% BOD removal often occurring after one week. Complete treatment of ammonia can take 6 weeks to achieve.
  - Shut down procedures are necessary if the treatment unit is to be taken out of operation for any significant period of time. These procedures are briefly summarized below:
  - Remove all accumulated sewage sludge from settlement chambers;
  - Clean disk media and flush unit clean; and
  - Drain tanks and pipes and disconnect pipes.

SECTION 6.0 - PWSP EFFLUENT RELEASE WORK PLAN

In 2009, BIM retained AMEC to prepare a technical strategy for the management, treatment, and disposal of the wastewater and sludge solids stored in the polishing/waste stabilization ponds (PWSPs) at Milne Inlet and the Mary River facilities. The technical strategy was successfully implemented during the 2009, 2010, and 2011 open water seasons. This strategy, presented in Appendix E.1, was updated by AMEC in 2012 to incorporate the practical experience gained during operations.

A large portion of the PWSP effluent at Milne was discharged (without pre-treatment) to Milne Inlet in 2009. At Mary River, a portion of the contents of PWSP Nos. 2 and 3 were discharged to Sheardown Lake without further treatment in the spring of 2011. During summer 2009 and 2011, portions of the Mary River PWSP Nos. 2 and 3 were treated and discharged to Sheardown Lake.

This section summarizes the current PWSP release work plan, which is built on the success of the 2009 and 2011 field programs.

This PWSP effluent release work plan was originally developed using information gathered from a number of sources including analytical monitoring/sampling data for the RBC and PWSPs, the Mary River RBC process design evaluation (Section 3.2), and environmental discharge criteria established based on water licence requirements and considering potential impacts to the receiving environment. The plan was developed iteratively and in cooperation with Knight Piésold (KP), North/South Consultants (NSC), and BIM, to quantify the projected discharge limits that are required to meet this objective (refer to Section 10).

It is critical that discharge water from the PWSPs meet the Water Licence criteria that were detailed in Section 3.1 of this report and are specified in Part D, Items 13, 14, and 15 of Water Licence 2BB-MRY1114. The target level for phosphorus has been established at 0.5 to 1.0 mg/L in consideration of anticipated overall phosphorus loadings to Sheardown Lake and modeling results that were presented in Section 10 of the 2009 WWMP (rev. 1) document. Ammonia concentrations are required to be acutely non-toxic. Most importantly, the PWSP effluent release work plan has been based on the practical experience and data collected during the 2009 and 2011 open water seasons.

The PWSP effluent release work plan for discharging the accumulated water from the PWSPs contain two main options.

Option no. 1 may be implemented if the PWSP melt water samples collected in May are in compliance with effluent regulatory criteria. If effluent is compliant, then discharge will commence. Once discharge has commenced, Baffinland will implement a field testing program that will provide early warning that effluent is approaching regulatory criteria limits.

Option no. 2 may be implemented if the PWSP water quality does not meet the effluent discharge criteria. In this case, the effluent would be treated using some or all of the polishing treatment system (as was used during the 2009 and 2011 open water seasons). The various components,

processes, monitoring program, and operating criteria for the system are presented in the AMEC technical memorandum provided in Appendix E.1 and the operations and maintenance manual for the PWSP polishing system is provided in Appendix E.2.

It should be noted that at the present time, it is not planned to implement Option No. 2 during 2012 due to the storage capacity available in the Mary River PWSPs and the modest field program planned for 2012.

The 2009 technical strategy also provided guidance regarding the future steps required to manage sewage sludge, discussed in Section 7.0.

SECTION 7.0 - ROUTINE SLUDGE MANAGEMENT AND LONG TERM TECHNICAL STRATEGY AND WORK PLAN

7.1 ROUTINE SLUDGE MANAGEMENT

At the design capacity of the RBC System at Mary River, the sludge would accumulate at a rate of approximately 13.5 kg per day in the Primary Settling Tank. During periods of camp occupancy at design capacity, this sludge is removed to PWSP No 1, as required, based on sludge depth measurements within the RBC. Sludge is not discharged to PWSP Nos. 2 or 3, since these two ponds are to be used for holding compliant effluent and/or future polishing treatment efforts. The accumulation of sludge in the WWTF can be indirectly monitored by visually observing the thickness of the scum blanket on the surface of the primary settlement tank and sludge depth measurements taken by means of a Sludge Judge sampling pole. The quantification of sludge volumes is difficult and depends on density and amount of liquid removed with the sludge.

At the design capacity of the RBC System at Milne Inlet, sludge accumulates at a rate of approximately 12.9 kg per day in the Primary Settling Tank.

7.2 2009 AND 2011 SLUDGE MONITORING

The 2009 and 2011 sludge management programs involved the quantification and characterization of sludge within each of the PWSPs resulting in solids inventories and bench-scale test work. AMEC prepared solids inventories of the PWSPs at Mary River and Milne in 2009 and 2011.

In 2009 the volume of sludge measured in the Mary River PWSPs Nos. 1 and 2 totalled approximately 542 m^3. There was a minimal, non-measureable, volume of sludge in PWSP No. 3. The estimated volume of sludge in the Milne PWSP was <200 m^3. Sludge thickness varied from 0.15 to 0.45 m. The physical characteristics for the settled sludge at the Mary River site are of relatively light density for primary sewage solids and as a result, the concentration is estimated to be less than 10,000 mg/L. The lighter weight solids cause the intermediate water depths to have relatively high concentrations of suspended solids which have been measured between 700 to 1000 mg/L TSS throughout in the majority of the water column.

In 2011 AMEC repeated the solids inventory testing of the PWSPs which showed a sludge depth of approximately 0.05 to 0.15 m of sludge in each of the PWSPs at Mary River and Milne. This reduced volume of sludge is expected to be due to a combination of sludge breakdown and compact. The biological solids in the sludge continue to degrade after being placed in the PWSPs resulting in a reduction of more than 50%.

7.3 SLUDGE MANAGEMENT AND TECHNICAL STRATEGIES – 2012 WORK PLAN

The small volumes of sludge present during the 2011 operating season prevented pilot scale trials of passive sludge dewatering techniques from being performed. No sludge dewatering is planned for 2012.

The overall sludge management strategy remains unchanged and depends on the required implementation timeframe. Should the site move to the abandonment and reclamation (A & R) stage, passive sludge dewatering and drying techniques such as geotextile sludge dewatering bags, a sludge drying bed system, or containerized sludge dewatering bins would be used. A more active sludge dewatering strategy would be incorporated if the project advances towards production. In the event the project advances, the relatively small volume of accumulated sludge present in the PWSPs will be transported to the mechanical sludge dewatering system incorporated into the larger project.

At this time such a sludge dewatering system is expected to consist of a filter press or other mechanical dewatering equipment. Disposal of the dewatered sludge solids will be via landfill or incineration.

SECTION 8.0 - CONTINGENCY MEASURES

Design criteria for the Mary River Camp WWTF have been reviewed and revised to provide additional safety factor. The average occupancy level for Mary River has now been established at 123 persons, revised downward from the original 150 persons. In the event that the Mary River Camp occupancy expands to greater numbers, a provisional contingency involving the installation of additional RBC media can be implemented (refer to Section 3.3).

There is currently acceptable safety factor built into the Milne Camp WWTF. The WWTF and PWSP effluent discharge strategies and work plans are designed to be protective of the receiving environment and meet or exceed the requirements of the water license. Baffinland has incorporated the temporary storage ponds to be used during periods of start-up, shut-down or during periods of system upset.

The RBC units and the PWSPs are located sufficiently remote from surface water bodies. The RBC is a fully enclosed unit and the PWSPs are designed with an impermeable liner. In the event of a spill of untreated or partially treated sewage from these facilities, Baffinland will follow the procedures in its spill response plan. Sewage spills are treated the same as more immediately hazardous hydrocarbon based spills.

SECTION 9.0 - SAMPLING, MONITORING, AND REPORTING

Monitoring and reporting under the water license is described in the updated Site Water Management Plan. Generally, sampling and monitoring of the wastewater treatment systems will include the following:

- Regular sampling of sewage discharge at both WWTFs and PWSPs in accordance with water licence requirements.
- More frequent internal process sampling (minimum once per week) and monitoring (daily) to identify potential upset conditions early that could lead to non-compliance.
- Record of volumes of sewage effluent discharged and sludge generated in accordance with water licence requirements.
- Completion of daily checklists related to the O&M requirements for the facilities and the reporting of any upset conditions that require action.
- Aquatic effects monitoring program to confirm/validate environmental predictions.

The monitoring program will identify upset conditions related to the WWTF and PWSPs which will be immediately reported to the Camp Manager for corrective action.

SECTION 10.0 - EFFLUENT EFFECT ON RECEIVING WATERS

Knight Piésold Ltd. (KPL) and North/South Consultants (NSC) were retained by BIM in 2007 to assess potential effects on the receiving waters from the WWTF and confirm that facility designs were appropriate given the projected operating schedule, and projected discharge concentrations and loadings. Based on available receiving environment data and process design considerations, the final effluent from the facilities was expected to be non-acutely toxic. The potential for eutrophication of the fresh water receiving environment (Sheardown Lake) was also evaluated by means of a mass balance modelling approach that used conservative assumptions. The model results indicated that fully mixed concentrations of TSS, ammonia, and nitrate would be within CCME guidelines for the protection of aquatic life, and that total phosphorus increases would remain within triggers specified in the CCME guidance framework for the management of phosphorus. Localized and short-term effects to biota were predicted to occur in the vicinity of the outfall, including localized DO depletion and chronic effects related to TSS, ammonia, and nitrate. The conclusions of the 2007 assessment were that that overall sites and facilities were designed to limit the impact of the treated sewage effluent on the receiving environments.

The 2009 and 2010 WWMPs (Rev. 1 and 2, respectively) updated the 2007 modeling and monitoring results and assessment based on operational plans for 2009 which included the PWSP discharge scenario. A revised and updated technical memorandum was prepared and presented in Appendix G of the WWMP (Rev. 1 and 2) documents. The results of the memorandum indicated that the effects of the PWSP discharge events on water quality in Sheardown Lake have been negligible.

10.1 EFFLUENT TOXICITY

Environment Canada recommended toxicity testing of the treated effluent during review of BIM's application to amend its water license in 2007, and the Nunavut Water Board incorporated this requirement into the amended water license. The WWTFs have been designed accordingly.

Environment Canada developed a guideline with respect to ammonia in wastewater effluent discharges (Canada Gazette, 2004). This guideline recommends weekly testing of ammonia and pH in wastewater effluent to establish if the effluent is acutely toxic, based on the following relationship established between ammonia concentration and pH:

$$y = 306132466.34 \times (2.7183(-2.0437 \times pH))$$

This relationship between ammonia concentration, pH and acute toxicity is shown on the attached Figure 4, extracted from the Environment Canada guideline (Canada Gazette, 2004).

The acute toxicity of ammonia increases with increasing with pH. Knight Piésold measured pH in the marine waters of Milne Inlet on two occasions in August 2007 and recorded pH measurements of 8.05 and 8.15. During water quality monitoring of on-ice drilling in May and June 2007, a pH of 8.27 was recorded. Based on the higher of these two summer-time pH measurements (pH= 8.15), the threshold at which ammonia is acutely toxic in the receiving waters of Milne Inlet is 17.9 mg/L.

Based on a pH of 8.0 in Sheardown Lake, ammonia is acutely toxic in that receiving water at 24.3 mg/L.

The RBC treatment facilities include nitrification such that ammonia-nitrogen concentrations in the final effluent will be less than 2 mg/L, which is non-acutely toxic according to the Environment Canada guideline. The final effluent from the RBCs is therefore expected to be acceptable for direct discharge to the final receiving waters of Sheardown Lake and Milne Inlet before mixing. The final effluent discharged from the PWSPs will be non-acutely toxic as demonstrated by water quality and toxicity sampling/analyses that will be conducted prior to and during discharge using applicable and approved methods.

Testing completed on the Mary River and Milne RBCs and PWSP effluents have indicated that effluent samples collected have never been acutely toxic to the test organisms (Daphnia magna and rainbow trout) and no mortalities of either test organism occurred over the duration of the toxicity tests.

10.2 EFFECTS OF SEWAGE EFFLUENT DISCHARGES TO SHEARDOWN LAKE

The following provides a summary of the effects assessment to Sheardown Lake from the PWSP discharge events.

Approach

Baseline data provided the foundation for assessing effects of effluent discharge on water quality in the receiving environment. Specifically, the monitoring results were examined for:

- Differences, relative to baseline water quality conditions, measured in the open-water seasons of 2007, 2008, 2009, and 2010;
- Spatial differences in water quality conditions across Sheardown Lake, in relation to distance from the effluent outfall; and
- Comparison to the Canadian Council of Ministers of the Environment (CCME) guidelines for the protection of aquatic life (PAL).

Sewage effluent quality, discharge rates, and acute toxicity were monitored during discharge to Sheardown Lake in August 2009. As an additional screening tool, effluent quality was also compared to CCME PAL water quality guidelines. As CCME guidelines are representative of "chronic" conditions, this comparison to effluent quality is highly conservative. However, where parameters are shown to meet CCME guidelines at the end-of-pipe, there is high certainty that the effluent would not lead to in-lake chronic toxicity.

Lastly, to provide an additional measure of potential effects of the discharge of treated sewage effluents on water quality in Sheardown Lake, a mass balance modelling approach was applied using the measured effluent discharge volume and effluent quality for the discharge period in August 2009.

Baseline Water Quality and Limnology of Sheardown Lake

Detailed descriptions of the water quality in Sheardown Lake were provided in the 2010 WWMP (rev. 2) and included information collected up to the fall of 2009. Figure 5 presents the bathymetry of the northwest basin of Sheardown Lake ("Sheardown Lake NW") and Figure 6 presents the locations of the sampling sites. The results of water quality monitoring completed during the open water season of 2011, subsequent to PWSP discharge, are similar to the results observed in 2009.

Lower DO concentrations at depth have been observed at several sites in winter and concentrations were below the CCME PAL guidelines at one site in 2007 and numerous sites in winter 2009.

In general, Sheardown Lake NW is a relatively clear lake (low turbidity and high Secchi Disk depth), is alkaline in the open-water season (pH > 7) and near neutral in the winter (Mean pH of 7.03 in May 2007), soft (hardness typically at or below 60 mg/L), and contains a relatively low concentration of dissolved solids (mean of 71 mg/L in the open-water season and 102 mg/L in winter). Like other lakes in the area, Sheardown Lake NW is nutrient-poor and contains low levels of total phosphorus (TP) and inorganic forms of nitrogen. TP was generally near or below the analytical detection limit (0.003 mg/L) over the period of baseline studies. Lake-wide mean TP concentrations were somewhat higher in the open-water season of 2008 than 2007. Similarly, nitrate, nitrite, and ammonia concentrations are low and were generally not detected over the baseline studies.

According to the CCME phosphorus guidance framework, Sheardown Lake would be classified as "ultra-oligotrophic" and "oligotrophic" on the basis of TP concentrations measured in 2007 and 2008 Similarly, on the basis of chlorophyll a concentrations measured in the open-water seasons of 2007 and 2008, Sheardown Lake would be categorized as ultra-oligotrophic or oligotrophic.

Effluent Discharge and Effluent Quality

PWSP treated sewage effluent discharge was monitored for toxicity and compared to CCME PAL guidelines (CCME 1999; updated to 2010) to assess chronic toxicity of undiluted effluent. All measurements of pH and ammonia were within or below CCME PAL guidelines. There was one exceedance of aluminum measured in a single sample which likely reflects an upset associated with the use of aluminum in the sewage treatment process. Aluminum was below the CCME PAL guideline in Sheardown Lake including the site nearest the effluent outfall.

Ambient Water Quality Monitoring

Water quality monitoring is conducted just after PWSP discharge using two approaches: effluent plume monitoring, and core water quality monitoring. The plume monitoring uses field parameters to detect and characterize the plume in the vicinity of the outfall. The core water quality monitoring was conducted at five sites and analyzed for a broad range of parameters.

The plume monitoring results for 2009 and 2011 indicated that there was no evidence of an effluent plume at the time of monitoring. Most routine water quality variables measured across four

sampling sites in Sheardown Lake were similar to lake-wide means obtained in 2007 and 2008 indicating that effluent discharge had no notable effect on water quality in the lake. Spatially, most routine water quality variables were similar across sites sampled in Sheardown Lake and there was no clear gradient from the effluent outfall to more distant sampling sites. All measurements of routine water quality variables (nitrate, ammonia, pH, dissolved oxygen, and total suspended solids) were within CCME PAL guidelines in August 2009 and feacal coliform bacteria were not detected in the lake. A comparison of mean concentrations of total and dissolved metals for the open-water seasons of 2007 and 2008 and the August 2009 and 2011 monitoring results indicates that conditions were relatively similar across years. The key exceptions were notably higher concentrations of total aluminum and sodium measured near the effluent outfall relative to other more distant sites. Although aluminum was within the range observed in Sheardown Lake NW in 2008, sodium was elevated relative to baseline studies.

Mass Balance Modelling

A whole-lake mass balance model was used to estimate the cumulative effects of treated sewage effluent discharged to Sheardown Lake NW in August 2009. The mass balance model indicates that if all effluents were instantaneously mixed in the lake (with no losses of water quality constituents), that the effects of the effluent on whole-lake pH, ammonia, TKN, TSS, TP, BOD, and faecal coliform bacteria would not be detectable.

Summary and Conclusions

Overall, the available water quality monitoring results indicate that discharge of treated sewage effluent did not result in notable changes in water quality in Sheardown Lake in August 2009 and 2011, with the possible exceptions of slight elevations in total sodium and aluminum and chlorophyll a near the outfall. Effluent discharge does not appear to have caused or contributed to exceedances of CCME PAL water quality guidelines.

Mass-balance modeling indicated that the effects of discharge of the PWSP effluent to Sheardown Lake in August 2009 would not have been expected to cause a detectable change in routine water quality lake-wide.

10.3 EFFECTS OF SEWAGE EFFLUENT DISCHARGES AT MILNE INLET

Receiving Drainage Ditch

The receiving environment for the treated sewage effluent at Milne Inlet is a large, wide ditch, several hundred metres in length, which reports to Milne Inlet. This drainage ditch has a small associated catchment of approximately 0.25 km^2.

Milne Inlet - Final Receiving Water

Available bathymetry for Milne Inlet is shown on Figure 3. The measurements shown on Figure 3 have not been corrected for tidal variations so are considered approximate. Near-shore water

depths have not been collected but water depths ranging from 1.5 m to 2.8 m were measured in excess of 60 m from shore, after which the water depth quickly increases to 10 to 15 m. The assumed average water depth from the shoreline to 60 m from shore is 1.0 m. Milne Inlet has semi-diurnal tides with the lowest tide typically ranging from 0.1 to 0.3 m and the highest tide typically ranging from 2.2 to 2.4 m (Department of Fisheries and Oceans, 2006). Current velocity within the Eclipse Sound area generally ranges from 15-35 cm/s (Buckley et al. 1987; Dickens et al. 1990).

Data collected in Ragged Channel, located at Cape Hatt near the northern end of Milne Inlet, indicated that temperature and salinity characteristics at that site were typical of the region (Buckley et al. 1987). In the ice-free season, freshwater inputs from snow melt and rain run off establish a strong surface layer characterized by lower salinity and higher water temperature, which ultimately is mixed with underlying cooler and more saline water by wind and currents. As the open water season progresses and freshwater inputs are reduced, the strength of the surface layer is reduced and thermal and saline stratification is reduced.

At Ragged Channel, water temperature during ice covered conditions (June, 1980) was 1.5ºC throughout the water column. During open water conditions in August, 1980, at the same location, water temperature was approximately 4ºC at the surface and declined to -1ºC by about 70 m depth (Buckley et al .1987). Similarly, salinity was uniform at ~32 ppt through the water column during June, but was stratified during August. At that time, surface salinity was about 24 ppt, and increased through the upper 10 m or so of the water column to about 30 ppt (Buckley et al. 1987). Recent salinity measurements at surface where the drainage ditch reports to Milne Inlet measured 22.9 ppt (Knight Piésold, unpublished data).

In-situ water quality measurements were recorded by Knight Piésold on three occasions at the shore where the ditch discharges in August 2007, and water temperatures ranged from 4.4ºC to 9.2ºC, pH ranged from 8.05 to 8.15, and dissolved oxygen ranged from 10.75 to 11.30 mg/L (Knight Piésold, unpublished data).

Discharge Conditions

Discharge conditions will vary with the season. In early summer (i.e. July), the active layer thaws and sea ice deteriorates and pulls away from shore. July has the largest monthly runoff and is also the month subject to break-up. For example, in early July 2007 and 2008, most of the sea ice at the lower portion of the inlet had melted, whereas sea ice in the upper half of the inlet towards the mouth was still intact. Phillips Creek would appear to have a meaningful influence on the deterioration of ice at the head of the inlet. Freeze up begins in late September or early October. Open water is present roughly from July through September.

The effluent is trucked or piped to a dedicated location where it is released to the ditch (refer to Figure 3). Some infiltration of the effluent into the active layer is expected to occur as the effluent flows towards Milne Inlet, depending upon the progress of ground thaw. During regular RBC operations, it is expected that at the low rate of discharge to the ditch that very little to none of the treated effluent will report directly to Milne Inlet.

During winter operations, effluent discharged to the drainage ditch freezes. The maximum volume of effluent that could be discharged to the ditch during this 8-month period (measured as water and not ice) is roughly 3,240 m^3 based on the peak design capacity of the WWTF. Actual volumes will be less. Due to low temperatures, the effluent will freeze within the ditch. During the spring thaw, the frozen treated effluent will melt and flow to the thawing ice or marine waters of Milne Inlet. It is estimated that the ice pack will melt over an approximate four week period from approximately mid-June to mid-July. Since the final effluent will be non-toxic, no meaningful environmental effects are anticipated under this discharge scenario. The winter storage, melting, and subsequent mixing in the final receiving waters of Milne Inlet provide some contingency if the final effluent does not achieve the expected treatment levels. A mixing zone in Milne Inlet has not been calculated on the basis that the effluent already meets discharge and acute toxicity requirements. Mixing zones are commonly incorporated into the design of sewage management facilities.

The decanting of the Milne PWSP during June 2009 involved the discharge of approximately 200 m^3 of effluent over a one week. The small volume of discharged effluent was not acutely toxic based on testing results and was unlikely to have had an adverse effect on the receiving environment of Milne Inlet due to mixing due to tidal current action.

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FIGURES

Figure 1 Project Location Map
Figure 2 Existing Site Layout at Mary River
Figure 3 Existing Site Layout at Milne Inlet
Figure 4 Acute Toxicity of Ammonia with pH
Figure 5 Sheardown Lake NW Bathymetry
Figure 6 Sheardown Lake NW Water Quality Sites

XREF FILE(S): IMAGE FILE(S): 4 Baffinland logo-blg corp Baffinland logo_new logo-blg corp NORTH BAFFINLAND

ᐊᑯᑭᑐᐃᑦ ᑭᑭᓯᓗᓂᖅ
BAFFIN BAY

ᑎᑎᒪᓕᒃᑲᑦ ᐊᑭᐊᓂᑐᖅ ᑭᑭᑦᓗᖅ
BYLOT ISLAND

ᐃᕆᐊᑦᓴᖅ
ARCTIC BAY

ᓇᓂᓯᕕᖅ
NANISIVIK

ᑎᑎᒪᓕᒃᑲᑦ ᑕᓇᐅᖅ
ECLIPSE SOUND

ᑎᑎᒪᓕᓴ
POND INLET

ᑭᓚᐃ
MILNE INLET

ᑭᓚᐃᓂ ᑕᒪᒫᖅ ᐊᒻᒪ ᑐᓴᑦᑕᒫᖅ
MILNE INLET CAMP AND PORT

ᑭᓚᐃᓂᑦ ᐊᖏᕐᑎᑎ
MILNE INLET TOTE ROAD

ᓄᓇᕗᓂ ᐅᕗᖅᓂᐊᒫᖅ
MARY RIVER SITE

ᐊᖑᑎᓯᑦ ᐊᕐᓗᐊᖏᓂ ᓄᓇᕆᐅᔨᓪᓚᖅ
MID RAIL CAMP

ᓄᓇᓕᐅᑎᓯᒃ ᐊᖏᕐᑎᑎᓂᐊᑦᑕᖏᑦ
PROPOSED RAIL ALIGNMENT

ᐃᐱᑭᑐᑦᓴᐊᖏᑦ ᑕᒪᓐᓇᐅᔨᖅ
ᐊᒻᒪᓗ ᑐᓴᑦᑕᒫᖅ
STEENSBY INLET CAMP
AND PROPOSED PORT

ᑲᖏᑦᓗᒃᓴᐊᖅ
STEENSBY INLET

ᑲᓪᓕᐅᖅ
KOCH ISLAND

ᐃᒡᓗᓕᒃ
IGLOOLIK

ᓴᓕᓐᓂᖅ
ROWLEY ISLAND

ᐅᓐᓂᐅᖅ
HALL BEACH

ᐃᒡᓗᓕᑦ ᐃᒪᖏᑐ
FOXE
BASIN

ᕿᑭᑦᓯᓗᒃ
BAFFIN ISLAND

ᑕᓪᓕᔪᓐ
CLYDE RIVER

ᑲᓇᑕ
CANADA

ᑐᑭᓯᐊᖅᑕᖏᑦ
LEGEND:

- ᐃᒥᖅ WATER
- ᑕᒪᒫᖅ ᓄᓇᖏᑦ CAMP LOCATION
- ᓄᓇᓕᒃ COMMUNITY

ᐊᖑᑎᓯᖏᑦ (ᓇᓕᑦᑕᓯᒪᔪᖅ) SCALE (APPROX.) 40 20 0 40 80 120 160 200 ᑭᒥᑕ km

Baffinland
Iron Mines Corporation

ᓄᓇᕗᓂ ᐅᕗᖅᓂᐅᑦᑐᑦ MARY RIVER PROJECT

ᐱᓕᕆᔨᖅᖏᑦ ᓄᓇᖏᒃᑐ ᓄᓇᕗᐊᖏᑦ
PROJECT LOCATION MAP

P/A NO.	REF.	REV.
NB102-181/15	NB09-00214	0

ᑎᑎᕆᐅᕗᖅᓯᒪᔪᖅ **FIGURE** 1

NORTH BAY ON_SAVED:k:\102-00181-15\Assignment\Acad\Figs\A04_3/13/2009 8:57:10 AM PRINTED:3/13/2009 9:49:30 AM_A_Landscape, Bpark

7917494 N
7916250 N
7915000 N
7913750 N
7912500 N
7911250 N
558750 E
560000 E
561250 E
562500 E
563750 E
565000 E

ᓄᓇᕗᑦ 1 ᑲᓱᕐᓂᓪᓗᒍ ᐱᖃᓐᓇᐅᑎ 2484
DEPOSIT NO. 1 MINING LEASE 2484

ᐊᑭᑐᐅᓪᓚᕆᔨᖅ ᐊᒥᓱ ᐊᑲᓱᕐᓗᓂᒃ ᑲᓱᕐᓂᐊᕐᓇᓚᕆᔨᖅ ᖃᓄᑎᑦ ᐊᖏᕐᕈᓂᐊᕆᔨᒃ
PROPOSED OPEN PIT OUTLINE

ᓴᓇᓴᒃᑕᑦ ᓯᓚᑦᑎᓂᐊᕐᓂᒃᑐᓂᒃ ᑲᓇᖅᑐᖅ
WEATHERED ORE STOCKPILE

ᑲᓇᓴᒃᑐᓂᒃ ᑲᑎᕐᓂ ᐃᓗᐊᓂᐊᕆᔨᖅ
BULK SAMPLE PIT

ᐅᕐᑲᑎᑦᓗᓂᒃ ᐊᒡᒐᖅ
HAUL ROAD

ᐅᓪᓗᖅᑐᑦ ᐊᑲᓱᕐᓗᓂᒃ ᐊᑐᓕᕐᓂᖅ ᐊᑐᖅᑐᓂᒃ ᐊᓂᒍᖅᑕᐅᓂᒃ ᐊᓂᒍᖅᑕᐅᓂᒃ ᐃᓚᖏᓪᓕᐊᓂᒃ ᐊᓯᔪᓐᓇᖅᑐᑦ ᐊᓂᒍᖅᑕᐅᓂᒃ ᐊᓂᒍᖅᑕᐅᓂᒃ ᐊᓂᒍᖅᑕᐅᓂᒃ

ᖃᓄᐃᓕ
MILNE INLET

1500 E
2000 E
2500 E
3000 E
3500 E
4000 E
4500 E
5000 E
7977000 N
7976500 N
7976000 N
7975500 N
7975000 N

27.28 24.4 21.6 20.1 15.5 12.3 10.1 7 21.2 22.49 16.11 12.35 9.65 10.8 11.27 6.5 2.15 1.5 26 28.66 29.21 28.47 21.1 16.72 29.96 24.22 19.23 17.67 11.1 9.24 8.6 2.1 17.1 10.4 2.8 5.2 5.8 5.9 2.8 2.7

ᐃᓂᒪᓕᒃ ᐊᑐᕐᓂᖅ ᐊᑐᖅᑕᐅᓯᒪᔪᖅ ᑲᑎᒪᔨᖅᑕᐅᓯᒪᔪᖅ ᐊᑐᖅᑕᐅᓯᒪᔪᖅ ᐃᓕᓴᕐᓂᐊᕐᓂᖅ ᑭᒃᑯᐊᒥᓂᖅ (ᐱᖓᓱᖅ 2008)
TEMPORARY SPUD BARGE ARRANGEMENT (REMOVED OCTOBER 2008)

ᐃᓕᓴᕐᓂᐊᕐᓂᖅ
EXISTING CABIN

ᓴᖅᑭᑎᒃ ᐊᒪᓗ ᓴᖅᑭᑎᒃ ᑲᑎᒪᓂᖅ ᐃᓄᖕᓇᖅ
ORE PAD AND RESIDUAL ORE

ᓴᓇᒪᒋᑦᑐᐃᓐᓇᖅ ᐊᑕᐅᓯᐅᓕᕆᓂᖅ ᐃᒥᐊᓕ ᑕᓯᓂᐊᓕᕆᓂᖅ
POLISHING/WASTE STABILIZATION POND

APPROXIMATE DISCHARGE LOCATION FROM WWTF OR PWSP

ᐅᑦᓯᐊᓗᐅᑎᐊᕐᓂᖅ
FUEL STORAGE

ᐃᓄᐃᑦᑐᖓᓂᒃ ᐃᓕᓐᓄᐊᕐᓂᖅ
LINED STORAGE AREA

ᒥᑦᑖᕐᓂᖅ
AIRSTRIP

ᓴᓇᔨᕐᓂᖅ ᐃᓕᓐᓄᑦᑎᓂᒃ
LINED STORAGE

ᐃᓂᒪᓕᒃ ᓄᓇᕗᑦ
FUEL FARM

ᓴᓇᐅᓂᒃ ᓄᓇᕗᑦ
TRAILER CAMP

ᐊᐅᓚᐅᕐᓂᓕᕆᔨᖅ ᐃᓕᑦᒧᖅ ᓴᓇᒪᓚᐃᐃᓂᖅ
WASTEWATER TREATMENT FACILITY

ᓴᖅᑭᑎᒃ
GARAGE

ᐃᓂᒪᓕᒃ
LAYDOWN AREA

ᐃᓂᒪᓕᒃ
LAYDOWN AREA

ᐅᐱᒪᑦᑐᐃᓐᓇᖅ
INCINERATOR

ᐊᑦᑕᓐᓇᑐᓂᒃ ᑲᑎᒪᓂᖅ ᖃᓄᐃᓕᓂᕐᒧᑦ ᐊᔾᓂᓕᕆᓂᖅ
HAZARDOUS WASTE BERM

ᓴᖅᑭᑎᒃ ᐊᒪᓗ ᓴᖅᑭᑎᒃ ᐱᖓᓱᖅ ᐃᓄᖕᓇᖅ
MILNE INLET TOTE ROAD

ᐅᖃᐅᓯᖅ ᐊᑐᖅᑕᐅᓯᖅ 1
ROCK QUARRY NO. 1

ᐅᖃᐅᓯᖅ
BORROW PITS

ᐃᓕᓴᕐᓂᐊᕐᓂᖅ ᐅᖃᐅᓯᖅ 1
BORROW SOURCE NO. 1

25
50
75
100

ᐅᑭᐅᖅ/ᑲᒪᓚᑦᓯᓂᖅ/ᑲᒪᐊᒪᐅᓕᖅ
RIVER/STREAM/DRAINAGE
ᓇᓗ ᑲᓚᒥᓂᐊᓕᒫᓂᖅ ᐊᒪᐅᓂᖅᓯᓂᑦᓯᓂᖅ
DIRECTION OF SURFACE WATER RUNOFF
ᖃᓄᐃᓕᓂᒃ ᐊᑐᖅᑎᒃ ᐅᓪᓗᑦᑎᐊᓂᖅ
MILNE INLET TOTE ROAD
ᐊᑐᖅᑎᒃ
ROAD
ᐅᖃᐅᓯᐅᑦᑎᑦᓯᓂᖅ (ᐃᓄᐃᑦ ᓄᓇᕗᒻᒥᓂ ᐳᓄᓕᔾᔪᑎᒃᑐᓂᖅ)
EXISTING ROCK QUARRY (IOL COMMERCIAL LEASE)
ᐅᖃᐅᓯᐅᑦᑐᖅ (ᐃᓄᐃᑦ ᓄᓇᕗᒻᒥᓂ ᐳᓄᓕᔾᔪᑎᒃᑐᓂᖅ)
EXISTING BORROW AREA (IOL COMMERCIAL LEASE)
ᐃᓄᖕᓇᖅ ᖃᓄᖅ ᓴᓇᔨᓂᒃᑐᖅ ᐊᑐᖅᑕᐅᓯᒪᔪᖅ ᐊᔾᔨᒌᒍᓐᓇᖅᑐᑦ
BAFFINLAND'S COMMERCIAL LEASE ON INUIT OWNED LAND

ᐃᓄᖕᓇᖅ
WATER
ᓴᖅᑭᑎᒃ ᓄᓇ
WETLAND
ᐃᓂᒪᓕᒃ
LAYDOWN AREA

ᐅᖃᐅᓯᖅ
LEGEND:

ᖃᓄᐃᓕᓂᒃ ᐊᑐᖅᑕᐅᓯᒪᔪᖅ
ᐳᓚᕐᓗᒍ ᐊᑐᖅᑕᐅᓯᒪᔪᖅ

ᐅᖃᐅᓯᖅ ᐊᑐᖅᑕᐅᓯᒪᔪᖅ ᐊᑐᖅᑕᐅᓯᒪᔪᖅ ᐊᑐᖅᑕᐅᓯᒪᔪᖅ

ᐅᖃᐅᓯ

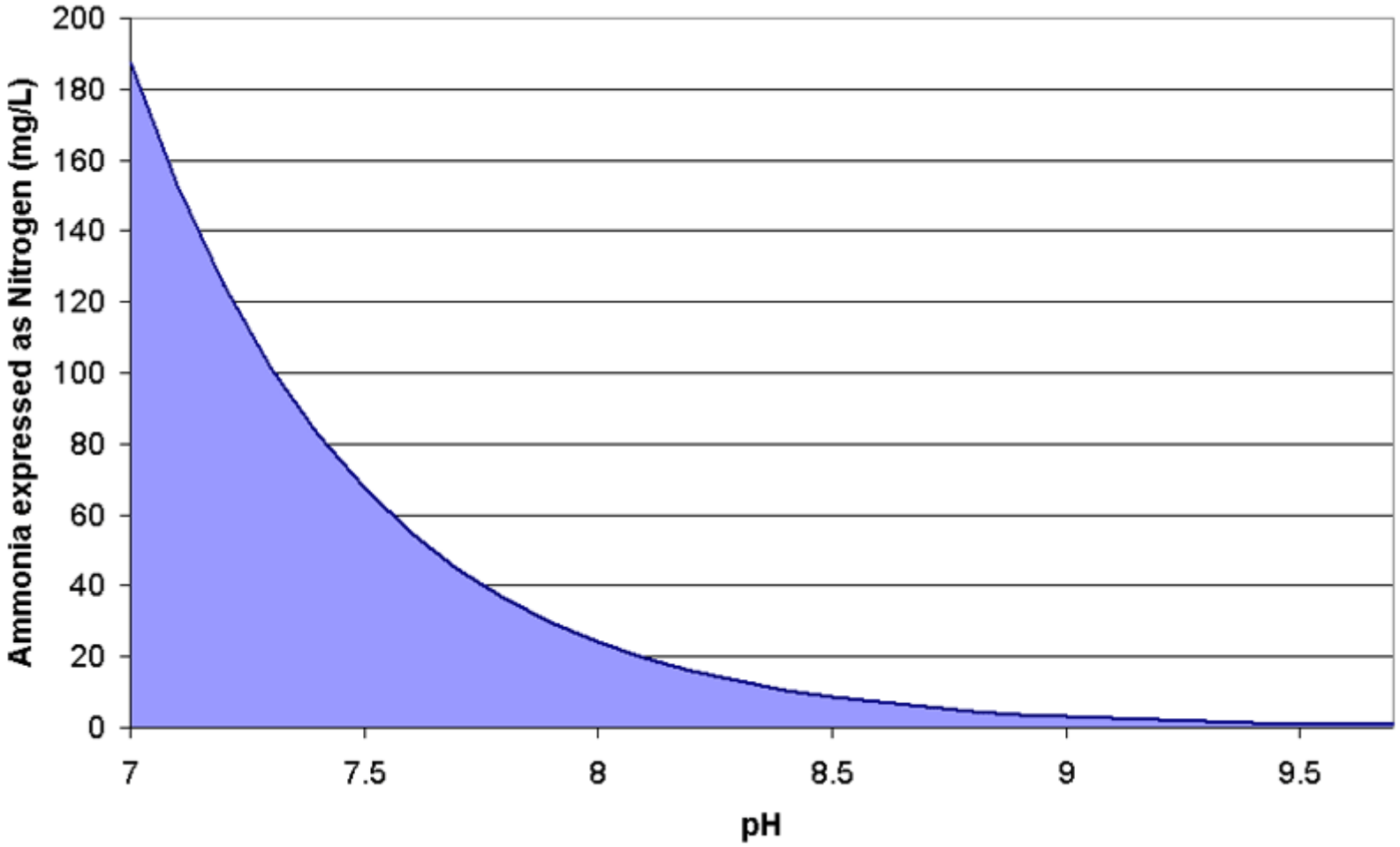


Figure 4. Acute Toxicity of Ammonia with pH.

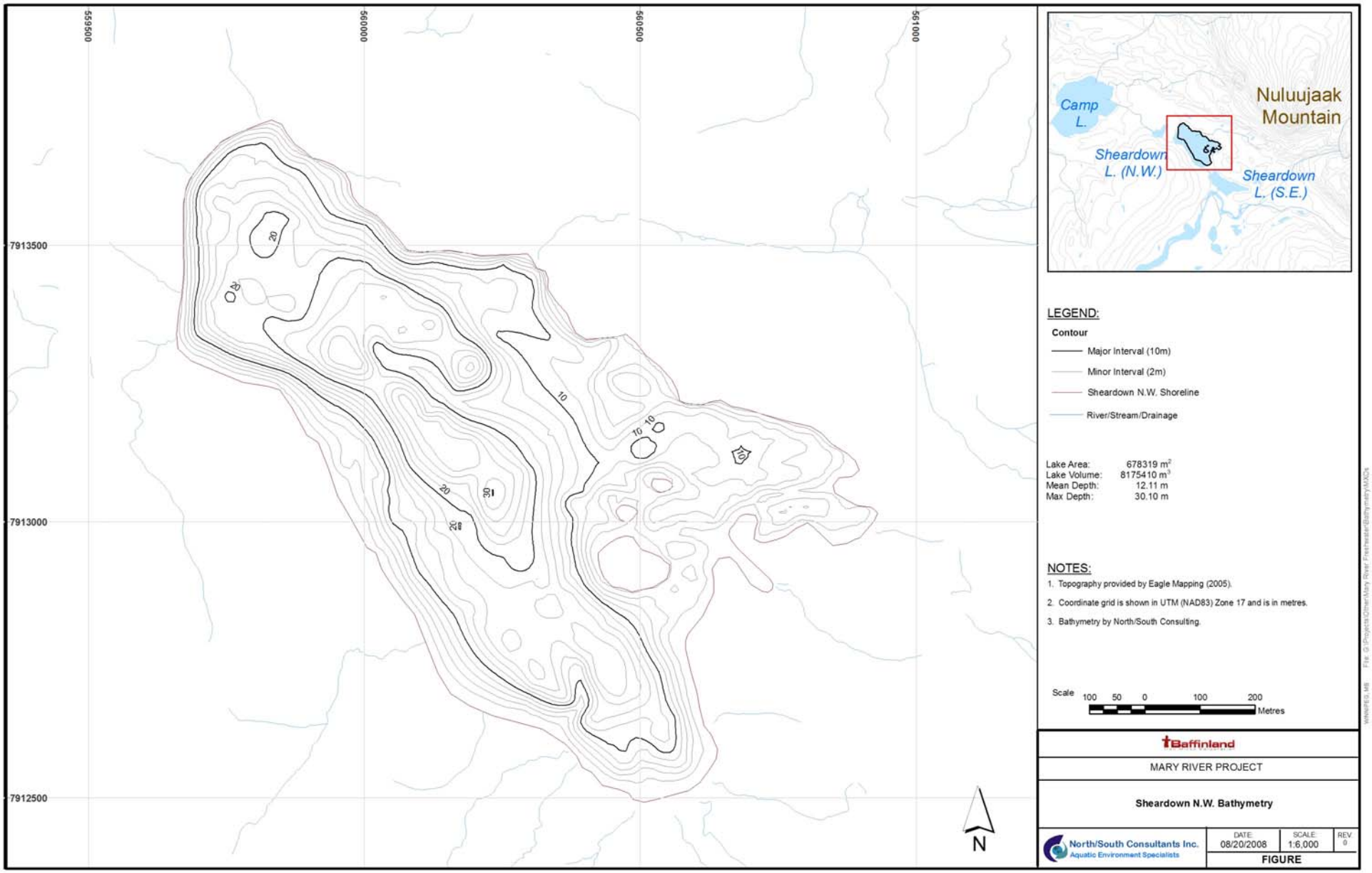


Figure 5: Sheardown Lake NW Bathymetry

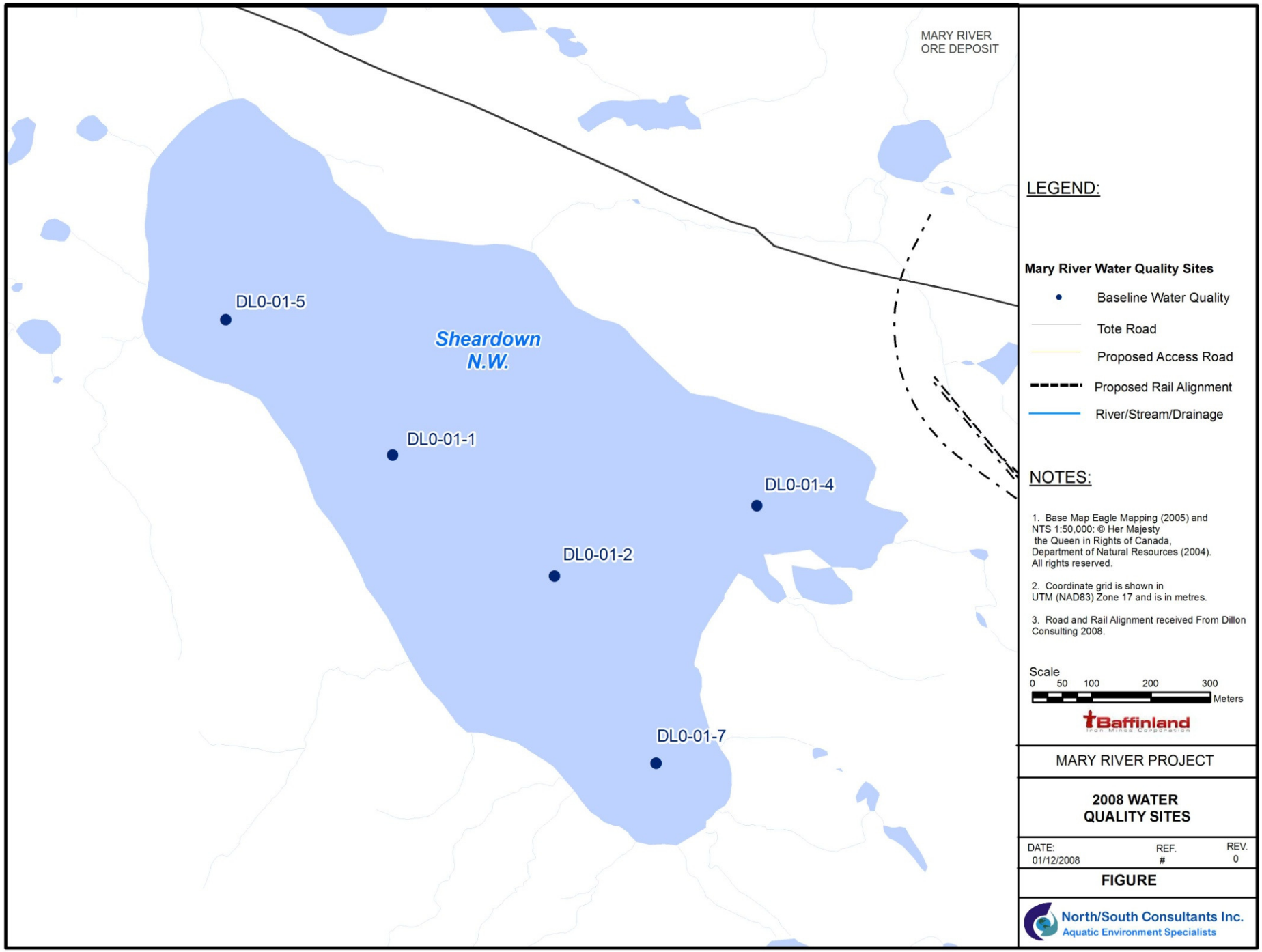
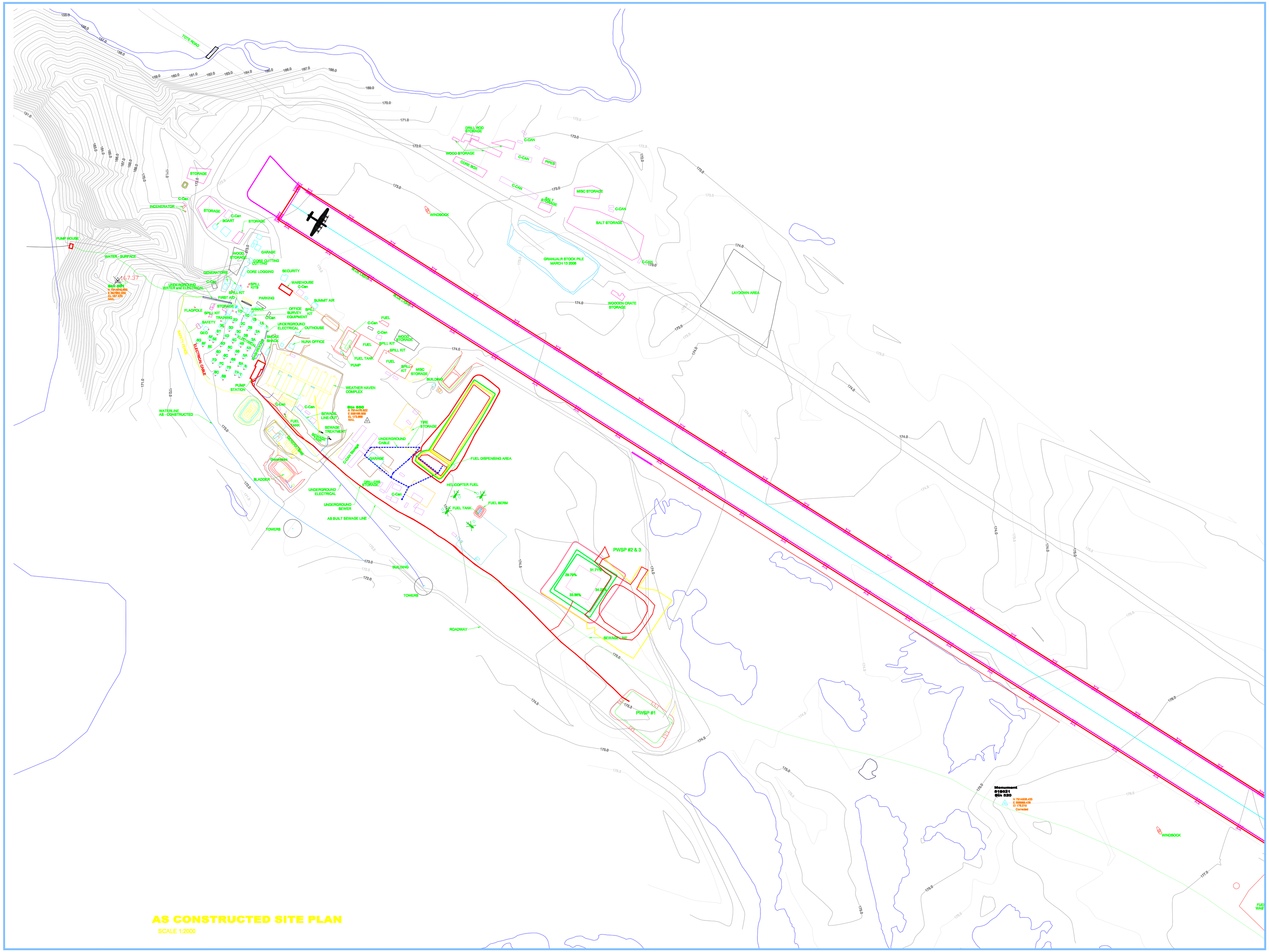


Figure 6: Sheardown Lake NW Water Quality Sites

DRAWINGS

Drawing 002 As Constructed Mary River Site Plan
Drawing 003 Milne Inlet As Constructed Site Plan
Drawing 004 Mary River Camp Sewage Discharge Profile & Details
Drawing 005 As Constructed Mary River PWSP No. 1 - Plan and Sections
Drawing 006 As Constructed Mary River PWSP No. 2 and No. 3 Plan and Sections
Drawing 007 As Constructed Milne Inlet PWSP No. 3 Plan and Profiles



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Project

MARY RIVER PROJECT
BAFFINLAND IRON MINES CORPORATION

BAFFIN ISLAND NUNAVUT

Drawing

AS CONSTRUCTED MARY RIVER SITE PLAN

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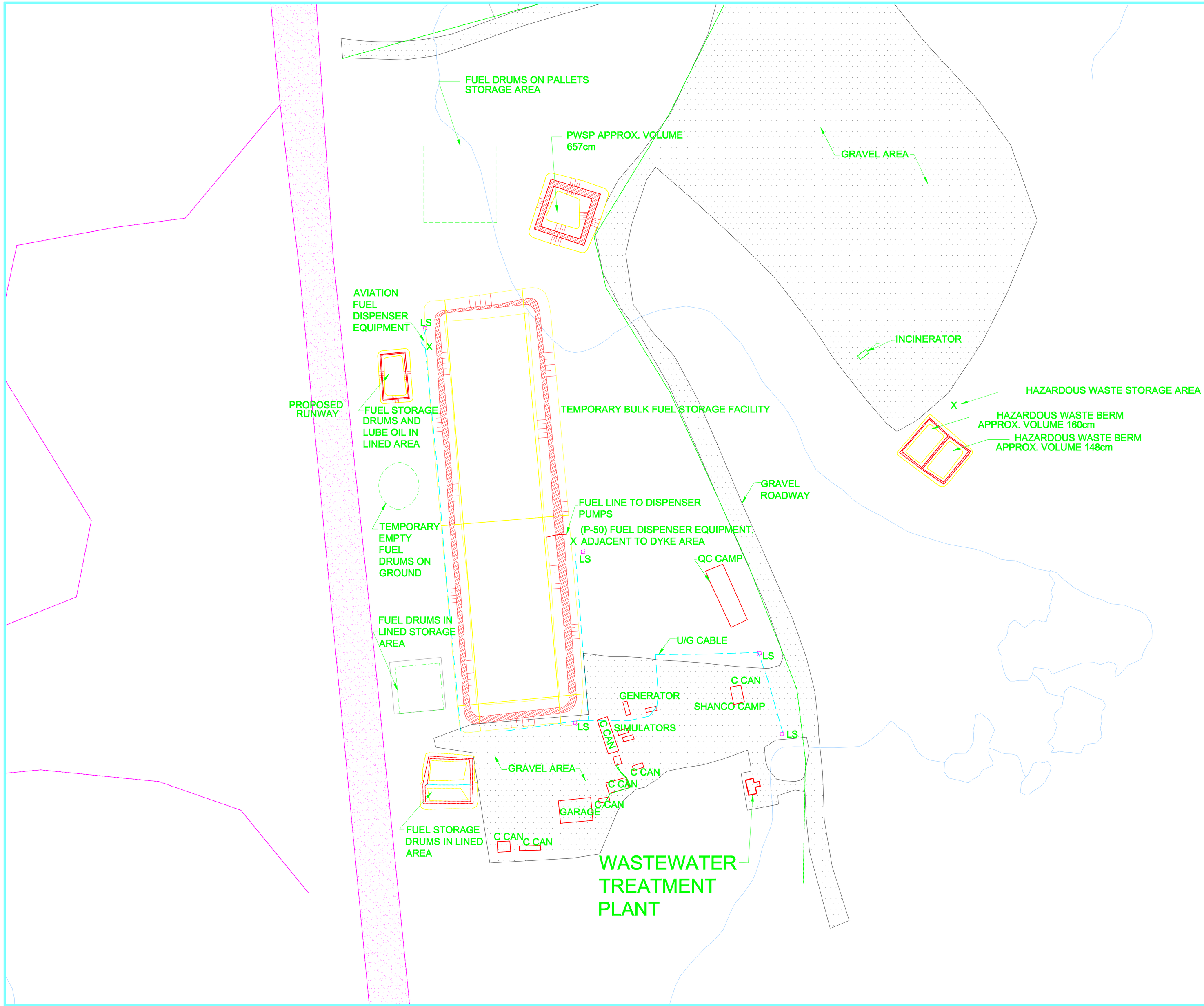
Checked MK	Drawing Number 002
Approved	

F4-44 of 486



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MILNE INLET
AS CONSTRUCTED SITE PLAN

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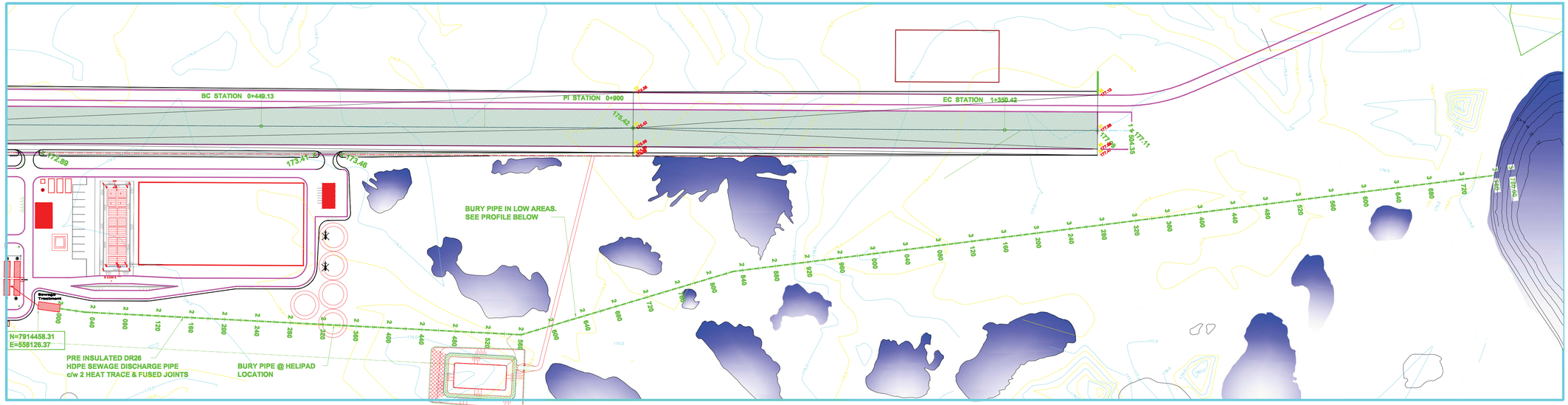
Scale 1:1000	Job Number 09-058
Drawn ABI\SO	
Checked	Drawing Number 003
Approved	

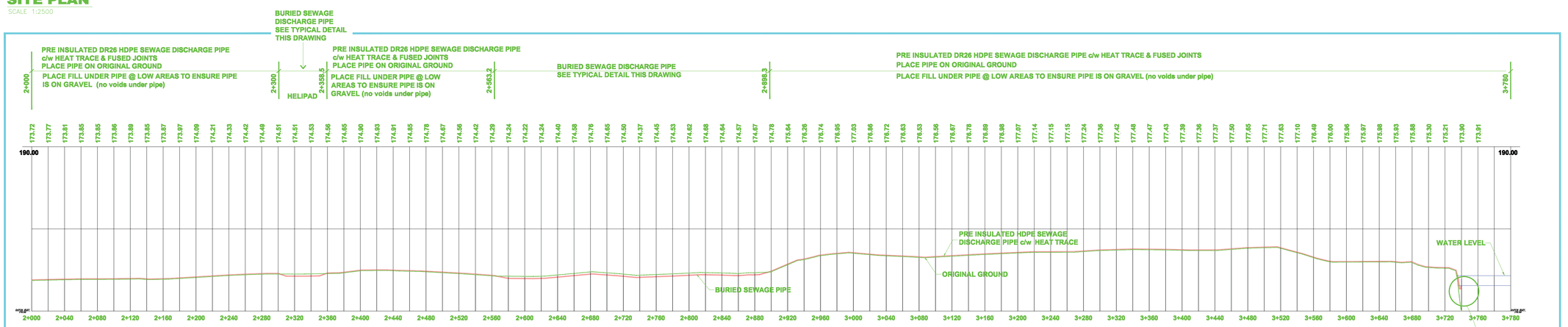
F4-45 of 486

SITE BENCH MARK



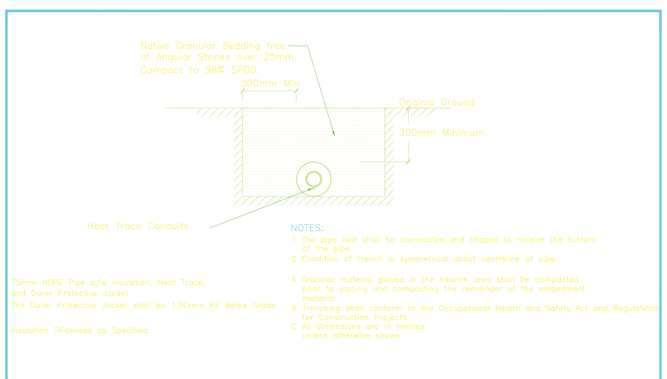
SITE PLAN

SCALE 1:2500

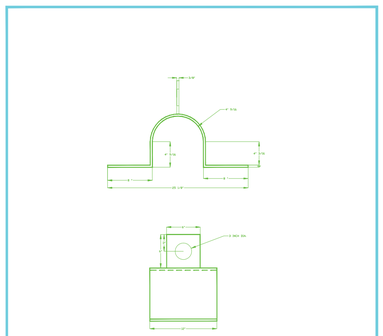


PROFILE THRU SEWAGE DISCHARGE PIPE

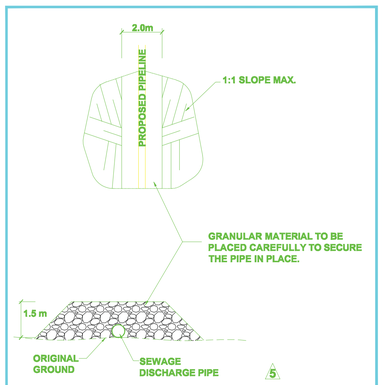
SCALE 1:2000 HORIZONTAL
SCALE 1:200 VERTICAL

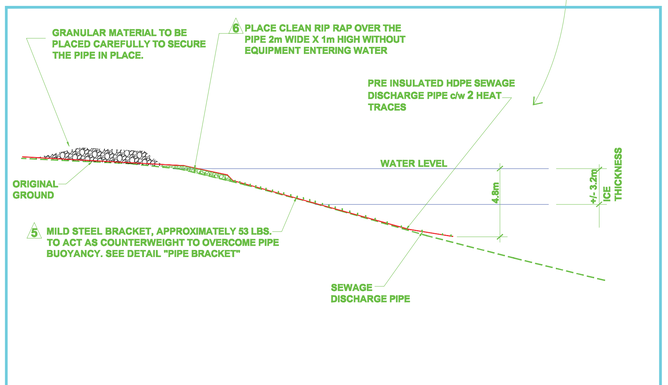


EFFLUENT OUTFALL PIPE DETAIL



PIPE BRACKET





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Description	Date	No.
Revisions and Issues		
RIP RAP ADDED	Aug. 29/08	6
RIP RAP REMOVED AND BRACKET ADDED	Jul. 29/08	5
NEW DETAIL	Oct. 29/07	4
REVISED PIPE INSTALLATION	Oct. 9/07	3
ISSUED FOR CONSTRUCTION	July 03,2007	1
ISSUED FOR TENDER/REVIEW	May 24,2007	0

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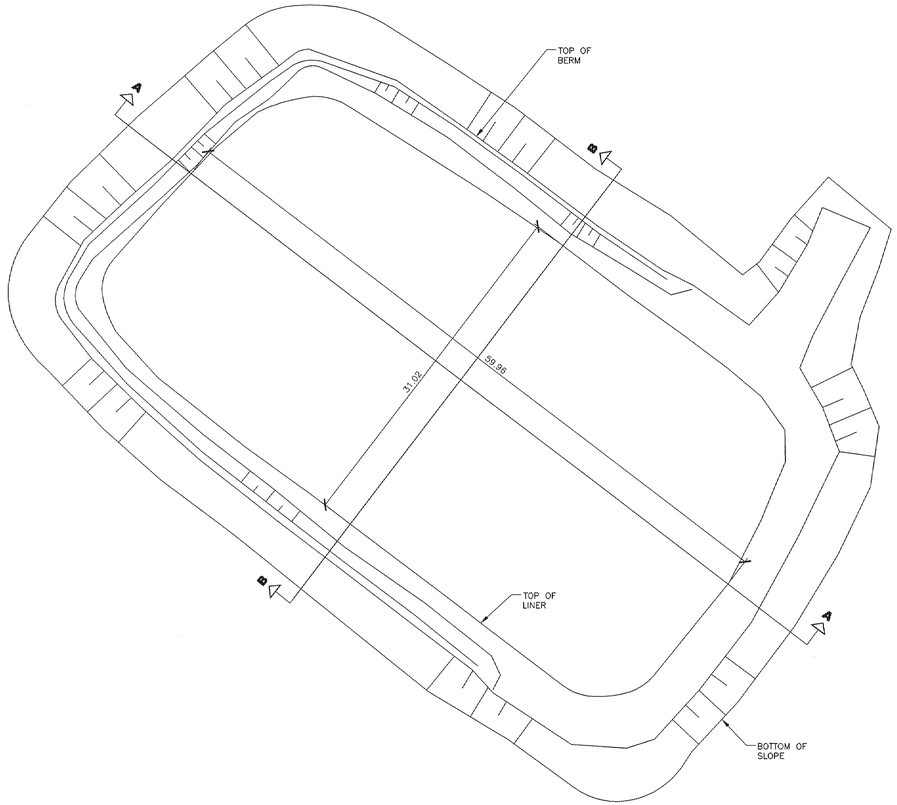
BAFFINLAND IRON MINES. CORP
BAFFIN ISLAND, NUNAVUT

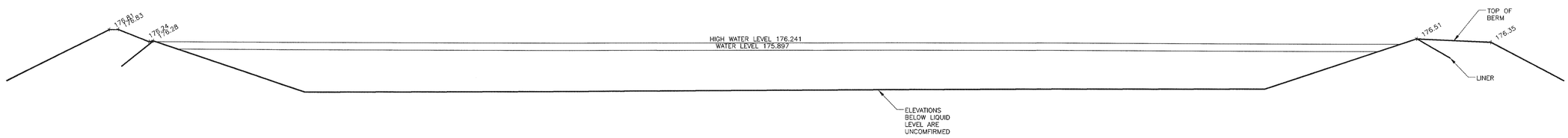
Drawing
MARY RIVER CAMP SEWAGE DISCHARGE PLAN/PROFILE & DETAILS

Date JULY 2008	CADD File Number 06-090/dwg/issued/C103-R6 and 09-058/report/wwmp
Scale AS NOTED	Job Number 09-058
Drawn rjr/SO	
Checked BHM	Drawing Number 004
Approved	

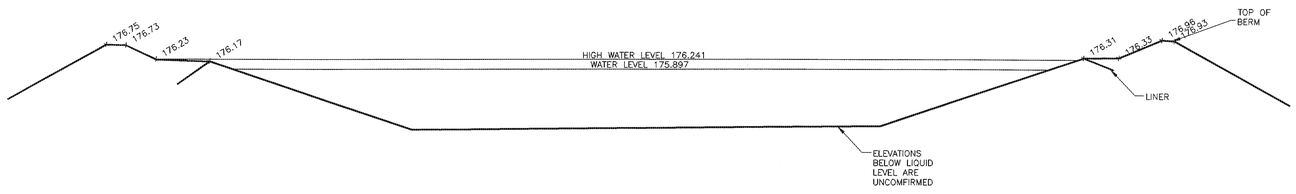
PWSP #1 AS BUILT PLAN VIEW

1:250





PWSP SECTION A
1:100 C302



PWSP SECTION B
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BAFFINLAND IRON MINES CORPORATION
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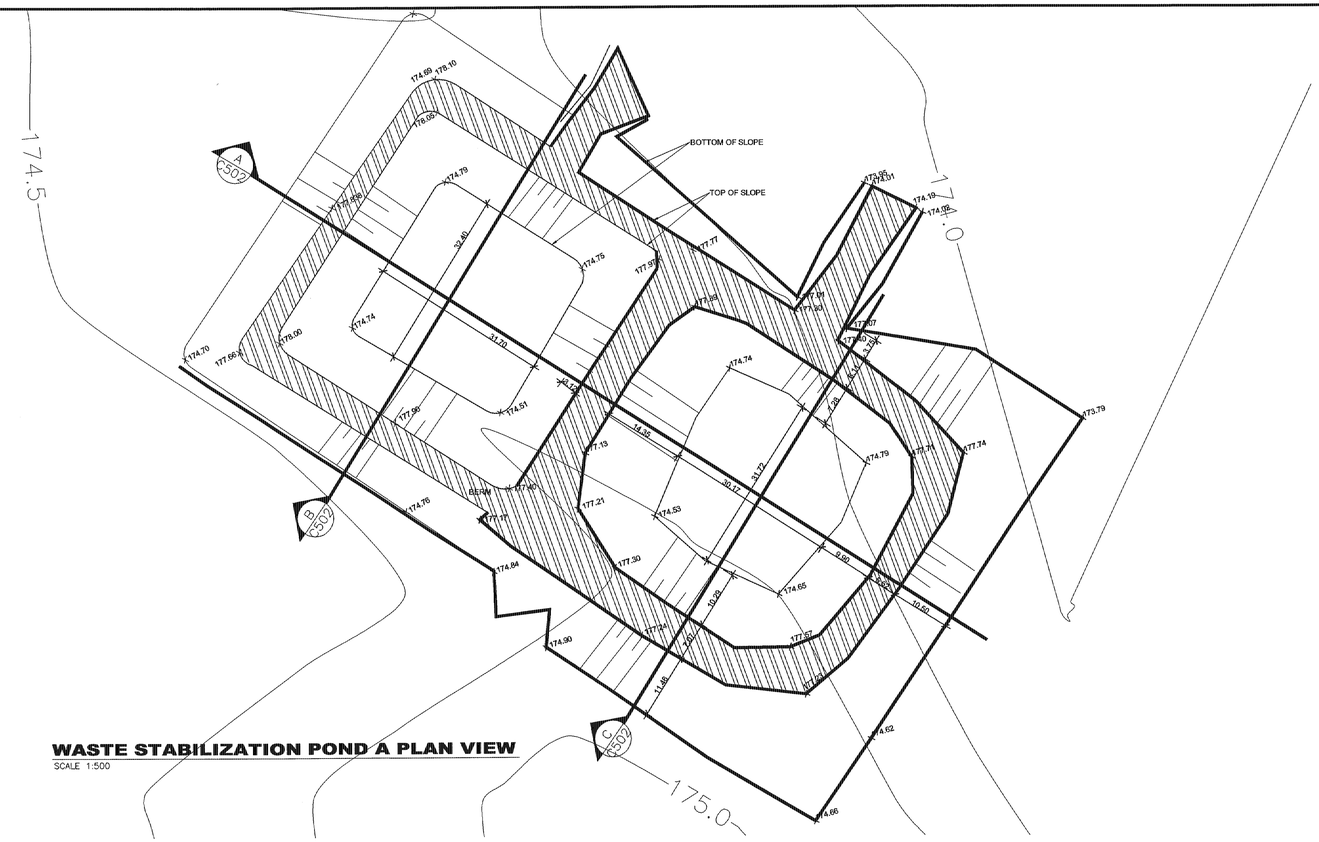
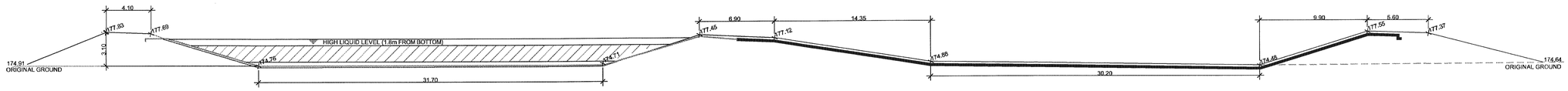
Drawing
AS CONSTRUCTED PWSP 1 PLAN AND SECTIONS

Date	CADD File Number
DATE	as const\mary...\pwsp..\200_06_03
Scale: SEPT 2008	Job Number: **07-039**
Drawn: AB	
Checked	Drawing Number: **200_06_03**
Approved	



WASTE STABILIZATION POND A PLAN VIEW
SCALE 1:500



SECTION A C502
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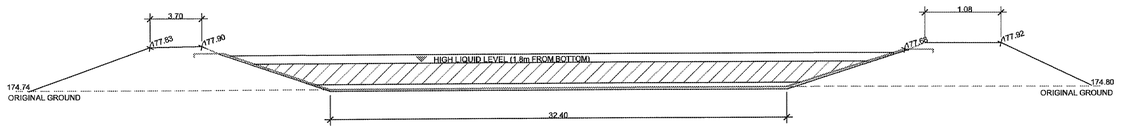

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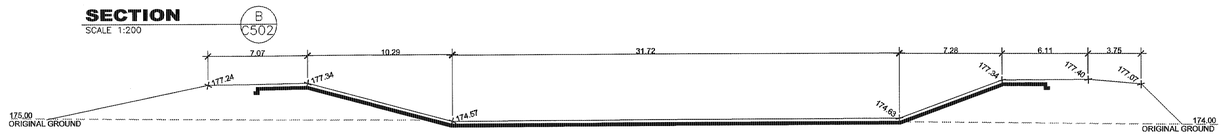

SECTION C C502
SCALE 1:200

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Description	Date	No.
2nd Pond	Nov 4_08	1

Revisions and Issues

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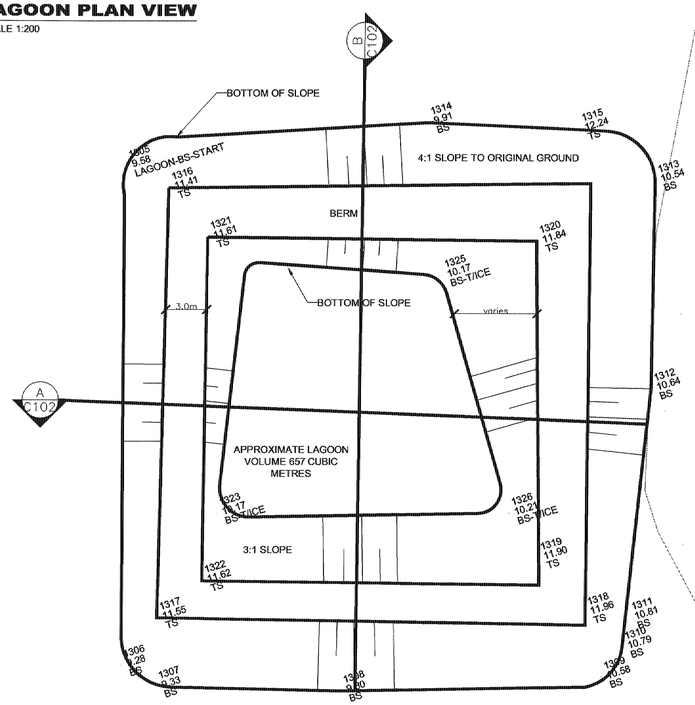
Drawing
AS CONSTRUCTED PWSP 2 PLAN AND SECTIONS

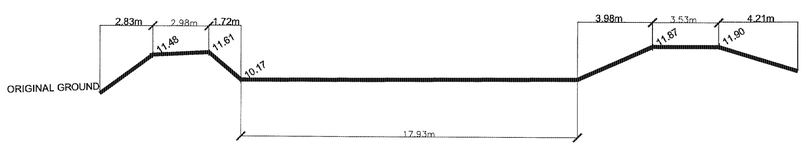
Date	CADD File Number
NOVEMBER 2008	\Mary..\PWSP\dwg\200_06_05
Scale: AS NOTED	Job Number: **07-039**
Drawn: SS/SO	
Checked: M.K	Drawing Number: **200_06_05**
Approved: M.K	

LAGOON PLAN VIEW

SCALE 1:200

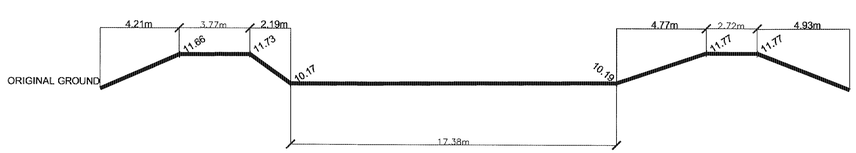


SECTION A C102



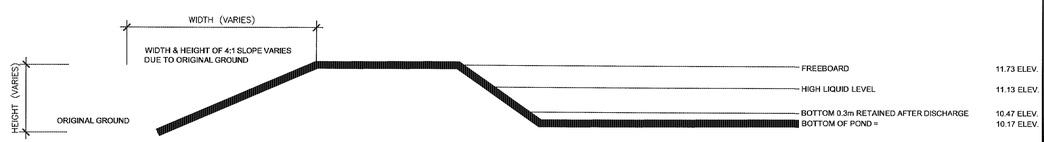
SECTION B C102

SCALE 1:150



TYPICAL LAGOON BERM

SCALE 1:75



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MILNE INLET

MARY-RIVER NUNAVUT

Drawing

AS BUILT SEWAGE LAGOON PLAN AND PROFILES

Date	CADD File Number
JAN 2008	milne..\pwsp..\dwg\100_06_01
Scale: AS NOTED	Job Number: **07-039**
Drawn: AB	
Checked	Drawing Number: **100_06_01**
Approved	

APPENDIX A

TABLES FROM COLD REGIONS UTILITIES MONOGRAPH

TABLE 10-3 TYPICAL QUANTITITES OF SEWAGE FLOW

Source		Quantity L/(p•d)
1. Communities and Permanent Military Bases		
a. 1,000 population with conventional piped water and sewage		
Thule Air Force Base, Greenland		303
College, AK		265
Fairbanks, AK		303
Ski resorts in Colorado and Montana		345
	Average	300
b. 1,000 population with conventional piped water and sewage		
Bethel, AK		265
DEW Line, Greenland		208
	Average	240
c. with truck-haul systems, conventional internal plumbing	Average	140
d. with truck-haul systems, low-flush toilets	Average	90
e. no household plumbing, water tanks and honey-bucket toilet	Average	1.5
f. same as (e) above but with central bathhouse and laundry	Average	15
2. Construction Camps		
North Slope, Ak (1971)		189
"Typical" Canadian		227
Alaska Pipeline (1976)		258
	Average	220
3. Remote Military with Limited Availability of Water		
McMurdo, Antarctica		151
Barrow, AK (DES Sta)		114
"Typical" Army Field Camp		129
	Average	130

wastes and extra amounts of garbage and grease from institutional kitchens.

10.3.1 Quantity. The resulting quantities of sewage flow depend on the type of installation and its permanence. Table 10-3 summarizes typical sewage flows for various cold-regions situations.

Separate facilities such as schools, laundries, restaurants, and hotels with conventional plumbing tend to have loadings similar to those in conventional temperate zone practice.

Projected data for the community should be used to establish a design value for per-person flow. The average values given in Table 10-3 may be used to

TABLE 10-4 CHARACTERISTICS OF BASIC WASTEWATER CATEGORIES

Parameter	Units	Undiluted (Heinke, 1973)	Moderately Diluted (Eggener & Tomlinson, 1978)	Conventional Diluted (Metcalf & Eddy Inc., 1979)	Greatly Diluted (Bethell, 1981)	Greywater (Hrudey & Raniga, 1981)
BOD_5	mg/L	–	460 280 to 700	220 110 to 400	55 40 to 60	–
COD	mg/L	110,400 80,800 to 134,800	1,000 700 to 1,300	500 250 to 1,000	–	(TOC) 210 40 to 900
Suspended solids (NFR)	mg/L	78,200 66,000 to 85,000	490 370 to 820	220 100 to 350	50 20 to 150	290 40 to 2,000
Total nitrogen	mg/L as N	8,100 7,300 to 9,500	–	40 20 to 90	(NH_3) 10 6 to 30	(NH_3/N) 1.4 8
Phosphorus	mg/L as P	1,200 1,100 to 1,400	–	8 4 to 15	3 2 to 6	9 4 to 20
Calculated flow*	L/(p•d)	1.2 1.1 to 1.4	170 110 to 290	360 200 to 730	1,500 1,300 to 2,000	310 50 to 2,300

All values rounded off from published data.

* Calculated based on 80 g BOD_5 per person per day and 90 g suspended solids (SS) per person per day (where applicable), modified activated sludge, and septic tanks. In some instances, lagoon treatment is followed by land disposal.

TABLE 13-1 WATER DEMAND VALUES FOR VARIOUS CAMPS

Camp Type	Population	Water Demand	
		Range*	Average*
Drilling camp		83 to 227	132
Base camp (Trink, 1981)		121 to 348	200
Exploration base (Murphy et al., 1977)	40 to 100 w/o bleeding		250
	40 to 100 with bleeding		445
Alaska pipeline construction (Eggener and Tomlinson, 1978)	200 to 1,300		265
Alaska pipeline construction (Murphy et al., 1977)	200 to 400		257
Alaska drilling camp (Alaskan Dept. of Health & Welfare, 1969)			212
Correctional camp (Grainge et al., 1973)	44		
Hydro generation construction camp (Belanger and Bodineau, 1977)	4,000 summer 2,000 winter		340**
Artificial island (Heuchert, 1974)			108**
U.S. military camps (Lufkin and Tobiasson, 1969)			
Main base	3,000 to 6,000	442 to 514	514
Ice research camp	25		79
Other camp with snow melt for water supply	96 to 227		121
Other camp with steam to melt snow for water supply	85 to 200		189
Alaska drilling rig camps (North Slope) (Tilsworth and Damron, 1973)			313
Value most frequently quoted	44	227 to 681	149**

* flow rate (L/(p•d))
** wastewater flow rate (L/(p•d))

vary from 1.4 to 1.77 (Lufkin and Tobiasson, 1969; Murphy et al., 1977; Given, 1978). These values do not represent a drastic change from those found for the households in small communities.

In addition to life support, water requirements specific to the work camp activity, for example, equipment washdown, pressure testing, and fire protection must be included in the estimate of total camp water supply.

An evaluation of water usage of various facilities at an Alaskan drilling camp and base camp is shown in Tables 13-2 and 13-3. The percentage of water

APPENDIX B

SEPROTECH DESIGN BRIEFS FOR MODELS N70 (MARY RIVER CAMP) AND N30 (MILNE INLET CAMP) RBC UNITS

APPENDIX B.1

MODEL N70 – MARY RIVER CAMP RBC

DESIGN BRIEF

BAFFINLAND - N70

May 25 2007

1. HYDRAULIC DESIGN: (AVERAGE DAILY FLOW)

1	unit at	34	**m3/day =**	34	**m3/day = Q**
	Peak Flow (to EQ tank)	101			
	design based on a	24	hour day.		

2. INFLUENT PARAMETERS:

BOD (biochemical oxygen demand) =	519	mg/l	
SS (suspended solids) =	519	mg/l	
TKN =	65	mg/l	
Phosphorus =	10	mg/l	

Ontario Application? n y/n
Designated Model? y y/n
What Model? N 70

3. TREATED EFFLUENT QUALITY:

BOD (biochemical oxygen demand) =	10	mg/l
SS (suspended solids) =	10	mg/l
NH3-N =	2	mg/l
Phosphorus =	0.5	mg/l

4. R.B.C. SURFACE AREA REQUIRED (AO):

a) Removal in Primary Settling Tank (P.S.T.)

Primary BOD Removal = 10% (Ref.1)
Primary Tank. Eff. BOD = 519 mg/l x 90%
to RBC = 467.1 mg/l

b) RBC BOD Loading.

Applied Load = 467.1 mg/l **34** **m3/day**
15.76 kg BOD/day

c) Area required to reduce BOD to 10 mg/l (AO)

Applied Load = 15.76 kg BOD/day **15.76** **kg BOD/ day**
For 10 mg/l* use 1.93 kg/day/100m2
817 m2

(*in a nitrification application, reduce BOD to 30 mg/l, the nitrification

d) NH3-N to be removed

(Assume Organic Nitrogen is converted to Ammonia NH3)

Removed to 5 mg/l = 65 less 5 times **33,750** **litres/day**
= 2.03 kg/day = **4.46** **lb/day**
Area Required to reduce NH3-N to 5 mg/l
= 2.03 kg/day over 0.147 kg NH3-N/day/100 m2 **(Ref. 12)**
= 1378 m2 =
Residual NH3-N to be removed
below 5 mg/l = 5 mg/l less 2 mg/l times **33,750** **litres/day**
= 0.101 kg/day
Area Required to reduce NH3-N to 2
= 0.101 kg/day over 0.068 kg NH3-N/day/100 m2
= 149 m2 =
Total Nitrification Area Required = 1526 m2 =

e) Total Surface Media Required

Total Surface Media Required = 2343 m2

f) Staging

Hydraulic Loading	0.15	L/d/m2
B.O.D.post primary	15.76	kg BOD/day
Media req'd(B.O.D)	817	m2
Media req'd(nitrfct'n)	1,526	m2
Total req'd	2,343	m2
Min req'd to prevent 1st st. overload	509	m2
Min req'd to prevent 2nd st. overload	509	m2

	ACTUAL AREA (m2)
First Stage	495
Second Stage	205
Third Stage	822
Fourth Stage	822
TOTAL	2,344

ACTUAL AREA (ft2)

First Stage	5,328	21%
Second Stage	2,207	9%
Third Stage	8,848	35%
Fourth Sytage	8,848	35%
TOTAL	25,230	

Minimum First Stage Media Area
Maximum loading to prevent first stage overload = 3.1 kg/day/100 m2
= 15.76 kg of post primary BOD/day divided by max. loading times 100 m2
= 509 m2
=

BOD remaining for 2nd Stage = 15.76 kg/day
Minimum Media 2nd Stage = 508.54 m2

5. PRIMARY SETTLING TANK (P.S.T.) (per RBC unit):

a) Primary Settling Tank Influent Flows (per RBC unit)

Average Daily Flow =	**33,750**	**litres/day**			
Recycle at	203%	% =	68584	litres/day	
Total Average Flow =	102,334	litres/day			
Peak Daily Flow =	101,250	litres/day			
Peak Flow including Recycle =	169,834	litres/day			

b) Loading Rates

Average Overflow Rate =	16,000	Litres/day/m2	max from	(Ref.5)
Peak Overflow Rate =	24,000	Litres/day/m2 (rounded)		(Ref.7)
Detention Time =	4	hours	use 4 hrs	(Ref.6)

c) Surface Area Required

i) by Average Overflow Rate = Total Average Flow divided by Average Overflow Rate
= 6.40 m2

ii) by Peak Flow Rate = Peak Flow divided by Peak Overflow Rate
= 7.08 m2

Therefore, use 7.08 m2 to compare with actual area of P.S.T.

P. S. T. Surface Area for Model N — 6.25 m x 3.35 m = 20.9 m2

Safety factor of: 2.96 times supplied.

Therefore **Surface Area Acceptable**

d) Volume Required = Q x Detention Time / 24 hrs / day
= 5.6 m3

P.S.T. Tank Capacity for this N is 44 m3
(after allowance for sludge) 7.7 **safety factor**

Therefore **Volume Acceptable**

6. FINAL SETTLING TANK (F.S.T.):

a) Loading Rates

Average Overflow Rate =	24000	Litres/day/m2	[Ref. 10]
Peak Overflow Rate =	44822	Litres/day/m2	[Ref. 10]
Detention Time =	3	hours	

b) Surface Area Required

i) by Average Overflow Rate = Average Flow divided by Average Overflow Rate
= 1.41 m2

ii) by Peak Flow Rate = Peak Flow divided by Peak Overflow Rate
= 2.26 m2

Therefore, use 2.26 m2 to compare with actual area of F.S.T.

F. S. T. Surface Area for Model N — 3.35 m x 3.0 m = **10** m2

Safety factor of 4.41 times supplied.

Therefore **Surface Area Acceptable**

c) Volume Required = Q x Detention Time / 1000 / 24 hrs / day
= 4.2 m3 =

F.S.T. Tank Capacity for this N is 10.9 m3
(after allowance for sludge) **2.6** safety factor

Therefore **Volume Acceptable**

7. ALUM DOSING CALCULATIONS:

Alum Dosing

$Al_2(SO_4)_3 + 2\ PO_4^{3-} = 2\ AlPO_4 + 3\ SO_4^{2-}$

Molecular Weights

Al	27	g/mol
P	31	g/mol
$AlPO_4$	122	g/mol
Al_2O_3	102	g/mol
$Al(OH)_3$	78	g/mol
$Al_2(SO_4)_3$	342	g/mol
$Al_2(SO_4)_3 14H$	594	g/mol

Assumptions

Conc. Al_2O_3 in comm. alum sol.:			8.1	%	
Density comm. alum sol.:		1.328	kg/l		
Data specific to site					
Conc. P PST:	10	mg/l			
Conc. P Out:	0.5	mg/l			
Required P removal:		9.5	mg/l		
		95	%		
Black and Veach suggested Al:P molar ratio:				2.3	
ADF	33,750	l/day			
Required tank autonomy:		28	days	= 4	weeks

mol Al per mol Al_2O_3:	2
mol AlPO4 per mol P:	1
mol Al per mol P in $AlPO_4$:	1
mol Al per mol $Al(OH)_3$:	1
mol Al per mol $AlPO_4$:	1

Dosing Calculations

Conc. Al_2O_3 needed =	37.8	mg/l	
Conc. comm. alum sol. needed =	467.1	mg/l	
Relative volume comm. alum sol. Needed =	0.000351765	l comm. alum/l wat.	

Daily comm. alum consumption =	**11.9**	**l/day**
(dosing pump sizing):	**0.49**	**l/h**
Volume tank required =	**332**	**l**
	73	**imp. gal.**
	88	**US gal.**

Black and Veach (with interpolations)

P Reduction Required (%)	Mole Ratio Al:P	Weight Ratio Al:P	Weight Ratio Alum:P
75	1.38	1.2	13
76	1.41	1.23	13.3
77	1.45	1.26	13.6
78	1.48	1.29	13.9
79	1.52	1.32	14.2
80	1.55	1.35	14.5
81	1.58	1.38	14.8
82	1.62	1.41	15.1
83	1.65	1.44	15.4
84	1.69	1.47	15.7
85	1.72	1.5	16
86	1.78	1.55	16.6
87	1.84	1.6	17.2
88	1.89	1.65	17.8
89	1.95	1.7	18.4
90	2	1.75	19
91	2.05	1.79	19.5
92	2.1	1.83	19.9
93	2.17	1.89	20.6
94	2.24	1.94	21.3
95	2.3	2	22
96	2.38	2.05	22.6
97	2.45	2.1	23.2
98	2.47	2.15	23.8
99.7	2.57	2.235	24.82

7. SLUDGE CALCULATIONS:

Assumptions Used for Calculation of Sludge Accumulation

1. Inlet TSS:	519	mg/l
2. Outlet TSS:	10	mg/l
3. Inlet BOD5:	519	mg/l
4. Outlet BOD5:	10	mg/l
5. Average Daily Flow:	34	m3/day
6. Proportion of inlet BOD5 soluble:	70%	
7. Total incoming solids	17.52	kg/d
8. Inert portion of solids (30%)	5.25	kg/d
9. Remaining organic solids (70%)	12.26	kg/d
11. Assuming Aerobic digester removal efficiency 50%.	6.13	kg/d
12. BOD removed in secondary treatment	15.09	kg/d
13. Sludge produce due to BOD removal	4.53	kg/d
15. Aerobic digester removal efficiency 50%.	2.26	kg/d
16. Total sludge produced per day	13.65	kg/d

Information Pertaining to the ROTORDISK Used in Calculation of Sludge Accumulation

1. All sludge accumulates in the PST (sludge settled in the FST is pumped back to the PST).		
2. PST Surface Area:	20.9	m2
3. PST Volume:	43.6	m3
4. PST Sludge Storage Capacity:	21.8	m3
TOTAL Mass of sludge produced that accumulates in the PST:	**13.6**	**kg/day**
Volume of Wet Sludge produced Daily:	0.2730	m3/day
Depth of Wet Sludge produced Daily:	0.0130	m/day
Frequency of Pump-Outs:	80	days

SUMMARY OF REFERENCES

Ref.1
excerpt from "Design of Municipal Wastewater Treatment Plants Volume 1", Chapters 1-12, WEF Manual of Practice No. 8, ASCE Manual and Report on Engineering Practice No. 76, p. 475, which states, " Sedimentation with coagulation may remove 60 to 90% of the TSS, 40 to 70% of BOD5, 30 to 60% of COD, 70 to 90% of the Phosphorus, and 80 to 90% of the bacteria loadings. In comparison, sedimentation without coagulation, may remove only 40 to 70% of the TSS, 25 to 40% of the BOD5, 5 to 10% of the Phosphorus loadings, and 50 to 60% of the bacteria loadings."

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No process or operating problems were experienced throughout the winter. The minimum temperature encountered in the unit, with a raw sewage feed rate of 320 gpd, was 4 oC. Process performance remained good during the winter even under conditions of intermittent operation.

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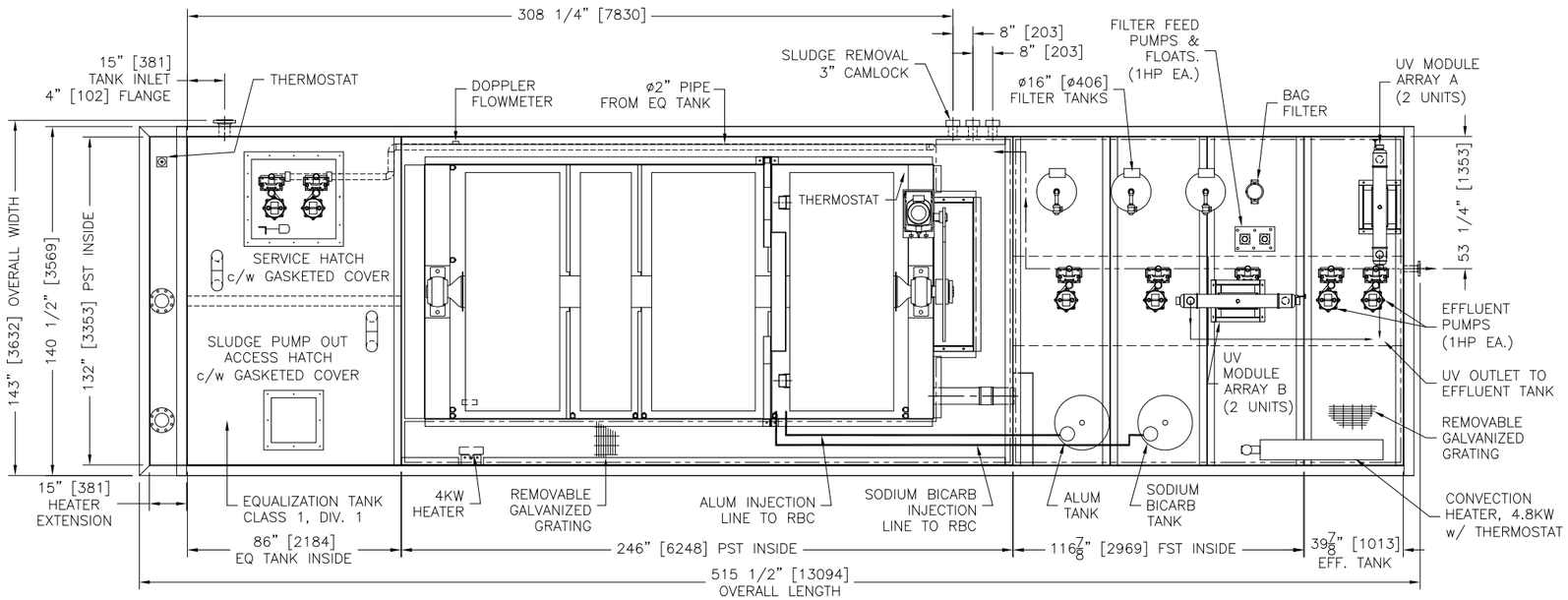
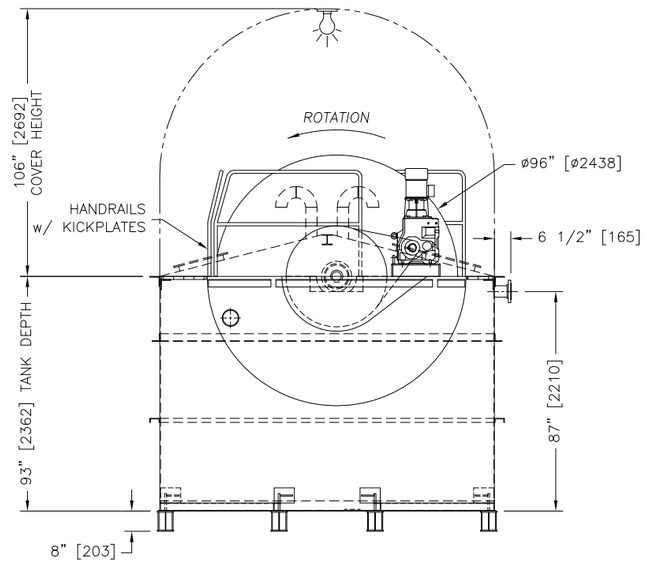
section 2.9.3, which states, " The observed denitrification rate at 550F was approximately 0.85 lb NO3-N /day/1000sq. ft.."

Ref.17
excerpt from "Design Information on Rotating Biological Contactors", by Richard C. Brenner, EPA-600/2-84-106,
section 2.9.2, which states, " The commonly used design value for the required methanol dosage is 3 mg/mg NO3-N reduced."

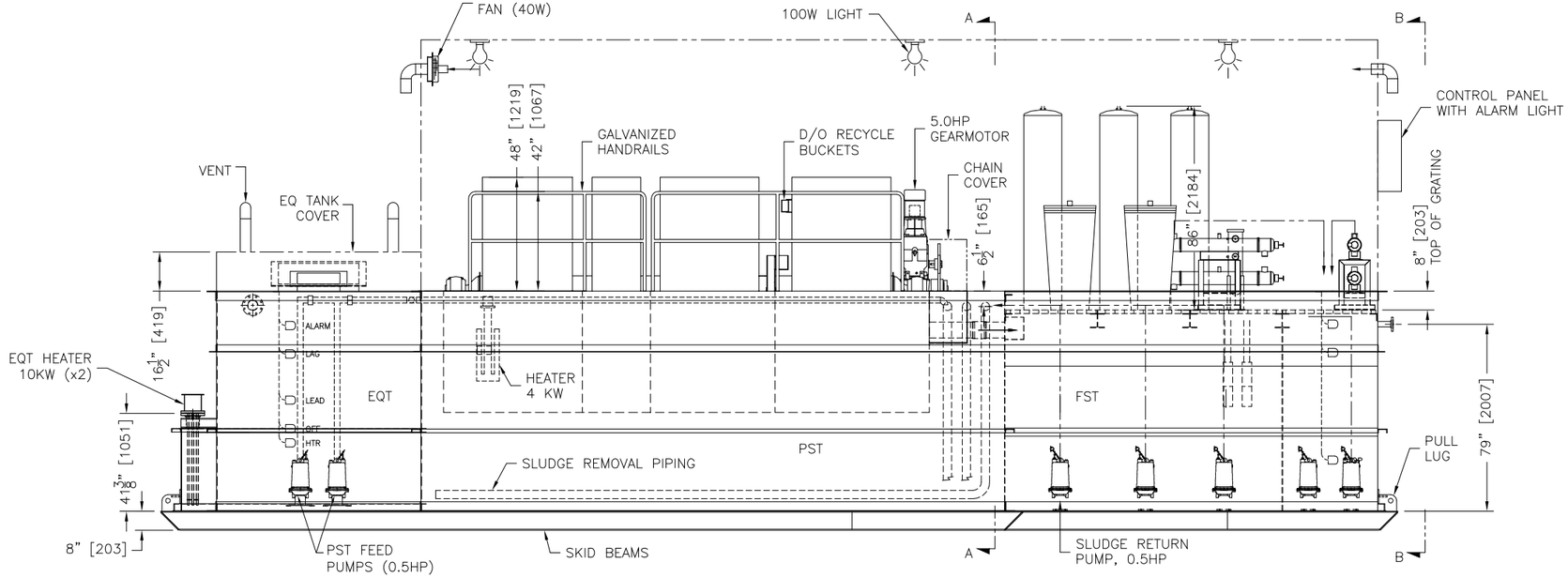
Ref.18
WEF MOPNo. 8, p913 states that "Oxygen recovery is 2.86 mg O2/mg NO3-N reduced." and that Heterotrophic biomass production is approximately 0.4 mg VSS/mg COD removed"

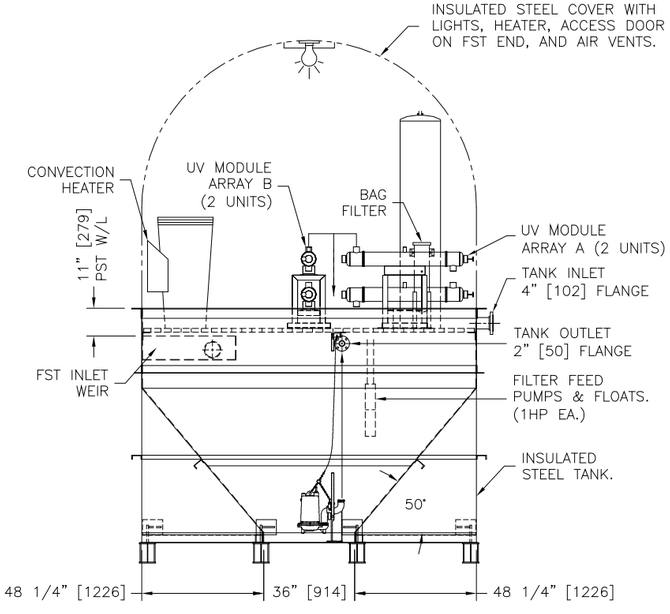
PRELIMINARY
NOT FOR CONSTRUCTION





SECTION A–A





SECTION B–B

NOTES:
1. UNIT TO BE PLACED LEVEL ON CONCRETE OR WELL COMPACTED GRAVEL. (PAD DESIGN BY OTHERS)
2. ALL DIMENSIONS IN BRACKETS ARE IN MILLIMETERS.
3. TANKS, RBC TROUGH, & SHAFT SANDBLASTED AND PAINTED WITH DEVTAR 5A FINISH.
4. INLET/OUTLET ARE STD. 150# ANSI B16.5 RAISED FACE FLANGES.

NOTES:
5. WEIGHT SHOWN IS DRY WEIGHT ONLY.
6. TANKS ARE EQUIPPED WITH DRAIN PORTS FOR SHIPPING PURPOSES ONLY.
7. THIS DRAWING IS NOT TO BE USED FOR CONSTRUCTION WITHOUT PRIOR APPROVAL OF SEPROTECH SYSTEMS INC.

REV	DESCRIPTION	YY/MM/DD	BY
1	AS BUILT CONFIGURATION	09/03/06	XX

PROJECT:
BAFFINLAND IRON MINES
MARY RIVER, NUNAVUT

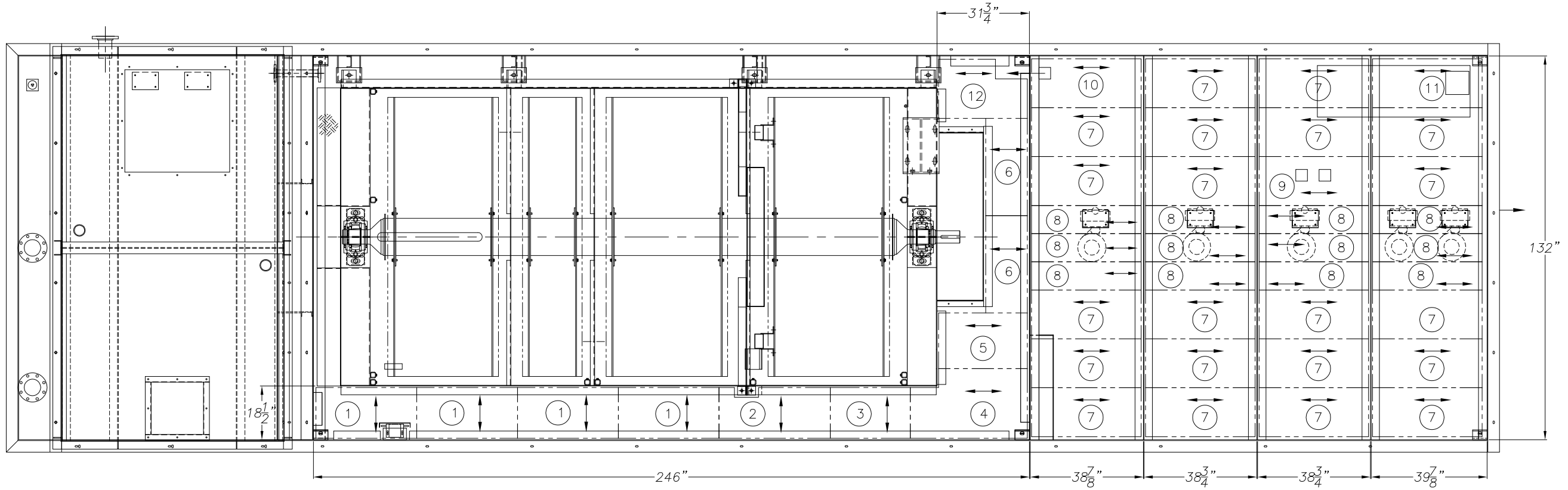
ALL TOLERANCES ARE +/– 1/32" UNLESS OTHERWISE SPECIFIED. DIMENSIONS ARE IN INCHES.

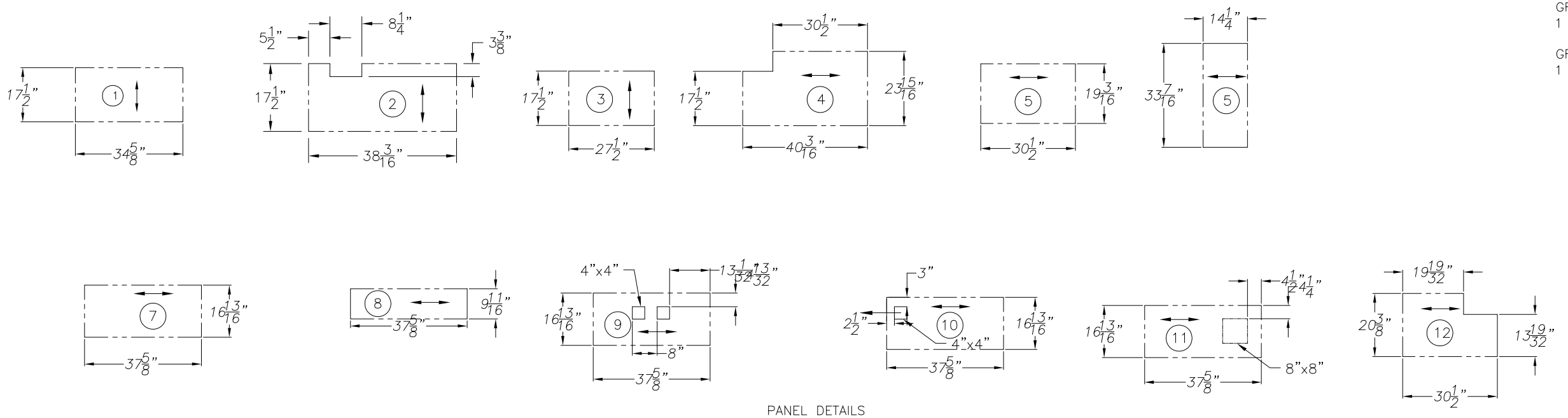
PROPRIETARY INFORMATION MAY NOT BE REPRODUCED OR DIVULGED WITHOUT PRIOR WRITTEN CONSENT OF SEPROTECH SYSTEMS INC. DO NOT SCALE. IF IN DOUBT, ASK

Seprotech
Water. Pure and Simple
SEPROTECH SYSTEMS INC.
2378 HOLLY LANE OTTAWA, ONTARIO, CANADA K1V 7P1
TEL: (613) 523-1641 FAX: (613) 731-0851
Email: contact@seprotech.com Web: http://www.seprotech.com

DESCRIPTION
MODEL N70, GENERAL ARRANGEMENT
FULL STEEL, w/ FILTERS, EQT & EFFLUENT TANK

DRAWN	CHECKED	DATE	SIZE	SCALE	WEIGHT	SHEET	DWG NO.	REV
AH		28–MAY–2007	B	1:60	50000 LB.	1 OF 1	60052–L01	1





PANEL DETAILS
SCALE = 1:32

BANDED GALVANIZED GRATING

GRATINGS 1 – 6 & 12 = W/B–6
1 1/4" X 3/16" (8.9 LB/SQ FT)

GRATING 7 – 11 = W/B–8
1 1/2" X 3/16" (10.6 LB/SQ FT)

SADDLE CLIPS INCLUDED.
2 PER PANEL. 94 TOTAL.

GRATING	QTY
1	4
2	1
3	1
4	1
5	1
6	2
7	21
8	12
9	1
10	1
11	1
12	1

F4-63 of 486

NOTES:
1. SADDLE CLIPS INCLUDED, 2 PER PANEL.

NOTES:

REV	DESCRIPTION	YY/MM/DD	BY
XX	XXXXX	YY/MM/DD	XX

ALL TOLERANCES ARE +/– 1/32" UNLESS OTHERWISE SPECIFIED. DIMENSIONS ARE IN INCHES.

PROPRIETARY INFORMATION MAY NOT BE REPRODUCED OR DIVULGED WITHOUT PRIOR WRITTEN CONSENT OF SEPROTECH SYSTEMS INC. DO NOT SCALE. IF IN DOUBT, ASK

Seprotech Water, Pure and Simple
SEPROTECH SYSTEMS INC.
2378 HOLLY LANE OTTAWA, ONTARIO, CANADA K1V 7P1
TEL: (613) 523–1641 FAX: (613) 731–0851
Email: contact@seprotech.com Web: http://www.seprotech.com

DESCRIPTION
GRATING, N70 – SPECIAL
E70S/F70 w/ FILTERS & EFF. TANK

DRAWN	CHECKED					
SA						
DATE	SIZE	SCALE	WEIGHT	SHEET	DWG NO.	REV
30–MAY–2007	B	1:40	1980 LB.	1 OF 1	60052–S03	0

APPENDIX B.2

MODEL N30 – MILNE INLET CAMP RBC

DESIGN BRIEF
SHANCO NUNAVUT - RETRO-FIT
*Note that since this is a retro-fit that has not been tested in the field, effluent values are target values.

1. HYDRAULIC DESIGN: (AVERAGE DAILY FLOW)

1	unit at	14	m3/day =	14	m3/day = Q	
	Peak Flow	41				
	design based on a	24	hour day.			

2. INFLUENT PARAMETERS:

BOD (biochemical oxygen demand) =	491	mg/l	Ontario Application?	n	y/n
SS (suspended solids) =	491	mg/l	Designated Model?	y	y/n
TKN =	70	mg/l	What Model?	B30	MODIFIED with extra media
Phosphorus =	n/a	mg/l	In concrete tank?	Full Steel	

3. TREATED EFFLUENT QUALITY:

BOD (biochemical oxygen demand) =	20	mg/l	
SS (suspended solids) =	20	mg/l	
NH3-N =	2	mg/l	this effluent concentration is expected after the retro-fit
Phosphorus =	n/a	mg/l	

4. R.B.C. SURFACE AREA REQUIRED (AO):

a) Removal in Primary Settling Tank (P.S.T.)

Primary BOD Removal =	10%				(Ref.1)
Primary Tank. Eff. BOD =	490.9090909	mg/l	x	90%	
to RBC =	441.8181818	mg/l			

b) RBC BOD Loading.

Applied Load =	441.8181818	mg/l		14	m3/day
	5.96	kg BOD/day			

c) Area required to reduce BOD to 20 mg/l (AO)

Applied Load =	5.96	kg BOD/day		5.96	kg BOD/ day	
For	20	mg/l*	use	1.95	kg/day/100 m2	(*in a nitrification application, reduce BOD to 30 mg/l, the nitrification process completes the BOD reduction)
	306	m2				

TABLE #1
BOD REMOVAL RATES
Seprotech Curve

Req. effl.	lbs/day/1000 ft2	kg/day/100 m2
5	1.25	0.61
10	2.65	1.29
15	2.00	0.98
20	2.65	1.29
25	3.35	1.64
30	4.00	1.95
35	4.60	2.25
40	5.15	2.52
50	6.00	2.92
60	7.15	3.52
70	8.28	4.05
80	9.40	4.59
90	10.53	5.13
	USE	1.95

* For effluent strengths less than 20 mg/l, filtration is required. Filtration removes the sloughed biomass 50% of which is BOD. Therefore, to obtain effluent strengths of 5 and 10 mg/l BOD use the loading rates for 10 and 20 mg/l respectively with filtration.

No temperature correction required
Refs. 13,14,&15

d) NH3-N to be removed

(Assume Organic Nitrogen is converted to Ammonia NH3)

Removed to	5	mg/l	=	70	less	5	times	13,500	litres/day
=	0.88	kg/day	=	1.93	lb/day				
Area Required to reduce NH3-N to	5	mg/l							
=	0.88	kg/day	over	0.147	kg NH3-N/day/100 m2		(Ref. 12)		
=	597	m2	=						
Residual NH3-N to be removed									
below 5 mg/l =	5	mg/l	less	2	mg/l	times	13,500	litres/day	
=	0.041	kg/day							
Area Required to reduce NH3-N to	0								
=	0.041	kg/day	over	0.089	kg NH3-N/day/100 m2		(Ref. 12)		
=	46	m2	=						
Total Nitrification Area Required =	642	m2	=		(Ref. 12)				

TABLE # 2 - Brenner

Req'd NH3-N concentration (mg/l)	Removal Rate (kg/day/100m2)
1	0.037
1.5	0.061
2	0.089
2.5	0.110
3	0.123
3.5	0.135
4	0.147
4.5	0.147
5	0.147

e) Total Surface Media Required

Total Surface Media Required = 948 m2

f) Staging

Hydraulic Loading	0.13	L/d/m2
B.O.D.post primary	5.96	kg BOD/day
Media req'd(B.O.D)	306	m2
Media req'd(nitrfct'n)	642	m2
Total req'd	948	m2
Min req'd to prevent 1st st. overload	192	m2
Min req'd to prevent 2nd st. overload	71	m2

Media Distribution After Retro-fit

	ACTUAL AREA (m2)
First Stage	205
Second Stage	140
Third Stage	784
Fourth Stage	0
TOTAL	1,129

Minimum First Stage Media Area

Maximum loading to prevent first stage overload = 3.1 kg/day/100 m2

= 5.96 kg of post primary BOD/day divided by max. loading times 100 m2

= 192 m2

BOD remaining for 2nd Stage = 2.21 kg/day

Minimum Media 2nd Stage = 71.38 m2

5. PRIMARY SETTLING TANK (P.S.T.) (per RBC unit):

a) Primary Settling Tank Influent Flows (per RBC unit)

Average Daily Flow = **13,500** **litres/day**

Recycle at 507% % = 68472 litres/day — The actual volume per bucket may change in the field depending on how much wastewater each bucket picks up

Total Average Flow = 81,972 litres/day

Peak Daily Flow = 40,500 litres/day

Peak Flow including Recycle = 108,972 litres/day

b) Loading Rates

Average Overflow Rate = 16,000 Litres/day/m2 — max from (Ref.5)

Peak Overflow Rate = 24,000 Litres/day/m2 (rounded) (Ref.7)

Detention Time = 4 hours — use 4 hrs (Ref.6)

c) Surface Area Required

i) by Average Overflow Rate = Total Average Flow divided by Average Overflow Rate

= 5.12 m2

ii) by Peak Flow Rate = Peak Flow divided by Peak Overflow Rate

= 4.54 m2

Therefore, use 5.12 m2 to compare with actual area of P.S.T.

P. S. T. Surface Area for Model B30 — 3.35 m x 4.19 m = 14.0 m2

Safety factor of: 2.74 times supplied.

Therefore **Surface Area Acceptable**

d) Volume Required = Q x Detention Time / 24 hrs / day

= 2.3 m3

P.S.T. Tank Capacity for this B30 is 27 m3

(after allowance for sludge) 12.0 **safety factor**

Therefore **Volume Acceptable**

6. FINAL SETTLING TANK (F.S.T.):

a) Loading Rates

Average Overflow Rate = 24000 Litres/day/m2 [Ref. 10]

Peak Overflow Rate = 44822 Litres/day/m2 [Ref. 10]

Detention Time = 3 hours

b) Surface Area Required

i) by Average Overflow Rate = Average Flow divided by Average Overflow Rate

= 0.56 m2

ii) by Peak Flow Rate = Peak Flow divided by Peak Overflow Rate

= 0.30 m2

Therefore, use 0.56 m2 to compare with actual area of F.S.T.

F. S. T. Surface Area for Model B30 — 3.35 m x 1.0 m = **3** m2

Safety factor of 5.75 times supplied.

Therefore **Surface Area Acceptable**

c) Volume Required = Q x Detention Time / 1000 / 24 hrs / day

= 1.7 m3 =

F.S.T. Tank Capacity for this B30 is 4.0 m3

(after allowance for sludge) **2.4** safety factor

Therefore **Volume Acceptable**

7. SLUDGE CALCULATIONS:

Assumptions Used for Calculation of Sludge Accumulation

1. Inlet TSS:	491	mg/l
2. Outlet TSS:	20	mg/l
3. Inlet BOD5:	491	mg/l
4. Outlet BOD5:	20	mg/l
5. Average Daily Flow:	34	m3/day
6. Proportion of inlet BOD5 soluble:	70%	
7. Total incoming solids	16.57	kg/d
8. Inert portion of solids (30%)	4.97	kg/d
9. Assuming Aerobic digester removal efficiency, 50%.	5.80	kg/d
10. BOD removed in secondary treatment	14.24	kg/d
11. Sludge produce due to BOD removal	4.27	kg/d
12. Aerobic digester removal efficiency 50%.	2.14	kg/d
13. Total sludge produced per day	12.90	kg/d

Information Pertaining to the ROTORDISK Used in Calculation of Sludge Accumulation

1. All sludge accumulates in the PST (sludge settled in the FST is pumped back to the PST).

2. PST Surface Area:	14.0	m2
3. PST Volume:	27.0	m3
4. PST Sludge Storage Capacity:	13.5	m3
TOTAL Mass of sludge produced that accumulates in the PST:	**12.9**	**kg/day**
Volume of Wet Sludge produced Daily:	0.2581	m3/day
Depth of Wet Sludge produced Daily:	0.0184	m/day
Frequency of Pump-Outs:	52	days

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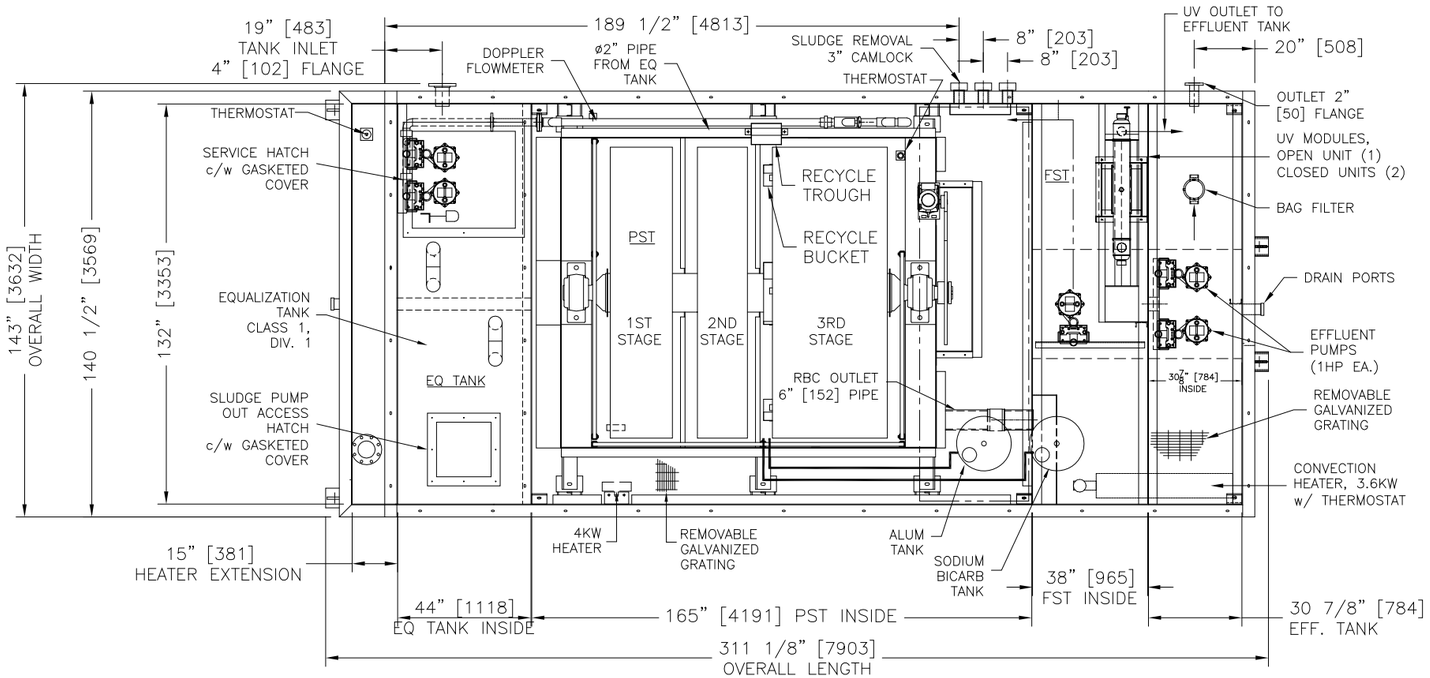
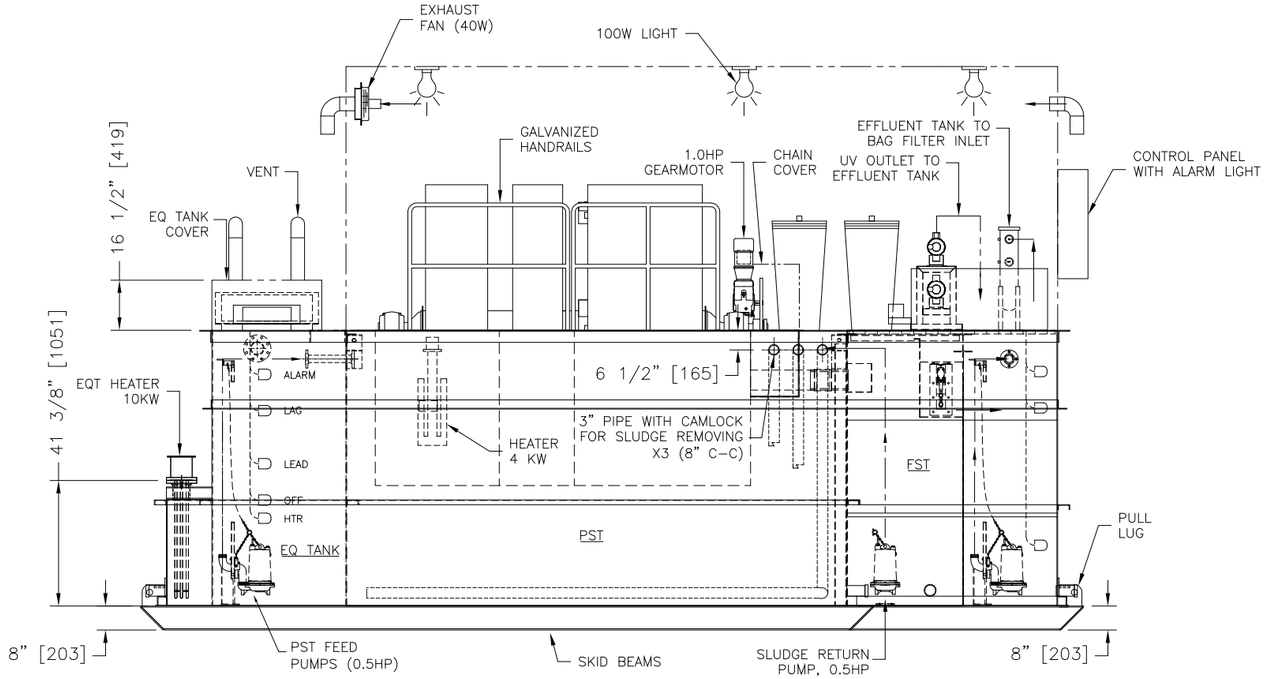
excerpt from "Design Information on Rotating Biological Contactors", by Richard C. Brenner, EPA-600/2-84-106, section 2.9.3, which states, " The observed denitrification rate at 550F was approximately 0.85 lb NO3-N /day/1000sq. ft.."

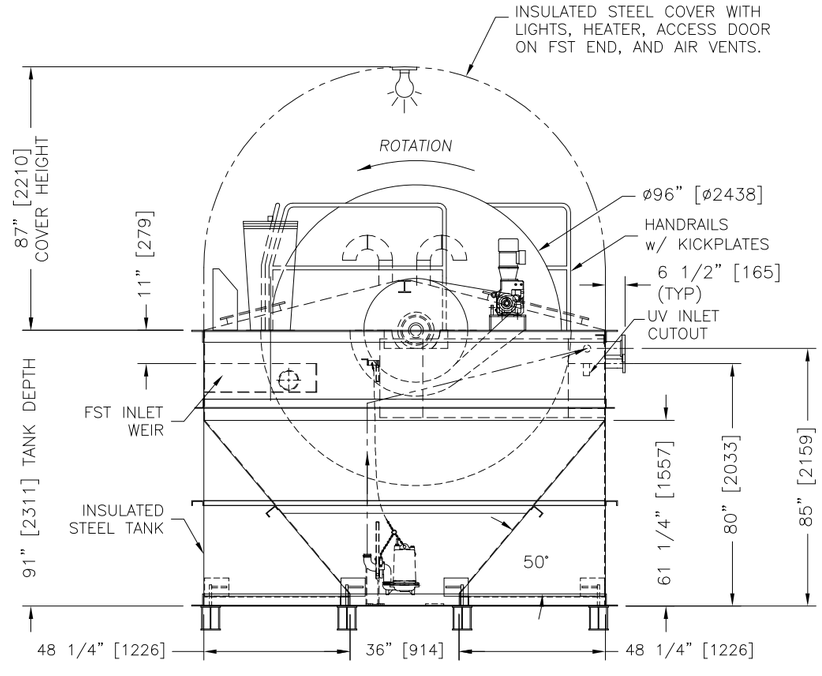
Ref.17
excerpt from "Design Information on Rotating Biological Contactors", by Richard C. Brenner, EPA-600/2-84-106, section 2.9.2, which states, " The commonly used design value for the required methanol dosage is 3 mg/mg NO3-N reduced."

Ref.18
WEF MOPNo. 8, p913 states that "Oxygen recovery is 2.86 mg O2/mg NO3-N reduced." and that Heterotrophic biomass production is approximately 0.4 mg VSS/mg COD removed"

PRELIMINARY
NOT FOR CONSTRUCTION







NOTES:
1. UNIT TO BE PLACED LEVEL ON CONCRETE OR WELL COMPACTED GRAVEL. (PAD DESIGN BY OTHERS)
2. ALL DIMENSIONS IN BRACKETS ARE IN MILLIMETERS.
3. TANKS, RBC TROUGH, & SHAFT SANDBLASTED AND PAINTED WITH DEVTAR 5A FINISH.
4. INLET/OUTLET ARE STD. 150# ANSI B16.5 RAISED FACE FLANGES.

NOTES:
5. WEIGHT SHOWN IS DRY WEIGHT ONLY.
6. TANKS ARE EQUIPPED WITH DRAIN PORTS FOR SHIPPING PURPOSES ONLY.
7. THIS DRAWING IS NOT TO BE USED FOR CONSTRUCTION WITHOUT PRIOR APPROVAL OF SEPROTECH SYSTEMS INC.

REV	DESCRIPTION	YY/MM/DD	BY
2	AS BUILT CONFIGURATION	09/03/06	DC
1	RETROFIT FROM B30 TO N30, RECYCLE [illegible]	07/11/21	AH

ALL TOLERANCES ARE +/- 1/32" UNLESS OTHERWISE SPECIFIED. DIMENSIONS ARE IN INCHES.

PROPRIETARY INFORMATION MAY NOT BE REPRODUCED OR DIVULGED WITHOUT PRIOR WRITTEN CONSENT OF SEPROTECH SYSTEMS INC. DO NOT SCALE. IF IN DOUBT, ASK

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TEL: (613) 523-1641 FAX: (613) 731-0851
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DESCRIPTION
GENERAL ARRANGEMENT, N30 – SPECIAL
E15/N30/F30 w/o FILTERS – SHANCO NUNAVUT

DRAWN	CHECKED						
SA	AH						
DATE	SIZE	SCALE	WEIGHT	SHEET	DWG NO.	REV
29-MAY-2007	B	1:24	34200 LB.	1 OF 1	60069-L00	2

APPENDIX C

MARY RIVER RBC PROCESS DESIGN EVALUATION

Technical Memorandum

To: Jim Millard
Environmental Superintendent
Baffinland Iron Mines Corporation

From: Dave Ellis, P.Eng., AMEC Geomatrix Limited
Jered Munro, AMEC Geomatrix Limited

Project: W01391.001

Date: March 27, 2009

Subject: Mary River RBC Process Design Evaluation

AMEC Geomatrix Limited (AMEC) has completed a third party review of the Mary River sewage treatment plant for Baffinland Iron Mines Corporation (BIM) and has summarized the findings of the review in this technical memorandum.

The memo discusses the original design basis provided from Seprotech Systems Inc. (Seprotech), actual 2008 operating conditions, and provides a recommendation on the treatment capacity of the installed system at Mary River. The treatment capacity recommendation is based on the estimated original design capacity and the actual loading data recorded during the 2008 operating season. AMEC has also prepared a process flow diagrams (attached) which provides information on proposed enhancements to the existing system for provisional future improvements in site treatment capacity.

Recommendations

Using the hydraulic and ammonia loading rates generated during 2008 at Mary River, AMEC recommends that BIM limit the maximum on-site staff at Mary River to 123 people for the existing treatment system. This recommendation is based on the assumption that the daily per capita hydraulic and organic loadings remain the same as the 2008 operating season and is conservative.

If in the future, BIM requires more than 123 employees on site, it is recommended that the additional media provided by Seprotech (Shaft #2) be installed in series with the existing Shaft #1 (current RBC unit). This will increase the nitrification capacity of the system to allow for up to 236 people. The increased capacity, however, does not allow for increased hydraulic loadings, i.e, the total water usage cannot be increased above current maximum average daily design flowrate.

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Wastewater Treatment System Review Assumptions

This wastewater treatment system review is based on the following general assumptions.

- We have assumed that 100% of the organic nitrogen measured in the total Kjeldahl nitrogen (TKN) test hydrolyzes to form ammonia-nitrogen (NH_3-N).
- A 10% removal across the primary clarifier section is assumed.
- The minimum wastewater system operating temperature of 15 deg C is maintained in the treatment sections throughout the operating season
- The specific BOD removal rates used by Seprotech in the design calculations are valid for their systems based on their experience with arctic installations..

Biological System Design Basis

The design basis for the Mary River wastewater treatment system was developed by Seprotech in 2007. The subsequent system design was required to produce treated effluent that would meet the regulated requirements established by the Nunavut Water Board (NWB). A summary of regulatory requirements specified in Baffinland's NWB Licence No. 2BB-MRY0710 are listed in Table 1.

Table 1: NWB Sewage Discharge Requirements

Parameter	Units	Maximum Average Concentration
BOD_5	mg/L	30
Total Suspended Solids (TSS)	mg/L	35
Faecal Coliform	CFU/100mL	1000
pH	-	6.5-9.0
Oil and Grease	-	No visible sheen
Acute Toxicity	-	Non acutely toxic*

* Acute lethality to Rainbow Trout, Oncorhynchus mykiss (as per Environment Canada's Environmental Protection Series Biological Test Method EPS/1/RM/13); and Acute lethality to Daphnia magna (as per Environment Canada's Environmental Protection Series Biological Test Method EPS/1/RM/14).

Although the limits do not specifically identify the effluent ammonia concentration, the requirement for acute toxicity testing provides an inherent effluent ammonia limit. Work completed by Knight Piesold and North/South Consultants Inc. in 2007 (Wastewater Management Plan) and confirmed in recent study (Section 10 of the revised Wastewater Management Plan herein), showed that effluent toxicity is generally expected to occur at ammonia-nitrogen concentrations above 15 mg/L.

A rotating biological contactor (RBC) was selected for treatment of the Mary River domestic wastewater and was commissioned in January 2008. During 2008, effluent quality did not consistently meet the criteria identified in Table 1, and hence did not permit discharge of treated effluent to the receiving environment.

AMEC Geomatrix completed a review of the original design basis used by Seprotech for the BIM system. The estimated hydraulic and organic loading rates are identified in Table 2.

Table 2: Mary River RBC Design Basis

Parameter	Units	MR Design Basis
BOD_5	mg/L	519[1]
TSS	mg/L	519[1]
TKN	mg/L	65[1]
People in camp	-	150[2]
Water Consumption	L/person/day	225[3]
Daily Average Flow	m^3	33.75

1. Estimated by Seprotech using Table 10-4: Characteristics of Basic Wastewater Categories "Cold Regions Utilities Monograph" Third Edition,1996 assuming "moderately diluted wastewater"
2. Estimation provided by BIM in July 2008.
3. Estimated by Seprotech using Table 10-3: Typical Quantities of Sewage Flow , Item 2 "Construction camps", "Cold Regions Utilities Monograph", Third Edition 1996

Using the data from Table 2, the resulting mass loadings were calculated and are summarized in Table 3.

Table 3: Mary River RBC Design Basis Mass Loading

Parameter	Mass Loading Rates (mg/L)	Mass Loading Rates (g/day)
BOD_5	519	17,517
TSS	519	17,517
TKN	65	2,194

This loading data was used by Seprotech to design and develop the system as installed at the Mary River Camp. From a review of *Wastewater Management Plan for Mary River and Milne Inlet Camp Sites* (September 2007), Seprotech used typical published RBC design parameters to determine the size of the system. For general background, it is important to understand that RBC design is based on hydraulic and organic loading rates across a surface area and that increases or decreases in surface area increase the fundamental treatment capacity of the system. The variability in surface area is provided by the configuration of the media (spacing and diameter) and promotes biofilm growth. The biofilm is responsible for removal of organic and nutrient constituents. Once the sludge reaches a certain thickness it sloughs off of the media for removal.

AMEC has reviewed the design parameters used by Seprotech against accepted published values and have summarized this review in Table 4.

Table 4: Comparison of Typical Design Parameters

		Design Information on Rotating Biological Contactors, EPA Design Manual No. 600[1]		Metcalf and Eddy, Wastewater Treatment and Design, 4th Edition[2]		Mary River Design by Seprotech
		Minimum	Maximum	Minimum	Maximum	Design
Hydraulic Loading	m^3/m^2*d	0.01	0.04	0.03	0.08	0.014
Organic Loading	g $sBOD_5/m^2*d$			2.5	8	9.4
	g $tBOD_5/m^2*d$		17	5	16	19.3
Maximum 1st Stage Organic Loading	g $sBOD_5/m^2*d$	5	17	12	15	16
	g $tBOD_5/m^2*d$	10	31	24	30	32
NH_3 Loading	g N/m^2*d	0.75	1.5	0.75	1.5	1.45
Hydraulic Retention	Hours	1.5	4	1.5	4	4
Effluent tBOD5	mg/L	7	15	7	15	10
Effluent NH4-N	mg/L	<2	<2	<2	<2	<2

Review of published design data suggests that the hydraulic capacity of the Mary River RBC is conservative (0.014 m^3/m^2/day used for design compared with published values of 0.01 to 0.08 m^3/m^2/day), however a recycle stream of 200% or 68 m^3/day is employed to re-oxygenate the influent water which results in a total hydraulic loading of approximately 0.042 m^3/m^2. This is still in the mid-range of published values. Since the primary treatment tank has been designed to accommodate the internal recycle flow of 68 m^3/day it is expected that the system will perform as intended at the maximum average daily design flowrate of 33.75 m^3/day.

The organic loading capacity of the system was designed using 19.3 g $tBOD_5/m^2$/day The maximum 1st stage loading rate was calculated using a rate of 31 g $tBOD_5/m^2$/day which agrees with the maximum value published in Metcalf and Eddy of 30 g/m^2/day. The design calculations identify that 509 m^2 of media are required to prevent first stage overloading and it is suspected that the 495m^2 installed in the first stage may have been due to physical equipment constraints. If treatment issues arise due to overloading of the first stage, installation of a small bypass to the second stage will reduce the loading to be within acceptable ranges. An overloaded first stage, where loading rates are consistently at or above design rates, may experience reduced treatment efficiency during peak loading which would likely result in increased effluent concentrations.

The total nitrification area available is 1527 m^2. The design ammonia loading rate is below the maximum published removal rates of 1.5 g/m^2/day and the calculated surface area required to produce an effluent ammonia concentration of 2 mg/L is 1509 m^2.

Efficient nitrification requires removal of BOD_5 to 30mg/l in order for nitrifying bacteria to thrive. At maximum loading rates, any reduction in BOD_5 removal efficiency will limit the surface area available for nitrification and could result in increased ammonia concentrations in the effluent.

A summary of the installed design is summarized in Table 5

Table 5: Mary River Design

	Units	Design
Daily per capita consumption	L/person/day	225
Mary River Staff on-site	people	150
Flowrate	m^3/day	33.75
BOD_5 Concentration	mg/L	519
BOD_5 after primary clarifier (10% removal)	mg/L	467
Total Organic Removal Area Required	m^2	817
Total Organic Removal Area Actual	m^2	817
1st Stage Area Required	m^2	508.5
1st Stage Area Actual	m^2	495
Nitrogen (TKN) Concentration	mg/L	65
Total Nitrification Area Req'd	m^2	1526
Total Nitrification Area Actual	m^2	1527
Total Surface Required	m^2	2343
Total Surface Area Actual	m^2	2344

In summary, although the system has been designed to operate within published loading criteria, little flexibility or safety factor has been designed into the system. It is possible that small changes in wastewater characteristics will have a significant impact on treatment efficiency, particularly the ability of the system to nitrify ammonia.

2008 Operating Treatment Capacity

Two independent sets of data were gathered during the 2008 operating season. One set of data was gathered by BIM staff while another was collected by Seprotech during a review of the treatment system during late spring 2008

Analytical wastewater treatment data, staffing records and monthly sewage effluent quantities gathered from BIM record data have been summarized to develop an “MR 2008 Average” data

set consisting of annual averages, although data from January 2008 was not included in the average due to unrepresentative start-up conditions. The August 2008 data was also not included in the average, because of sludge removal activities that occurred near the time of the sampling event. The data generally shows that the nitrogen influent concentrations in wastewater were double what was expected but other parameters were generally consistent with the original design basis.

Lab analysis data from the Seprotech 2008 review provided representative average wastewater concentrations measured during the course of their late spring 2008 sampling program. The average data presented in the Seprotech report has been identified as the "2008 Seprotech data set for the purposes of this technical memorandum. The data collected by Seprotech between May 5 and June 8 2008 was during a period with an increased average number of staff on-site (182 compared with 150 as used for the design basis).

AMEC's review indicates that the 2008 Seprotech data is an accurate representation of the loadings on-site. This is due in large part to the sampling intensity during Seprotech's spring 2008 monitoring program and the larger-than-usual number of samples that were collected during that time.

Table 5: Actual 2008 Measured Wastewater Loading Data

Parameter	Units	Design Basis (Table 2)	2008 Seprotech Data,	MR 2008 Average[1] Data, Baffinland
BOD_5	mg/L	519[1]	664	520
TSS	mg/L	519[1]	500	225
TKN	mg/L	65[1]	125	135
People in camp	-	150	182	160
Water Consumption	L/person/day	225[3]	143	138
Daily Average Flow	m^3/day	33.75	26	26

[1]Average for 2008 operating period excluding Jan 2008 (start-up) and August 2009 (sludge removal event) data

A review of the average values from the two data sets against the design basis data identifies significantly lower flowrates than estimated in the design basis (26 m^3/day compared with 33.75 m^3/day in design basis). It is suspected that the daily habits of camp crews have impacted the overall flowrates to the wastewater treatment system in that some flows of dilute wastewater have not been entering the system. The higher concentration material has continued to enter the system which has resulted in overall wastewater concentrations that are higher (particularly nitrogen) than in the original design basis.

The resulting mass loading rates as outlined in Table 6 were similar to design mass loading rates although TKN loading was higher than original estimates.

Table 6: 2008 Actual Mass Loading

Parameter	Units	Mary River Average Loading	
		Design Basis	Actual 2008 Operating Data Seprotech
People	-	150	182
Water Consumption	L/person	225	143
Daily Flow	m^3/day	33.8	26.0
BOD	mg/L	519	664
	g/day/person	116.8	95.0
	g/day	17,516	17,281
TSS	mg/L	519	500
	g/day/person	116.8	71.5
	g/day	17,516	13,013
TKN	mg/L	65.0	125.0
	g/day/person	14.6	17.9
	g/day	2194	3253

The analytical data from the sampling program conducted by Seprotech in 2008 has been used to determine the maximum operating capacity of the installed treatment system based on the number of employee's on-site.

Maximum Operating Capacity of Current System

It has been identified that TKN is the limiting design parameter for the current RBC system currently operating at Mary River. The treatment system was designed with a maximum ammonia loading of 2194 g/day. To produce effluent meeting the water licence criteria in the current RBC configuration (1 shaft, 4 stages) the recommended average number of staff on-site is 123 people based on per capita loading rates of 16.9 g of nitrogen/person/day that would provide sufficient surface area for nitrification. The operational parameters are summarized below.

Table 7: Revised Capacity and Operating Scenario

	Units	TKN Limited
Daily per capita consumption	L/person/day	143
Mary River Staff on-site	people	123
Flowrate	m^3/day	17.6
BOD_5 Concentration	mg/L	664
BOD_5 after primary (10% removal)	mg/L	598
BOD_5 loading	g/day	10525
Total Organic Removal Area Required	m^2	545[1]
Total Organic Removal Area Actual	m^2	817
1st Stage Area Required[2]	m^2	386.2
1st Stage Area Actual	m^2	495
Nitrogen (TKN)	mg/L	125
Nitrogen loading	g/day	2200
Total Nitrification Area Required[3]	m^2	1517
Total Nitrification Area Actual	m^2	1527
Total Surface Required	m^2	2137
Total Surface Area Actual	m^2	2344

[1] based on 19,3 gBOD/m^2/day
[2] based on 30 gBOD/m^2/day
[3] based on 1.45 gN/m^2/day

Provisional Treatment Capacity

BIM has an additional RBC component system available at the Mary River site that was purchased from Seprotech in 2008. The component system, which has not yet been installed, includes a complete, high density packaged unit designed specifically for nitrification with a total treatment surface area of 3038 m^2.

Specifically, the components consist of a four stage, single shaft RBC system with an effluent break tank. The unit is not equipped with any other tankage or treatment equipment and as a result will not increase the hydraulic capacity of the existing system. The unit, however, is well suited for increasing the nitrification capacity of the current RBC system.

A review of the additional component system indicates that the plates, or media, spacing in the first stage is much closer than in the existing system. The spacing of the media is important to the treatment capacity of the system since bridging of the biofilm can result in reduced treatment

efficiency. For this reason in particular, the new unit is not suitable for installation in parallel with the existing unit and can only be installed in series.

The suggested system layout would consist of connecting the existing 4-stage Shaft #1 in series with the 4-stage shaft Shaft #2 for a total of two shafts and eight stages. A summary of the physical layout is listed below and conceptual process flow diagrams are attached..

Table 8: Provisional treatment configuration

Shaft	Stage	Actual Area (m^2)
1	Stage One	495
1	Stage Two	205
1	Stage Three	822
1	Stage Four	822
2	Stage Five	736
2	Stage Six	736
2	Stage Seven	783
2	Stage Eight	783
	Total Surface Area	5382 m^2

As part of the retrofit, AMEC suggests removing the baffle between Stages One and Two on Shaft #1 in order to provide sufficient first stage surface area to prevent organic overload.

In the proposed configuration, the first four stages of Shaft #1 would be used for BOD removal and the remaining 4 stages on Shaft #2 would be used for nitrification. Although the additional RBC will not increase the existing hydraulic capacity it will allow the existing system to operate at maximum capacity instead of the current “TKN limited” hydraulic capacity. The maximum hydraulic loading would be limited by the current system hydraulic loading of 33.75 m^3/day. The additional shaft would increase the existing treatment capacity and result in a more robust system capable of treating a maximum of 236 people at 143 L/person/day. The tanks, pumps, alum system and filter systems will not need to be upgraded as the hydraulic capacity will not change.

The treatment capacity calculations are summarized in Table 9. For the purposes of determining a maximum number of staff that the Mary River facility can support the sizing calculations were performed based on the “Actual 2008” data presented in Table 6 and available surface area A surplus of 1119 m3 of treatment capacity is expected to be available under these conditions.

Seprotech provided a design basis for the provisional system with peak loadings that were observed during their sampling program. The loading rates were calculated using a single data set captured during the 2008 sampling program that were approximately double the average

rates observed during the course of the sampling program and have been included in the final column of the table as “Maximum Loading”. This scenario was provided to be representative of potential changes in the wastewater characteristics due to future changes in work activities on-site. As demonstrated the provisional system has sufficient capacity to accommodate process variations.

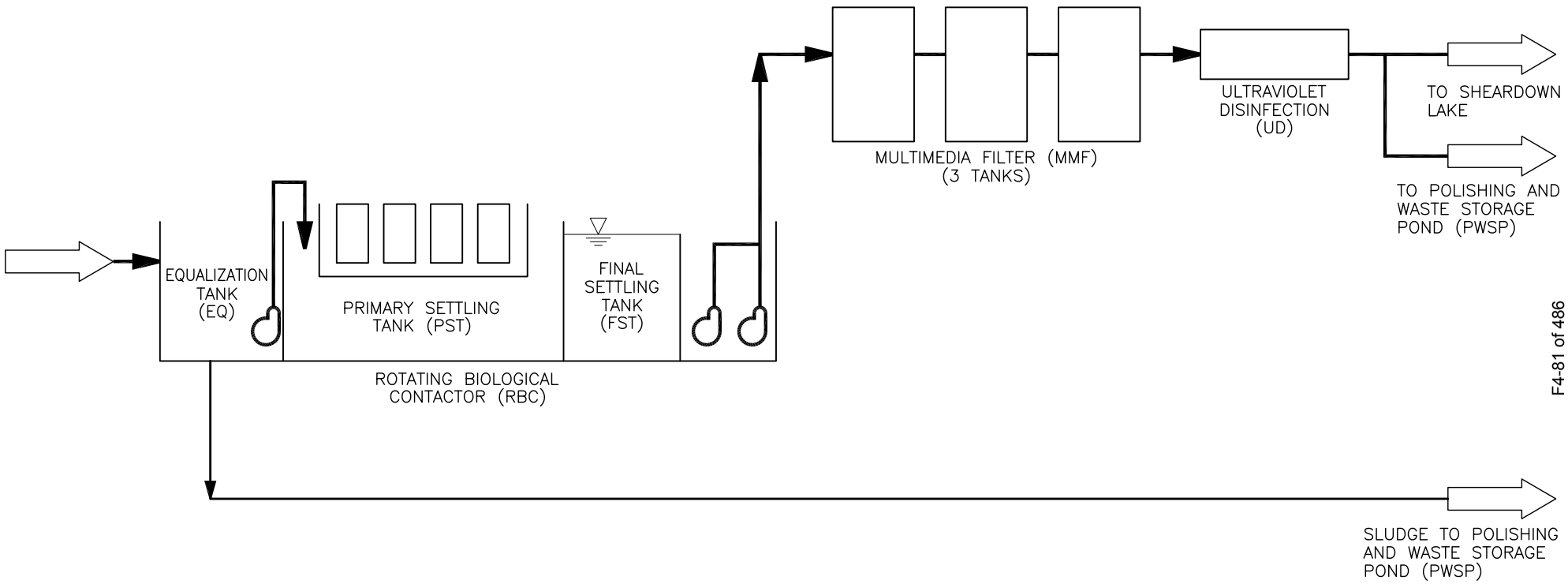
Table 9: Provisional Treatment Capacity

	Units	Actual Observed Loading (2008)	Maximum Observed Loading (2008)
Daily per capita consumption	L/person/day	143	143
Mary River Staff on-site	people	236	234
Flowrate	m^3/day	33.75	33.5
BOD_5 concentration	mg/L	664	1204
BOD_5 after primary (10% removal)	mg/L	598	1083
BOD_5 loading	g/day	20183	36281
Total Organic Removal Area Required[1]	m^2	1046	2035
Total Organic Removal Area Actual	m^2	2344	2344
1st Stage Area Required[2]	m^2	672	1209
1st Stage Area Actual	m^2	700	1522
Nitrogen (TKN)	mg/L	125	152
Nitrogen loading	g/day	4219	5092
Total Nitrification Area Req'd[3]	m^2	2910	3500
Total Nitrification Area Actual	m^2	3038	3038
Total Surface Required	m^2	4183	5382
Total Surface Area	m^2	5382	5382

[1] based on 19.3 gBOD/m^2/day
[2] based on 30 gBOD/m^2/day
[3] based on 1.45 gN/m^2/day

It should be noted that to avoid first stage overload using the “maximum loading” condition, provisions would be required to remove sufficient baffles in order to avoid first stage organic overload. The physical arrangement of the plate spacing would also need to be reviewed. It is possible that plates would need to be removed in stage three and four on the first shaft to accommodate biofilm growth associated with organic removal in these stages.

If the per capita water usage on-site increases, a resulting reduction in staff will be required to avoid exceeding the daily effluent volume of 33.75 m^3/day. If the provisional system were to be installed an increase in sludge removal frequency would also be required.



F4-81 of 486

March 17, 2009–4:48pm

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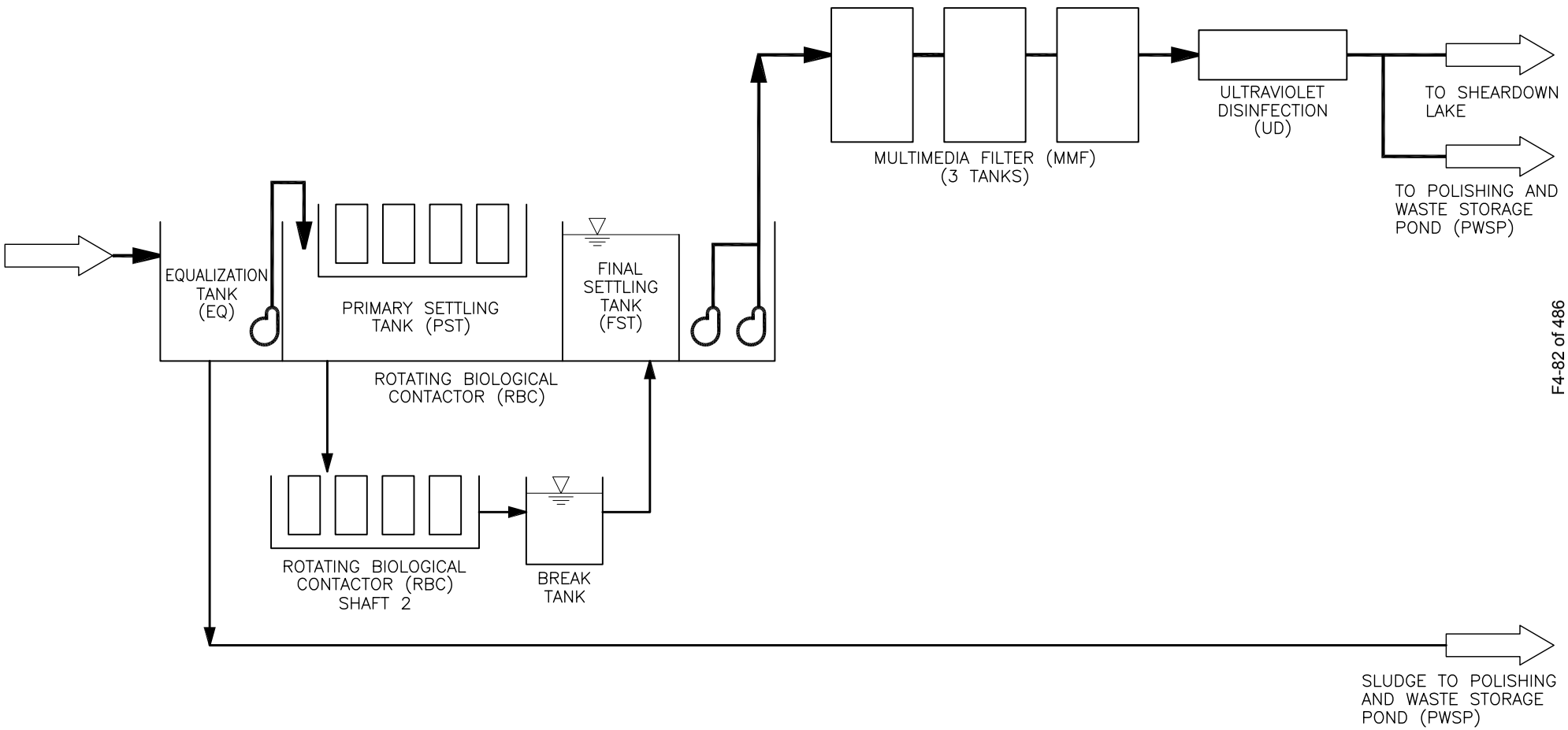
PROCESS FLOW DIAGRAM
MARY RIVER WWTP

BAFFINLAND IRON MINES
BAFFIN ISLAND, NUNAVUT TERRITORY

DATE	PROJ. NO.
MARCH 2009	W01391.001
FILE NO.	DWG. NO.
W01391–PFD	PFD-01



F4-82 of 486

March 17, 2009–4:48pm

AMEC Geomatrix

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PROCESS FLOW DIAGRAM
MARY RIVER WWTP
ADDITIONAL CAPACITY RETROFIT
BAFFINLAND IRON MINES
BAFFIN ISLAND, NUNAVUT TERRITORY

DATE	PROJ. NO.
MARCH 2009	W01391.001
FILE NO.	DWG. NO.
W01391–PFD	PFD-01a

DESIGN BRIEF

DATE: July 8, 2008
PROJECT NAME: Mary River

1. HYDRAULIC DESIGN: (AVERAGE DAILY FLOW)

1 units each at 29 m3/day = 29 m3/day = Q
design based on a 24 hour day.

2. INFLUENT PARAMETERS:

BOD (biochemical oxygen demand) =	1204	mg/l
SS (suspended solids) =	N/A	mg/l
TKN =	152	mg/l
Phosphorus =	N/A	mg/l

3. TREATED EFFLUENT QUALITY:

BOD (biochemical oxygen demand) =	20	mg/l
SS (suspended solids) =	N/A	mg/l
NH3-N =	2	mg/l
Phosphorus =	N/A	mg/l

4. R.B.C. SURFACE AREA REQUIRED (AO):

a) Removal in Primary Settling Tank (P.S.T.)

Primary BOD Removal = 10% (Ref.1)
Primary Tank. Eff. BOD = 1204 mg/l x 90%
to RBC = 1083,6 mg/l

b) RBC BOD Loading.

Applied Load = 1083,6 mg/l 29 m3/day
30,88 kg BOD/day

c) Area required to reduce BOD to 20 mg/l (AO)

Applied Load = 30,88 kg BOD/day 30,88 kg BOD/ day
For 20 mg/l* use 1,29 kg/day/100 m2
2394 m2

(*in a nitrification application, reduce BOD to 30 mg/l, the nitrification

d) NH3-N to be removed

(Assume Organic Nitrogen is converted to Ammonia NH3)

Removed to 5 mg/l = 152 less 5 times **28 500** **litres/day**
= 4,19 kg/day = **9,22** **lb/day**

Area Required to reduce NH3-N to 5 mg/l
= 4,19 kg/day over 0,147 kg NH3-N/day/100 m2 **(Ref. 12)**
= 2850 m2 =

Residual NH3-N to be removed
below 5 mg/l = 5 mg/l less 2 mg/l times **28 500** **litres/day**
= 0,086 kg/day

Area Required to reduce NH3-N to 2
= 0,086 kg/day over 0,089 kg NH3-N/day/100 m2 **(Ref. 12)**
= 96 m2 =

Total Nitrification Area Required = 2946 m2 =

(Ref. 12)

TABLE # 2 - Brenner

Req'd NH3-N concentration (mg/l)	Removal Rate (kg/day/ 100m2)
1	0,037
1,5	0,061
2	0,089
2,5	0,110
3	0,123
3,5	0,135
No temperature 4	0,147
correction required 4,5	0,147
Refs. 13,14,&15 5	0,147

e) Total Surface Media Required

Total Surface Media Required = 5340 m2

f) Staging

Hydraulic Loading	5,30	L/d/m2
B.O.D.post primary	30,88	kg BOD/day
Media req'd(B.O.D)	2 394	m2
Media req'd(nitrfct'n)	2 946	m2
Total req'd	5 340	m2
Min req'd to prevent 1st st. overload	996	m2
Min req'd to prevent 2nd st. overload	582	m2

	ACTUAL AREA (m2)
First Bank	495
Second Bank	205
Third Bank	822
Fourth Bank	822
Fifth Bank	736
Sixth Bank	736
Seventh Bank	783
Eighth Bank	783
TOTAL	**5 382**

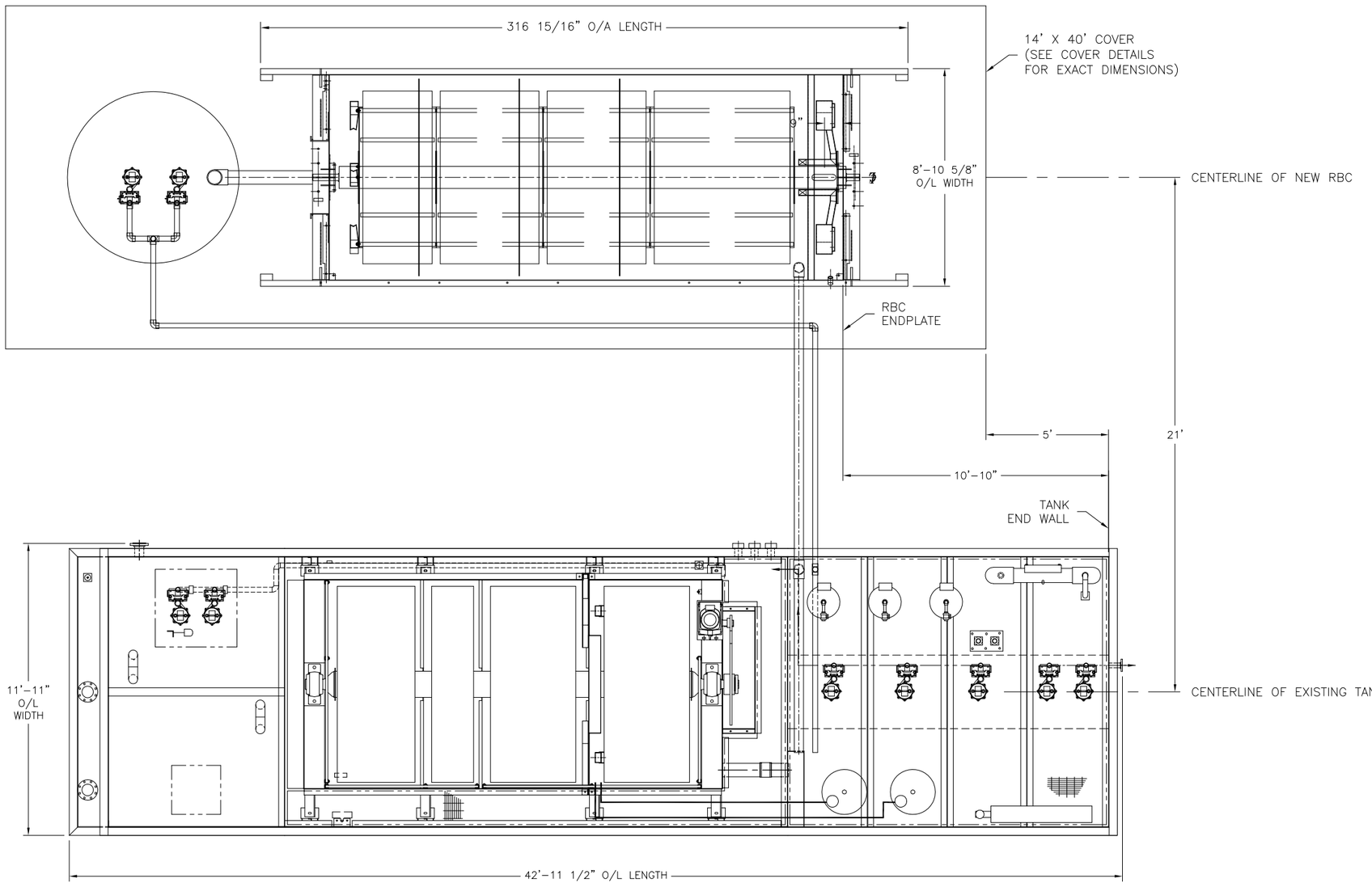
Minimum First Stage Media Area

Maximum loading to prevent first stage overload = 3,1 kg/day/100 m2
= 30,88 kg of post primary BOD/day divided by max. loading times 100 m2
= 996 m2

BOD remaining for 2nd Stage = 18,03 kg/day
Minimum Media 2nd Stage = 582 m2

OPR.	DESCRIPTION

ITEM	PART #	DESCRIPTION	QTY



NOTES:
1. XXXXX

NOTES:

REV	DESCRIPTION	YY/MM/DD	BY
XX	XXXX XXXXX	YY/MM/DD	XX

ALL TOLERANCES ARE
+/- 1/32"
UNLESS OTHERWISE SPECIFIED.
DIMENSIONS ARE IN INCHES.

PROPRIETARY INFORMATION
MAY NOT BE REPRODUCED OR
DIVULGED WITHOUT PRIOR
WRITTEN CONSENT OF
SEPROTECH SYSTEMS INC.
DO NOT SCALE. IF IN DOUBT, ASK

Seprotech
Water. Pure and Simple
SEPROTECH SYSTEMS INC.
2378 HOLLY LANE OTTAWA, ONTARIO, CANADA K1V 7P1
TEL: (613) 523-1641 FAX: (613) 731-0851
Email: contact@seprotech.com Web: http://www.seprotech.com

DESCRIPTION
GENERAL ARRANGEMENT, N70 - SPECIAL BAFFINLAND ADDITION

DRAWN	CHECKED	DATE	SIZE	SCALE	WEIGHT	SHEET	DWG NO.	REV
DC		15-OCT-2008	B	1:60	50000 LB.	1 OF 1	60052-L04	0

APPENDIX D

SEPROTECH RBC INSTALLATION, OPERATION, AND MAINTENANCE MANUALS

APPENDIX D.1

RBC WASTEWATER TREATMENT INSPECTION LOGS

Baffinland Iron Mines Corporation

DATE: _____

MARY RIVER N70 RBC WASTEWATER TREATMENT INSPECTION LOG

Submit daily the completed log to Baffinland Camp Manager

System Performance Checks

	Yes	No	N/A	Corrective Action Taken
Are there any alarms?	☐	☐	☐	
Are ice and other obstructions removed from doorway?	☐	☐	☐	
Are ice and other obstructions removed from ventilation ports?	☐	☐	☐	
Are influent, effluent & RBC vent heat trace warm?	☐	☐	☐	
Are the floats clear of debris?	☐	☐	☐	
Are the UV lights operating?	☐	☐	☐	
Are all the pumps set in auto?	☐	☐	☐	
Is there more than 2" of foam on PST? (Skim it clean)	☐	☐	☐	
Wipe grease off of bearings?	☐	☐	☐	
Lube oil level at top of chain?	☐	☐	☐	
Is bacteria growing on walls of FST & lift station	☐	☐	☐	

UV Lamps: Intensity: _____ Sheaths require cleaning?: Yes ☐ No ☐ Intensity after cleaning: _____

Sodium Hypochlorite: Pump stroke: _____ Stroke percent: _____ Volume remaining: _____ Batch Mixed? _____

Alum: Pump stroke: _____ Stroke percent: _____ Volume remaining: _____ Batch Mixed? _____

Process Performance Checks

	Value	Unit	Acceptable Range	Corrective Action Taken
pH		None	Minimum 7.6	
24 hour Total Flow Rate		Litres	Maximum 33,750 L	
Temperature		℃	Minimum 17℃	
PST sludge level		Feet	Maximum depth = 2'	PST sludge pumped ☐
Odour		Smell	Musty	
Colour on primary disk		Colour	Medium brown	
Colour on secondary disk		Colour	Medium brown	
Colour on final disk		Colour	Medium brown	
Effluent Clarity Test		Solids	Clear – No solids	

Adjustments/Corrective Action/Comments (Document if instructions provided by 3rd party): _____

Chemical Performance Checks:

Monday Operator Analysis Completed ☐ **UV light Cleaned** ☐

Influent	Value	Unit	Maximum Limit
pH		None	
Temperature		℃	
COD		mg/L	
TSS		mg/L	490
TKN		mg/L	65
TP		mg/L	10

Effluent	Value	Unit	Acceptable Range
pH		None	6.0 to 9.5
Temperature		℃	N/A
COD		mg/L	N/A
TSS		mg/L	Maximum 35 mg/L
TKN		mg/L	N/A
TP		mg/L	N/A

Monthly Lab Sample Taken by Technician: Check box to indicate sample taken ☐

Weekly Ops PM checklist complete on Monday ☐ **Monthly Ops PM checklist complete 1st day of the month** ☐

Adjustments/Corrective Action/Comments (Document if instructions provided by 3rd party): _____

OPERATOR (please print): _____ SIGN OFF: _____

Baffinland Iron Mines Corporation

DATE: _____

MARY RIVER N30 RBC WASTEWATER TREATMENT INSPECTION LOG

Submit daily the completed log to Baffinland Camp Manager

System Performance Checks

	Yes	No	N/A	Corrective Action Taken
Are there any alarms?	☐	☐	☐	
Are ice and other obstructions removed from doorway?	☐	☐	☐	
Are ice and other obstructions removed from ventilation ports?	☐	☐	☐	
Are influent, effluent & RBC vent heat trace warm?	☐	☐	☐	
Are the floats clear of debris?	☐	☐	☐	
Are the UV lights operating?	☐	☐	☐	
Are all the pumps set in auto?	☐	☐	☐	
Is there more than 2" of foam on PST? (Skim it clean)	☐	☐	☐	
Wipe grease off of bearings?	☐	☐	☐	
Lube oil level at top of chain?	☐	☐	☐	
Is bacteria growing on walls of FST & lift station	☐	☐	☐	

UV Lamps: Intensity: _____ Sheaths require cleaning?: Yes ☐ No ☐ Intensity after cleaning: _____

Sodium Hypochlorite: Pump stroke: _____ Stroke percent: _____ Volume remaining: _____ Batch Mixed? _____

Alum: Pump stroke: _____ Stroke percent: _____ Volume remaining: _____ Batch Mixed? _____

Process Performance Checks

	Value	Unit	Acceptable Range	Corrective Action Taken
pH		None	Minimum 7.6	
24 hour Total Flow Rate		Litres	Maximum 33,750 L	
Temperature		℃	Minimum 17℃	
PST sludge level		Feet	Maximum depth = 2'	PST sludge pumped ☐
Odour		Smell	Musty	
Colour on primary disk		Colour	Medium brown	
Colour on secondary disk		Colour	Medium brown	
Colour on final disk		Colour	Medium brown	
Effluent Clarity Test		Solids	Clear – No solids	

Adjustments/Corrective Action/Comments (Document if instructions provided by 3rd party): _____

Chemical Performance Checks: **Monday Operator Analysis Completed** ☐ **UV light Cleaned** ☐

Influent	Value	Unit	Maximum Limit
pH		None	
Temperature		℃	
COD		mg/L	
TSS		mg/L	490
TKN		mg/L	65
TP		mg/L	10

Effluent	Value	Unit	Acceptable Range
pH		None	6.0 to 9.5
Temperature		℃	N/A
COD		mg/L	N/A
TSS		mg/L	Maximum 35 mg/L
TKN		mg/L	N/A
TP		mg/L	N/A

Monthly Lab Sample Taken by Technician: Check box to indicate sample taken ☐

Weekly Ops PM checklist complete on Monday ☐ **Monthly Ops PM checklist complete 1st day of the month** ☐

Adjustments/Corrective Action/Comments (Document if instructions provided by 3rd party): _____

OPERATOR (please print): _____ SIGN OFF: _____

APPENDIX D.2

MODEL N70 – MARY RIVER CAMP

ROTORDISK®
Aerobic Wastewater Treatment Plant
Model N70

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

BAFFINLAND
Project #: 60052

Seprotech
Water. Pure and Simple

ROTORDISK®

Wastewater Treatment Plant
Model N70

INSTALLATION, OPERATION & MAINTENANCE MANUAL

AUGUST 2007

SEPROTECH SYSTEMS INC.
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INSTALLATION, OPERATION AND MAINTENANCE MANUAL

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TABLE OF CONTENTS

1.0 SITE INSTALLATION
- 1.1 STEEL TANKAGE
- 1.2 CONCRETE TANKAGE
- 1.3 DIRECTION of SHAFT ROTATION
- 1.4 DISSOLVED OXYGEN RECYCLE for ROTORDISK®
- 1.5 SUMMARY OF OPERATION

2.0 VISUAL CHECKS ON PHYSICAL AND BIOLOGICAL FUNCTIONING OF ROTORDISK® & DESCRIPTION OF TREATMENT PROCESS
- 2.1 PRIMARY SETTLING TANK (PST)
- 2.2 ROTORZONE
  - 2.2.1 'BATHTUB RING'
- 2.3 ACETIC ACID INJECTION SYSTEM
- 2.4 DENITRIFICATION ZONE
- 2.5 FINAL SETTLING TANK (FST)
- 2.6 FILTERS FEED PUMPS LOGIC AND LEVELS IN THE FST
- 2.7 POST FILTRATION SYSTEM
- 2.8 MONITORING OF DISCHARGE FLOW RATE
- 2.9 OPERATING PARAMETERS ADJUSTABLE ON THE CONTROL PANEL
- 2.10 FREQUENCY OF INSPECTION

3.0 STANDARD RECOMMENDATIONS AND PROCEDURES FOR SLUDGE REMOVAL
- 3.1 STORAGE CAPACITIES
- 3.2 DETERMINATION OF ACCUMULATED SLUDGE VOLUMES
- 3.3 SLUDGE REMOVAL
- 3.4 CONSEQUENCES OF MAXIMUM SLUDGE OPERATION
- 3.5 SLUDGE LEVEL SCHEMATIC DIAGRAM
- 3.6 PUMPOUT PROCEDURES FOR ROTORDISK® TREATMENT SYSTEMS
- 3.7 START-UP PROCEDURES OF ROTORDISK®

4.0 STORAGE OF ROTORDISK® SEWAGE TREATMENT EQUIPMENT

5.0 ASSEMBLY INSTRUCTIONS FOR ROTORDISK® MECHANICAL COMPONENTS

6.0 ROUTINE MECHANICAL MAINTENANCE OF ROTORDISK® SEWAGE TREATMENT PLANTS
- 6.1 MOTOR
- 6.2 REDUCER
- 6.3 BEARINGS
- 6.4 SPROCKETS AND CHAIN

7.0 TROUBLE SHOOTING
- 7.1 MECHANICAL HARDWARE
- 7.2 ROTORDISK® PROCESS

8.0 MAINTENANCE PROGRAM - Do's and Don'ts

9.0 INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS FOR VARIOUS MECHANICAL PARTS OF THE ROTORDISK® AND OTHER EQUIPMENT SUPPLIED.

10.0 LIMITED WARRANTY

IMPORTANT: READ THIS INSTALLATION PROCEDURE PRIOR TO START-UP.

1.0 SITE INSTALLATION OF ROTORDISK® SEWAGE TREATMENT PLANTS:

1.1 (applies to Steel Tankage only)

When there is a complete ROTORDISK® unit supplied, site preparation is as follows:

A level concrete or well-compacted gravel base is to be supplied by Customer/Contractor.

Unit to be lifted only at lifting points by use of hooks and spreader bars.

All anchoring and levelling of ROTORDISK® on site to be done by customer/contractor. Check alignment of shaft and sprockets and clearances of couplings where applicable prior to start-up, failure to do so may void manufacturer's warranty. Refer to this ROTORDISK® manual for details. If required, the contractor must perform levelling.

All hydraulic piping, to and from the unit, is to be supplied and installed by customer/contractor.

All input electric and hydro hook-ups to be done by customer/contractor to local governing regulations and a signed approval sent to SEPROTECH SYSTEMS INCORPORATED. Under no circumstances must electrical connections, junction boxes or equipment pertaining to the electrical function of the unit be installed in the ROTORDISK® tank.

SEPROTECH SYSTEMS INCORPORATED GROUP INC. will supply a man on-site to assist customer/contractor at a specified rate and at customer/contractor discretion.

If unit is not shipped completely assembled assembly instructions and drawings will be supplied.

IMPORTANT: READ THIS INSTALLATION PROCEDURE PRIOR TO START-UP.

1.2 - (applies to Concrete Tankage for ROTORDISK® only)

If the ROTORDISK® unit supplied is to be encased in concrete tankage, the site preparation is as follows:

The unit is lowered into the concrete tankage, the pipe at the end of the unit is placed into the opening of the intermediate wall between the primary and final settlement chambers and lowered onto the anchor bolts (contractors supply).

Unit to be lifted only at lifting points by use of hooks and spreader bars.

All anchor bolts (contractors supply) should be correctly located in concrete in a vertical position. In addition, all bolts should include a levelling nut.

All anchoring and levelling of ROTORDISK® on site to be done by customer/contractor. When the unit is set onto the anchor bolts in the concrete tank, it must be levelled to a slope of no more than 3/4" in 20' along the length. The unit is then centred in the tank and completely bolted down.

After the unit has been bolted down, check alignment of shaft and sprockets and clearances of couplings where applicable prior to start-up, failure to do so may void manufacturer's warranty. Refer to this ROTORDISK® manual for details. If required, the contractor must perform levelling.

All hydraulic piping, to and from the unit, is to be supplied and installed by customer/contractor.

All input electric and hydro hook-ups to be done by customer/contractor to local governing regulations and a signed approval sent to SEPROTECH SYSTEMS INCORPORATED. Under no circumstances must electrical connections, junction boxes or equipment pertaining to the electrical function of the unit be installed in the ROTORDISK® tank.

SEPROTECH SYSTEMS INCORPORATED will supply a man on-site to assist customer/contractor at a specified rate and at customer/contractor discretion.

If unit is not shipped completely assembled assembly instructions and drawings will be supplied. (As shown)

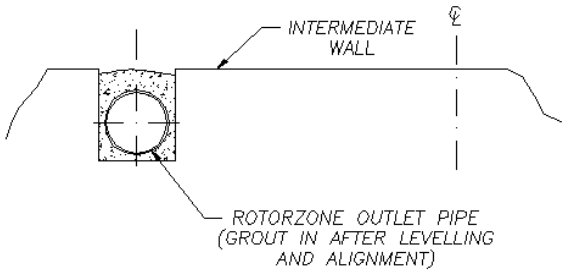


Figure a - **ROTORDISK®** tank outlet through intermediate wall between settlement tank chambers.

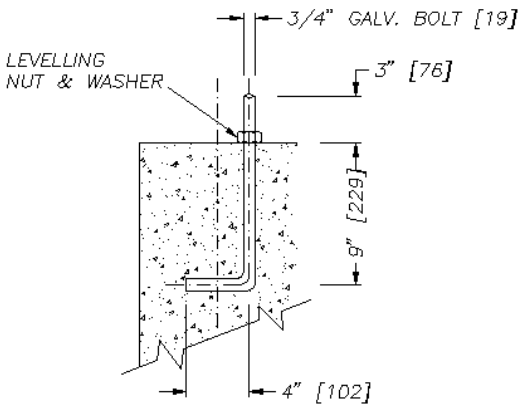
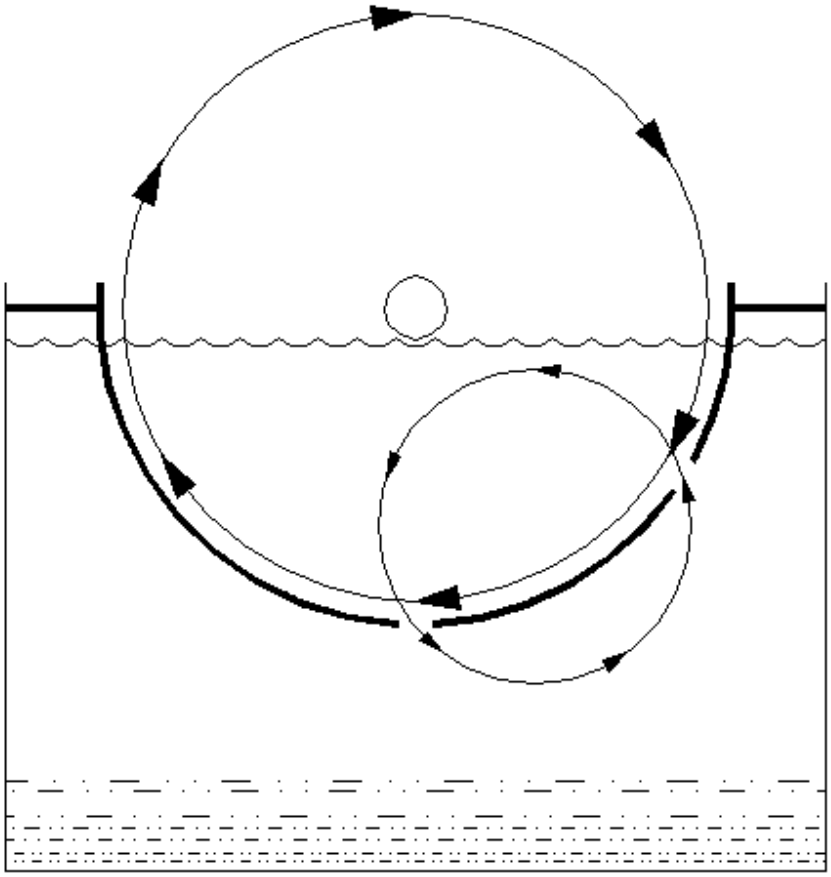


Figure b - anchor bolt detail for **ROTORDISK®** tank.

1.3 - DIRECTION OF SHAFT ROTATION



The direction of shaft rotation should be such that disks mounted on shaft will enter water on the side where inlet to "Rotorzone" is located. The electric motor driving the shaft should be wired accordingly.

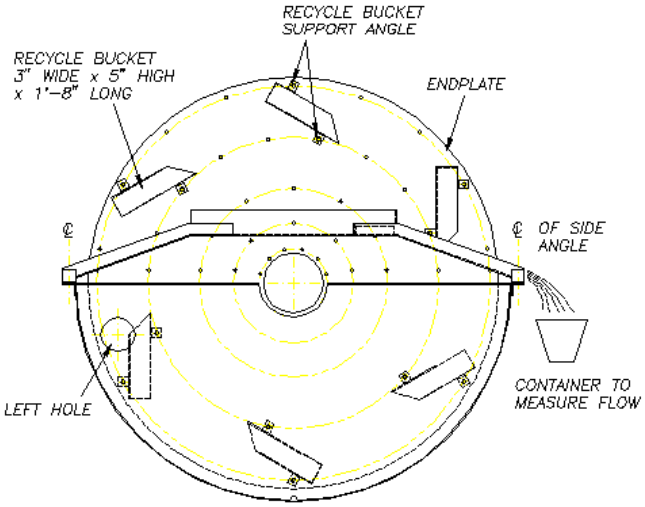
1.4 - DISSOLVED OXYGEN (D.O.) RECYCLE for ROTORDISK®

1.4.1 Recycle buckets are mounted on the last stage of the ROTORDISK®. These buckets rotate at the same speed as the disks. See the attached elevation view of the recycle buckets and trough on the Rotorzone tank.

1.4.2 As the disks rotate, the buckets scoop-up treated wastewater. As this wastewater falls into the recycle trough, it is exposed to the atmosphere, where it absorbs fresh oxygen. The wastewater then cascades on one side of the trough through a narrow steel channel and mixes back with the contents of the Primary Clarifier, thereby introducing fresh dissolved oxygen in the Primary Clarifier. See the section of diskbank assembly showing buckets and recycle trough.

1.4.3 The set-up described above is comprised of the recycle buckets and recycle trough, is what we term as our D.O. re-circulation device. This is especially advantageous to preventing septic conditions from occurring in the Primary Clarifier in small flow or low flow situations.

1.4.4 It is **important** to measure the **actual recycle rate** on the **ROTORDISK®**. This data is compared to our theoretical recycle rate designed. This is advantageous prior to connecting and setting-up for service. Using a container (5 gallon bucket is ideal) and a stopwatch, record the water flowing out of the effluent channel of the recycle trough. Make 3-5 readings, and report this data to SEPROTECH SYSTEMS INCORPORATED for future reference.



SECTION OF DISKBANK ASSEMBLY SHOWING 6 BUCKETS AND RECYCLE TROUGH

1.5 - SUMMARY OF OPERATION

(ROTORDISK® systems designed for BOD/SS/Ammonia/Nitrate removal)

A). The sewage plant (as supplied by SEPROTECH SYSTEMS INCORPORATED) is comprised of five (5) main components: the primary settling tank, the RBC tank, the denitrification tank, the secondary settling tank and the multi-media filters.

B). The RBC tank is the aerobic section of the treatment plant divided into four (4) stages.

Raw sewage is pumped and/or gravity flows into the primary settling tank (PST). When the sewage is pumped into the plant, pumping must simulate conditions encountered in gravity fed systems. Indeed, over a 24-hour period, the plant is designed to handle a flow rate corresponding to the Average Daily Flow (ADF) and can accommodate for two Peak Daily Flow (PDF) periods of two (2) hours per day. Each PDF event can be at a maximum of three times ADF.

In the PST, sedimentation separates heavy solids from the bulk of the liquid and the supernatant enters the aerobic section through the inlet slot located at the front section of the RBC tank.

The aerobic section is made up of four stages. The 1st stage is mounted on one common shaft. This 1st stage is comprised of one (1) to three (3) disk banks. The normal colour of the bacteria in the 1st stage is dark brown. This is the stage where most of the BOD removal by biological oxidation occurs. The succeeding 2nd, 3rd, and 4th stages are mounted on the rest of the shaft or another common shaft. Each stage has one (1) to three (3) disk banks. It is in the 2nd stage that further BOD is removed, and nitrifying bacteria (those which convert ammonia (NH_3) in the form of ammonium ions (NH_4^+) into nitrite (NO_2^-) and, ultimately, nitrate (NO_3^-)) start to predominate in the 3rd and 4th stages. The 4th and last aerobic stage has recycle buckets that introduce both fresh dissolved oxygen into the primary settling tank and nitrifying bacteria present in the recycled water.

The rotation of the disks in and out of the water provides a mean of air and heat transfer from the ambient air to the water. The transfer of air to the water is important for aerobic bacteria to remove BOD and ammonia. The transfer of heat to the water is important to maintain the water at an optimum temperature of 15 °C and above such that BOD and ammonia removal rates by the bacteria are maximised (removal rates are a function of the water temperature). Because maintaining a temperature that provides acceptable removal rates is important to the process, RBC's are installed indoors and ambient air is maintained at 15 °C and above.

C). The media in the denitrification section is completely submerged since denitrifying bacteria convert nitrate (NO_3^-) to nitrogen gas (N_2) in an anoxic (i.e., in the absence of dissolved oxygen (DO)) environment.

(Text missing pending completion of patent application process.)

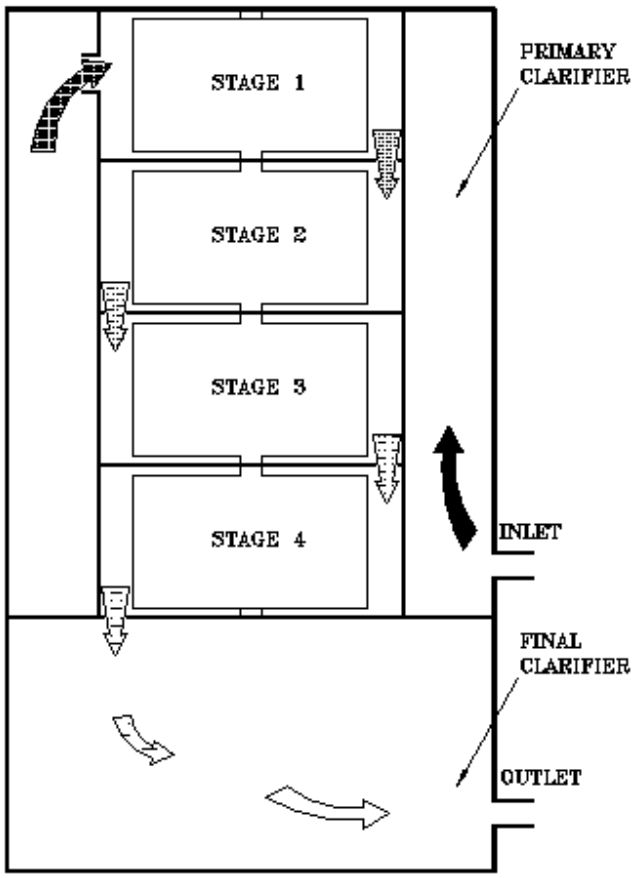
The denitrification section is comprised of two stages separated by a baffle. An equal amount of media is provided in both stages.

D). Partially treated water from the denitrification section then enters the secondary settling tank. Sloughed off biomass from the disks and media bundles and other suspended solids is further settled in this chamber.

E). The partially treated water is then fed to three (3) multi-media filters using one of two (2) submerged pumps. The purpose of these filters is to further reduce the concentration of suspended solids in the final effluent.

2.0 - ROUTINE VISUAL CHECKS ON PHYSICAL AND BIOLOGICAL FUNCTIONING OF ROTORDISK® & DESCRIPTION OF TREATMENT PROCESS

ROTORDISK® sewage treatment plants have three major steps in the purification process. In the primary settling tank, gross solids separate from the flow by either sinking or floating. In the Rotorzone, dissolved pollutants are broken down to simple, non-pollutant compounds by the bacteria ("biomass") which grows on the rotating disks. The final settling tank permits gravity separation of spent biological growth, which continually sloughs off the disks in the Rotorzone preceding it.



2.1 - PRIMARY SETTLING TANK (PST OR PRIMARY "CLARIFIER")

The accumulation of floating scum on the surface of the primary clarifier is normal. It is proportional to the accumulation of settle-able solids at the bottom of the tank. Periodic (9-12 months) removal of sludge at the bottom of the tank is required for proper operation of the Unit.

If no sludge measuring device is available, the accumulation of 9"-12" depth of scum on the surface is a good indication that it is time to remove the accumulated deposits of sludge from the bottom of the tank(s).

2.2 - ROTORZONE

The Rotorzone is subdivided into four sections, with disk banks in each. The wastewater first enters the Rotorzone in the section marked "1" in the sketch (furthest away from the inlet to the plant). The flow then proceeds through sections 2, 3, and 4 before entering the denitrification zone.

The accumulation of biological growth will be greatest in section 1, and gradually decrease through subsequent sections. Generally, the growth will be thick, and often filamentous ("stringy"), in section 1, becoming thinner and more compact through sections 2-4.

The colour of the growth will typically be dark brown to black in Section 1. Some grey growth may also be noticed, depending on the relative load and type of wastewater being treated. Growth in sections 2-4 will typically vary from medium brown to a light brown or tan growth in section 4.

In a well-functioning unit with the appropriate feed of wastewater, there will be an earthy, humus-like ("musty") smell inside the unit. A substantial sour, "sewage" smell may be an indication of sub-optimal conditions in the treatment process.

2.2.1 - 'BATHTUB RING'

The wastewater flows by gravity within a ROTORDISK® Plant thus the water level is relatively constant. Changes in water level of 1" to 2" are not unusual due to surge flows entering the unit. The evidence of this is a 'bathtub ring' 1" - 2" above the normal level. A 'bathtub ring' higher than this suggests that partial or complete flooding of the unit has occurred since the last check. If so, the (gravity or pump) discharge system should be checked for blockages or mechanical malfunction. Another condition which can lead to the level of water rising to greater levels than 1" – 2" is if the plant is fed by pumps that exceed the design limits of the plant (i.e., ADF over a period of 24 hours including a maximum of two (2) PDF events no longer than 2 hours each).

2.3 – ACETIC ACID INJECTION SYSTEM

One of the most important building blocks of life is carbon. The bacteria responsible for denitrification need carbon in an organic form to grow and thus convert nitrate to nitrogen gas. Most soluble organic carbon (often measured in terms of Biochemical Oxygen Demand or BOD) has been consumed in the aerobic section of the wastewater treatment plant and there is thus very little left for the denitrifiers by the time the wastewater reaches the denitrification section of the plant. It is for this reason that acetic acid (vinegar), an easily biodegradable organic carbon source, is injected at the inlet of the denitrification zone.

The system provided consists in a 125 imp. gal. storage tank (ϕ=30", H=49") equipped with a mixer and of a dosing pump of maximum capacity 12.3 l/h mounted on a skid.

The dosing pump can be controlled in either of two ways: by a 4-20 mA signal coming from the flowmeter located on the effluent outlet pipe (the system is programmed to be operated that way by default) or by a dry contact (by others) located outside SEPROTECH SYSTEMS INCORPORATED's main control panel. For example, that dry contact (by others) could be closed when the pumps (by others) feeding the wastewater treatment plant are running and opened when they are not.

The target dose of pure acetic acid (CH_3COOH) in the water is: 175 mg/litre. Assuming that commercial acetic acid is at a concentration of 12% by weight, this means that the target dose of commercial acetic acid at the inlet of the denitrification section would be 1460 mg of commercial acetic acid per liter of water. At ADF (i.e., 49,000 litres per day), this corresponds to a dosing rate of 2.9 litres of commercial acetic acid per hour. If the 4-20 mA signal from the flowmeter is used to control the dosing pump (again, this is the default mode), then the actual dosing rate will be $3 \times 2.9 = 8.7$ litres of commercial acetic acid per hour one third of the time since the flow exiting the plant (via the flowmeter) is pumped from the FST to the multi-media filters at a rate of $3 \times$ ADF = PDF (i.e., 147,000 litres per day).

The average daily quantity of commercial acetic acid necessary has been estimated at 70 l/day (15.4 imp. gal per day) based on an ADF of 49,000 litres/day.

2.4 – DENITRIFICATION ZONE

(Text missing pending completion of patent application process.)

In the denitrification zone, the media is completely submerged such that anoxic conditions (i.e., the absence of Dissolved Oxygen (DO) in the water) prevail and thus the denitrification process (i.e., the conversion of nitrate (NO_3^-) to nitrogen gas (N_2)) can take place. The denitrification zone includes two (2) stages that are separated by a baffle.

2.5 – FINAL SETTLING TANK (FST OR FINAL "CLARIFIER")

The effluent near the outlet at the backside of the final clarifier should be relatively clear and colourless and relatively free of suspended matter. Clarity can best be judged by scooping a small volume of the final effluent into a clear glass container. This is particularly true of larger units where the depth and dark colour of the tank walls may make clarity hard to determine. (Note: Although the risk of infection is very small, the wearing of rubber gloves is a rational safety precaution when hand-scooping the effluent for a clarity check. This is particularly true if there are open cuts on the hands.)

Although the final effluent itself should be relatively clear, some floating matter may accumulate on the surface of the final clarifier. This is normal, and will typically be much less than the accumulation of floating scum in the primary clarifier.

2.6 – FILTERS FEED PUMPS LOGIC AND LEVELS IN THE FST

The level in the FST is controlled in the following manner:

- Level Switch Low (LSL or float #1): both filter feed pumps (each of capacity = 3 × ADF) stop when this level is reached;
- Level Switch High (LSH or float #2): lead filter feed pump starts when this level is reached;
- Level Switch High High (LSHH or float #3): lag filter feed pump starts (lead filter feed pump is maintained in operation) and an alarm goes off when this level is reached (i.e., the alarm light is activated);
- Overflow: the FST is equipped with an outlet that can be connected directly to the storm sewer in the exceptional case that the plant is overflowed (piping between this outlet and the storm sewer is out of SEPROTECH SYSTEMS INCORPORATED' scope of supply).

2.7 – POST FILTRATION SYSTEM

The clarified water is pumped from the FST to three multi-media filters operating in parallel. The purpose of these multi-media filters is to reduce further the concentration of suspended solids in the treated wastewater.

The three filters operated in parallel are designed to treat peak low rates (PDF) of 3 times the design average daily flow (ADF) and are fed at this flow rate since each filter feed pump also has a capacity of PDF.

Each of the three filters is filled with anthracite, sand and garnet with gravel underbedding. The water is filtered from top to bottom of each filter with the coarser filtration media placed on top and the finer on the bottom of the filter. Each vessel is made of fibreglass. In normal operation (i.e., when all 3 filters operate in parallel), the filtration velocity is about 10 m/h on each filter.

A backwash of one of the three filters is performed approximately every 4 hours. The filters are backwashed alternately, i.e., filter no. 2 gets backwashed approximately 4 hour (exactly 4 hours + the time it takes to backwash and rinse a filter) after filter no. 1 gets backwashed and filter no. 3 gets backwashed approximately 4 hour after filter no. 2 gets backwashed. These operating parameters are adjustable on the plant's main control panel (see Section 2.9). When a backwash occurs, the water pumped at PDF from the FST is fed to two of the filters and the filtrate from these is used to backwash the third filter from bottom to top (inverse direction than in filtration mode). The two filters used to produce the filtrate operate at velocities of approximately 15 m/h while the third filter gets backwashed at a velocity of approximately 30 m/h.

The filtration system is controlled by the main control panel for the plant. The automatic diaphragm valves installed on the filtration unit are pneumatic and are thus opened and closed using compressed air. A compressor is provided with the plant. The compressed air transits through a filters solenoid valves panel.

2.8 – MONITORING OF DISCHARGE FLOW RATE

The plant is equipped with a magnetic flow meter located on the clean effluent's discharge pipe. This instrument is equipped with a counter that allows tracking of the total volume of clean effluent discharged by the plant. As mentioned in paragraph 2.3, the flow meter is also used to control the injection rate of acetic acid. A thermal chart recorder was also provided in order to produce hardcopies of the flow measurements taken by the flowmeter.

2.9 – OPERATING PARAMETERS ADJUSTABLE ON THE CONTROL PANEL

The following operating parameters were set as default in the Programmable Logic Control (PLC) panel provided with the plant but are adjustable within the ranges shown below. Making changes and adjustments to the default plant's operating parameters requires a good understanding of the wastewater treatment process and should therefore only be performed by qualified and trained staff. Please contact SEPROTECH SYSTEMS INCORPORATED if assistance is needed to optimise the operation of the plant.

	T1 Time between backwashes	T2 Time for a backwash	T3 Time for rinse	T4 Time between sludge pumping	T5 Time for sludge pumping
Factory Setting	4 h	10 min	5 min	1.0 h	0.25 min
Minimum	1 h	5 min	2 min	0.5 h	0.10 min
Maximum	18 h	30 min	30 min	12.0 h	1.00 min

2.10 - FREQUENCY OF INSPECTION

Visual checks every week should be sufficient. However, for better preventative maintenance of the wastewater treatment plant and thus the capital investment, a daily walk through is often the preferred frequency of visit. Many owners prefer the visual and audible (look and listen) walk through. A standard operator checklist should be prepared and used by the person responsible for periodic maintenance of the plant at every visit. SEPROTECH SYSTEMS INCORPORATED can assist in preparing such checklist upon request.

The acetic acid storage tank should be topped off every time the plant is being visited.

The pressure loss on every filter should also be controlled. Two pressure gauges were provided for this purpose, one on the inlet pipe and one on the outlet pipe of each filter. The pressure drop across a filter shouldn't exceed 15 PSI. If it does even after a filter has been backwashed, the frequency and/or duration of backwashes should be increased.

3.0 - STANDARD RECOMMENDATIONS AND PROCEDURES FOR SLUDGE REMOVAL

3.1 - STORAGE CAPACITIES

A design feature of ROTORDISK®, which contributes greatly to overall simplicity of the process, is the sizing of clarifiers to accommodate static internal sludge storage for extended periods. Depending on such factors as raw wastewater solids concentrations, and design organic loading in a given application, maximum sludge storage levels will typically be reached in 6-9 months of operation.

This period is based on calculated rates of initial decomposition of raw and biological solids, and, upon operating experience, indicating the degree of auto-digestion/compacting, which proceeds during the storage period. The 6-9 month period will be shortened to the extent that design hydraulic and waste loads are exceeded. It will be lengthened to the extent that flows and waste load are less than those designed for.

3.2 - DETERMINATION OF ACCUMULATED SLUDGE VOLUMES

The accumulation of maximum storage capacities can be indirectly monitored through visual observation of the thickness of the scum blanket on the surface of the primary clarifier. When the scum blanket has matured to a height of approximately 7"-10", this is a good indication that sludge accumulations at the bottom of both clarifiers are at or near maximum levels, and that sludge withdrawal is indicated.

A more accurate procedure of determining sludge levels is to directly measure actual accumulations, and compare these to the maximum storage capacities listed on the "Details" section of the general arrangement drawing for the ROTORDISK® model in question.

A variety of sludge measuring devices is commercially available. The two most common are the weighted hollow tube type, and, the (electronic) turbidity-change detector type. The former is less costly, relatively easy to use, and more appropriate because of the low frequency with which measurements need to be made in a ROTORDISK® unit.

Whatever means of measuring the sludge may be selected, it must be kept in mind that the sludge is <u>not</u> a firm solids substance. Domestic wastewater sludge is mostly trapped water and other liquids. Only to determine sludge levels by "feeling" for a solid layer with a stick or pole. The settled sludge is far more liquid than the surface scum, which is perhaps 30-40% solids by volume.

Irrespective of the type of device used, sludge levels should be measured at several locations in each settlement tank to ensure a reasonably accurate calculation of accumulated volumes. This is required since sludge accumulation levels are not uniform; being highest at the inlet ends of both clarifiers, and, below the slot at the bottom of the first section of the Rotorzone trough.

Once an average sludge height has been determined, multiply by the surface area of the clarifier in question to determine the existing volume of stored sludge. Compare to maximum design capacity listed on the general arrangement drawing. If the accumulated levels equal or exceed design values, it is time to remove the sludge from the unit.

3.3 - SLUDGE REMOVAL

A pump-out truck of the same type that pumps out septic tanks normally does the sludge removal. For smaller ROTORDISK® units, the entire liquid contents of the treatment plant can be withdrawn. For larger installations, the haulage contractor should be instructed to get the suction hose directly to the bottom of the tanks and withdraw the sludge only, while taking as little of the supernatant as possible. Once the primary sludge is withdrawn from the primary settlement tank, the supernatant of the secondary clarifier can be transferred to the primary settlement tank to expose the secondary sludge. The suction hose should be placed down at a multiple number of points to help ensure complete removal of accumulated sludge deposits. Floating surface scum should also be removed. Haulage contractors should be given a brief description of the unit and its operation if they are not already familiar with it. A particular point to emphasise is that the biological growth on the disks should not be washed off, but should be left in place. The exception to this is if the disks have accumulated excess biomass due to sludge pump out being delayed past the indicated intervals.

Sludge removed from the unit is normally hauled away by the pumping truck and disposed of at municipal facilities, or, by controlled spreading on farmland. On-site disposal in shallow trenches and/or some form of on-site volume reduction (prior to export) may be feasible or desirable depending on the specific opportunities and limitations afforded by the site of a given installation.

3.4 - POTENTIAL CONSEQUENCES OF OPERATING ROTORDISK® UNITS PAST DESIGNATED MAXIMUM SLUDGE STORAGE LEVELS

Sludge accumulations should be removed once they reach indicated maximum storage levels, because failure to do so could result in lowered treatment efficiency, and possibly cause serious damage to the structure of the Rotating Assembly and drive unit. The potential for problems is as described below and depicted in the attached sketches.

Figure (c) shows a unit operating with sludge build-ups at or near maximum storage levels. This will cause no problem since the storage heights are designated so that flows through the primary clarifier will not disturb the sludge layer. Characteristics of wastewater reaching the Rotorzone at this time (and since start-up) will be in the range of 180-200 mg BOD/1 and 50-250 mg SS/1. The supporting structure of the rotating assembly is over designed for the amount of biological build-up which will occur on the disks under this operating condition, and the shear force of the rotation through the trough water will limit the thickness of growth.

However, if sludge is allowed to accumulate past designated storage heights, flow through the primary clarifier will begin to disturb the sludge blanket, and thus carry loads of solids and dissolved organic matter into the Rotorzone which are not anticipated in the design of the unit (Figure d). The pollutant load reaching the biomass on the first stage of disks will overload that biomass (in terms of F:M ratio), and force a change in its activity and growth. The biomass becomes more gelatinous, and does not shear off as well with disk rotation. Additionally, the biomass will readily adsorb and entrap the extra solids with the sum effect being an increase in weight on the rotating assembly that considerably exceeds that which its design is based on.

This tendency reaches its extreme if sludge is allowed to accumulate to the point where it will be disturbed by-, and caught up in -, the re-circulation pattern created by the two slots in the trough on the first section of the Rotorzone (see Figure e).

The sludge will have characteristics in the order of 20,000 mg TSS/1 and 10,000 mg BOD/1, so it is obvious that even a minor amount of this material caught up in the re-circulation flow will significantly increase the concentration of the waste stream entering the Rotorzone. If, for example, the sludge was caught up in the recycle flow at a ratio of as little as 1:10 or 1:15, the resulting concentration would be sufficient to produce a considerable first-stage overload on an amount of disk area selected based on normal concentrations.

The resulting build-up of poorly-shearing gelatinous biomass and trapped solids would pose a serious potential for strain on the drive unit, and for structural damage to disk bank assemblies and shaft, in spite of them being considerably over designed for loads anticipated in normal operation.

Clearly, these potential problems should be avoided by the removal of sludge once it reaches the level specified as maximum for the ROTORDISK® unit in question.

3.5 - FRONT VIEW SCHEMATIC OF ROTORDISK®

UNIT OPERATING AT-, AND ABOVE-,
RECOMMENDED MAXIMUM SLUDGE STORAGE LEVELS

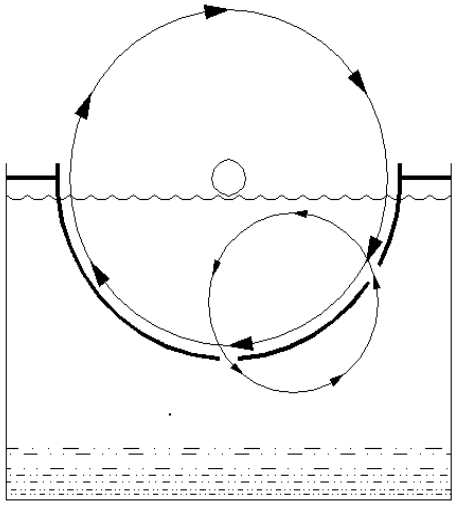


Figure c-unit operating at maximum sludge storage levels. Neither influent flows, nor re-circulating flows, disturb sludge blanket.

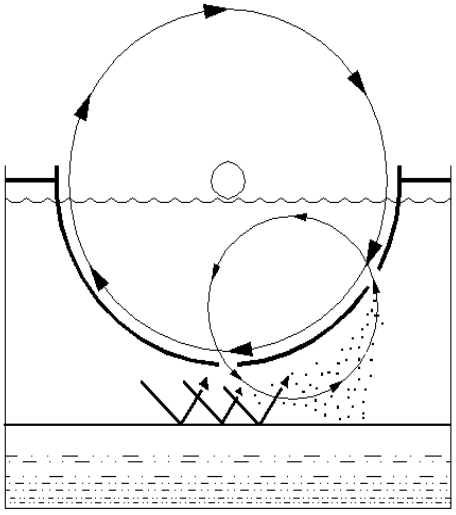


Figure d- unit operating with excess accumulations. Influent flows may disturb sludge blanket and increase BOD and solids loads to Rotorzone to levels above treatment design.

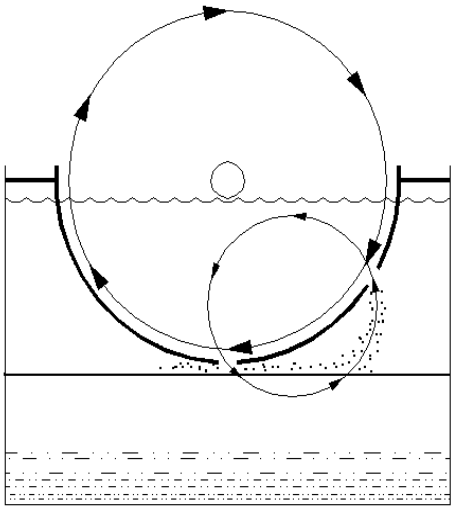


Figure e-Unit operating with excess sludge accumulated to base of Rotorzone. Both influent flows and re-circulation flows will disturb and carry sludge solids. Increase in BOD and solids loads entering Rotorzone will be substantially above design treatment levels, increase accumulated masses on rotating assembly, produce potential for damage to structure and drive unit.

3.6 - PUMPOUT PROCEDURES FOR ROTORDISK® TREATMENT SYSTEMS (summary)

Using suction hose, floating or surface scum should be removed first. Place the suction hose directly to the bottom of the tank and withdraw sludge only, while taking as little as possible of the volume of waste liquid above the sludge blanket (supernatant).

Move the hose at multiple number of points along the bottom of the settlement tanks. Do not wash off biological growth (biomass) on the disks. The exception to this is excess accumulated biomass on the disks due to an overdue sludge pump-out. Excess accumulated biomass is when a disk bank is 100% fully covered with biomass and the colour is grey with a slight odour.

Keep a record of all pump-outs to arrive at an actual normal operating interval for sludge pump-outs. For systems with several flow meters, it is also beneficial to note the total flow generated between pump-outs.

3.7 - START-UP PROCEDURES OF ROTORDISK®

WARNING: A VALVE LOCATED AT THE BOTTOM OF THE DENITRIFICATION TANK AND EQUIPPED WITH A REMOTE ACTUATION MECHANISM WAS PROVIDED WITH YOUR UNIT. THIS VALVE:

- Needs to be OPEN: when the plant is first filled with water, during draining if the plant ever requires such operation and during subsequent refilling operations. FAILURE TO OPEN THIS VALVE DURING FILLING AND DRAINING WILL RESULT IN SERIOUS DAMAGE TO THE PLANT. This is because, during a filling operation, the water rising in the PST would push the denitrification tank upwards while it is empty (this tank wouldn't have had a chance to fill with water until the water level reaches the inlet slot between the PST and the aerobic ROTORDISK®. Th open valves provide a mean of filling the PST and the through (denitrification tank included) at the same time.

- Needs to be CLOSED: during normal operation of the plant. Indeed, the denitrification section contains water already partly treatment thus this water and that contained in the PST shouldn't mix. FAILURE TO CLOSING THIS VALVE DURING NORMAL OPERATION OF THE PLANT WILL RESULT IN A POOR QUALITY EFFLUENT.

The ROTORDISK® sewage treatment plant is based on a fixed film treatment process referred to as the Rotating Biological Contactor (RBC). In this process, micro-organisms or bugs are attached and grown on the surface of a media, the quantity of bugs being directly proportional to the amount of food in the wastewater. When starting up a new system, it will normally take about two weeks to get organic removal from the wastewater and three to four weeks to establish the nitrification process at normal domestic sewage temperatures. The method of and effluent discharge during system start-up should be discussed and thoroughly communicated with the environmental authority. The primary sedimentation tank and RBC of the system should, preferably, be filled with fresh water before admitting wastewater to the system. A flow less than design is not a problem. The biomass will develop themselves on the media. If there is a small flow only a portion of the disk will have biomass. As the flow increases the amount of biomass will increase.

Seeding a ROTORDISK® with activated sludge, although not required, can be accomplished. The activated sludge should be at the same temperature as the influent. Sudden changes in wastewater temperature cause biomass sloughing. In most cases, the use of domestic waste as a seed culture has provided the required biomass for continuous operation. When seeding the ROTORDISK® with activated sludge is decided, the primary sedimentation tank and RBC of the system should first be filled with fresh water (preferably) and the activated sludge added to the RBC. The RBC should be rotating at all times. The wastewater introduced to the tank needs to have only 20% of the disks covered with waste. This can already provide the needed wetting and still provide some time to reach normal operating levels when source flow is introduced. The final clarifier does not need to be filled with anything.

Alternately, seeding can be accomplished using dry bacteria and a source of organic carbon such as raw molasses or sugar. This can be done, for example, in situations where wastewater or activated sludge are not available and the plant needs to be ready to treat wastewater very shortly after it begins receiving it. By simulating the conditions encountered in wastewater (where large amounts of organic carbon and bacteria are present), biomass will establish on the ROTORDISK® and the plant can thus be prepared to work under actual conditions before these are actually encountered. SEPROTECH SYSTEMS INCORPORATED can help find appropriate supplies of both dry bacteria and raw molasses.

The preferred start up is the introduction of source wastewater at design or less than design loading. The disks need to be rotating at all times. When the disks are rotating and wastewater is introduced the biomass will develop and the pollutants will be removed.

The practice of starting up a sewage plant with a charge of septage or activated sludge may be appropriate for suspended growth systems where sludge return is an essential and necessary part of the process. However, start-up with septage is not an appropriate practice for fixed film systems such as the Rotating Biological Contactor process and is not recommended. This is especially true of the ROTORDISK® process and its static, internal storage of sludge.

Studies have shown that the natural start-up time for a ROTORDISK® is 2 1/2 – 3 weeks (normal temperatures and BOD reduction only), and that it has already developed sufficient biomass for 50% removals in only 1 week. These are time frames significantly shorter than respective ones for suspended growth systems. Thus there is little rationale for "pre-starting" a ROTORDISK® unit with septage.

Further, septage contains solids that are already well digested, and therefore not subject to further digestion-compaction in the storage zones. This contrasts to the fresh solids, which will undergo considerable digestion-compaction in the 6 – 9 months after initial settlement. Therefore, a charge of septage would contribute disproportionately to the accumulation of sludge levels, and necessitate a shorter interval to the first pump-out of the unit.

The ROTORDISK® concept of static sludge storage contributes greatly to its overall operation and maintenance simplicity. Following the above guidelines and recommendations will help ensure that the trouble-free simplicity of ROTORDISK® is maintained.

4.0 - STORAGE OF **ROTORDISK®** SEWAGE TREATMENT EQUIPMENT

If the unit is not to be operated for an extended period, then the motor-reducer assembly (drive unit) should be removed from its mound and stored at room temperature in a reasonably dry area (unless the whole unit is being stored in such an area).

Additionally:

1. Reducer: The input shaft should be given several turns once a month to re-lubricate the upper bearings.

NOTE: Some reducers are shipped to site filled with synthetic lubrication. Otherwise, fill the reducer with the lubricant (see reducer section of installation & maintenance instructions).

2. Motor: The motor has a tendency to take on moisture when not in operation. It requires no attention during storage, but before it goes into operation the insulation should be measured using a Meger. It should be at least 1.0 mega-ohm. If below 1.0 mega-ohm, it has taken on excessive condensation, and must be dried out before being operated. (Note: any electrical contractor or repair shop commonly understands these terms and procedures).

3. Support bearings on main ROTORDISK® shaft(s) should be re-lubricated prior to start-up.

4. The system should not be installed and operated in water. In the absence of sewage inputs and normal biological activity, freezing and consequent mechanical damage would be a distinct possibility. Water level in the primary settlement tank to be dropped to below the bottom of the Rotorzone tank level, if freezing of the tank contents is possible.

5.0 - ASSEMBLY PROCEDURE OF ROTORDISK® COMPONENTS SUPPLIED BY SEPROTECH SYSTEMS INCORPORATED

1. Upon receipt of mechanical components:

   a. Check packing list for any missing items on delivery.

   b. Motor/Reducer is shipped loose, for assembly on the reducer flange. The reducer is shipped completely filled with synthetic lubricant.

   c. Bearing components are shipped as a set. Open only when ready for assembly, to avoid moisture contamination.

   d. Chain and sprockets are shipped as a set. Check for the following:

   -Large sprocket bushing (O.D.) fits into the large sprocket bore.
   -Large sprocket bushing bore (I.D.) fits the Rotordisk® shaft drive end.
   -Small sprocket bore (I.D.) fits on the reducer output shaft.
   -Cottered chain fits or matches the teeth on the sprockets.

   e. Coupling (applicable only to split-shaft ROTORDISK® is shipped as a set. Check the coupling hubs if they fit the center stub ends of the ROTORDISK®shafts.

   f. Disk banks are shipped pre-assembled on the shaft by SEPROTECH SYSTEMS INCORPORATED and are shipped on A-frames. Handle with care, as the Fiberglass of the disk banks is brittle.

   g. Hardware (bolts, nuts, washers) for mounting the following items are provided:

   -Bearings
   -Reducer
   -Recycle trough

2. If, for any reason, the diskbanks must be removed from the shaft, the procedure for remounting them is as follows:

If disk banks are 5 ft. in diameter or larger (supplied in semicircular sections)

Mount them on shaft(s) as shown on Dwg.# GL-28D, with 1/2-20NFX1-1/2 Bolts. Connect two half sections with two connecting plates (see sketch of typical mounting details) Remove outer nuts on required tie rods, fit connecting plate on tie rods over the end plates, then fasten them together with nuts and washers.

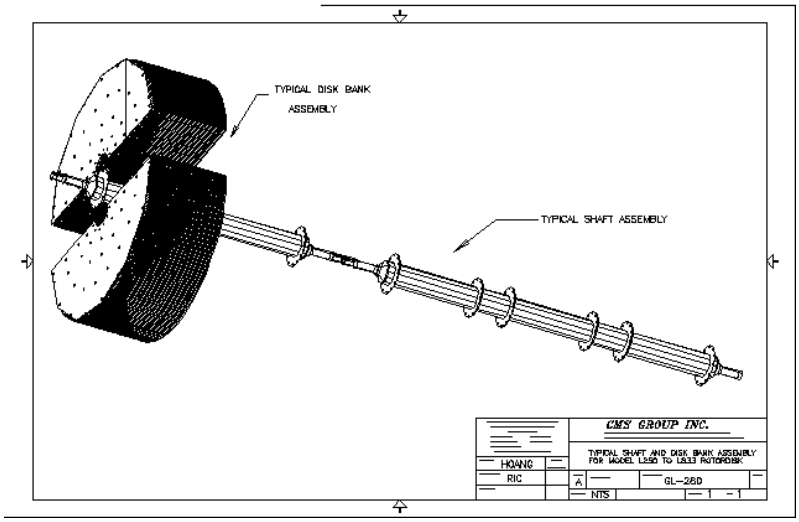


Figure f - typical mounting of disk banks on the shaft(s).

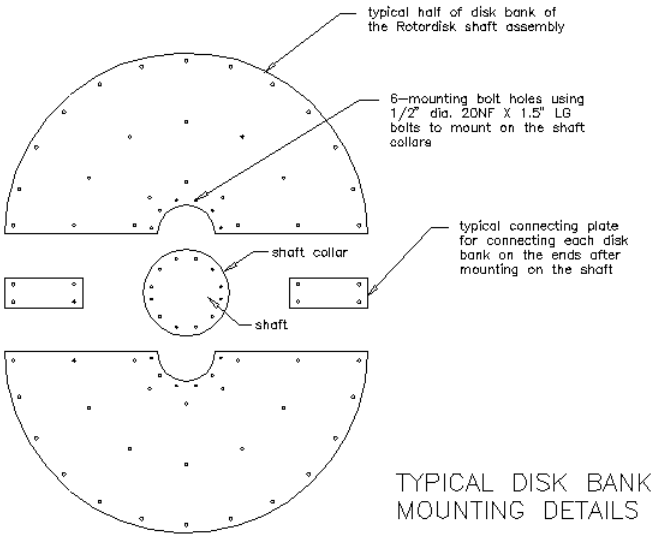


Figure g - exploded view of disk bank mounting parts.

3. Mount Bearings on Shaft(s).

a) Bearing should be mounted at the centre of stub end. Follow bearing manufacturer's installation instructions.
b) Use of the bearing fixing rings: one bearing of each pair is "fixed", the other "floating". Install the fixed bearing on the drive end of the shaft and the floating bearing on the non-drive end.

FOR 'L'Rotordisk® models ONLY: On the shaft where the large sprocket will be mounted, fix the bearing into its housing closest to the sprocket. On the other shaft fix the bearing into its housing closest to the coupling (i.e. one bearing should be fixed on every shaft).

NOTE: All bearings mounted on tapered sleeves have to be driven up the taper to the tolerances given in the manual, using a bearing locking tool or equal. See installation, operation and maintenance instructions section of this manual regarding bearings.

4. Mount coupling hubs on their respective shafts (if applicable) so that hub face is flush with the end of its shaft (for direct drive and 'L' models). See installation, operation and maintenance instructions section of this manual regarding couplings.

5. Install shaft(s) in ROTORDISK® tank.

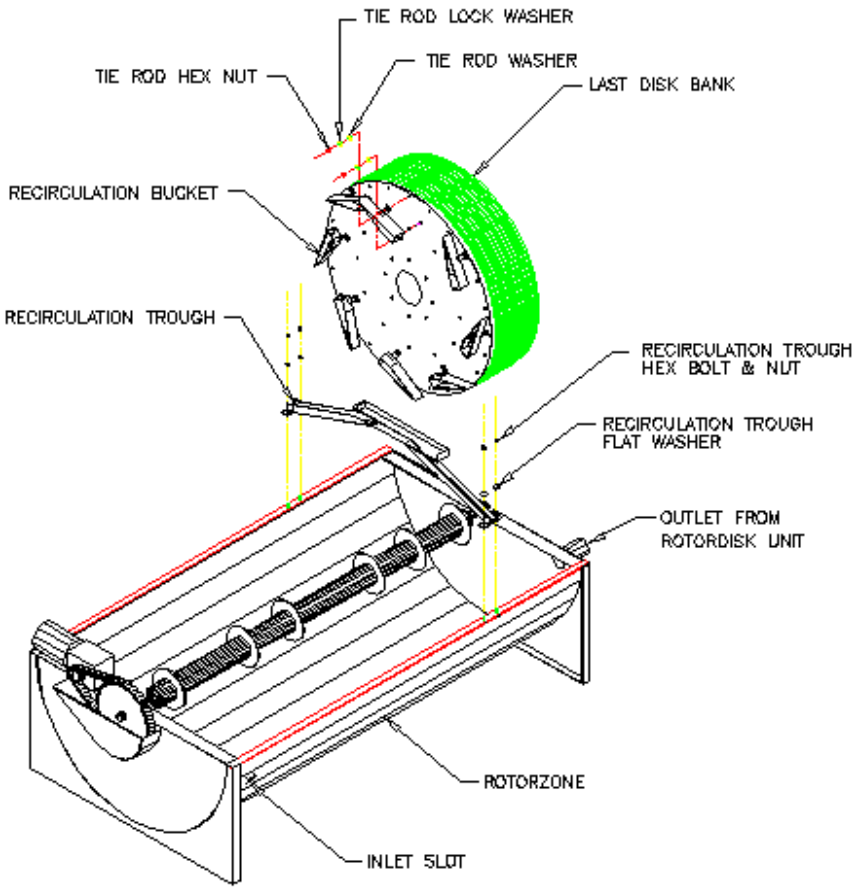
6. Mount small sprocket/coupling hubs on reducer output shaft (whichever is applicable).

7. Install Reducer-Motor Assembly in place. The reducer comes completely filled with synthetic lubricant. Ensure that the breather plug (mounted on top of one of the reducer oil intake ports) is installed on the reducer, after it is mounted on the ROTORDISK®. It is recommended that the motor be mounted into the reducer prior to assembly into the ROTORDISK® tank. Allow for some play in the reducer mounting bolt tightness so the chain tightness can be adjusted later.

8. Connect sprockets with chain. Check the axial alignment of the sprockets while tightening the chain. Tighten the previously loosened reducer mounting bolts after the sprockets are aligned and set in place. See installation, operation and maintenance instructions section of this manual regarding roller chain drives.

9. Connect two coupling hubs, grease, and fit coupling cover (if applicable). Before mounting, check bore on both hubs to match the shaft diameter. See installation, operation and maintenance instructions section of this manual regarding couplings.

10. Mount the stainless steel recycle trough on the ROTORDISK® tank with the bucket opening points to the proper rotation of the shaft.



NOTES:

1. Follow manufacturers instructions in the "Installation & Maintenance Manuals" included by SEPROTECH SYSTEMS INCORPORATED for mounting bearings, couplings (if applicable), reducer, sprockets and chain (if applicable).

2. Make sure all setscrews on sprockets and coupling hubs; bolts on reducer and bearings, are all well tightened before machine goes into operation.

6.0 - ROUTINE MECHANICAL MAINTENANCE OF **ROTORDISK®** SEWAGE TREATMENT PLANTS

6.1 - MOTOR:

If motor is equipped with grease fittings and relief plugs, it should be re-lubricated using a low-pressure gun once a year with Shell Alvenia R2" grease (DO NOT OVER-LUBRICATE). There is no lubrication required for motors without grease fittings and relief plugs

6.2 - REDUCER:

Reduction gear on ROTORDISK® units is filled with synthetic long life lubricant. No inspection or maintenance outside of periodic visual inspection is normally required. If there are no evidence of oil leaks on the seals, the synthetic lubricant must be changed every five (5) years for ROTORDISK® units running 24 hours a day.

Reduction Gear on medium and large ROTORDISK® size units are filled with Shell Tivela 75 oil and does not require oil changes (permanent lubrication). Periodic visual inspection is required. Check oil level and top up to required level with same oil, if necessary.

6.3 - BEARINGS:

Lubricant will deteriorate in time and rate of deterioration is a function of the operating conditions encountered. Lubrication cycle can be determined by analysing the samples taken near the bearing. See bearing manufacturer's maintenance instructions.

6.4 - SPROCKETS AND CHAIN:

(Applicable to non-direct drive ROTORDISK® units)

Chain drive should be inspected every six- (6) months for following points:
- If Chain is covered with grit or chips, it should be cleaned in kerosene and re-lubricated.
- Inspect oil for contamination, such as chips, dirt or grit. Replace oil if necessary (Oil with viscosity of SAE30 at ambient temperature 40^{o} to 100^{o} F is recommended).
- Milky white colour of the oil is indicative of flooding. Replace oil and determine the cause of the flood.
-Check Chain tension and adjust if required.

6.5 - COUPLING:

(Applicable for direct drive ROTORDISK® units and 'L' models)

Coupling should be checked for lubricant level. Lubricant is to be added if required. Re-lubrication with NLGI#2 or LTG Grease once a year is usually adequate.

7.0 - TROUBLE SHOOTING

7.1 - MECHANICAL HARDWARE

TROUBLE	PROBABLE CAUSE	CORRECTIVE ACTION
Noisy chain	1. Loose chain 2. Faulty lubrication 3. Misalignment 4. Worn Parts 5. Moving parts rubbing stationary parts	1. Tighten chain 2. Lubricate properly 3. Correct sprocket alignment 4. Replace worn chain 5. Align & tighten chain to clear oil bath
Rapid wear on chain	1. Faulty lubrication 2. Loose or misalign parts	1. Lubricate properly 2. Align & tighten entire drive
Chain climbing sprockets	1. Worn out chain and sprockets 2. Loose chain	1. Replace worn out parts 2. Tighten chain
Stiff chain	1. Misalignment 2. Worn out chain or sprockets 3. Faulty lubrication 4. Rust corrosion	1. Correct alignment 2. Replace worn out parts 3. Lubricate properly 4. Clean and lubricate
Noisy Bearing	Rollers or bearings damaged	Replace bearing cartridge
Bearing grease discoloured or mixed with water	Insufficient grease in the bearings	Purge bearing with grease and increase lubrication interval
Hot bearing	1. Improper lubrication 2. Rollers or bearing race damaged	1. Purge bearing with grease and decrease lubrication interval 2. Replace bearing cartridge
Reducer temperature rises above 200 degrees Fahrenheit.	Oil level too high or too low	Maintain proper oil level
Oil leakage from reducer	1. Oil seals need to be replaced 2. Ventilators/breather plugged causing pressure build-up inside the reducer. 3. Oil level too high	1. Replace oil seals 2. Clean Ventilators 3. Correct oil level
Noisy reducer	1. Bearing failure 2. Misalignment in worm gear inside 3. Coupling between motor and reducer worn out and misalign	1. Check bearings and replace if necessary 2. Align worm gear shafts. 3. Replace coupling between motor and reducer. Align coupling hub vertically
Noisy Motor	Bearing damage	Replace damaged bearings
Motor overheating	1. Reducer overheating 2. Cooling fins on motor are clogged 3. Overload 4. Rotor rubbing on stator 5. Over greasing or lubrication	1. Check reducer 2. Clean fins 3. Check for excess friction or imbalance 4. Replace bearings 5. Avoid packing grease too tightly
Motor won't start	1. Power trouble 2. Single phasing at station 3. Fuse blown	1. Check source of power supply 2. Do not try to make it go and "fry" motor. Check starter windings 3. Replace fuse
Knocking/rumbling on motor bearings	1. Bearing worn due to lack of lubrication or excessive mechanical overload 2. bearings slack in housing	1. Replace bearing and put new grease of recommended grade. 2. Fir new end shields
Rotordisk® shaft doesn't turn	1. Power failure 2. Motor failure 3. Reducer failure 4. chain drive failure	1. Check power supply 2. Check and replace motor and bearings. 3. Check teeth worn gears and bearings. Replace necessary parts 4. Replace chain

7.2 - ROTORDISK® PROCESS

ROTORDISK® TROUBLESHOOTING GUIDE

Problem	Cause	Corrective Action
1. Slime on media appears shaggy with a brown colour	PROPER OPERATION	NO PROBLEM NORMAL CONDITION
2. Black slime growing on disks	Solids and/or BOD overloading	**a.** Pre-aerate RBC influent **b.** For severe organic overloads, increase recycle rate **c.** De-sludge unit **d.** Place another RBC unit in parallel
3. Rotten egg or other obnoxious odors	Solids or BOD overloading	See Problem 2, solutions a, b, c and d, above
4. Development of odors and white biomass over most of the media surface	1. Septic influent wastewater or high hydrogen sulfide or sulfate concentration	**e.** Determine the cause of the problem and correct it at source. For example, aerate equalization tank **f.** Pre-aerate influent wastewater **g.** Determine the cause of the problem, possibly with the addition of chlorine or hydrogen peroxide; potassium permanganate has also been used
	2. Overload first stage	**a.** Check dissolved oxygen levels to confirm overload problem **b.** Increase number of recycle buckets
5. White slime	1. Bacteria that feed on sulfur compounds. Also, industrial discharges containing sulfur compounds may cause an overload	▪ See Problem 2, solutions a and b above
	2. Grease on the disks	**a.** Remove grease at source **b.** Install grease traps
6. Sloughing or loss of slime (biomass)	1. Toxic or inhibitory substances in influent, including abrupt pH changes	**a.** Eliminate source of toxic or inhibitory substances **b.** Reduce peaks of toxic or inhibitory substances by carefully regulating inflow to plant **c.** Dilute influent using plant effluent or any other source of water **d.** See Problem 7.4
	2. Variation in flow or organic loading	**a.** - During low flow or loading periods, pump from secondary clarifier or 4th stage RBC unit effluent to recycle water with food and dissolved oxygen through the RBC unit **b.** - During high flow or loading conditions, attempt to throttle plant inflow during peak periods **c.** - For severe organic under loads, add a cheap source of soluble carbon in the PST such as molasses

ROTORDISK® TROUBLESHOOTING GUIDE

Problem	Cause	Corrective Action
7. Decrease in process efficiency	1. Reduced wastewater temperature	**a.** Decrease air opening in RBC building **b.** Heat air inside RBC unit cover or building
	2. Unusual variations in flow or organic loading	▪ See Problem 6, cause 2, solutions a and b above
	3. Sustained flows or loads above design levels	▪ Install additional treatment units
	4. High or low pH values	▪ Adjust pH to near neutral
	5. Improper rotation of media	▪ Inspect chain tension and adjust
8. Accumulation of solids and clogging in the RBC system	Solids removal in pre-treatment steps is not adequate	**a.** Improve pre-treatment efficiencies **b.** Provide supplemental aeration to help prevent solids from settling **c.** De-sludge primary tank
9. Floating or rising sludge in the secondary clarifier	Removal of sludge from the clarifier is inadequate	**a.** Increase the duration of pumping sludge from the clarifier **b.** Remove sludge from the clarifier more often
10. Excess shaft weight or biomass thickness	1. Organic loading too high	▪ Decrease organic loading
	2. Stage loading too high	**a.** Increase number of recycle buckets
	3. Inorganic solids accumulation because of inadequate pre-treatment	▪ Check primary treatment and grit removal equipment for proper operation
	4. Accumulation of minerals	▪ Use chemical pre-treatment to eliminate minerals
	5. Digester supernatant adding excessive BOD or sulfides	▪ Modify supernatant pumping frequency
11. Shaft rotation non-uniform or “jerky”	1. Normal variations in balance	▪ Time rotation by quarters. A difference of less than 3 seconds in quarter rotation time is normal
	2. Uneven biomass weight due to power outage	**a.** If severe, shut unit down and wash down disks **b.** Turn off the unit temporarily and rotate manually to uniformly wet biomass growth before restarting **c.** Decrease or stop flow of wastewater to affected units **d.** contact manufacturer for assistance

ROTORDISK® TROUBLESHOOTING GUIDE

Problem	Cause	Corrective Action
12. Effluent quality apparently below requirements	1. Organic loading too high	**a.** Add additional operating RBCs **b.** Identify cause of additional loading and eliminate at source **c.** Add supplemental air to RBC trough
	2. Sampling or testing procedures inaccurate	**a.** If nitrification is occurring, analyze for carbon BOD only by using nitrification inhibitor **b.** Check for contaminated dilution water, sampler lines, or improper sampling storage
	3. Inadequate secondary clarifier operation	**a.** Clean and de-sludge clarifier **b.** Modify sludge removal procedures to eliminate BOD kickback **c.** Install filters after clarifier **d.** Increase alum dose to enhance flocculation
	4. Anaerobic solids in the RBC tanks producing BOD kickback	▪ Flush or drain tanks
13. Snails or other nuisance organisms in RBC tanks	Nutritional and conducive environment for reproduction of hard-bodied shell snails ($^1/_8$" - $^1/_2$" in size)	**a.** Addition of controlled dosages of chlorine. Physical removal may be required with taking units out of service temporarily **b.** Contact manufacturer

Contact SEPROTECH SYSTEMS INCORPORATED for advice on how to resolve problems related to the process before making changes to the process or equipment.

Adapted from Water Pollution Control Federation “Manual of Practice OM-10”, 1988.

8.0 - MAINTENANCE PROGRAM – Do's and Don'ts

DO'S

1. Do use biodegradable soap if at all possible. The system will however handle a certain amount of normal soap. When laundering clothes, please follow manufacturer's instructions regarding quantity of detergent. Excessive use of detergent can cause odour in the system.

2. Do put large amounts of grease in a container and dump in garbage. The system will handle a certain amount of fat and grease. If a tile bed is used and if fats and grease get into it, they may plug the pores of the soil and seal up the bed. Never put large amounts of grease (i.e. old grease from deep fryer) into the sewer lines.

3. Have your system pumped out a minimum of once a year to remove sludge and scum to maintain top operating treatment in your system and filter bed.

4. For small systems equipped with a service hatch, keep the service hatch above the ground. Do not let run-off water enter system, as this will cause hydraulic overload.

5. If a tile bed is used, do keep traffic such as cars, snowmobiles, etc., away from the system bed areas as they will break pipes and seal the soil over the bed.

6. If a tile bed is used, do leave the raised filter in place without disturbing it. The filter is specifically designed to provide maximum dispersal of the water. Altering it by adding fill, covering it up or changing in any way may destroy its water dispersal characteristics and result in bed failure.

7. If a tile bed is used, do encourage a growth of ground cover over the filter bed as it helps disperse water by evaporation and transpiration.

DON'Ts

1. Do not put non-biodegradable materials downs the drain, put them in the garbage, these include any plastics, rubber, disposable diapers, sanitary napkins, rubber goods, cigarettes, children's toys, cellophane, etc. They will plug the system, and a pump out will be needed.

2. Do not put harsh chemicals down the drain. They will kill the bacteria necessary for efficient treatment. These include acid or caustic cleaners, gasoline, oil, turpentine, photographic chemicals, etc. Disinfectant and chlorine bleaches should be kept to domestic uses.

3. Do not leave taps running or faulty toilets. The excess water may overload the system and, if used, tile field causing breakout and poor treatment.

4. If you do not have access to workers with appropriate training, do not attempt to fix the mechanical parts yourself. Your dealer is trained to repair your plant and work safely with electrical and mechanical components. Call him if you have a problem or concerns.

5. Do not connect any other electrical load to the fuse or breaker feeding the plant as it will cause damage to the controls.

6. Never put large amounts of grease (i.e. old grease from deep fryer) into the sewer lines.

YOUR CO-OPERATION WITH RESPECT TO THE ABOVE POINTS SHOULD ENSURE TROUBLE-FREE OPERATION OF YOUR TREATMENT PLANT AND WILL BE GREATLY APPRECIATED.

9.0 - INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS FOR VARIOUS MECHANICAL PARTS OF THE **ROTORDISK®** AND OTHER EQUIPMENT SUPPLIED

9.1 INSTALLATION & MAINTENANCE DETAILS FOR ROLLER CHAIN DRIVES

CHAIN TENSIONING:

The proper fit of a chain may be obtained by adjusting the sprocket centres. When a chain is correctly tensioned, the total mid-span movement (double amplitude) in the slack span should be 4-6% of the span length for normal drives.

Where there is no adjustment means, adjustment may be made by removing links to compensate for elongation due to wear (Drives with fixed centres). Proper lubrication and proper drive maintenance may minimize chain wear.

LUBRICATION:

Although many slow speed drives operate successfully with little or no lubrication beyond the initial factory lubrication, proper lubrication will greatly extend the useful life of every chain drive.

A good grade of clean petroleum oil without additives, free from flowing at the prevailing temperatures should be used.

Chain drives should be protected from abrasive and corrosive conditions, and the oil supply kept free of contamination. Periodic oil change is desirable. The lubricant viscosity recommended for ambient temperature 40^{o} - 100^{o}F is SAE 30.

OIL BATH:

With bath lubrication, the lower strand of chain runs through a sump of oil in the drive housing. The oil level should reach the pitch line of the chain at its lowest point while operating. Only a short length of chain should run through oil.

INSTALLATION RECOMMENDATIONS:

Shafting, bearings and foundations should be supported rigidly to maintain the initial alignment. Roller chain should be free of grit and dirt. Wash chain in kerosene when required. Re-lubricate!

Misalignment results in uneven loading across the width of the chain and may cause roller link-plate and sprocket tooth wear. Drive alignment involves two things:

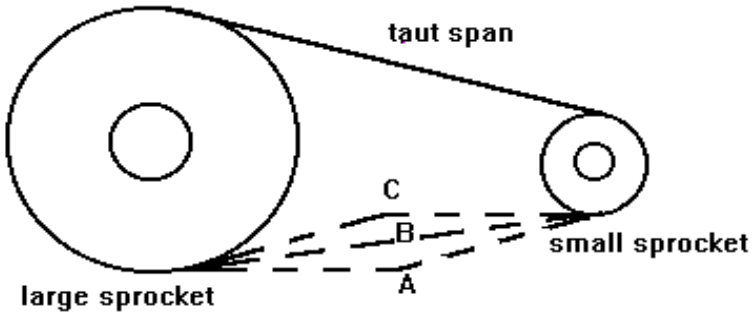
a) Parallel shaft alignment: Shafts should be parallel and level.
b) Axial sprocket alignment: Sprocket axial alignment can be checked with a straight edge, which will extend across the finished sides of the two sprockets.

Normally, it is good practice to align sprockets as close to the shaft bearings as possible.

Installing the Chain: Recheck all preceding adjustments for alignment and make sure all setscrews, bolts and nuts are tight. Fit chain around both sprockets and bring free ends together around one sprocket for connection.

Chain Tension: Check chain tension to be sure that the slack span has 4-6% mid-span movement in horizontal drives.

Recommended Possible Mid-Span Movement AC									
Drive	Tangent Length Between Sprockets								
Center-Line									
	5”	10”	15”	20”	30”	40”	60”	80”	100”
Horizontal to 45	.25”	.5”	.75”	1”	1.5”	2”	3”	4”	5”
Vertical to 45	.12”	.25”	.38”	.5”	.75”	1”	1.5”	2”	2.5”



AC = Total Possible Mid-Span Movement
Depth of Free Sag = .866 AB, approximately

MAINTENANCE RECOMMENDATIONS:

Regular maintenance schedules should be followed for all chain drives. Each drive should be inspected every six months. At each inspection period the following points should be checked:

a) Check Lubrication: If chain is covered with grit or chips, it should be cleaned in kerosene and re-lubricated before reinstalling. With bath lubrication, oil should be maintained at the proper level, as shown in lubrication instructions. Add oil if necessary. At each inspection, oil should be checked for contamination, such as chips, dirt or grit.

b) Check sprocket alignment: If the chain is properly aligned, no wear will show on the inner surfaces of the chain roller link-plates. If wear is apparent, this is evidence that sprockets are misalign and should be realigned as outlined in the installation instructions to prevent further chain and sprocket wear.

c) Check sprocket tooth wear: If sprocket shows evidence of wear high on the sprocket teeth, this is evidence of excessive wear in the chain, the chain should be replaced. If the sprocket teeth are severely worn, the sprocket should be replaced. Do not run new chain on worn sprockets.

d) Check chain tension: At each inspection period, the chain tension should be adjusted. If excessive slack has accumulated which cannot be removed by available shaft centre adjustment (i.e. by moving reducer away from large sprocket using chain tensioning bolts), two or more pitches of chain should be removed and chain reconnected.

9.2 PROCEDURE FOR ASSEMBLING BEARINGS AND PILLOW BLOCKS

Shaft Preparation
Clean shaft and remove any burrs or sharp edges. Check the shaft diameter to given specifications.

Seal Installation
Place seal, which consists of: Double lip 'G' type seal

MOUNTING OF BEARING ON SHAFT

Adapter Sleeve Mounting
Position adapter sleeve on the shaft to correct location with respect to required bearing centerline. A smear of lubricating oil (SAE 10 or 20) applied to the sleeve outside diameter surface results in easier bearing mounting and removal. (For pillow blocks mounted close to a pulley hub or similar obstruction, mount the adapter sleeve with threads inboard for easy removal. Remember to slide lock-nut, lock-washer and bearing onto the shaft before positioning the sleeve.)

NOTE: All bearings mounted on tapered sleeves have to be driven up the taper to the tolerances given in SKF tables, to ensure correct fits. Spherical roller bearings can be measured between the unloaded rollers and the outer ring sphere surface.

Un-mounted Clearance, Spherical Roller Bearings
Measure the un-mounted internal clearance in the bearing by inserting and sliding progressively larger feeler blades the full length of the roller between the most vertical unloaded rollers and the outer ring sphere. Never run the rollers over the feeler blade, as the wrong value will be obtained. Record the measurement of the largest size blade that will slide through. This is the un-mounted internal clearance.

Bearing
Mount the bearing hand tight on the adapter sleeve. Be sure the large end of the bore of the inner ring matches the taper of the adapter. To avoid damage to the bearing it is most important during this and subsequent operation that the shaft is blocked up so the bearing is unloaded. Do not apply lock-washer. Drive up procedure may damage it.

Bearing Drive Up, Spherical Roller Bearings
Lubricate the face and thread of the lock nut and apply to sleeve with chamfered face toward the bearing. Tighten the lock nut. Do not attempt to tighten the lock nut with a hammer and drift (use proper wrenches), the lock nut can be damaged and chips can enter the bearing. Further tighten the lock nut and measure the internal clearance until the internal clearance is less than the un-mounted clearance figure by the amount shown in the attached table (see last page). Finally, remove lock nut, position lock washer with outer tangs facing away from the bearing, and inner tang properly seated in the slot provided in the adapter. Replace lock nut and tighten until firmly seated.

PREPARATION OF PILLOW BLOCK HOUSING

Check to be sure all pillow block parts are free of burrs and are completely clean. Internal surfaces should be removed. Apply a thin coat of grease to the bearing seat in the base. Fit the bearing and seal inserts into the pillow block base, being careful not to damage to O-rings. For assembling larger sizes where hoists must be used, it may be convenient to seat both bearings into their housing bases simultaneously.

FIXING RINGS

On each shaft one bearing is generally "Held" and other bearings are "Free", to permit shaft expansion. For "Held" bearing housings, use two fixing rings. Place one on each side of bearing.

CAPPING THE PILLOW BLOCK

Place the cap on the base so that the dowel pins in the base align with the holes in the cap, being careful not to damage the O-rings. Caps and bases are not manufactured for interchangeable assembly. They must be kept together. Install cap-bolts with lock washers and tighten securely.

GREASE LUBRICATED BLOCKS

Lubrication Notes

Grease Lubrication

If grease is used as a lubricant, it should be smeared between the rolling elements and worked in. The lower half of the housing should be packaged $^{1}/_{2}$ to $^{3}/_{4}$ full.

PROCEDURE FOR APPLYING LUBRICANT TO BEARINGS AND PILLOW BLOCKS

Pack each bearing as completely full of the specified grease as possible by swiveling the outer ring open and rotating it as necessary to inject the grease. Then, swivel the outer ring closed being careful not to use force in the event a roller end catch the corner of the outer ring sphere.

B) Before assembling the pillow block cap to the base, and after completing bearing and base assembly, fill $^{1}/_{2}$ to $^{3}/_{4}$ of the pillow block base with the same lubricant that was used to pack the bearing.

LUBRICATION PROCEDURE TO BE USED AT START-UP

A) All pillow block assemblies that have not been prepared for stage are ready for use, assuming the installation procedures have been correctly followed.

B) While shaft is rotating, lubricate each seal through the outside lubricant fittings until grease is seen emerging from the labyrinth areas. Make sure the outside of the lubricant fitting is clean before applying grease.

RE LUBRICATION

Lubricants deteriorate in time, and the rate of deterioration is a function of the lubricant used at the operating conditions encountered. Determining the re-lubrication cycle depends on sampling the grease and analysis of the samples. Provisions must be made to adequately evaluate the contamination by solids. Samples for grease evaluation should be taken from near the bearing, and evaluation of the samples should dictate the re-lubrication cycle.

Remove caps once a year and re-apply new grease.

Each seal assembly should be lubricated once a month, while the bearing is rotating, with the same grease that is used in the bearing.

GREASE CLASSIFICATION

		Oil Viscosity Saybolt Second (approx. SSU)		
Class	Type of Base (1)	@ 100 F	@ 210 F	NLGI (2) Grade
A	Lithium or Equal	200 - 500	48 – 55	0
B	Lithium or Equal	400 - 600	58 – 68	1
C	Lithium or Equal	800 - 1,000	75 – 82	1
D	Lithium only	800 - 1,000	75 – 82	2

	Grease requirement from above			
Operating temperature of bearing (4)	Low (5)	Medium	High	Suggested Re-lube cycle
0 – 70	A or B			6 – 12 months
70 – 120	B or C			6 – 12 months
120 – 160	B or C	C or D (6)	D (7)	2 - 3 weeks
160 – 200	C	C or D (6)	D (7)	1 - 4 weeks

1) Calcium Complex Greases NOT recommended for spherical roller bearings.

2) National Lubricating Grease Institute Consistency Code.

3) Definition of speed categories:
Low: up to 1/4 of catalog speed limit for static oil lubrication.
Medium: 1/4 to 1/2 catalog speed limit for static oil lubrication.
High: 1/2 to full catalog speed limit for static oil lubrication.

4) Consult SKF Engineering if temperature is below 0^{o} or above 200^{o}F.

5) Extremely slow speed will require special consideration if loads are high.

* Under all conditions, application should be checked using the SKF lubricant film parameter found in the Engineer Data Catalog.

6) Use type "C" where load is heavy, 15,000 hours-rating life or less and/or speed are less than RPM.

7) Consult SKF Engineering - Grease lube not normally recommended under this combination of operating conditions.

8) Dry clean applications only. For moderate conditions of dirt and/or moisture, use cycle of 1 to 2 months. For extreme conditions of dirt and/or moisture, use cycle of 1 week. Vertical applications normally require shorter than normal re-lube cycle.

9) Never mix greases with unlike bases.

10) Remove old grease at least once a year.

10 - LIMITED WARRANTY

SEPROTECH SYSTEMS INCORPORATED warrants the parts in each treatment plant to be free from defects in material and workmanship; for a period of 15 months from shipment or 12 months from start-up, whichever occurs first, in the treatment of domestic wastewater. Sole obligation under this warranty is as follows:

SEPROTECH SYSTEMS INCORPORATED shall fulfil this warranty by repairing or exchanging any component part, F.O.B. our factory, that in SEPROTECH SYSTEMS' judgement, shows evidence of defects, provided said component part has been paid for and is returned through an authorized dealer, transportation prepaid. The warranty must also specify the nature of the defect to the manufacturer. New placed parts are under warranty for one year.

The warranty does not cover treatment plants that have been flooded, by external means, or that have been disassembled by unauthorized persons, improperly installed, subjected to external damage or damage due to altered or improper wiring or overload protection.

This warranty applies only to the treatment plant and does not include any other electrical wiring, plumbing, drainage, or disposal system. SEPROTECH SYSTEMS INCORPORATED is not responsible for any delay or damages caused by defective components or material, or for loss incurred because of interruption of service, or for any other special or consequential damages or incidental expenses arising from the manufacture, sale, or use of this plant.

SEPROTECH SYSTEMS INCORPORATED reserves the right to revise, change, or modify the construction and design of the treatment plant for domestic wastewater or any component part or parts thereof without incurring any obligation to make such changes for modifications in previously sold equipment. SEPROTECH SYSTEMS INCORPORATED also reserves the right, in making replacements of component parts under this warranty, to furnish a component part, which, in its judgement is equivalent to the Company part replaced.

Under no circumstance will SEPROTECH SYSTEMS INCORPORATED, be responsible to the warrantee for any other direct or consequential damages. Including but not limited to; lost profits, lost income, labour charges, delays in production, and/or idle production, which damages are caused by a defect in material and/or workmanship in its parts.

This warranty is expressly in lieu of any other expressed or implied warranty, excluding any warranty of merchantability or fitness, and of any other obligation on the part of SEPROTECH SYSTEMS INCORPORATED.

APPENDIX D.3

MODEL N30 – MILNE INLET CAMP

ROTORDISK®
Aerobic Wastewater
Treatment Plant

Model B30
Shanco Baffinland
Project #60069

ROTORDISK®
Aerobic Wastewater Treatment Plant
Model B30

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

Shanco Baffinland
Project #60069

Seprotech
Water. Pure and Simple

ROTORDISK®

Wastewater Treatment Plant
Model B30

INSTALLATION, OPERATION & MAINTENANCE MANUAL

August 2007

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INSTALLATION, OPERATION AND MAINTENANCE MANUAL

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TABLE OF CONTENTS

1.0 SITE INSTALLATION
- 1.1 STEEL TANKAGE
- 1.2 CONCRETE TANKAGE
- 1.3 DIRECTION of SHAFT ROTATION
- 1.4 DISSOLVED OXYGEN RECYCLE for ROTORDISK®
- 1.5 SUMMARY OF OPERATION

2.0 VISUAL CHECKS ON PHYSICAL AND BIOLOGICAL FUNCTIONING OF ROTORDISK® & DESCRIPTION OF TREATMENT PROCESS
- 2.1 PRIMARY SETTLING TANK (PST)
- 2.2 ROTORZONE
  - 2.2.1 'BATHTUB RING'
- 2.3 ACETIC ACID INJECTION SYSTEM
- 2.4 DENITRIFICATION ZONE
- 2.5 FINAL SETTLING TANK (FST)
- 2.6 FILTERS FEED PUMPS LOGIC AND LEVELS IN THE FST
- 2.7 POST FILTRATION SYSTEM
- 2.8 MONITORING OF DISCHARGE FLOW RATE
- 2.9 OPERATING PARAMETERS ADJUSTABLE ON THE CONTROL PANEL
- 2.10 FREQUENCY OF INSPECTION

3.0 STANDARD RECOMMENDATIONS AND PROCEDURES FOR SLUDGE REMOVAL
- 3.1 STORAGE CAPACITIES
- 3.2 DETERMINATION OF ACCUMULATED SLUDGE VOLUMES
- 3.3 SLUDGE REMOVAL
- 3.4 CONSEQUENCES OF MAXIMUM SLUDGE OPERATION
- 3.5 SLUDGE LEVEL SCHEMATIC DIAGRAM
- 3.6 PUMPOUT PROCEDURES FOR ROTORDISK® TREATMENT SYSTEMS
- 3.7 START-UP PROCEDURES OF ROTORDISK®

4.0 STORAGE OF ROTORDISK® SEWAGE TREATMENT EQUIPMENT

5.0 ASSEMBLY INSTRUCTIONS FOR ROTORDISK® MECHANICAL COMPONENTS

6.0 ROUTINE MECHANICAL MAINTENANCE OF ROTORDISK® SEWAGE TREATMENT PLANTS
- 6.1 MOTOR
- 6.2 REDUCER
- 6.3 BEARINGS
- 6.4 SPROCKETS AND CHAIN

7.0 TROUBLE SHOOTING
- 7.1 MECHANICAL HARDWARE
- 7.2 ROTORDISK® PROCESS

8.0 MAINTENANCE PROGRAM - Do's and Don'ts

9.0 INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS FOR VARIOUS MECHANICAL PARTS OF THE ROTORDISK® AND OTHER EQUIPMENT SUPPLIED.

10.0 LIMITED WARRANTY

IMPORTANT: READ THIS INSTALLATION PROCEDURE PRIOR TO START-UP.

1.0 SITE INSTALLATION OF ROTORDISK® SEWAGE TREATMENT PLANTS:

1.1 (applies to Steel Tankage only)

When there is a complete ROTORDISK® unit supplied, site preparation is as follows:

A level concrete or well-compacted gravel base is to be supplied by Customer/Contractor.

Unit to be lifted only at lifting points by use of hooks and spreader bars.

All anchoring and levelling of ROTORDISK® on site to be done by customer/contractor. Check alignment of shaft and sprockets and clearances of couplings where applicable prior to start-up, failure to do so may void manufacturer's warranty. Refer to this ROTORDISK® manual for details. If required, the contractor must perform levelling.

All hydraulic piping, to and from the unit, is to be supplied and installed by customer/contractor.

All input electric and hydro hook-ups to be done by customer/contractor to local governing regulations and a signed approval sent to SEPROTECH SYSTEMS INCORPORATED. Under no circumstances must electrical connections, junction boxes or equipment pertaining to the electrical function of the unit be installed in the ROTORDISK® tank.

SEPROTECH SYSTEMS INCORPORATED GROUP INC. will supply a man on-site to assist customer/contractor at a specified rate and at customer/contractor discretion.

If unit is not shipped completely assembled assembly instructions and drawings will be supplied.

IMPORTANT: READ THIS INSTALLATION PROCEDURE PRIOR TO START-UP.

1.2 - (applies to Concrete Tankage for ROTORDISK® only)

If the ROTORDISK® unit supplied is to be encased in concrete tankage, the site preparation is as follows:

The unit is lowered into the concrete tankage, the pipe at the end of the unit is placed into the opening of the intermediate wall between the primary and final settlement chambers and lowered onto the anchor bolts (contractors supply).

Unit to be lifted only at lifting points by use of hooks and spreader bars.

All anchor bolts (contractors supply) should be correctly located in concrete in a vertical position. In addition, all bolts should include a levelling nut.

All anchoring and levelling of ROTORDISK® on site to be done by customer/contractor. When the unit is set onto the anchor bolts in the concrete tank, it must be levelled to a slope of no more than 3/4" in 20' along the length. The unit is then centred in the tank and completely bolted down.

After the unit has been bolted down, check alignment of shaft and sprockets and clearances of couplings where applicable prior to start-up, failure to do so may void manufacturer's warranty. Refer to this ROTORDISK® manual for details. If required, the contractor must perform levelling.

All hydraulic piping, to and from the unit, is to be supplied and installed by customer/contractor.

All input electric and hydro hook-ups to be done by customer/contractor to local governing regulations and a signed approval sent to SEPROTECH SYSTEMS INCORPORATED. Under no circumstances must electrical connections, junction boxes or equipment pertaining to the electrical function of the unit be installed in the ROTORDISK® tank.

SEPROTECH SYSTEMS INCORPORATED will supply a man on-site to assist customer/contractor at a specified rate and at customer/contractor discretion.

If unit is not shipped completely assembled assembly instructions and drawings will be supplied. (As shown)

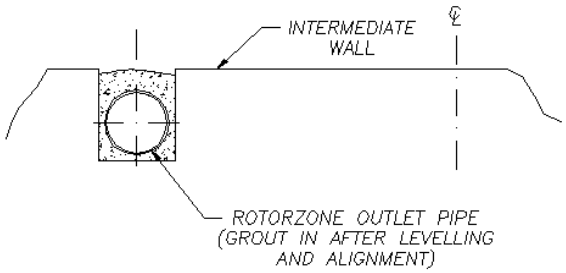


Figure a - **ROTORDISK®** tank outlet through intermediate wall between settlement tank chambers.

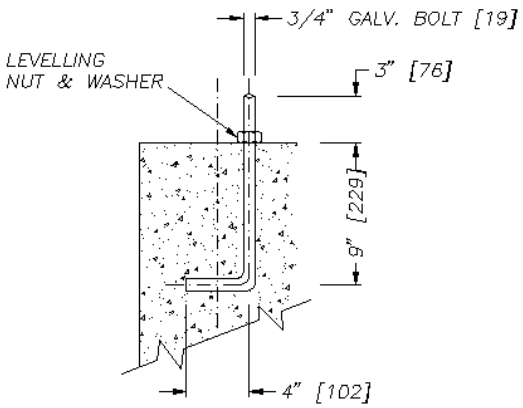
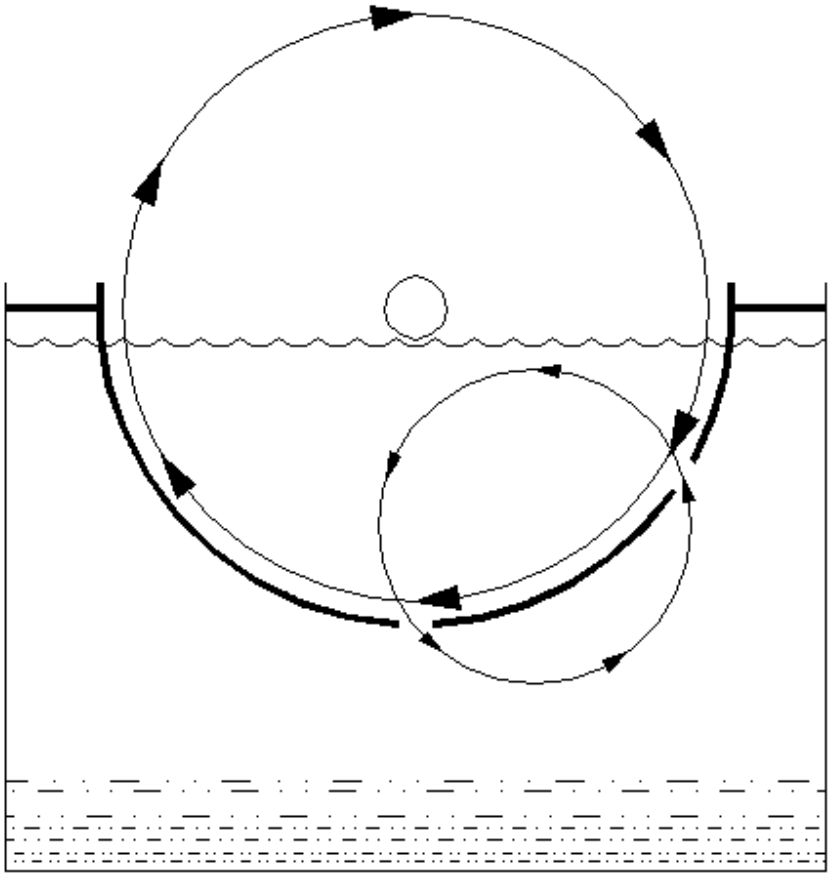


Figure b - anchor bolt detail for **ROTORDISK®** tank.

1.3 - DIRECTION OF SHAFT ROTATION



The direction of shaft rotation should be such that disks mounted on shaft will enter water on the side where inlet to "Rotorzone" is located. The electric motor driving the shaft should be wired accordingly.

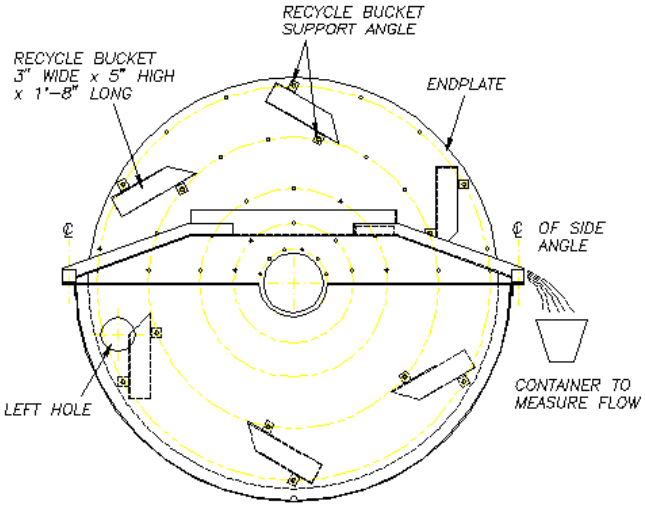
1.4 - DISSOLVED OXYGEN (D.O.) RECYCLE for ROTORDISK®

1.4.1 Recycle buckets are mounted on the last stage of the ROTORDISK®. These buckets rotate at the same speed as the disks. See the attached elevation view of the recycle buckets and trough on the Rotorzone tank.

1.4.2 As the disks rotate, the buckets scoop-up treated wastewater. As this wastewater falls into the recycle trough, it is exposed to the atmosphere, where it absorbs fresh oxygen. The wastewater then cascades on one side of the trough through a narrow steel channel and mixes back with the contents of the Primary Clarifier, thereby introducing fresh dissolved oxygen in the Primary Clarifier. See the section of diskbank assembly showing buckets and recycle trough.

1.4.3 The set-up described above is comprised of the recycle buckets and recycle trough, is what we term as our D.O. re-circulation device. This is especially advantageous to preventing septic conditions from occurring in the Primary Clarifier in small flow or low flow situations.

1.4.4 It is **important** to measure the **actual recycle rate** on the **ROTORDISK®**. This data is compared to our theoretical recycle rate designed. This is advantageous prior to connecting and setting-up for service. Using a container (5 gallon bucket is ideal) and a stopwatch, record the water flowing out of the effluent channel of the recycle trough. Make 3-5 readings, and report this data to SEPROTECH SYSTEMS INCORPORATED for future reference.



SECTION OF DISKBANK ASSEMBLY
SHOWING 6 BUCKETS
AND RECYCLE TROUGH

1.5 - SUMMARY OF OPERATION

(ROTORDISK® systems designed for BOD/SS/Ammonia/Nitrate removal)

A). The sewage plant (as supplied by SEPROTECH SYSTEMS INCORPORATED) is comprised of five (5) main components: the primary settling tank, the RBC tank, the denitrification tank, the secondary settling tank and the multi-media filters.

B). The RBC tank is the aerobic section of the treatment plant divided into four (4) stages.

Raw sewage is pumped and/or gravity flows into the primary settling tank (PST). When the sewage is pumped into the plant, pumping must simulate conditions encountered in gravity fed systems. Indeed, over a 24-hour period, the plant is designed to handle a flow rate corresponding to the Average Daily Flow (ADF) and can accommodate for two Peak Daily Flow (PDF) periods of two (2) hours per day. Each PDF event can be at a maximum of three times ADF.

In the PST, sedimentation separates heavy solids from the bulk of the liquid and the supernatant enters the aerobic section through the inlet slot located at the front section of the RBC tank.

The aerobic section is made up of four stages. The 1st stage is mounted on one common shaft. This 1st stage is comprised of one (1) to three (3) disk banks. The normal colour of the bacteria in the 1st stage is dark brown. This is the stage where most of the BOD removal by biological oxidation occurs. The succeeding 2nd, 3rd, and 4th stages are mounted on the rest of the shaft or another common shaft. Each stage has one (1) to three (3) disk banks. It is in the 2nd stage that further BOD is removed, and nitrifying bacteria (those which convert ammonia (NH_3) in the form of ammonium ions (NH_4^+) into nitrite (NO_2^-) and, ultimately, nitrate (NO_3^-)) start to predominate in the 3rd and 4th stages. The 4th and last aerobic stage has recycle buckets that introduce both fresh dissolved oxygen into the primary settling tank and nitrifying bacteria present in the recycled water.

The rotation of the disks in and out of the water provides a mean of air and heat transfer from the ambient air to the water. The transfer of air to the water is important for aerobic bacteria to remove BOD and ammonia. The transfer of heat to the water is important to maintain the water at an optimum temperature of 15 °C and above such that BOD and ammonia removal rates by the bacteria are maximised (removal rates are a function of the water temperature). Because maintaining a temperature that provides acceptable removal rates is important to the process, RBC's are installed indoors and ambient air is maintained at 15 °C and above.

C). The media in the denitrification section is completely submerged since denitrifying bacteria convert nitrate (NO_3^-) to nitrogen gas (N_2) in an anoxic (i.e., in the absence of dissolved oxygen (DO)) environment.

(Text missing pending completion of patent application process.)

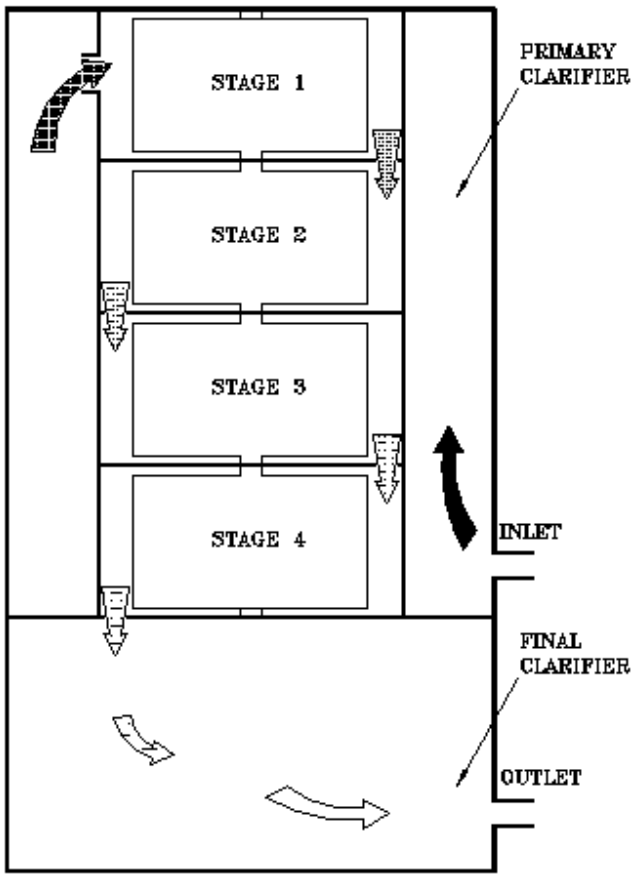
The denitrification section is comprised of two stages separated by a baffle. An equal amount of media is provided in both stages.

D). Partially treated water from the denitrification section then enters the secondary settling tank. Sloughed off biomass from the disks and media bundles and other suspended solids is further settled in this chamber.

E). The partially treated water is then fed to three (3) multi-media filters using one of two (2) submerged pumps. The purpose of these filters is to further reduce the concentration of suspended solids in the final effluent.

2.0 - ROUTINE VISUAL CHECKS ON PHYSICAL AND BIOLOGICAL FUNCTIONING OF ROTORDISK® & DESCRIPTION OF TREATMENT PROCESS

ROTORDISK® sewage treatment plants have three major steps in the purification process. In the primary settling tank, gross solids separate from the flow by either sinking or floating. In the Rotorzone, dissolved pollutants are broken down to simple, non-pollutant compounds by the bacteria ("biomass") which grows on the rotating disks. The final settling tank permits gravity separation of spent biological growth, which continually sloughs off the disks in the Rotorzone preceding it.



2.1 - PRIMARY SETTLING TANK (PST OR PRIMARY "CLARIFIER")

The accumulation of floating scum on the surface of the primary clarifier is normal. It is proportional to the accumulation of settle-able solids at the bottom of the tank. Periodic (9-12 months) removal of sludge at the bottom of the tank is required for proper operation of the Unit.

If no sludge measuring device is available, the accumulation of 9"-12" depth of scum on the surface is a good indication that it is time to remove the accumulated deposits of sludge from the bottom of the tank(s).

2.2 - ROTORZONE

The Rotorzone is subdivided into four sections, with disk banks in each. The wastewater first enters the Rotorzone in the section marked "1" in the sketch (furthest away from the inlet to the plant). The flow then proceeds through sections 2, 3, and 4 before entering the denitrification zone.

The accumulation of biological growth will be greatest in section 1, and gradually decrease through subsequent sections. Generally, the growth will be thick, and often filamentous ("stringy"), in section 1, becoming thinner and more compact through sections 2-4.

The colour of the growth will typically be dark brown to black in Section 1. Some grey growth may also be noticed, depending on the relative load and type of wastewater being treated. Growth in sections 2-4 will typically vary from medium brown to a light brown or tan growth in section 4.

In a well-functioning unit with the appropriate feed of wastewater, there will be an earthy, humus-like ("musty") smell inside the unit. A substantial sour, "sewage" smell may be an indication of sub-optimal conditions in the treatment process.

2.2.1 - 'BATHTUB RING'

The wastewater flows by gravity within a ROTORDISK® Plant thus the water level is relatively constant. Changes in water level of 1" to 2" are not unusual due to surge flows entering the unit. The evidence of this is a 'bathtub ring' 1" - 2" above the normal level. A 'bathtub ring' higher than this suggests that partial or complete flooding of the unit has occurred since the last check. If so, the (gravity or pump) discharge system should be checked for blockages or mechanical malfunction. Another condition which can lead to the level of water rising to greater levels than 1" – 2" is if the plant is fed by pumps that exceed the design limits of the plant (i.e., ADF over a period of 24 hours including a maximum of two (2) PDF events no longer than 2 hours each).

2.3 – ACETIC ACID INJECTION SYSTEM

One of the most important building blocks of life is carbon. The bacteria responsible for denitrification need carbon in an organic form to grow and thus convert nitrate to nitrogen gas. Most soluble organic carbon (often measured in terms of Biochemical Oxygen Demand or BOD) has been consumed in the aerobic section of the wastewater treatment plant and there is thus very little left for the denitrifiers by the time the wastewater reaches the denitrification section of the plant. It is for this reason that acetic acid (vinegar), an easily biodegradable organic carbon source, is injected at the inlet of the denitrification zone.

The system provided consists in a 125 imp. gal. storage tank (ϕ=30", H=49") equipped with a mixer and of a dosing pump of maximum capacity 12.3 l/h mounted on a skid.

The dosing pump can be controlled in either of two ways: by a 4-20 mA signal coming from the flowmeter located on the effluent outlet pipe (the system is programmed to be operated that way by default) or by a dry contact (by others) located outside SEPROTECH SYSTEMS INCORPORATED's main control panel. For example, that dry contact (by others) could be closed when the pumps (by others) feeding the wastewater treatment plant are running and opened when they are not.

The target dose of pure acetic acid (CH_3COOH) in the water is: 175 mg/litre. Assuming that commercial acetic acid is at a concentration of 12% by weight, this means that the target dose of commercial acetic acid at the inlet of the denitrification section would be 1460 mg of commercial acetic acid per liter of water. At ADF (i.e., 49,000 litres per day), this corresponds to a dosing rate of 2.9 litres of commercial acetic acid per hour. If the 4-20 mA signal from the flowmeter is used to control the dosing pump (again, this is the default mode), then the actual dosing rate will be $3 \times 2.9 = 8.7$ litres of commercial acetic acid per hour one third of the time since the flow exiting the plant (via the flowmeter) is pumped from the FST to the multi-media filters at a rate of $3 \times$ ADF = PDF (i.e., 147,000 litres per day).

The average daily quantity of commercial acetic acid necessary has been estimated at 70 l/day (15.4 imp. gal per day) based on an ADF of 49,000 litres/day.

2.4 – DENITRIFICATION ZONE

(Text missing pending completion of patent application process.)

In the denitrification zone, the media is completely submerged such that anoxic conditions (i.e., the absence of Dissolved Oxygen (DO) in the water) prevail and thus the denitrification process (i.e., the conversion of nitrate (NO_3^-) to nitrogen gas (N_2)) can take place. The denitrification zone includes two (2) stages that are separated by a baffle.

2.5 – FINAL SETTLING TANK (FST OR FINAL "CLARIFIER")

The effluent near the outlet at the backside of the final clarifier should be relatively clear and colourless and relatively free of suspended matter. Clarity can best be judged by scooping a small volume of the final effluent into a clear glass container. This is particularly true of larger units where the depth and dark colour of the tank walls may make clarity hard to determine. (Note: Although the risk of infection is very small, the wearing of rubber gloves is a rational safety precaution when hand-scooping the effluent for a clarity check. This is particularly true if there are open cuts on the hands.)

Although the final effluent itself should be relatively clear, some floating matter may accumulate on the surface of the final clarifier. This is normal, and will typically be much less than the accumulation of floating scum in the primary clarifier.

2.6 – FILTERS FEED PUMPS LOGIC AND LEVELS IN THE FST

The level in the FST is controlled in the following manner:

- Level Switch Low (LSL or float #1): both filter feed pumps (each of capacity = 3 × ADF) stop when this level is reached;
- Level Switch High (LSH or float #2): lead filter feed pump starts when this level is reached;
- Level Switch High High (LSHH or float #3): lag filter feed pump starts (lead filter feed pump is maintained in operation) and an alarm goes off when this level is reached (i.e., the alarm light is activated);
- Overflow: the FST is equipped with an outlet that can be connected directly to the storm sewer in the exceptional case that the plant is overflowed (piping between this outlet and the storm sewer is out of SEPROTECH SYSTEMS INCORPORATED' scope of supply).

2.7 – POST FILTRATION SYSTEM

The clarified water is pumped from the FST to three multi-media filters operating in parallel. The purpose of these multi-media filters is to reduce further the concentration of suspended solids in the treated wastewater.

The three filters operated in parallel are designed to treat peak low rates (PDF) of 3 times the design average daily flow (ADF) and are fed at this flow rate since each filter feed pump also has a capacity of PDF.

Each of the three filters is filled with anthracite, sand and garnet with gravel underbedding. The water is filtered from top to bottom of each filter with the coarser filtration media placed on top and the finer on the bottom of the filter. Each vessel is made of fibreglass. In normal operation (i.e., when all 3 filters operate in parallel), the filtration velocity is about 10 m/h on each filter.

A backwash of one of the three filters is performed approximately every 4 hours. The filters are backwashed alternately, i.e., filter no. 2 gets backwashed approximately 4 hour (exactly 4 hours + the time it takes to backwash and rinse a filter) after filter no. 1 gets backwashed and filter no. 3 gets backwashed approximately 4 hour after filter no. 2 gets backwashed. These operating parameters are adjustable on the plant's main control panel (see Section 2.9). When a backwash occurs, the water pumped at PDF from the FST is fed to two of the filters and the filtrate from these is used to backwash the third filter from bottom to top (inverse direction than in filtration mode). The two filters used to produce the filtrate operate at velocities of approximately 15 m/h while the third filter gets backwashed at a velocity of approximately 30 m/h.

The filtration system is controlled by the main control panel for the plant. The automatic diaphragm valves installed on the filtration unit are pneumatic and are thus opened and closed using compressed air. A compressor is provided with the plant. The compressed air transits through a filters solenoid valves panel.

2.8 – MONITORING OF DISCHARGE FLOW RATE

The plant is equipped with a magnetic flow meter located on the clean effluent's discharge pipe. This instrument is equipped with a counter that allows tracking of the total volume of clean effluent discharged by the plant. As mentioned in paragraph 2.3, the flow meter is also used to control the injection rate of acetic acid. A thermal chart recorder was also provided in order to produce hardcopies of the flow measurements taken by the flowmeter.

2.9 – OPERATING PARAMETERS ADJUSTABLE ON THE CONTROL PANEL

The following operating parameters were set as default in the Programmable Logic Control (PLC) panel provided with the plant but are adjustable within the ranges shown below. Making changes and adjustments to the default plant's operating parameters requires a good understanding of the wastewater treatment process and should therefore only be performed by qualified and trained staff. Please contact SEPROTECH SYSTEMS INCORPORATED if assistance is needed to optimise the operation of the plant.

	T1 Time between backwashes	T2 Time for a backwash	T3 Time for rinse	T4 Time between sludge pumping	T5 Time for sludge pumping
Factory Setting	4 h	10 min	5 min	1.0 h	0.25 min
Minimum	1 h	5 min	2 min	0.5 h	0.10 min
Maximum	18 h	30 min	30 min	12.0 h	1.00 min

2.10 - FREQUENCY OF INSPECTION

Visual checks every week should be sufficient. However, for better preventative maintenance of the wastewater treatment plant and thus the capital investment, a daily walk through is often the preferred frequency of visit. Many owners prefer the visual and audible (look and listen) walk through. A standard operator checklist should be prepared and used by the person responsible for periodic maintenance of the plant at every visit. SEPROTECH SYSTEMS INCORPORATED can assist in preparing such checklist upon request.

The acetic acid storage tank should be topped off every time the plant is being visited.

The pressure loss on every filter should also be controlled. Two pressure gauges were provided for this purpose, one on the inlet pipe and one on the outlet pipe of each filter. The pressure drop across a filter shouldn't exceed 15 PSI. If it does even after a filter has been backwashed, the frequency and/or duration of backwashes should be increased.

3.0 - STANDARD RECOMMENDATIONS AND PROCEDURES FOR SLUDGE REMOVAL

3.1 - STORAGE CAPACITIES

A design feature of ROTORDISK®, which contributes greatly to overall simplicity of the process, is the sizing of clarifiers to accommodate static internal sludge storage for extended periods. Depending on such factors as raw wastewater solids concentrations, and design organic loading in a given application, maximum sludge storage levels will typically be reached in 6-9 months of operation.

This period is based on calculated rates of initial decomposition of raw and biological solids, and, upon operating experience, indicating the degree of auto-digestion/compacting, which proceeds during the storage period. The 6-9 month period will be shortened to the extent that design hydraulic and waste loads are exceeded. It will be lengthened to the extent that flows and waste load are less than those designed for.

3.2 - DETERMINATION OF ACCUMULATED SLUDGE VOLUMES

The accumulation of maximum storage capacities can be indirectly monitored through visual observation of the thickness of the scum blanket on the surface of the primary clarifier. When the scum blanket has matured to a height of approximately 7"-10", this is a good indication that sludge accumulations at the bottom of both clarifiers are at or near maximum levels, and that sludge withdrawal is indicated.

A more accurate procedure of determining sludge levels is to directly measure actual accumulations, and compare these to the maximum storage capacities listed on the "Details" section of the general arrangement drawing for the ROTORDISK® model in question.

A variety of sludge measuring devices is commercially available. The two most common are the weighted hollow tube type, and, the (electronic) turbidity-change detector type. The former is less costly, relatively easy to use, and more appropriate because of the low frequency with which measurements need to be made in a ROTORDISK® unit.

Whatever means of measuring the sludge may be selected, it must be kept in mind that the sludge is <u>not</u> a firm solids substance. Domestic wastewater sludge is mostly trapped water and other liquids. Only to determine sludge levels by "feeling" for a solid layer with a stick or pole. The settled sludge is far more liquid than the surface scum, which is perhaps 30-40% solids by volume.

Irrespective of the type of device used, sludge levels should be measured at several locations in each settlement tank to ensure a reasonably accurate calculation of accumulated volumes. This is required since sludge accumulation levels are not uniform; being highest at the inlet ends of both clarifiers, and, below the slot at the bottom of the first section of the Rotorzone trough.

Once an average sludge height has been determined, multiply by the surface area of the clarifier in question to determine the existing volume of stored sludge. Compare to maximum design capacity listed on the general arrangement drawing. If the accumulated levels equal or exceed design values, it is time to remove the sludge from the unit.

3.3 - SLUDGE REMOVAL

A pump-out truck of the same type that pumps out septic tanks normally does the sludge removal. For smaller ROTORDISK® units, the entire liquid contents of the treatment plant can be withdrawn. For larger installations, the haulage contractor should be instructed to get the suction hose directly to the bottom of the tanks and withdraw the sludge only, while taking as little of the supernatant as possible. Once the primary sludge is withdrawn from the primary settlement tank, the supernatant of the secondary clarifier can be transferred to the primary settlement tank to expose the secondary sludge. The suction hose should be placed down at a multiple number of points to help ensure complete removal of accumulated sludge deposits. Floating surface scum should also be removed. Haulage contractors should be given a brief description of the unit and its operation if they are not already familiar with it. A particular point to emphasise is that the biological growth on the disks should not be washed off, but should be left in place. The exception to this is if the disks have accumulated excess biomass due to sludge pump out being delayed past the indicated intervals.

Sludge removed from the unit is normally hauled away by the pumping truck and disposed of at municipal facilities, or, by controlled spreading on farmland. On-site disposal in shallow trenches and/or some form of on-site volume reduction (prior to export) may be feasible or desirable depending on the specific opportunities and limitations afforded by the site of a given installation.

3.4 - POTENTIAL CONSEQUENCES OF OPERATING ROTORDISK® UNITS PAST DESIGNATED MAXIMUM SLUDGE STORAGE LEVELS

Sludge accumulations should be removed once they reach indicated maximum storage levels, because failure to do so could result in lowered treatment efficiency, and possibly cause serious damage to the structure of the Rotating Assembly and drive unit. The potential for problems is as described below and depicted in the attached sketches.

Figure (c) shows a unit operating with sludge build-ups at or near maximum storage levels. This will cause no problem since the storage heights are designated so that flows through the primary clarifier will not disturb the sludge layer. Characteristics of wastewater reaching the Rotorzone at this time (and since start-up) will be in the range of 180-200 mg BOD/1 and 50-250 mg SS/1. The supporting structure of the rotating assembly is over designed for the amount of biological build-up which will occur on the disks under this operating condition, and the shear force of the rotation through the trough water will limit the thickness of growth.

However, if sludge is allowed to accumulate past designated storage heights, flow through the primary clarifier will begin to disturb the sludge blanket, and thus carry loads of solids and dissolved organic matter into the Rotorzone which are not anticipated in the design of the unit (Figure d). The pollutant load reaching the biomass on the first stage of disks will overload that biomass (in terms of F:M ratio), and force a change in its activity and growth. The biomass becomes more gelatinous, and does not shear off as well with disk rotation. Additionally, the biomass will readily adsorb and entrap the extra solids with the sum effect being an increase in weight on the rotating assembly that considerably exceeds that which its design is based on.

This tendency reaches its extreme if sludge is allowed to accumulate to the point where it will be disturbed by-, and caught up in -, the re-circulation pattern created by the two slots in the trough on the first section of the Rotorzone (see Figure e).

The sludge will have characteristics in the order of 20,000 mg TSS/1 and 10,000 mg BOD/1, so it is obvious that even a minor amount of this material caught up in the re-circulation flow will significantly increase the concentration of the waste stream entering the Rotorzone. If, for example, the sludge was caught up in the recycle flow at a ratio of as little as 1:10 or 1:15, the resulting concentration would be sufficient to produce a considerable first-stage overload on an amount of disk area selected based on normal concentrations.

The resulting build-up of poorly-shearing gelatinous biomass and trapped solids would pose a serious potential for strain on the drive unit, and for structural damage to disk bank assemblies and shaft, in spite of them being considerably over designed for loads anticipated in normal operation.

Clearly, these potential problems should be avoided by the removal of sludge once it reaches the level specified as maximum for the ROTORDISK® unit in question.

3.5 - FRONT VIEW SCHEMATIC OF ROTORDISK®

UNIT OPERATING AT-, AND ABOVE-,
RECOMMENDED MAXIMUM SLUDGE STORAGE LEVELS

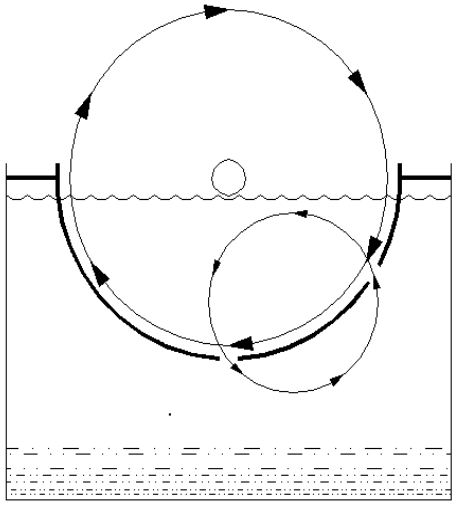


Figure c-unit operating at maximum sludge storage levels. Neither influent flows, nor re-circulating flows, disturb sludge blanket.

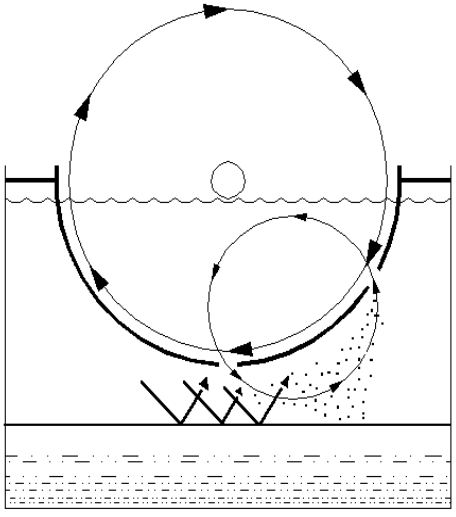


Figure d- unit operating with excess accumulations. Influent flows may disturb sludge blanket and increase BOD and solids loads to Rotorzone to levels above treatment design.

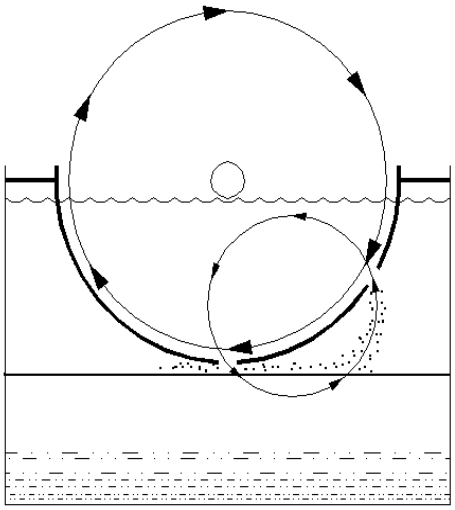


Figure e-Unit operating with excess sludge accumulated to base of Rotorzone. Both influent flows and re-circulation flows will disturb and carry sludge solids. Increase in BOD and solids loads entering Rotorzone will be substantially above design treatment levels, increase accumulated masses on rotating assembly, produce potential for damage to structure and drive unit.

3.6 - PUMPOUT PROCEDURES FOR ROTORDISK® TREATMENT SYSTEMS (summary)

Using suction hose, floating or surface scum should be removed first. Place the suction hose directly to the bottom of the tank and withdraw sludge only, while taking as little as possible of the volume of waste liquid above the sludge blanket (supernatant).

Move the hose at multiple number of points along the bottom of the settlement tanks. Do not wash off biological growth (biomass) on the disks. The exception to this is excess accumulated biomass on the disks due to an overdue sludge pump-out. Excess accumulated biomass is when a disk bank is 100% fully covered with biomass and the colour is grey with a slight odour.

Keep a record of all pump-outs to arrive at an actual normal operating interval for sludge pump-outs. For systems with several flow meters, it is also beneficial to note the total flow generated between pump-outs.

3.7 - START-UP PROCEDURES OF ROTORDISK®

WARNING: A VALVE LOCATED AT THE BOTTOM OF THE DENITRIFICATION TANK AND EQUIPPED WITH A REMOTE ACTUATION MECHANISM WAS PROVIDED WITH YOUR UNIT. THIS VALVE:

- Needs to be OPEN: when the plant is first filled with water, during draining if the plant ever requires such operation and during subsequent refilling operations. FAILURE TO OPEN THIS VALVE DURING FILLING AND DRAINING WILL RESULT IN SERIOUS DAMAGE TO THE PLANT. This is because, during a filling operation, the water rising in the PST would push the denitrification tank upwards while it is empty (this tank wouldn't have had a chance to fill with water until the water level reaches the inlet slot between the PST and the aerobic ROTORDISK®. Th open valves provide a mean of filling the PST and the through (denitrification tank included) at the same time.

- Needs to be CLOSED: during normal operation of the plant. Indeed, the denitrification section contains water already partly treatment thus this water and that contained in the PST shouldn't mix. FAILURE TO CLOSING THIS VALVE DURING NORMAL OPERATION OF THE PLANT WILL RESULT IN A POOR QUALITY EFFLUENT.

The ROTORDISK® sewage treatment plant is based on a fixed film treatment process referred to as the Rotating Biological Contactor (RBC). In this process, micro-organisms or bugs are attached and grown on the surface of a media, the quantity of bugs being directly proportional to the amount of food in the wastewater. When starting up a new system, it will normally take about two weeks to get organic removal from the wastewater and three to four weeks to establish the nitrification process at normal domestic sewage temperatures. The method of and effluent discharge during system start-up should be discussed and thoroughly communicated with the environmental authority. The primary sedimentation tank and RBC of the system should, preferably, be filled with fresh water before admitting wastewater to the system. A flow less than design is not a problem. The biomass will develop themselves on the media. If there is a small flow only a portion of the disk will have biomass. As the flow increases the amount of biomass will increase.

Seeding a ROTORDISK® with activated sludge, although not required, can be accomplished. The activated sludge should be at the same temperature as the influent. Sudden changes in wastewater temperature cause biomass sloughing. In most cases, the use of domestic waste as a seed culture has provided the required biomass for continuous operation. When seeding the ROTORDISK® with activated sludge is decided, the primary sedimentation tank and RBC of the system should first be filled with fresh water (preferably) and the activated sludge added to the RBC. The RBC should be rotating at all times. The wastewater introduced to the tank needs to have only 20% of the disks covered with waste. This can already provide the needed wetting and still provide some time to reach normal operating levels when source flow is introduced. The final clarifier does not need to be filled with anything.

Alternately, seeding can be accomplished using dry bacteria and a source of organic carbon such as raw molasses or sugar. This can be done, for example, in situations where wastewater or activated sludge are not available and the plant needs to be ready to treat wastewater very shortly after it begins receiving it. By simulating the conditions encountered in wastewater (where large amounts of organic carbon and bacteria are present), biomass will establish on the ROTORDISK® and the plant can thus be prepared to work under actual conditions before these are actually encountered. SEPROTECH SYSTEMS INCORPORATED can help find appropriate supplies of both dry bacteria and raw molasses.

The preferred start up is the introduction of source wastewater at design or less than design loading. The disks need to be rotating at all times. When the disks are rotating and wastewater is introduced the biomass will develop and the pollutants will be removed.

The practice of starting up a sewage plant with a charge of septage or activated sludge may be appropriate for suspended growth systems where sludge return is an essential and necessary part of the process. However, start-up with septage is not an appropriate practice for fixed film systems such as the Rotating Biological Contactor process and is not recommended. This is especially true of the ROTORDISK® process and its static, internal storage of sludge.

Studies have shown that the natural start-up time for a ROTORDISK® is 2 1/2 – 3 weeks (normal temperatures and BOD reduction only), and that it has already developed sufficient biomass for 50% removals in only 1 week. These are time frames significantly shorter than respective ones for suspended growth systems. Thus there is little rationale for "pre-starting" a ROTORDISK® unit with septage.

Further, septage contains solids that are already well digested, and therefore not subject to further digestion-compaction in the storage zones. This contrasts to the fresh solids, which will undergo considerable digestion-compaction in the 6 – 9 months after initial settlement. Therefore, a charge of septage would contribute disproportionately to the accumulation of sludge levels, and necessitate a shorter interval to the first pump-out of the unit.

The ROTORDISK® concept of static sludge storage contributes greatly to its overall operation and maintenance simplicity. Following the above guidelines and recommendations will help ensure that the trouble-free simplicity of ROTORDISK® is maintained.

4.0 - STORAGE OF **ROTORDISK®** SEWAGE TREATMENT EQUIPMENT

If the unit is not to be operated for an extended period, then the motor-reducer assembly (drive unit) should be removed from its mound and stored at room temperature in a reasonably dry area (unless the whole unit is being stored in such an area).

Additionally:

1. Reducer: The input shaft should be given several turns once a month to re-lubricate the upper bearings.

NOTE: Some reducers are shipped to site filled with synthetic lubrication. Otherwise, fill the reducer with the lubricant (see reducer section of installation & maintenance instructions).

2. Motor: The motor has a tendency to take on moisture when not in operation. It requires no attention during storage, but before it goes into operation the insulation should be measured using a Meger. It should be at least 1.0 mega-ohm. If below 1.0 mega-ohm, it has taken on excessive condensation, and must be dried out before being operated. (Note: any electrical contractor or repair shop commonly understands these terms and procedures).

3. Support bearings on main ROTORDISK® shaft(s) should be re-lubricated prior to start-up.

4. The system should not be installed and operated in water. In the absence of sewage inputs and normal biological activity, freezing and consequent mechanical damage would be a distinct possibility. Water level in the primary settlement tank to be dropped to below the bottom of the Rotorzone tank level, if freezing of the tank contents is possible.

5.0 - ASSEMBLY PROCEDURE OF ROTORDISK® COMPONENTS SUPPLIED BY SEPROTECH SYSTEMS INCORPORATED

1. Upon receipt of mechanical components:

   a. Check packing list for any missing items on delivery.

   b. Motor/Reducer is shipped loose, for assembly on the reducer flange. The reducer is shipped completely filled with synthetic lubricant.

   c. Bearing components are shipped as a set. Open only when ready for assembly, to avoid moisture contamination.

   d. Chain and sprockets are shipped as a set. Check for the following:

   -Large sprocket bushing (O.D.) fits into the large sprocket bore.
   -Large sprocket bushing bore (I.D.) fits the Rotordisk® shaft drive end.
   -Small sprocket bore (I.D.) fits on the reducer output shaft.
   -Cottered chain fits or matches the teeth on the sprockets.

   e. Coupling (applicable only to split-shaft ROTORDISK® is shipped as a set. Check the coupling hubs if they fit the center stub ends of the ROTORDISK®shafts.

   f. Disk banks are shipped pre-assembled on the shaft by SEPROTECH SYSTEMS INCORPORATED and are shipped on A-frames. Handle with care, as the Fiberglass of the disk banks is brittle.

   g. Hardware (bolts, nuts, washers) for mounting the following items are provided:

   -Bearings
   -Reducer
   -Recycle trough

2. If, for any reason, the diskbanks must be removed from the shaft, the procedure for remounting them is as follows:

If disk banks are 5 ft. in diameter or larger (supplied in semicircular sections)

Mount them on shaft(s) as shown on Dwg.# GL-28D, with 1/2-20NFX1-1/2 Bolts. Connect two half sections with two connecting plates (see sketch of typical mounting details) Remove outer nuts on required tie rods, fit connecting plate on tie rods over the end plates, then fasten them together with nuts and washers.

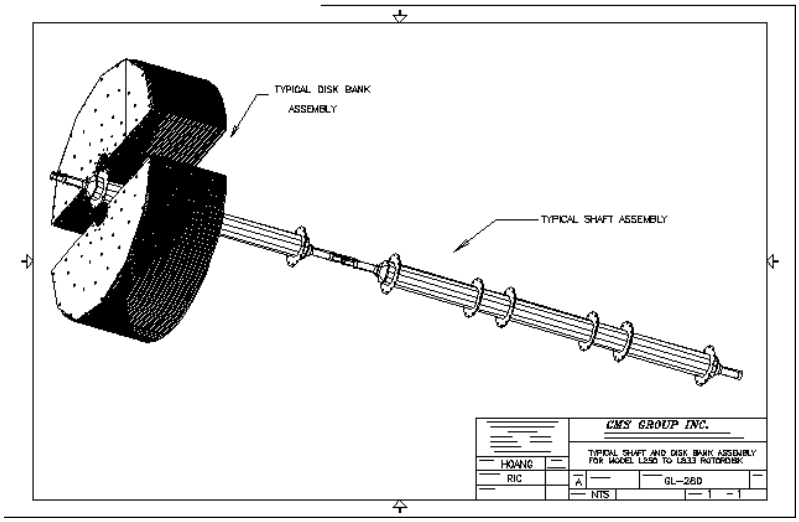


Figure f - typical mounting of disk banks on the shaft(s).

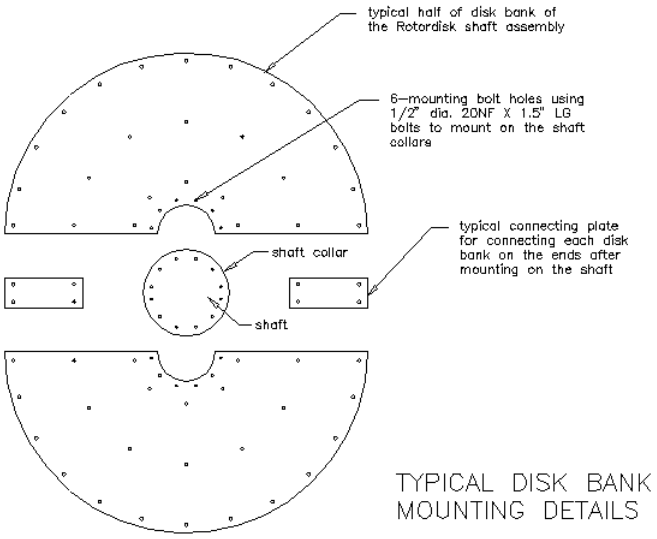


Figure g - exploded view of disk bank mounting parts.

3. Mount Bearings on Shaft(s).

a) Bearing should be mounted at the centre of stub end. Follow bearing manufacturer's installation instructions.
b) Use of the bearing fixing rings: one bearing of each pair is "fixed", the other "floating". Install the fixed bearing on the drive end of the shaft and the floating bearing on the non-drive end.

FOR 'L'Rotordisk® models ONLY: On the shaft where the large sprocket will be mounted, fix the bearing into its housing closest to the sprocket. On the other shaft fix the bearing into its housing closest to the coupling (i.e. one bearing should be fixed on every shaft).

NOTE: All bearings mounted on tapered sleeves have to be driven up the taper to the tolerances given in the manual, using a bearing locking tool or equal. See installation, operation and maintenance instructions section of this manual regarding bearings.

4. Mount coupling hubs on their respective shafts (if applicable) so that hub face is flush with the end of its shaft (for direct drive and 'L' models). See installation, operation and maintenance instructions section of this manual regarding couplings.

5. Install shaft(s) in ROTORDISK® tank.

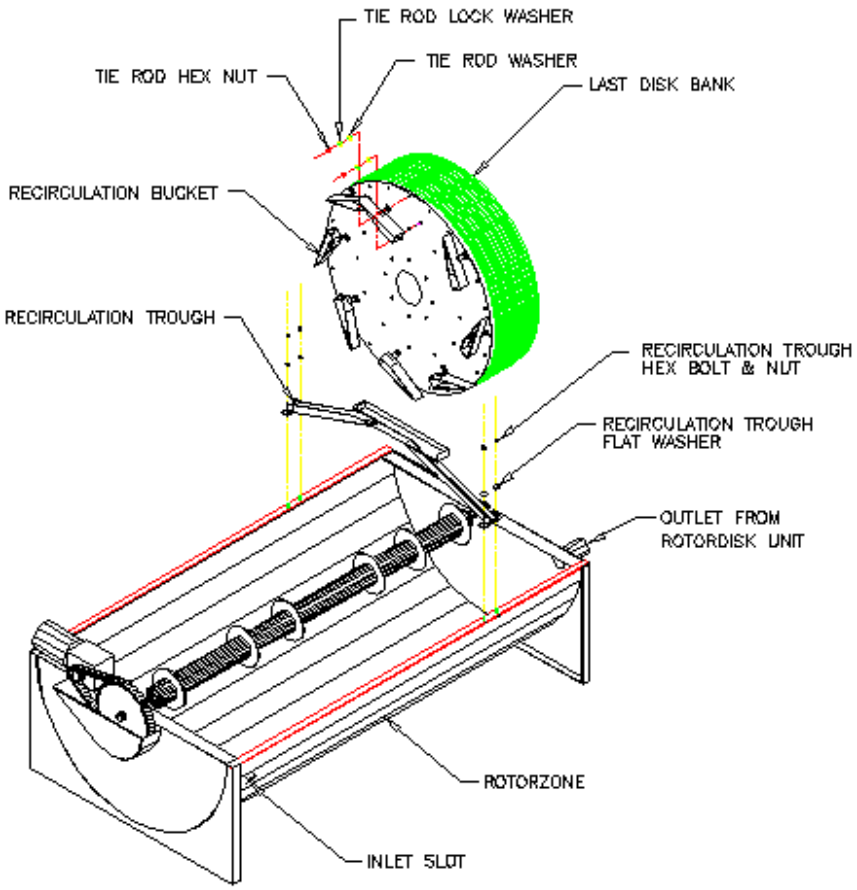
6. Mount small sprocket/coupling hubs on reducer output shaft (whichever is applicable).

7. Install Reducer-Motor Assembly in place. The reducer comes completely filled with synthetic lubricant. Ensure that the breather plug (mounted on top of one of the reducer oil intake ports) is installed on the reducer, after it is mounted on the ROTORDISK®. It is recommended that the motor be mounted into the reducer prior to assembly into the ROTORDISK® tank. Allow for some play in the reducer mounting bolt tightness so the chain tightness can be adjusted later.

8. Connect sprockets with chain. Check the axial alignment of the sprockets while tightening the chain. Tighten the previously loosened reducer mounting bolts after the sprockets are aligned and set in place. See installation, operation and maintenance instructions section of this manual regarding roller chain drives.

9. Connect two coupling hubs, grease, and fit coupling cover (if applicable). Before mounting, check bore on both hubs to match the shaft diameter. See installation, operation and maintenance instructions section of this manual regarding couplings.

10. Mount the stainless steel recycle trough on the ROTORDISK® tank with the bucket opening points to the proper rotation of the shaft.



NOTES:

1. Follow manufacturers instructions in the "Installation & Maintenance Manuals" included by SEPROTECH SYSTEMS INCORPORATED for mounting bearings, couplings (if applicable), reducer, sprockets and chain (if applicable).

2. Make sure all setscrews on sprockets and coupling hubs; bolts on reducer and bearings, are all well tightened before machine goes into operation.

6.0 - ROUTINE MECHANICAL MAINTENANCE OF **ROTORDISK®** SEWAGE TREATMENT PLANTS

6.1 - MOTOR:

If motor is equipped with grease fittings and relief plugs, it should be re-lubricated using a low-pressure gun once a year with Shell Alvenia R2" grease (DO NOT OVER-LUBRICATE). There is no lubrication required for motors without grease fittings and relief plugs

6.2 - REDUCER:

Reduction gear on ROTORDISK® units is filled with synthetic long life lubricant. No inspection or maintenance outside of periodic visual inspection is normally required. If there are no evidence of oil leaks on the seals, the synthetic lubricant must be changed every five (5) years for ROTORDISK® units running 24 hours a day.

Reduction Gear on medium and large ROTORDISK® size units are filled with Shell Tivela 75 oil and does not require oil changes (permanent lubrication). Periodic visual inspection is required. Check oil level and top up to required level with same oil, if necessary.

6.3 - BEARINGS:

Lubricant will deteriorate in time and rate of deterioration is a function of the operating conditions encountered. Lubrication cycle can be determined by analysing the samples taken near the bearing. See bearing manufacturer's maintenance instructions.

6.4 - SPROCKETS AND CHAIN:

(Applicable to non-direct drive ROTORDISK® units)

Chain drive should be inspected every six- (6) months for following points:
- If Chain is covered with grit or chips, it should be cleaned in kerosene and re-lubricated.
- Inspect oil for contamination, such as chips, dirt or grit. Replace oil if necessary (Oil with viscosity of SAE30 at ambient temperature 40^{o} to 100^{o} F is recommended).
- Milky white colour of the oil is indicative of flooding. Replace oil and determine the cause of the flood.
-Check Chain tension and adjust if required.

6.5 - COUPLING:

(Applicable for direct drive ROTORDISK® units and 'L' models)

Coupling should be checked for lubricant level. Lubricant is to be added if required. Re-lubrication with NLGI#2 or LTG Grease once a year is usually adequate.

7.0 - TROUBLE SHOOTING

7.1 - MECHANICAL HARDWARE

TROUBLE	PROBABLE CAUSE	CORRECTIVE ACTION
Noisy chain	1. Loose chain 2. Faulty lubrication 3. Misalignment 4. Worn Parts 5. Moving parts rubbing stationary parts	1. Tighten chain 2. Lubricate properly 3. Correct sprocket alignment 4. Replace worn chain 5. Align & tighten chain to clear oil bath
Rapid wear on chain	1. Faulty lubrication 2. Loose or misalign parts	1. Lubricate properly 2. Align & tighten entire drive
Chain climbing sprockets	1. Worn out chain and sprockets 2. Loose chain	1. Replace worn out parts 2. Tighten chain
Stiff chain	1. Misalignment 2. Worn out chain or sprockets 3. Faulty lubrication 4. Rust corrosion	1. Correct alignment 2. Replace worn out parts 3. Lubricate properly 4. Clean and lubricate
Noisy Bearing	Rollers or bearings damaged	Replace bearing cartridge
Bearing grease discoloured or mixed with water	Insufficient grease in the bearings	Purge bearing with grease and increase lubrication interval
Hot bearing	1. Improper lubrication 2. Rollers or bearing race damaged	1. Purge bearing with grease and decrease lubrication interval 2. Replace bearing cartridge
Reducer temperature rises above 200 degrees Fahrenheit.	Oil level too high or too low	Maintain proper oil level
Oil leakage from reducer	1. Oil seals need to be replaced 2. Ventilators/breather plugged causing pressure build-up inside the reducer. 3. Oil level too high	1. Replace oil seals 2. Clean Ventilators 3. Correct oil level
Noisy reducer	1. Bearing failure 2. Misalignment in worm gear inside 3. Coupling between motor and reducer worn out and misalign	1. Check bearings and replace if necessary 2. Align worm gear shafts. 3. Replace coupling between motor and reducer. Align coupling hub vertically
Noisy Motor	Bearing damage	Replace damaged bearings
Motor overheating	1. Reducer overheating 2. Cooling fins on motor are clogged 3. Overload 4. Rotor rubbing on stator 5. Over greasing or lubrication	1. Check reducer 2. Clean fins 3. Check for excess friction or imbalance 4. Replace bearings 5. Avoid packing grease too tightly
Motor won't start	1. Power trouble 2. Single phasing at station 3. Fuse blown	1. Check source of power supply 2. Do not try to make it go and "fry" motor. Check starter windings 3. Replace fuse
Knocking/rumbling on motor bearings	1. Bearing worn due to lack of lubrication or excessive mechanical overload 2. bearings slack in housing	1. Replace bearing and put new grease of recommended grade. 2. Fir new end shields
Rotordisk® shaft doesn't turn	1. Power failure 2. Motor failure 3. Reducer failure 4. chain drive failure	1. Check power supply 2. Check and replace motor and bearings. 3. Check teeth worn gears and bearings. Replace necessary parts 4. Replace chain

7.2 - ROTORDISK® PROCESS

ROTORDISK® TROUBLESHOOTING GUIDE

Problem	Cause	Corrective Action
1. Slime on media appears shaggy with a brown colour	PROPER OPERATION	NO PROBLEM NORMAL CONDITION
2. Black slime growing on disks	Solids and/or BOD overloading	**a.** Pre-aerate RBC influent **b.** For severe organic overloads, increase recycle rate **c.** De-sludge unit **d.** Place another RBC unit in parallel
3. Rotten egg or other obnoxious odors	Solids or BOD overloading	See Problem 2, solutions a, b, c and d, above
4. Development of odors and white biomass over most of the media surface	1. Septic influent wastewater or high hydrogen sulfide or sulfate concentration	**e.** Determine the cause of the problem and correct it at source. For example, aerate equalization tank **f.** Pre-aerate influent wastewater **g.** Determine the cause of the problem, possibly with the addition of chlorine or hydrogen peroxide; potassium permanganate has also been used
	2. Overload first stage	**a.** Check dissolved oxygen levels to confirm overload problem **b.** Increase number of recycle buckets
5. White slime	1. Bacteria that feed on sulfur compounds. Also, industrial discharges containing sulfur compounds may cause an overload	▪ See Problem 2, solutions a and b above
	2. Grease on the disks	**a.** Remove grease at source **b.** Install grease traps
6. Sloughing or loss of slime (biomass)	1. Toxic or inhibitory substances in influent, including abrupt pH changes	**a.** Eliminate source of toxic or inhibitory substances **b.** Reduce peaks of toxic or inhibitory substances by carefully regulating inflow to plant **c.** Dilute influent using plant effluent or any other source of water **d.** See Problem 7.4
	2. Variation in flow or organic loading	**a.** - During low flow or loading periods, pump from secondary clarifier or 4th stage RBC unit effluent to recycle water with food and dissolved oxygen through the RBC unit **b.** - During high flow or loading conditions, attempt to throttle plant inflow during peak periods **c.** - For severe organic under loads, add a cheap source of soluble carbon in the PST such as molasses

ROTORDISK® TROUBLESHOOTING GUIDE

Problem	Cause	Corrective Action
7. Decrease in process efficiency	1. Reduced wastewater temperature	**a.** Decrease air opening in RBC building **b.** Heat air inside RBC unit cover or building
	2. Unusual variations in flow or organic loading	▪ See Problem 6, cause 2, solutions a and b above
	3. Sustained flows or loads above design levels	▪ Install additional treatment units
	4. High or low pH values	▪ Adjust pH to near neutral
	5. Improper rotation of media	▪ Inspect chain tension and adjust
8. Accumulation of solids and clogging in the RBC system	Solids removal in pre-treatment steps is not adequate	**a.** Improve pre-treatment efficiencies **b.** Provide supplemental aeration to help prevent solids from settling **c.** De-sludge primary tank
9. Floating or rising sludge in the secondary clarifier	Removal of sludge from the clarifier is inadequate	**a.** Increase the duration of pumping sludge from the clarifier **b.** Remove sludge from the clarifier more often
10. Excess shaft weight or biomass thickness	1. Organic loading too high	▪ Decrease organic loading
	2. Stage loading too high	**a.** Increase number of recycle buckets
	3. Inorganic solids accumulation because of inadequate pre-treatment	▪ Check primary treatment and grit removal equipment for proper operation
	4. Accumulation of minerals	▪ Use chemical pre-treatment to eliminate minerals
	5. Digester supernatant adding excessive BOD or sulfides	▪ Modify supernatant pumping frequency
11. Shaft rotation non-uniform or “jerky”	1. Normal variations in balance	▪ Time rotation by quarters. A difference of less than 3 seconds in quarter rotation time is normal
	2. Uneven biomass weight due to power outage	**a.** If severe, shut unit down and wash down disks **b.** Turn off the unit temporarily and rotate manually to uniformly wet biomass growth before restarting **c.** Decrease or stop flow of wastewater to affected units **d.** contact manufacturer for assistance

ROTORDISK® TROUBLESHOOTING GUIDE

Problem	Cause	Corrective Action
12. Effluent quality apparently below requirements	1. Organic loading too high	**a.** Add additional operating RBCs **b.** Identify cause of additional loading and eliminate at source **c.** Add supplemental air to RBC trough
	2. Sampling or testing procedures inaccurate	**a.** If nitrification is occurring, analyze for carbon BOD only by using nitrification inhibitor **b.** Check for contaminated dilution water, sampler lines, or improper sampling storage
	3. Inadequate secondary clarifier operation	**a.** Clean and de-sludge clarifier **b.** Modify sludge removal procedures to eliminate BOD kickback **c.** Install filters after clarifier **d.** Increase alum dose to enhance flocculation
	4. Anaerobic solids in the RBC tanks producing BOD kickback	▪ Flush or drain tanks
13. Snails or other nuisance organisms in RBC tanks	Nutritional and conducive environment for reproduction of hard-bodied shell snails ($^1/_8$" - $^1/_2$" in size)	**a.** Addition of controlled dosages of chlorine. Physical removal may be required with taking units out of service temporarily **b.** Contact manufacturer

Contact SEPROTECH SYSTEMS INCORPORATED for advice on how to resolve problems related to the process before making changes to the process or equipment.

Adapted from Water Pollution Control Federation “Manual of Practice OM-10”, 1988.

8.0 - MAINTENANCE PROGRAM – Do's and Don'ts

DO'S

1. Do use biodegradable soap if at all possible. The system will however handle a certain amount of normal soap. When laundering clothes, please follow manufacturer's instructions regarding quantity of detergent. Excessive use of detergent can cause odour in the system.

2. Do put large amounts of grease in a container and dump in garbage. The system will handle a certain amount of fat and grease. If a tile bed is used and if fats and grease get into it, they may plug the pores of the soil and seal up the bed. Never put large amounts of grease (i.e. old grease from deep fryer) into the sewer lines.

3. Have your system pumped out a minimum of once a year to remove sludge and scum to maintain top operating treatment in your system and filter bed.

4. For small systems equipped with a service hatch, keep the service hatch above the ground. Do not let run-off water enter system, as this will cause hydraulic overload.

5. If a tile bed is used, do keep traffic such as cars, snowmobiles, etc., away from the system bed areas as they will break pipes and seal the soil over the bed.

6. If a tile bed is used, do leave the raised filter in place without disturbing it. The filter is specifically designed to provide maximum dispersal of the water. Altering it by adding fill, covering it up or changing in any way may destroy its water dispersal characteristics and result in bed failure.

7. If a tile bed is used, do encourage a growth of ground cover over the filter bed as it helps disperse water by evaporation and transpiration.

DON'Ts

1. Do not put non-biodegradable materials downs the drain, put them in the garbage, these include any plastics, rubber, disposable diapers, sanitary napkins, rubber goods, cigarettes, children's toys, cellophane, etc. They will plug the system, and a pump out will be needed.

2. Do not put harsh chemicals down the drain. They will kill the bacteria necessary for efficient treatment. These include acid or caustic cleaners, gasoline, oil, turpentine, photographic chemicals, etc. Disinfectant and chlorine bleaches should be kept to domestic uses.

3. Do not leave taps running or faulty toilets. The excess water may overload the system and, if used, tile field causing breakout and poor treatment.

4. If you do not have access to workers with appropriate training, do not attempt to fix the mechanical parts yourself. Your dealer is trained to repair your plant and work safely with electrical and mechanical components. Call him if you have a problem or concerns.

5. Do not connect any other electrical load to the fuse or breaker feeding the plant as it will cause damage to the controls.

6. Never put large amounts of grease (i.e. old grease from deep fryer) into the sewer lines.

YOUR CO-OPERATION WITH RESPECT TO THE ABOVE POINTS SHOULD ENSURE TROUBLE-FREE OPERATION OF YOUR TREATMENT PLANT AND WILL BE GREATLY APPRECIATED.

9.0 - INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS FOR VARIOUS MECHANICAL PARTS OF THE **ROTORDISK®** AND OTHER EQUIPMENT SUPPLIED

9.1 INSTALLATION & MAINTENANCE DETAILS FOR ROLLER CHAIN DRIVES

CHAIN TENSIONING:

The proper fit of a chain may be obtained by adjusting the sprocket centres. When a chain is correctly tensioned, the total mid-span movement (double amplitude) in the slack span should be 4-6% of the span length for normal drives.

Where there is no adjustment means, adjustment may be made by removing links to compensate for elongation due to wear (Drives with fixed centres). Proper lubrication and proper drive maintenance may minimize chain wear.

LUBRICATION:

Although many slow speed drives operate successfully with little or no lubrication beyond the initial factory lubrication, proper lubrication will greatly extend the useful life of every chain drive.

A good grade of clean petroleum oil without additives, free from flowing at the prevailing temperatures should be used.

Chain drives should be protected from abrasive and corrosive conditions, and the oil supply kept free of contamination. Periodic oil change is desirable. The lubricant viscosity recommended for ambient temperature 40^{o} - 100^{o}F is SAE 30.

OIL BATH:

With bath lubrication, the lower strand of chain runs through a sump of oil in the drive housing. The oil level should reach the pitch line of the chain at its lowest point while operating. Only a short length of chain should run through oil.

INSTALLATION RECOMMENDATIONS:

Shafting, bearings and foundations should be supported rigidly to maintain the initial alignment. Roller chain should be free of grit and dirt. Wash chain in kerosene when required. Re-lubricate!

Misalignment results in uneven loading across the width of the chain and may cause roller link-plate and sprocket tooth wear. Drive alignment involves two things:

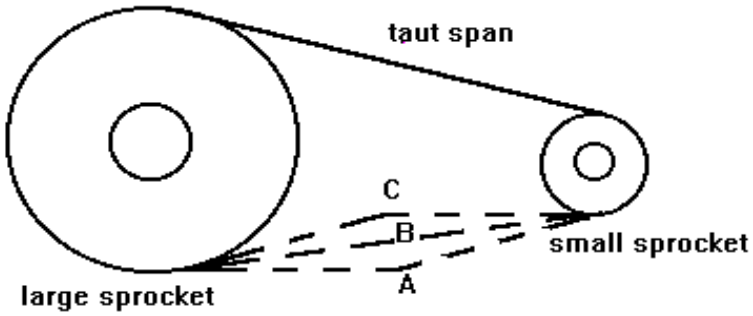
a) Parallel shaft alignment: Shafts should be parallel and level.
b) Axial sprocket alignment: Sprocket axial alignment can be checked with a straight edge, which will extend across the finished sides of the two sprockets.

Normally, it is good practice to align sprockets as close to the shaft bearings as possible.

Installing the Chain: Recheck all preceding adjustments for alignment and make sure all setscrews, bolts and nuts are tight. Fit chain around both sprockets and bring free ends together around one sprocket for connection.

Chain Tension: Check chain tension to be sure that the slack span has 4-6% mid-span movement in horizontal drives.

Recommended Possible Mid-Span Movement AC									
Drive	Tangent Length Between Sprockets								
Center-Line									
	5”	10”	15”	20”	30”	40”	60”	80”	100”
Horizontal to 45	.25”	.5”	.75”	1”	1.5”	2”	3”	4”	5”
Vertical to 45	.12”	.25”	.38”	.5”	.75”	1”	1.5”	2”	2.5”



AC = Total Possible Mid-Span Movement
Depth of Free Sag = .866 AB, approximately

MAINTENANCE RECOMMENDATIONS:

Regular maintenance schedules should be followed for all chain drives. Each drive should be inspected every six months. At each inspection period the following points should be checked:

a) Check Lubrication: If chain is covered with grit or chips, it should be cleaned in kerosene and re-lubricated before reinstalling. With bath lubrication, oil should be maintained at the proper level, as shown in lubrication instructions. Add oil if necessary. At each inspection, oil should be checked for contamination, such as chips, dirt or grit.

b) Check sprocket alignment: If the chain is properly aligned, no wear will show on the inner surfaces of the chain roller link-plates. If wear is apparent, this is evidence that sprockets are misalign and should be realigned as outlined in the installation instructions to prevent further chain and sprocket wear.

c) Check sprocket tooth wear: If sprocket shows evidence of wear high on the sprocket teeth, this is evidence of excessive wear in the chain, the chain should be replaced. If the sprocket teeth are severely worn, the sprocket should be replaced. Do not run new chain on worn sprockets.

d) Check chain tension: At each inspection period, the chain tension should be adjusted. If excessive slack has accumulated which cannot be removed by available shaft centre adjustment (i.e. by moving reducer away from large sprocket using chain tensioning bolts), two or more pitches of chain should be removed and chain reconnected.

9.2 PROCEDURE FOR ASSEMBLING BEARINGS AND PILLOW BLOCKS

Shaft Preparation
Clean shaft and remove any burrs or sharp edges. Check the shaft diameter to given specifications.

Seal Installation
Place seal, which consists of: Double lip 'G' type seal

MOUNTING OF BEARING ON SHAFT

Adapter Sleeve Mounting
Position adapter sleeve on the shaft to correct location with respect to required bearing centerline. A smear of lubricating oil (SAE 10 or 20) applied to the sleeve outside diameter surface results in easier bearing mounting and removal. (For pillow blocks mounted close to a pulley hub or similar obstruction, mount the adapter sleeve with threads inboard for easy removal. Remember to slide lock-nut, lock-washer and bearing onto the shaft before positioning the sleeve.)

NOTE: All bearings mounted on tapered sleeves have to be driven up the taper to the tolerances given in SKF tables, to ensure correct fits. Spherical roller bearings can be measured between the unloaded rollers and the outer ring sphere surface.

Un-mounted Clearance, Spherical Roller Bearings
Measure the un-mounted internal clearance in the bearing by inserting and sliding progressively larger feeler blades the full length of the roller between the most vertical unloaded rollers and the outer ring sphere. Never run the rollers over the feeler blade, as the wrong value will be obtained. Record the measurement of the largest size blade that will slide through. This is the un-mounted internal clearance.

Bearing
Mount the bearing hand tight on the adapter sleeve. Be sure the large end of the bore of the inner ring matches the taper of the adapter. To avoid damage to the bearing it is most important during this and subsequent operation that the shaft is blocked up so the bearing is unloaded. Do not apply lock-washer. Drive up procedure may damage it.

Bearing Drive Up, Spherical Roller Bearings
Lubricate the face and thread of the lock nut and apply to sleeve with chamfered face toward the bearing. Tighten the lock nut. Do not attempt to tighten the lock nut with a hammer and drift (use proper wrenches), the lock nut can be damaged and chips can enter the bearing. Further tighten the lock nut and measure the internal clearance until the internal clearance is less than the un-mounted clearance figure by the amount shown in the attached table (see last page). Finally, remove lock nut, position lock washer with outer tangs facing away from the bearing, and inner tang properly seated in the slot provided in the adapter. Replace lock nut and tighten until firmly seated.

PREPARATION OF PILLOW BLOCK HOUSING

Check to be sure all pillow block parts are free of burrs and are completely clean. Internal surfaces should be removed. Apply a thin coat of grease to the bearing seat in the base. Fit the bearing and seal inserts into the pillow block base, being careful not to damage to O-rings. For assembling larger sizes where hoists must be used, it may be convenient to seat both bearings into their housing bases simultaneously.

FIXING RINGS

On each shaft one bearing is generally "Held" and other bearings are "Free", to permit shaft expansion. For "Held" bearing housings, use two fixing rings. Place one on each side of bearing.

CAPPING THE PILLOW BLOCK

Place the cap on the base so that the dowel pins in the base align with the holes in the cap, being careful not to damage the O-rings. Caps and bases are not manufactured for interchangeable assembly. They must be kept together. Install cap-bolts with lock washers and tighten securely.

GREASE LUBRICATED BLOCKS

Lubrication Notes

Grease Lubrication

If grease is used as a lubricant, it should be smeared between the rolling elements and worked in. The lower half of the housing should be packaged $^{1}/_{2}$ to $^{3}/_{4}$ full.

PROCEDURE FOR APPLYING LUBRICANT TO BEARINGS AND PILLOW BLOCKS

Pack each bearing as completely full of the specified grease as possible by swiveling the outer ring open and rotating it as necessary to inject the grease. Then, swivel the outer ring closed being careful not to use force in the event a roller end catch the corner of the outer ring sphere.

B) Before assembling the pillow block cap to the base, and after completing bearing and base assembly, fill $^{1}/_{2}$ to $^{3}/_{4}$ of the pillow block base with the same lubricant that was used to pack the bearing.

LUBRICATION PROCEDURE TO BE USED AT START-UP

A) All pillow block assemblies that have not been prepared for stage are ready for use, assuming the installation procedures have been correctly followed.

B) While shaft is rotating, lubricate each seal through the outside lubricant fittings until grease is seen emerging from the labyrinth areas. Make sure the outside of the lubricant fitting is clean before applying grease.

RE LUBRICATION

Lubricants deteriorate in time, and the rate of deterioration is a function of the lubricant used at the operating conditions encountered. Determining the re-lubrication cycle depends on sampling the grease and analysis of the samples. Provisions must be made to adequately evaluate the contamination by solids. Samples for grease evaluation should be taken from near the bearing, and evaluation of the samples should dictate the re-lubrication cycle.

Remove caps once a year and re-apply new grease.

Each seal assembly should be lubricated once a month, while the bearing is rotating, with the same grease that is used in the bearing.

GREASE CLASSIFICATION

		Oil Viscosity Saybolt Second (approx. SSU)		
Class	Type of Base (1)	@ 100 F	@ 210 F	NLGI (2) Grade
A	Lithium or Equal	200 - 500	48 – 55	0
B	Lithium or Equal	400 - 600	58 – 68	1
C	Lithium or Equal	800 - 1,000	75 – 82	1
D	Lithium only	800 - 1,000	75 – 82	2

	Grease requirement from above			
Operating temperature of bearing (4)	Low (5)	Medium	High	Suggested Re-lube cycle
0 – 70	A or B			6 – 12 months
70 – 120	B or C			6 – 12 months
120 – 160	B or C	C or D (6)	D (7)	2 - 3 weeks
160 – 200	C	C or D (6)	D (7)	1 - 4 weeks

1) Calcium Complex Greases NOT recommended for spherical roller bearings.

2) National Lubricating Grease Institute Consistency Code.

3) Definition of speed categories:
Low: up to 1/4 of catalog speed limit for static oil lubrication.
Medium: 1/4 to 1/2 catalog speed limit for static oil lubrication.
High: 1/2 to full catalog speed limit for static oil lubrication.

4) Consult SKF Engineering if temperature is below 0^{o} or above 200^{o}F.

5) Extremely slow speed will require special consideration if loads are high.

* Under all conditions, application should be checked using the SKF lubricant film parameter found in the Engineer Data Catalog.

6) Use type "C" where load is heavy, 15,000 hours-rating life or less and/or speed are less than RPM.

7) Consult SKF Engineering - Grease lube not normally recommended under this combination of operating conditions.

8) Dry clean applications only. For moderate conditions of dirt and/or moisture, use cycle of 1 to 2 months. For extreme conditions of dirt and/or moisture, use cycle of 1 week. Vertical applications normally require shorter than normal re-lube cycle.

9) Never mix greases with unlike bases.

10) Remove old grease at least once a year.

10 - LIMITED WARRANTY

SEPROTECH SYSTEMS INCORPORATED warrants the parts in each treatment plant to be free from defects in material and workmanship; for a period of 15 months from shipment or 12 months from start-up, whichever occurs first, in the treatment of domestic wastewater. Sole obligation under this warranty is as follows:

SEPROTECH SYSTEMS INCORPORATED shall fulfil this warranty by repairing or exchanging any component part, F.O.B. our factory, that in SEPROTECH SYSTEMS' judgement, shows evidence of defects, provided said component part has been paid for and is returned through an authorized dealer, transportation prepaid. The warranty must also specify the nature of the defect to the manufacturer. New placed parts are under warranty for one year.

The warranty does not cover treatment plants that have been flooded, by external means, or that have been disassembled by unauthorized persons, improperly installed, subjected to external damage or damage due to altered or improper wiring or overload protection.

This warranty applies only to the treatment plant and does not include any other electrical wiring, plumbing, drainage, or disposal system. SEPROTECH SYSTEMS INCORPORATED is not responsible for any delay or damages caused by defective components or material, or for loss incurred because of interruption of service, or for any other special or consequential damages or incidental expenses arising from the manufacture, sale, or use of this plant.

SEPROTECH SYSTEMS INCORPORATED reserves the right to revise, change, or modify the construction and design of the treatment plant for domestic wastewater or any component part or parts thereof without incurring any obligation to make such changes for modifications in previously sold equipment. SEPROTECH SYSTEMS INCORPORATED also reserves the right, in making replacements of component parts under this warranty, to furnish a component part, which, in its judgement is equivalent to the Company part replaced.

Under no circumstance will SEPROTECH SYSTEMS INCORPORATED, be responsible to the warrantee for any other direct or consequential damages. Including but not limited to; lost profits, lost income, labour charges, delays in production, and/or idle production, which damages are caused by a defect in material and/or workmanship in its parts.

This warranty is expressly in lieu of any other expressed or implied warranty, excluding any warranty of merchantability or fitness, and of any other obligation on the part of SEPROTECH SYSTEMS INCORPORATED.

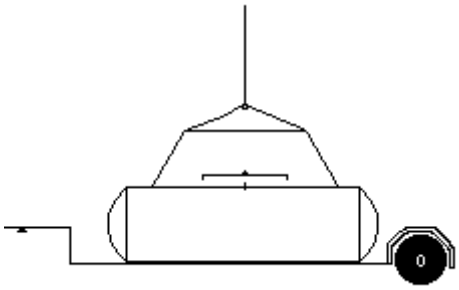
Seprotech Systems Incorporated
2378 Holly Lane, K1V 7P1
Ottawa, Ontario, Canada
Telephone (613) 523-1641
Fax (613) 731-0851

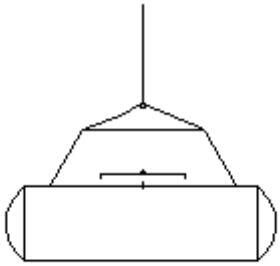
LIFTING

INSTRUCTIONS

NOTICE

The enclosed materials are considered proprietary of Seprotech Systems Inc. No assignments either implied or expressed, of intellectual property right, data, know how, trade secrets or licenses of use thereof are given. All information is provided exclusively to the addressee for information purposes and is not to be reproduced or divulged to other parties, nor used for manufacture or other means or authorize any of the above, without the express written consent of Seprotech Systems Inc. The acceptance of this document will be construed as an acceptance of the foregoing conditions.





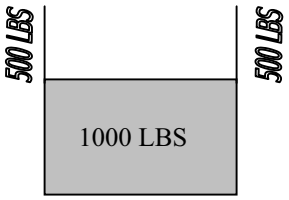
CENTER OF GRAVITY

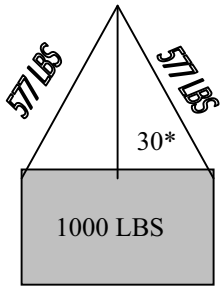
It is always important in rigging practice to rig the load so that it is stable. A stable load is one in which the center of gravity of the load is directly below the main hook and below the lowest point of attachment of the slings. The center of gravity of an object is that point at which the object will balance. The entire weight may be considered as concentrated at this point. A suspended object will always move so that the center of gravity is below the point of support. In order to make a level or stable lift, the crane or hook block must be directly above this point. Thus a load, which is slung above and through the center of gravity, will be stable and will not tend to topple or slide out of the slings.

Predicting the center of mass for an object to be lifted is not a trivial matter. It may require several attempts at rigging to find the appropriate balance point. Many objects are not rectangular such that predicting the center of mass is often difficult. In all crane lifts the center of mass must remain below the hook and below the point of attachment for any rigging. A center of mass above the hook is inherently unstable and will cause the load to flip. Similarly, loads that are not balanced in the horizontal plane may slip form the rigging. The overall stability of the load is a combination of balance with respect to the center of mass, weight distribution, and rigging tightness.

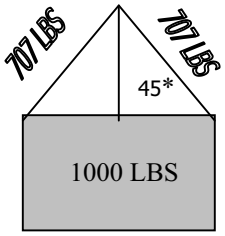
Crane operators should adjust the rigging and test for the actual center of gravity before the load is lifted.

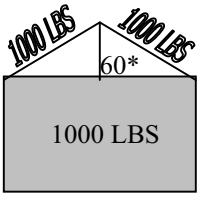
WEIGHT vs. ANGLE





Sling Angle With Vertical △	Stresses per Sling Leg Per 1000 LBS Total Load
0	500
5	502
10	508
15	518
20	532
25	552
30	577
35	610
40	653
45	707
50	778
55	872
60	1000
80	2880





The angle at which a sling holds a given load influences the effective weight of the load. Stresses are minimal for loads with slings held perpendicular to the load, as shown in Figure A. For distributing the load vertically among more than a single leg of a sling, a spreader bar may be used. As shown in figures B-D, increasing the angle of the sling to the hook from 30 to 60 degrees increases the effective mass of the load from 1154 lbs. to 2000 lbs., essentially doubling the weight on each leg of the sling at 60 degrees. The chart in the middle offers a handy guide for assessing the effective angle of the sling to the relative weight. Thus, it is always better to limit the angle of the sling. Further, such changes in sling angle must be accounted for in lifts that are close to the sling weight limit and/or for critical lifts (greater than 90% of the crane limit). Crane operators should download a copy of this chart and carry it with them during crane operations.

RIGGING

- Loads should be well secured
- Slings should be adequate to the task
- Slings should be un-kinked and load balanced and secured
- No sudden stops
- No obstructions while lifting or traveling
- No loose items on load or crane before lift
- Bumping into runway stops is prohibited
- Hoist line must be vertical prior to the lift (remove slack in the hoist slowly)
- No crane load should pass overhead of personnel, clear the area before making the lift
- No one is to ride the crane without permission

The most important job of any crane operation is rigging of the load. Poor rigging may result in personnel injury, property damage, or other serious hazards. Rigging is the most time consuming of any crane operation and represents the single most hazardous potential of crane operation. In a multi-sling operation, each leg must be of the same length and must contribute equally to load distribution. Nylon slings are susceptible to damage by sharp corners on the item to be rigged. Caution must be taken to ensure that slings are not damaged by sharp corners or by excessive loading. Rigging requires years of practice to perfect. If in doubt about the security of your rigging, ask for help. Rigging should be checked by lifting the load a few inches off the ground to ensure that no swing develops and that the load is completely secure. Remember it is important to take the time to accomplish this task correctly. Not doing so may result in catastrophic consequences. One of the most important things to check before lifting a load is to look for loose items, such as screws or tools, which may have been used to secure the load. Such items can become projectiles during a lift. This is the reason why crane operators or especially tag line operators should wear hard hats when operating the crane and why it is essential to make sure the path of the crane does not pass over the head of any individual.

Spreader bars must be used when lifting the B30. Slings are to be attached at the lifting lugs located at the Four Inside Corners of the B30.

Overall Weight	34, 200 Lbs
- Weight Trough	3,650
- Weight Shaft	4,634
- Weight Hood	3,900
- Miscellaneous	22,000

Overall Dimensions 311 Inch Long x 143 Inch Wide x 186 Inch High

(Refer to the General Arrangement Drawing for exact dimensions)

The following handling and installation instructions are intended to help customers install the RBC properly and efficiently.

Handling and installation instructions are only recommendations. They do not relieve the purchaser from full responsibility for proper inspection, handling and installation. Improper handling or installation, which results in damage or tank failure, is the sole responsibility of the purchaser. Failure by the customer to comply with the handling or installation instructions will void the tank warranty. Unknown situations or conditions are also the burden of the purchaser.

The presence of SEPROTECH SYSTEMS personnel or an authorized representative at the installation site does not relieve the purchaser of their responsibilities.

DO NOT fully assemble RBC prior to lifting. First install the tank, and then assemble the shaft and other components onto installed tank.

INSPECTION

At the time of delivery, the customer shall be responsible for inspecting the tank for damage during transit. Both the inside and the outside of the tank must be inspected. If damage has occurred it should be noted on the delivery receipt prior to signing acceptance, whether it be a SEPROTECH SYSTEMS truck of common carrier. If a SEPROTECH SYSTEMS truck makes delivery, the factory should be immediately contacted prior to unloading or acceptance. The customer accepts all future responsibility for a damaged tank if the procedures set forth are not followed.

Minor damage can be repaired at the delivery site.

SEPROTECH SYSTEMS tanks are designed to withstand normal handling. Note the following handling precautions:

1. NEVER roll or slide a RBC. Lift the tank using a crane or other approved method.
2. Operators of hoist equipment should follow proper rigging procedures at all times. NEVER allow RBC to swing out of control.
3. Do not drop or allow hard impact from tools, spreader bars, etc.
4. Avoid the use of equipment inside the tank that could scratch or damage the inner corrosion barrier.
5. NEVER use cables or chains around tank.
6. NEVER lift tank by using fittings. Use designated lifting lugs.
7. If RBC is being stored prior to installation, be sure to lay on padded surface and tie down securely.

APPENDIX E

PWSP EFLLUENT DISCHARGE PLAN

APPENDIX E.1

PWSP EFFLUENT DISCHARGE PLAN

Technical Memorandum

To: Jim Millard, Baffinland Iron Mines

From: Dave Ellis, P.Eng., AMEC
Jered Munro, AMEC

Date: March 27, 2012

REGISTERED PROFESSIONAL ENGINEER
D.D.J. ELLIS
LICENSEE
Mar 27/12
NT/NU

Subject: PWSP Effluent Discharge Plan

Baffinland Iron Mines Corporation (BIM) has retained AMEC Environment & Infrastructure (AMEC) to prepare this plan for the management, treatment, and disposal of the wastewater stored in the polishing/ waste stabilization ponds (PWSPs) at the Milne Inlet and Mary River facilities.

This plan updates the previous plan presented March 2010. To the extent possible, the discharge plans and options presented herein are flexible with a view to accommodating various seasonal operating requirements.

AMEC was retained by BIM in 2009 to develop and design a polishing treatment system for treating the effluent from the Mary River sanitary treatment system stored in the three PWSPs at that site. This memorandum identifies the following:

- the design criteria,
- overall discharge approach,
- the polishing system treatment components and functionality, and
- the sampling and performance monitoring plan.

This PWSP effluent discharge plan remains largely unchanged from the 2009 plan.

POLISHING SYSTEM DESIGN CRITERIA

Discharge Quality

The design criteria for the effluent discharge quality are defined in the water licence issued by the Nunavut Water Board, Licence 2BB-MRY1114 dated April 5, 2011 and are summarized below:

Table 1: Discharge Criteria of PWSP Effluent

Parameter	Discharge Criteria (Maximum Concentration of any Grab Sample)	
Location	**Mary River WWTF**	**Milne Inlet WWTF**
BOD_5	30 mg/ L	100 mg/L
TSS	35 mg/L	120 mg/ L
Faecal Coliform	1,000 CFU/100mL	10,000 CFU/100mL
Oil and Grease	No visible sheen	No visible sheen
pH	Between 6.0 and 9.5	Between 6.0 and 9.5
Toxicity	Final effluent not acutely toxic	Final effluent not acutely toxic
Ammonia[1]	N/A	N/A
Total Phosphorus[2]	0.5 – 1.0 mg/L	N/A

AMEC Environment & Infrastructure
A division of AMEC Americas Limited
900 Maple Grove Road, Unit 10
Cambridge, ON N3H 4R7
Tel 519-650-7100
Fax 519-653-6554
www.amec.com

Notes: 1. No specific criteria for ammonia, but effluent must be acutely non-toxic.
2. The range set for total phosphorus discharge target levels to Sheardown Lake were set based on results of the mass loading model developed by North South Consultants.

The phosphorus limit was confirmed to not be detrimental to the receiving aquatic environment by North/South Consultants, who employed modelling software to predict the effects of the effluent discharge based on the maximum design parameters listed in Table 1.

Following Part I, Items 4 and 5, the water licence requires sampling of the effluent from the PWSPs to be completed once prior to discharge, and every four weeks thereafter, for the following parameters:

- Biochemical oxygen demand (BOD),
- Total suspended solids,
- pH,
- Faecal coliform, and
- Oil and grease (visual).

Toxicity testing on treated effluent is required to be completed once annually during open water season at the final discharge point in accordance with the following tests:

- Acute lethality to Rainbow Trout (Oncorhynchus mykiss) as per Environment Canada's Environmental Protection Series Biological Test Method EPS/1/RM/13.
- Acute lethality to Daphnia magna as per Environment Canada's Environmental Protection Series Biological Test Method EPS/1/RM/14.

The discharge criteria remain largely unchanged from the previous licence 2BB-MRY0710 with the notable exception that the current licence specifies the compliance parameters in terms of "maximum concentration of any grab sample" as compared to the previous licence which listed compliance parameters as "maximum average" concentrations.

Discharge Flow

The design polishing system flow rate was originally determined based on a desired operating schedule of 24 hours per day, 7 days per week, for a duration of 3 weeks. The combined storage volume contained in the Mary River PWSPs No. 2 and 3 was estimated at approximately 6 million liters (~1.5 MUSG).

The flow rate of 375 L/min (100 USgpm) was set as the nominal design flow rate for the polishing system. This design flow rate was used to select the required chemical dosing equipment and was used for initial planning purposes based on an assumed 75% uptime rate and a discharge of 75% of the design flow rate.

The effluent discharge pipe to Sheardown Lake is a 3" diameter, HDPE pipe that is approximately 1.5 km long. To achieve the 100 USgpm design flow rate through the long discharge pipe requires considerable discharge pressure be developed at the pump discharge. Practical limitations in operating gas-powered centrifugal pumps in series have prevented the planned flow rate from being achieved.

The Milne PWSP is estimated to hold approximately 0.5 million litre (approximately 130,000 USgals) of combined RBC sludge, grey water, and snow melt.

OVERALL PWSP DISCHARGE APPROACH

Once the water in the PWSPs begins to thaw in late May, a sample from each of the PWSPs is submitted for analysis of the regulated effluent criteria parameters. Depending on the water quality confirmed in the respective PWSP, discharge may commence, as detailed below.

Option #1—Spring Discharge

If the PWSP melt water sample is in compliance with the regulated criteria, Baffinland will commence discharge of the compliant effluent.

Once discharge has commenced, Baffinland will field test for pH, and turbidity and complete confirmatory sampling using bench-top screening methods to monitor the effluent quality. Discharge will be discontinued following established Standard Operating Procedures (SOPs) if any of the tests approach effluent criteria limits.

Sheardown Lake remains ice covered during the Spring Discharge. This ice cover requires a hole be augered through the ice and a temporary discharge pipe installed. The temporary discharge pipe conducts the effluent to a point below the ice to prevent erosion or sediment entrainment due to the discharge flow. At the completion of the Spring Discharge the temporary pipe is removed from Sheardown.

The quality of the water in the Milne PWSP has typically been such that the spring melt water has been compliant with the criteria without further polishing treatment.

Option #2—Summer Polishing Treatment and Discharge

If the water quality in the PWSPs does not meet all effluent discharge criteria, then the effluent would be treated using all or part of the polishing treatment system, depending on the particular parameters of concern. During the start-up of the polishing treatment system, the effluent is discharged back into a PWSP. The treated effluent would not be discharged until laboratory analytical results confirmed that the polishing treatment system was producing compliant effluent.

Following confirmation of effluent quality, the polishing system is operated and the treated water discharged to Sheardown Lake until the PWSPs have been emptied or weather conditions become unfavourable for treatment.

Should the Milne PWSP water require further polishing treatment, it can be transferred to Mary River for treatment and discharge through the Mary River PWSP system.

POLISHING TREATMENT SYSTEM COMPONENTS AND FUNCTIONALITY

The polishing treatment system was designed to provide additional treatment for total suspended solids (TSS) and total phosphorus (TP) removal, as well as pH control.

The polishing system contains the following unit processes, as shown in the attached Process Flow Diagram, PFD-01 (Attachment A) and the attached photographs (Attachment B). A more detailed description and photographs are included in the system Operation and Maintenance Manual.

Influent Pump and Flow Meter

A pump draws from one of the ponds and feeds water at a design flow of 100 USgpm. A flow meter with totalizer is used to monitor this influent flow. Flow to the polishing system can be controlled by throttling the influent pump speed or by adjusting a 3-inch ball-valve that bleeds water back into the pond.

Chemical Addition

Water treatment chemicals were added to the influent water to aid in the treatment process. The following chemicals were used in the 2009 and 2011 polishing system:

- Aluminum sulphate (commonly called “alum”), and
- A polymer, marked “Polyfloc AP1138” by the manufacturer, GE Betz Inc.

Aluminum Sulphate (Alum) Addition

Aluminum sulphate is added to achieve three goals:

- Precipitation of soluble phosphorous to a solid,
- Coagulation of algae and other suspended solids, and
- Reduction of pH.

Alum is dosed into the influent pipe by means of a chemical metering pump and then mixed in the flocculator piping to promote precipitation and coagulation chemical reactions and achieve flocc formation.

Polymer Addition

Polymer is added, after the alum, to further enhance the formation of larger solids allowing them to separate more quickly from the bulk liquid once in the DAF tank. The polymer serves as a flocculant which promotes the agglomeration of smaller coagulated solids into larger flocs. These larger flocs are more readily removed by downstream processes.

Polymer is added in a similar fashion as the aluminum sulphate, with mixing in the flocculator piping before entrance into the DAF.

Dissolved Air Flotation (DAF) System

Water containing alum and polymer is combined with a recirculating stream of water which is supersaturated with dissolved air. As the dissolved air comes out of solution, microscopic air bubbles are formed on the flocculated solids, thus increasing their buoyancy. These buoyant solids float to the surface and can be easily skimmed off.

Air Dissolving Pump

The dissolved air flotation (DAF) system is comprised of a number of components. The heart of the system is a Hellbender-brand air dissolving pump. This pump is specifically designed to accept large amounts of air mixed with water, and operates under high pressure to dissolve and shear the air into fine micro bubbles. When the high pressure, air-rich, stream meets the lower pressure flocculated influent water, dissolved air comes out of solution forming small air bubbles. These small bubbles attach to the flocculated solids causing them to rise to the surface once inside the DAF tank.

DAF Tank

Influent water that has already been combined with the air-rich recirculation water is distributed across the width of the rectangular DAF tank through a relatively large, 6-inch diameter distribution header. This large inlet header is used to minimize water entrance velocity and facilitate a quiescence of the water in the tank.

These quiescent conditions in the DAF tank allow the buoyant solids to float to the surface. Solids are periodically skimmed off the top of the tank, over a collection beach, into a sludge trough. The sludge trough discharges collected solids by gravity to two large totes for disposal.

At the opposite end of the DAF tank from the inlet is the outlet. Clarified water is collected through a 4-inch diameter effluent header located halfway up the height of the tank. The clarified water is directed to the final effluent clear-well tanks.

Floated Solids Storage and Pumping

Two parallel solids holding tanks have been provided to capture the floated solids. A pump is used to pump the float solids into PWSP No. 1 for storage.

Final pH Adjustment

Two effluent clear-well tanks are connected in series so that the water can be pH adjusted with sodium bicarbonate, if needed.

Final Filtration

If desired, the effluent can be passed through a final filtration process prior to discharge.

Effluent Pumping and Flow Monitoring

Clarified water is pumped through Tsurumi brand trash pumps, that discharge into the 3-inch Sheardown discharge pipeline. The treated water discharge flow is measured using a flowmeter with totalizer.

SAMPLING AND PERFORMANCE MONITORING

During operation, the treatment system is attended on a continuous basis. Samples of the daily field logs are attached (Attachment C). Attachment C.1 is the daily field log used during the spring discharge, when there is little or no treatment of the PWSP water required. Attachment C.2 is used when the full polishing system is required as may be necessary during late summer.

The polishing system is controlled using field testing devices for pH and turbidity measurement. Adjustments were made to the aluminum sulphate and sodium bicarbonate dosing pumps to control the pH and the polymer dosing pump was used to control the turbidity (indicative of total suspended solids-TSS). Physical inspection of the DAF inlet and discharge streams, as well as the consistency of the floated solids layer, indicated to the operators how well the system was operating. In the event of a suspect test result, a bypass valve is used to redirect effluent back to the PWSP while the system operation was adjusted and retested.

A summary of the PWSP external lab and in-house analysis program can be found in tables (2) and (3).

Table 1 – On-site lab analysis parameters and schedule.

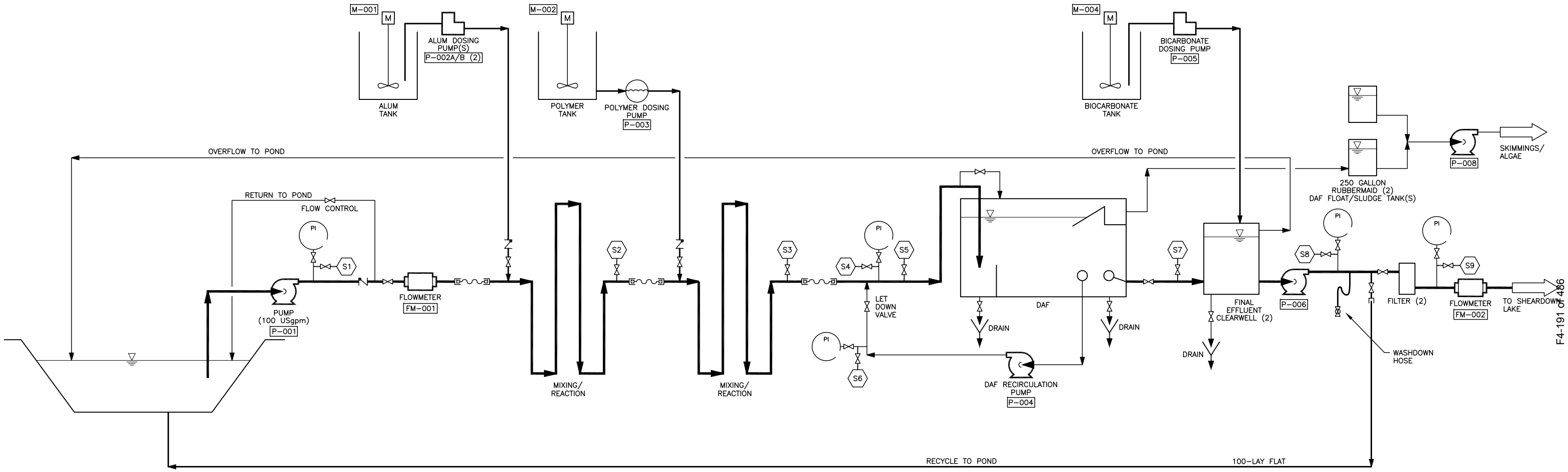
In House Analysis	Daily (onsite lab)	Hourly (in field)
pH	✓	✓
Temperature	✓	✓
Turbidity	✓	✓
TP	✓	
Ammonia	✓	
COD	✓	

Table 2 – External lab analysis parameters and schedule.

External Lab Analysis	Pre Discharge	Middle of Discharge	Every Week
BOD	✓		✓
COD	✓		✓
TSS	✓		✓
TP	✓		✓
Fecal Coliforms	✓		✓
Toxicity	✓	✓	
O&G	✓		✓

Attachment A

PWSP Polishing System Process Flow Diagram (PFD-01)



F4-191 OF 486

CAUTION: THIS PLAN MAY BE REDUCED 0 25mm 50mm ORIGINAL SCALE

NO.	REVISION	DATE	APRVD
0	O&M REVISIONS	08/10	

DRAWN JR AUG 2010
DESIGNED JW AUG 2010
CHECKED
REVIEWED

Baffinland Iron Mines Corporation

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PROCESS FLOW AND INSTRUMENTATION DIAGRAM
BAFFINLAND IRON MINES
POND WASTEWATER TREATMENT
DISSOLVED AIR FLOATATION SYSTEM

DATE: MARCH 2012
SCALE: N.T.S.
SHEET: 1 OF 1 SHEETS
PROJ No: TR1662
P&ID-01

Filepath: T:\Pete\Geomatrix\2012\122684-1 Baffinland (TR\TR1662-P&ID01.dwg
Plot Time: Mar 23, 2012 - 11:43am, Plotted By: Dell Survey2

Attachment B

PWSP Polishing System Photographs

PHOTOGRAPH LOG
Baffinland Iron Mines
Effluent Discharge Treatment System (2010)

Photograph 1 Dissolved Air Flotation Tank

Photograph 2 Aluminum Sulphate and Polymer Dosing Systems with Flocculation Piping

PHOTOGRAPH LOG
Baffinland Iron Mines
Effluent Discharge Treatment System (2010)

Photograph 3 Floated Solids Tanks(left) and Effluent Clear Well Tanks (right

Photograph 4 Treatment System Aerial

Attachment C

PWSP Polishing System Field Log, Sample Sheets
C.1 – Spring Field Log, Sample Sheet
C.2 – Summer Treatment Field Log, Sample Sheet

Baffinland Iron Mines - Mary River Pond Water Spring Treatment Period
Daily Field Log Sheet

Pond being treated:

		Field Parameters					Lab Parameters				Observations/Notes
Date	Time	pH	Turbidity	Temperature	Cartridge Filter ΔP	Flowrate	Ammonia as N	TP as P	COD	Turbidity	
dd/mmm/yy	(24hr)	-	NTU	deg C	psig	US GPM	mg/L	mg/L	mg/L	NTU	

Baffinland Iron Mines - Mary River Pond Water Summer Treatment Period
Daily Field Log Sheet

Pond being treated:

		Feed Pump					Alum Pump					Poly Pump		Bicarb		DAF Pump				Discharge Pump							
Date	Time	Pressure	Flow	T1	T2	pH	Pump	Stroke	Speed	Flow	pH	Speed	Flow	Stroke	Speed	Gate Valve P	Discharge P	Airflow	Totalizer	Flow	Filter 1 Inlet	Filter 1 Out	Filter 2 Inlet	Filter 2 Out	pH	Turbidity	Temp.
dd/mmm/yy	(24hr)	(psi)	Lpm	m3	m3		#	%	%	ml/min		%	mL/min	%	%	psi	psi	SCFH	m3	Lpm	psi	psi	psi	psi		NTU	deg C

APPENDIX E.2

PWSP EFFLUENT POLISHING SYSTEM OPERATION AND MAINTENANCE MANUAL

BAFFINLAND IRON MINES
MARY RIVER PROJECT
BAFFIN ISLAND, NUNAVUT

SEWAGE POLISHING BY DISSOLVED AIR FLOTATION OPERATION AND MAINTENANCE MANUAL

Submitted to:
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Submitted by:
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900 Maple Grove Road, Unit 10
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March 2012

TABLE OF CONTENTS

PAGE

1.0 INTRODUCTION 1
2.0 DISSOLVED AIR FLOTATION TREATMENT SYSTEM 2
3.0 WASTEWATER QUALITY 4
4.0 TREATABILITY TESTING PROCEDURES 8
4.1 Sludge Inventory of the Ponds 9
5.0 ASSEMBLY INSTRUCTIONS 10
6.0 SYSTEM OPERATION 24
7.0 SYSTEM SAMPLING AND EFFLUENT MONITORING REQUIREMENTS 29
7.1 Water Sampling 29
7.2 Sample Collection 31
7.3 Process Monitoring 31
8.0 TROUBLESHOOTING 31
9.0 RECOMMENDED IMPROVEMENTS 35
9.1 Consideration of alternate ph adjustment chemicals - R 35

LIST OF TABLES

Table 2.1: Major Equipment List and Description
Table 3.1: Mary River Domestic Wastewater Effluent Criteria
Table 3.2: Raw Water Quality
Table 3.3: Raw Water Quality
Table 4.1: Treatability Testing Matrix Example
Table 7.1: Effluent Monitoring Requirements (2009)
Table 7.2: On-site lab analysis parameters and schedule
Table 7.3: External lab analysis parameters and schedule

LIST OF APPENDICES

Appendix A: Drawings
Appendix B: Original System Details
Appendix C: Vendor Manuals
Appendix D: Possible Improvements
Appendix E: MSDS
Appendix F: Log Sheets

1.0 INTRODUCTION

This manual provides a description of the sewage polishing system used by Baffinland in the summer of 2009 and 2011 to polish sewage stored in Polishing/Waste Stabilization Ponds (PWSPs) #2 and #3 at the Mary River Camp located on Baffin Island, Nunavut. Using this system, partially treated sewage from the rotating biological contactor (RBC) was treated to below regulatory levels, allowing it to be discharged to Sheardown Lake.

This O&M manual presents the following elements of the system:

- overall description,
- equipment layout,
- unit process purpose,
- basic operational, monitoring, and sampling procedures, and
- maintenance requirements for the Dissolved Air Flotation (DAF) system.

This manual is intended to be an instructional tool for those persons responsible for the successful operation of the treatment system in future years. It is intended to be used by all operators. However, it is important that someone with a technical background be involved throughout the process of pre-treatment testing, assembling, operating, and monitoring of the treatment system. The contents of this manual have been organized as follows:

Section 1: Introduction

Section 2: Overview of Process and Equipment
The process is introduced by using the process flow diagram and system photos to give an overall view of the physical layout of the treatment system. Each major unit process will be introduced and its function described.

Section 3: Wastewater Characterization and Regulatory Limits
A summary of wastewater characterization data from previous years will be discussed with respect to regulatory requirements.

Section 4: Pre-treatment and treatability procedures
A discussion of the pre-treatment testing procedure, and treatability testing that was performed in 2009 to determine the appropriate course of action for treatment is presented.

Section 5: Assembly Instructions
More detailed information and photographs are provided in this section to help with the assembly of the system.

Section 6: System Operation
This section will provide details on the start-up, operation, and shut-down of the system.

Section 7: System Monitoring and Sampling Requirements
Monitoring of mechanical, electrical, and process parameters are required for the successful operation of the system. This section describes what should be monitored and provides sample tables that can be used for recording of monitored values.

Section 8: Troubleshooting
A compilation of lessons learned from the 2009 and 2011 system operation that will help future users who have not been involved with operating the system learn from previous experience.

Section 9: Recommended Improvements
A number of recommended improvements are listed in this section. Some are necessary, and others are optional to improve process efficiency.

2.0 DISSOLVED AIR FLOTATION TREATMENT SYSTEM

Purpose: The Mary River Camp produces domestic wastewater that is treated using a Rotating Biological Contactor (RBC). This treatment system has been successful in removing biochemical oxygen demand, suspended solids, most of the phosphorous, and some nitrogen from the wastewater. The quality of the effluent has not been sufficient in the past to meet all of the regulatory limits for direct discharge to Sheardown Lake. Therefore, three storage lagoons have been built and used to store RBC effluent for further polishing or accumulated sludge from the RBC process. The purpose of the treatment system that was designed and built in 2009 and modified in 2011 was to remove suspended solids and phosphorous to below regulatory limits, and to discharge the treated effluent to Sheardown Lake.

Description: This section is intended to introduce the user to the major equipment and its intended purpose. P&ID-01 in the drawings (Appendix A) is used to illustrate how the system is constructed and how each unit process is related. Table 2.1 provides a detailed listing of the equipment in the dissolved air flotation treatment system. The design details are provided to allow the user to refer to specific equipment manuals for more detail on each piece of equipment.

Table 2.1: Major Equipment List and Description

Process Tag	Description	Design Details
P-001	Influent Pump. Draws water from the top of either pond and feeds the DAF system.	3-inch Gas powered Honda Pump Model WT30XK3C
FM-001	Influent Flow Meter. Used to set the flow to the DAF treatment system.	2” Badger Model 2000 Magnetic Flow Meter Purchased from J&M Engineering & Sales

Process Tag	Description	Design Details
P-002A&B	Alum Dosing Pump. Used for coagulation of suspended solids and phosphorous. Added 2nd pump in 2011 as 100% standby.	Pulsatron LPH8SAPTCBXXX rated at 94.6 litres per hour @ 30 psi. Purchased from Visser Sales Corp.
P-003	Polymer Pump with variable speed controller. Used for the flocculation of coagulated solids to enhance solids and phosphorous removal	NEMO® pump with drive Model # NM011BY02S12B 0020 KB Penta Variable speed controller 115V – 90VDC, supplied loose Purchased from PFE Pumps
P-004	Dissolved Air Flotation Pump. Used to dissolve air from an eductor under high pressure. Air comes out of solution in tiny bubbles once released into the Skimming tank.	Hellbender DAF Pump Model Number HB-60. Purchased from ETS Environmental
M-001	Alum Mixer used to mix powdered aluminum sulphate into water to be injected into the influent line.	Model EV1P. There are two identical green coloured mixers.
M-002	Polymer Mixer used to mix dry polymer into solution.	CG-3 Mixer. Only spec sheet available. See Appendix C
Skimming Tank	The separation tank where coagulated/flocculated solids are floated to the surface by the dissolved air coming out of solution. The solids are skimmed from the surface, and disposed as sludge. The clean effluent is collected in the effluent clearwell	This tank is a new roll-off bin that was customized into a skimming tank in 2011. The original skimming tank is in use as part of the Milne Oily Water treatment system.
M-003	Effluent Clearwell Mixer. Intended to mix sodium bicarbonate into the final effluent if final effluent pH adjust is necessary. This mixer was not available in 2011 so it was not installed and was not used.	Model EV1P.
M-004	Sodium bicarbonate make-down mixer. Used to make a concentrated sodium bicarbonate solutions that can be fed to the effluent clearwell.	Model EV1P. There are two identical green coloured mixers.
P-005	Sodium bicarbonate metering pump. Used to control the rate of bicarbonate addition to reduce the pH to the desired pH.	Pulsatron LPH6SAPTC3XXX rated at 18.9 liters per hour @ 100 psi Purchased from Vissers Sales Corp.

Process Tag	Description	Design Details
P-006	Final Effluent Pump 1. Used to pressurize the final effluent to provide wash water in and around the treatment system.	4-inch Tsurumi Gas Powered Trash Pump Model Number EPT 3-100 HA or Honda Model WT40XK2C
F-006A&B	Final Effluent Filters. Used to remove residual particulate solids. Can be used in series or in parallel.	Hurricane Filter Housing Model Number C-HUR.170.HP. Filter cartridges 10 micron rating Part Number F-HC.170.10; 1 micron rating Part Number F-HC.170.1 Purchased from Service Filtration
FM-002	Final Effluent Flow meter. Important for recording and reporting total discharged volumes.	2" Badger Industrial Turbo Flow Meter Part Number 53400-003. Purchased from J&M Engineering & Sales
P-008	DAF Float/Sludge Pump. Used to pump the solids that are skimmed off of the DAF to Pond #1. These will then settle and be incorporated into the sludge in the pond.	3-inch Gas powered Honda Pump Model WT30XK3C

3.0 WASTEWATER QUALITY

The quality of the water in the ponds is dependant upon a number of factors including:

- The quality of treatment from the RBC
- The month of the treatment season
- The amount of algae growing in the ponds
- The pH and temperature of the ponds

In 2009, the following observations were made over the course of the treatment season:

June--the water was a yellowish colour, and was high in ammonia, phosphorous, and lower in suspended solids. In the 2011 operating season the RBC effluent accumulated in the PWSP was compliant for ammonia, phosphorus and TSS due to improved winter operation of the RBC system.

July--all three ponds had turned green due the presence of algae in the water. A significant increase in pH was observed over the month of July.

August--the pH in the ponds had risen to 12 units by the beginning of August. By this point, ammonia had volatilized due to the high pH of the water, and suspended solids had increased due to the presence of algae. Phosphorous concentrations were constant. Biochemical oxygen demand remained below regulatory limits in both Pond 2 and 3.

The water quality observed during the 2011 operating season differed from 2009 in that the measured pH did not increase to as high levels and algae growth was reduced. This reduced algal growth is thought to be due to the lower phosphorus concentrations in the PWSPs in June and July. In addition it was determined that the ability to correlate field turbidity readings to the TSS concentrations resulting from third party testing of a collected sample is variable and dependent on the type/composition of the solids in solution. Despite this variability the treatment requirement remained were unchanged.

Therefore, the treatment system was designed to:

- lower pH, and
- remove both phosphorous and TSS.

Careful attention must be paid to all regulated effluent parameters when operating the system. Certain process modifications/additions may be necessary depending on the specific quality of the water. For example, if treatment was commenced at the beginning of July, the system would have had to treat ammonia as well as phosphorous. This would have required batch treatment of the ponds using lime and some form of air stripping system to remove ammonia. By letting the algae do the work of raising the pH, and the natural wind and wave action in the ponds accomplish the air stripping, this step was eliminated from the treatment process, and reduced the amount of inert sludge that would have been produced from lime addition.

During the spring of 2009 approximately 400 m^3 of Pond 1 water was decanted and added to Pond 2. If this decanting of Pond #1 is repeated, careful attention to pumping relatively clear decant water from the top of the pond is important. Because the Pond 1 decant water can still be relatively high in BOD or other parameters, it is also necessary to ensure that there is enough dilution water in the pond being pumped into so that no parameter that is untreatable ends up contaminating the entire pond. . The only way to feasibly remove soluble 5-day Biochemical Oxygen Demand (BOD_5) from the system is through the RBC. Therefore, if the Pond 2 or 3 BOD_5 is above regulatory limits, all of that pond water would have to be sent back through the RBC before polishing with the DAF treatment system.

Table 3.1 summarizes the effluent quality criteria that domestic wastewater from Mary River must achieve in order to be discharged to Sheardown Lake.

Table 3.1: Mary River Domestic Wastewater Effluent Criteria

Parameter	Mary River	Milne Inlet
Total BOD_5 (mg/L)	30	100
TSS (mg/L)	35	120
Faecal Coliforms (CFU/100ml)	1000	10,000
Oil and Grease	No visible sheen	No visible sheen
pH (pH units)	6.0 to 9.5	6.0 to 9.5
Toxicity	Final effluent not acutely toxic	Final effluent not acutely toxic
Ammonia (mg/L)	N/A	N/A
Total Phosphorous (mg/L)	0.5 – 1.0	N/A

Operators should ensure that this table is up to date with the most recent effluent criteria to ensure compliance before discharge is commenced.

Table 3.2 illustrates how the pond water changed over the summer in Ponds 2 and 3 in 2009. Table 3.3 summarizes the pond water quality test results from 2011.

Table 3.2: Raw Water Quality

Pond 3 Water Quality				
	May 27 2009	June 24 2009	Aug 9 2009	August 20 2009
total BOD5	4		10	6
COD	35		62	40
NH3	0.76	0.95	0.1	0.07
pH	8.13	9.19	10.2	
TKN	1.54	2.95	3.69	
TP	0.13	0.32	0.18	
TSS	9	7	28	
Fecal Coliforms	Never an issue in 2009			
O&G				

Pond 2 Water Quality		
	May 27 2009	August 8 2009
total BOD5	15	32
COD	83	116
NH3	2.89	2.9
pH	7.44	10.4
TKN	6.09	12.1
TP	0.77	3.46
TSS	7	74
Fecal Coliforms	Never an Issue in 2009	
O&G		

Table 3.3: Raw Water Quality

Mary-4B	PWSP Pond 2														
Pond 2 Water Quality															
Date	**May 16**	**June 8**	**June 19**	**June 26**	**July 11**	**July 13**	**July 18**	**July 25**	**July 27**	**August 1**	**August 3**	**August 8**	**August 10**	**August 14**	**August 29**
Faecal	<10		0	<10	-	<10	<10	<10			-		-		
BOD	3	3	11	8	15	20	36	30	25		31	17	12		24
COD	15	-	100	105	200	200	200	170	250	250	250	175	145	138	145
COD (sol)					85	60	90	128	95		-	-	-		
N-NH3	0.03	0.05	1.84	1.2	<0.02	<0.02	0.04	0.06	0.04	0.04	0.04	0.04	<0.02	0.02	0.05
pH	6.81	7.28	7.35	7.39	10	10.2	9.89	10.3	9.84		9.72	9.63	9.62	9.67	9.22
TKN					5.3	4.85	5.61	4.16	4.85	4.49	3.99		3.46	3.17	3.67
TP (PO4)	0.67	0.33	2.11	2.46	2.35	1.88	2.28	1.64	1.43	2.05	1.6	1.65	1.12	1.55	1.49
TP (PO4) sol.					0.99	0.88	0.78	0.86	0.81			1.26	1.04		
Turb/TSS	11	7	11	20	73	85	101	71	70	61	51	34	25	25	32
O&G			<1	<1	<1	<1	-	<1	<1	<1	<1	<1	2		

Mary-4C	PWSP Pond 3																					
Pond 3 Water Quality, 2011																						
Date	**May 16**	**May 18**	**May 22**	**May 24**	**May 26**	**May 28**	**May 29**	**June 6**	**June 8**	**June 15**	**June 19**	**June 26**	**July 11**	**July 13**	**July 18**	**July 25**	**July 27**	**August 1**	**August 3**	**August 8**	**August 10**	**August 14**
Faecal	<10	<10	<10								0.00	<10	-	<10	<10	<10					-	
BOD	2	1	2	-	**1**	**1**	**1**	3	2	1	4.00	9.00	20	17	35	21	30		18	12	9	
COD	<5	5	30	20	18	25	20	30	-	-	35.00	100.00	160	150	175	150	155	250	128	150	135	75
COD (sol)													100	110	105	140	140		-	-	-	
N-NH3	0.2	0.17	0.15	0.12	0.16	0.22	0.13	0.14	0.05	0.07	0.15	0.72	0.07	0.07	0.05	0.08	0.09	0.07	0.08	0.06	0.09	0.16
pH	7.96	7.99	8	7.98	8.06	8	8.08	7.67	7.9	7.86	8.01	9.49	10.20	10.40	10.3	10.7	10.3		10.2	10.2	10.2	9.91
TKN													6.29	6.94	6.91	4.3	4.28	4.45	4.2	4.3	3.78	3.66
TP (PO4)	0.79	0.93	1.06	1.05	0.9	1.25	1.18	1.58	0.74	0.394	0.40	0.56	0.36	0.36	0.48	0.23	0.23	0.195	0.172	0.174	0.17	0.16
TP (PO4) sol.													0.14	0.13	0.14	0.13	0.13		-	0.12	0.09	
Turb/TSS	3	4	3	4	<2	4	2	9	5	3	8.00	17.00	34	51	68	34	32	20	10	15	16	22
O&G		<1	<1								<1	5	5	<1	<1	<1	<1	<1	<1	<1	2	

4.0 TREATABILITY TESTING PROCEDURES

A number of bench scale and pilot scale treatability tests were performed in June and July 2009 and again prior to the 2011 summer operating season to demonstrate the process design concept was capable of polishing the pond water to below effluent limits. Since this was the first time this process was being used, more rigorous testing needed to be performed. It may still be useful to perform some bench-scale treatability testing before beginning to operate this system so that target dosages for alum and polymer can be determined. This methodology is only applicable if soluble BOD_5 and ammonia are below effluent limits. If this is not the case, the current treatment system would need to be modified to remove these constituents.

Materials needed:

- 20 L representative sample of the pond being treated
- 5 or 6 position jar testing apparatus (This is recommended, but if not available, 500 ml plastic sample bottles can be used. Ensure equal agitation and mixing of reactants for each dosage as best as possible if sample bottles are used).
- 5 or 6 clean 1 L beakers (if using a jar stirrer)
- Scale with precision to at least 0.1 g
- Alum stock solution of 10 mg/ml (or 1%)
- Polymer stock solution of 1 mg/ml (or 0.1%)
- pH meter
- glass stirring rods or disposable coffee stir sticks
- 0 to 5 ml pipette or disposable 0 to 10 ml syringes (needles are not necessary)

Method:

1. Obtain a representative sample by manually compositing samples from at least four locations around the perimeter of the pond. Record the initial pH of the water.
2. Using Table 4.1 as a guide, keeping the alum dosage constant, perform at least five series of jar tests, noting visual observations for each unique alum & polymer dosage combination.(e.g. start with an alum dosage of 40 mg/L in every beaker/bottle, and then add 0.25, 0.5, 0.75, 1, 1.25 and 1.5 mg/L of polymer to the various beakers/bottles.
3. After both chemicals have been added, stir vigorously for 5 seconds and then gently for another 10 seconds.
4. Allow each sample to sit, and record qualitative results, like which solution separates faster, whether the solids float or sink, the relative size of the flocculated particles (floc), which solution is clearer, and the final pH of the solution.

5. Repeat this step for different alum concentrations of 60, 80, 100, and 120 mg/L. Once this initial round of qualitative observations has been made, choose three of the best alum/polymer combinations, and repeat the test using these dosages; being careful to treat each sample equally.
6. Allow the samples to sit for at least 24 hours after initial settling, and observe any changes in the effluent quality. In 2009, it was typical for the solids to float to the surface initially due to carbon dioxide off-gassing, but over time, the solids would begin to settle to the bottom of the container, once the gas had left the solids. The solids themselves appeared to be neutrally buoyant, which is why dissolved air flotation was used to force the solids to the surface of the skimming tank.
7. Once an optimum dose of alum and polymer has been determined, it is recommended that this be verified at a larger scale using either a bucket or a drum. Allow the sample to sit for at least a few (1 to 3) hours.
8. Verify the solids are either on the top or the bottom, and take samples of the clarified liquid for onsite analysis of phosphorous, turbidity, pH, and COD. If the internal lab results are positive, a sample should be sent to Exova for all regulated parameters.
9. If phosphorous is not acceptable, the treatability testing should be repeated.
10. If the pH is too low, sodium bicarbonate can be used to raise the pH to effluent requirements.
11. In 2009, the chemical dosage was controlled based on pH measurement by the operator and adjusted to the target level. Sometimes pH measurement was not a reliable control method, and alum dosage was controlled based on slow changes to the dose, and qualitative observation of improved or lower coagulation of solids.

Table 4.2: Treatability Testing Matrix Example

Polymer dosage (mg/L)	0.25	0.50	0.75	1.0	1.25	1.5
Alum Dosage (mg/L)						
40						
60						
80						
100						
120						

4.1 Sludge Inventory of the Ponds

At the beginning of each season, the quantity of sludge in each pond should be estimated, and the interface between the liquid/sludge should be known. This will help operators know how far down they can pump the ponds before they reach sludge. Recording sludge levels from year to year while keeping careful records of any sludge that is added to a pond will provide useful information on how sludge levels change, and how much sludge the algae may be contributing.

Materials Needed:

- Two people
- Personal flotation devices and gloves for each person
- Rubber raft suitable for two people to sit and stand in
- ¼" Nylon rope securely fastened across the middle of the pond in question
- Notepad
- Pen
- Sludge judge
- Two clean 20 L buckets

Method:

1. Starting at one side of the pond, one person inserts the sludge judge to the bottom of the bottom and draws up a representative sample of the water column for that location
2. The other person records the sludge/water interface height, and notes the length of any transition zone.
3. The one recording also holds onto the nylon rope, and moves the raft forward 3 feet.
4. Repeat steps 1 to 3 until the other side of the pond is reached. At least 20 readings should be taken across the length of the pond. For additional detail, more than one transit of the pond can be performed, although in 2008 we found the sludge levels to be fairly uniform. Sludge inventory of the three ponds was conducted in August 2011 and found negligible levels of accumulated solids (1 to 3 inches) in all 3 of the PWSP at Mary River.

5.0 ASSEMBLY INSTRUCTIONS

This section is intended to assist in the proper assembly of the DAF treatment system. Using the P&ID-01, the layout drawings C-01 and C-02 in Appendix A, along with the photos in this section, operators will be able to layout and assemble all the major components of the treatment system. The system is designed to be modular, and a certain degree of flexibility is available to the assembler. This section will act as a guide to convey the main design intent for the treatment train. Operators should refer to the specific equipment manuals in Appendix C of this manual for specific maintenance and operating procedures of individual pieces of equipment.

The first task that should be done at the beginning of the treatment season is to lay the system out, and identify any broken or missing pieces of equipment so that suitable replacements can be ordered that can be integrated into the existing system.

Photo 1 – Aerial View

This shows an overview view of the process layout. Using drawings C-01, C-02 and the P&ID along with this photo will give the operator a good feeling for the overall footprint and layout of the system. *Note: In 2011 two filter housings were added downstream of the final effluent pump to remove residual particulate solids. These filters are not shown in this photo.*

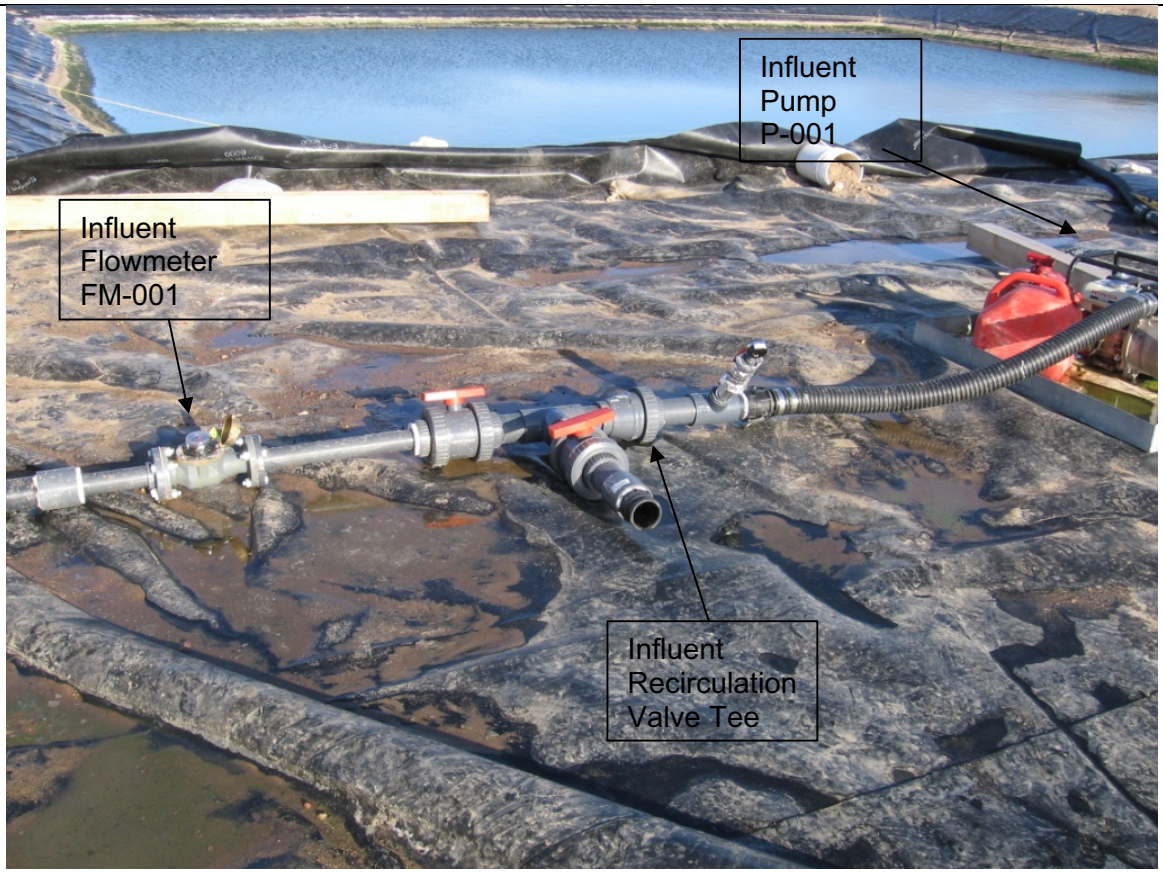


Photo 2 – Influent Piping

The key components in the influent piping are the 3" influent pump, the valve tee, and the flow meter. The recirculation valve is used when priming the pump and to isolate the influent pump from the treatment system if the treatment system is running, or if the influent pump has to be restarted or re-primed. Use this flow meter to set the desired flow of the influent pump to the treatment system. The intake for the influent pump should be made to float just below the surface of the pond to minimize drawing sludge off the bottom of a pond. See the background of Photo 5. *Note: In 2011 a magnetic flowmeter was installed to replace the industrial turbine type influent flowmeter shown in this photo to reduce plugging tendency and improve measuring reliability.*

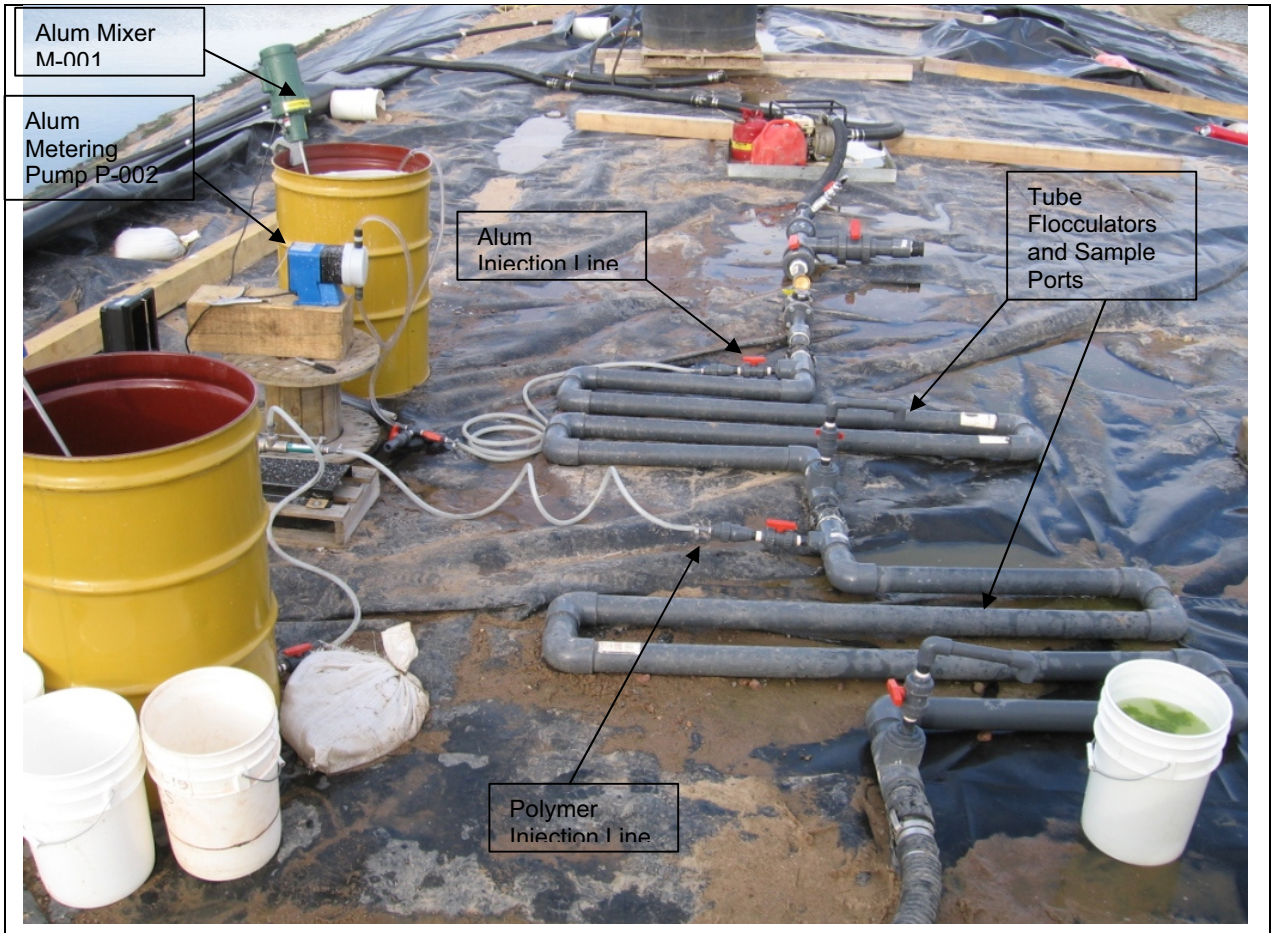


Photo 3 – Chemical Dosing and Mixing System

Connect the two tube flocculators together ensuring that the sample ports and chemical injection points are not broken. Ideally, injection quills should replace the current chemical injection ports. Two chemical make-down barrels used to make stock solutions of alum and polymer with mixers are required as well. Ensure that the Blue mixer is used for polymer make down, as it has a larger impeller with a gear reducer to slow down the speed of the mixer. Make sure that the alum is injected upstream of the polymer. *Note: In 2011 a second alum dosing pump was installed to provide 100% standby capacity to maintain continuous chemical addition during shutdown of the duty pump for periodic cleaning and maintenance.*

Photo 4 – Chemical Dosing System View Towards DAF

Use an appropriately sized 3" hose to connect the chemical dosing system to combination Tee by the DAF system. The moyno pump is needed for polymer dosing as the polymer is very viscous. Using one of the chemical dosing pumps would not be sufficient to deliver the required amount of polymer and would likely damage the pump as well. Both these types of pumps are 120/240V and were run from a light stand generator. *Note: In 2011, the power supply was upgraded and all chemical dosing pumps and make-down mixers are powered from GFI protected plug-in receptacles.*

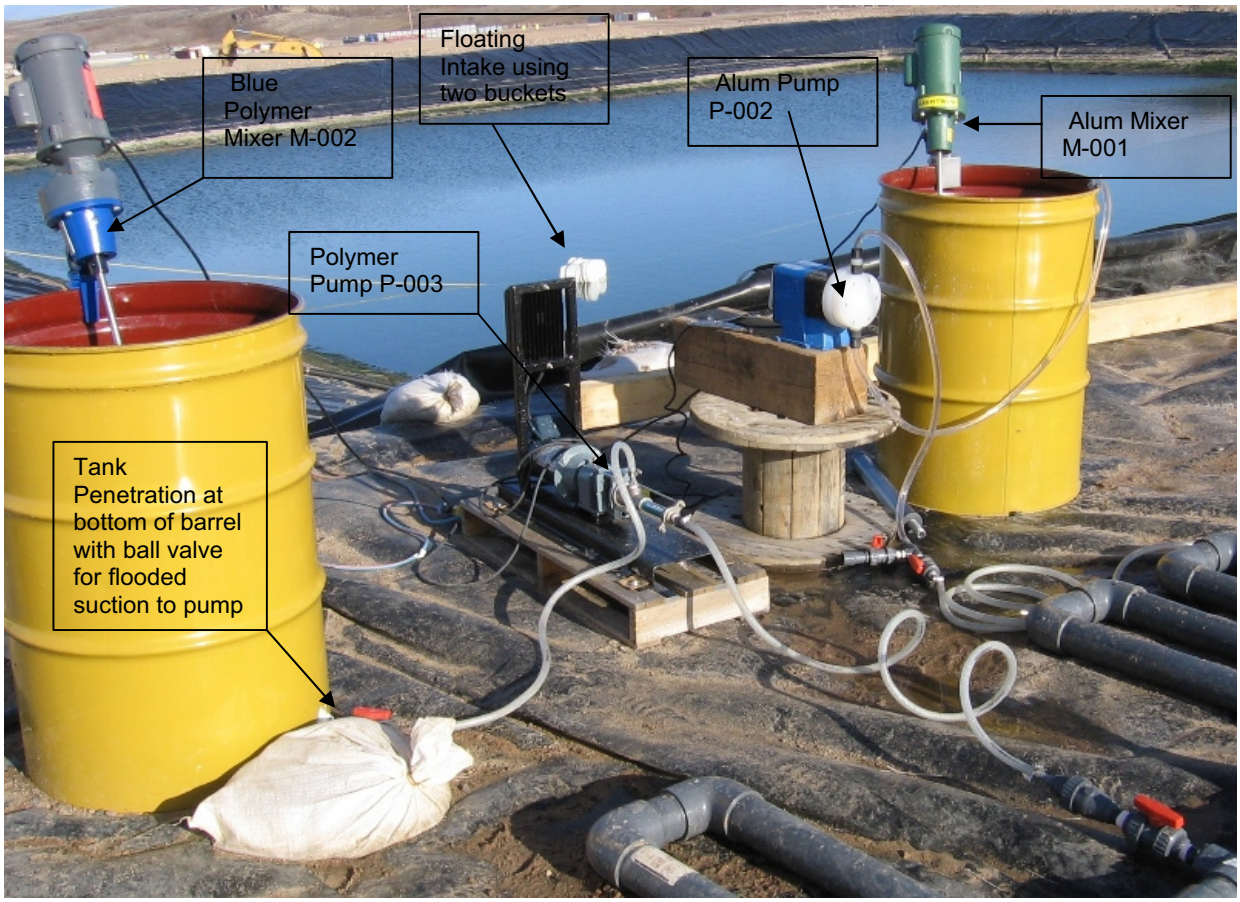


Photo 5 – Alternate View of the Chemical Dosing System

It is recommended that a tank penetration similar to the one shown here feeding the polymer pump be added to the alum system. This should help reduce the frequency of the alum pump losing prime. *Note: In 2011 the steel over-pack barrel used for alum make-down shown in this photo was replaced with a 300 USG HDPE tank with outlet connection located near the bottom to provide flooded suction to the alum dosing pumps. The increase in storage capacity reduced the number/frequency of required batch make-downs and decreased the variation in the concentration of the alum solution injected into the raw feed stream.*

Photo 6 – DAF Combination Tee

This is where the influent combines with air-rich recirculation line and both are conveyed up the 6 inch pipe to the DAF tank. The Gate valve is used to control the pressure coming from the recirculation stream. This should be set so that the pressure gauge at the recirculation pump reads 92psi. Any higher and the pump may be damaged. Any lower, and not enough air will dissolve into the recirculation stream. The pressure gauge on the downstream side of the gate valve should read just above or zero. *Note: In 2011, this piping arrangement was modified so that the influent now enters the recirculation line through the leg of a 6-inch wye.*

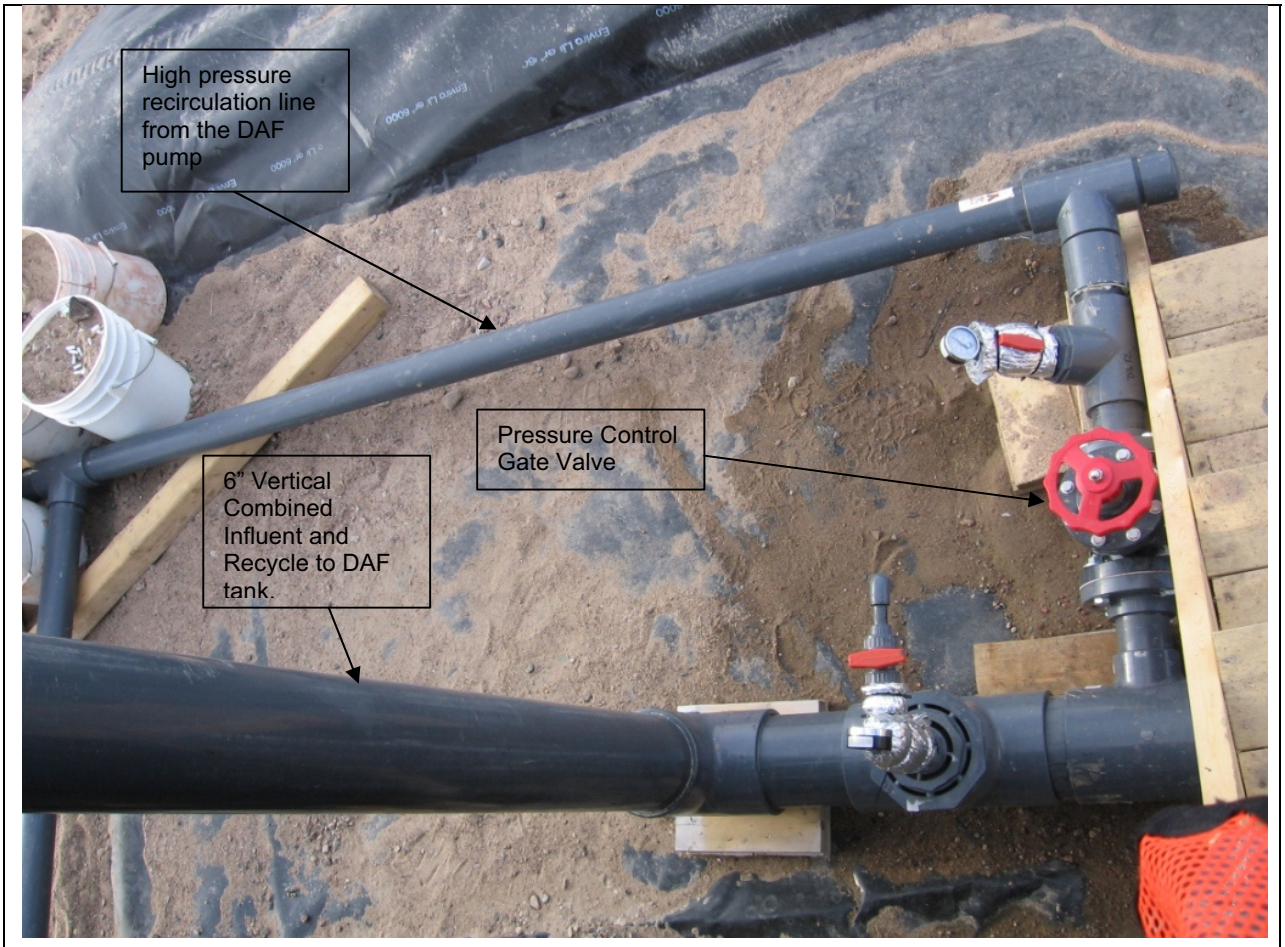


Photo 7 - Combined Influent and Recirculation Feed to DAF

This photo shows the recirculation line coming from the DAF pump. This should all be one large piece. The Pressure Control Gate Valve is critical for setting the backpressure on the DAF pump. It should be inspected before each season to verify it is functioning well and is not eroded from previous use.

Photo 8 – DAF Influent Header

- The DAF Influent header is made of six inch pipe and should be supported on the inside of the DAF with tie wraps or wire to the metal supports that are welded on the inside of the DAF. *Note: In 2011 a new DAF Skimming Tank was fabricated from a new roll-off bin and dedicated to the Mary River site.*

Photo 9 – 2009 DAF Recirculation Piping Configuration.

This configuration caused the pump to pull too much air quite frequently due to the large horizontal section of pipe going from the effluent back through the eductor loop, which caused the pump to lose prime. The configuration in photo 10 was used in 2010 for the Milne OWS system, and eliminated the air problem.

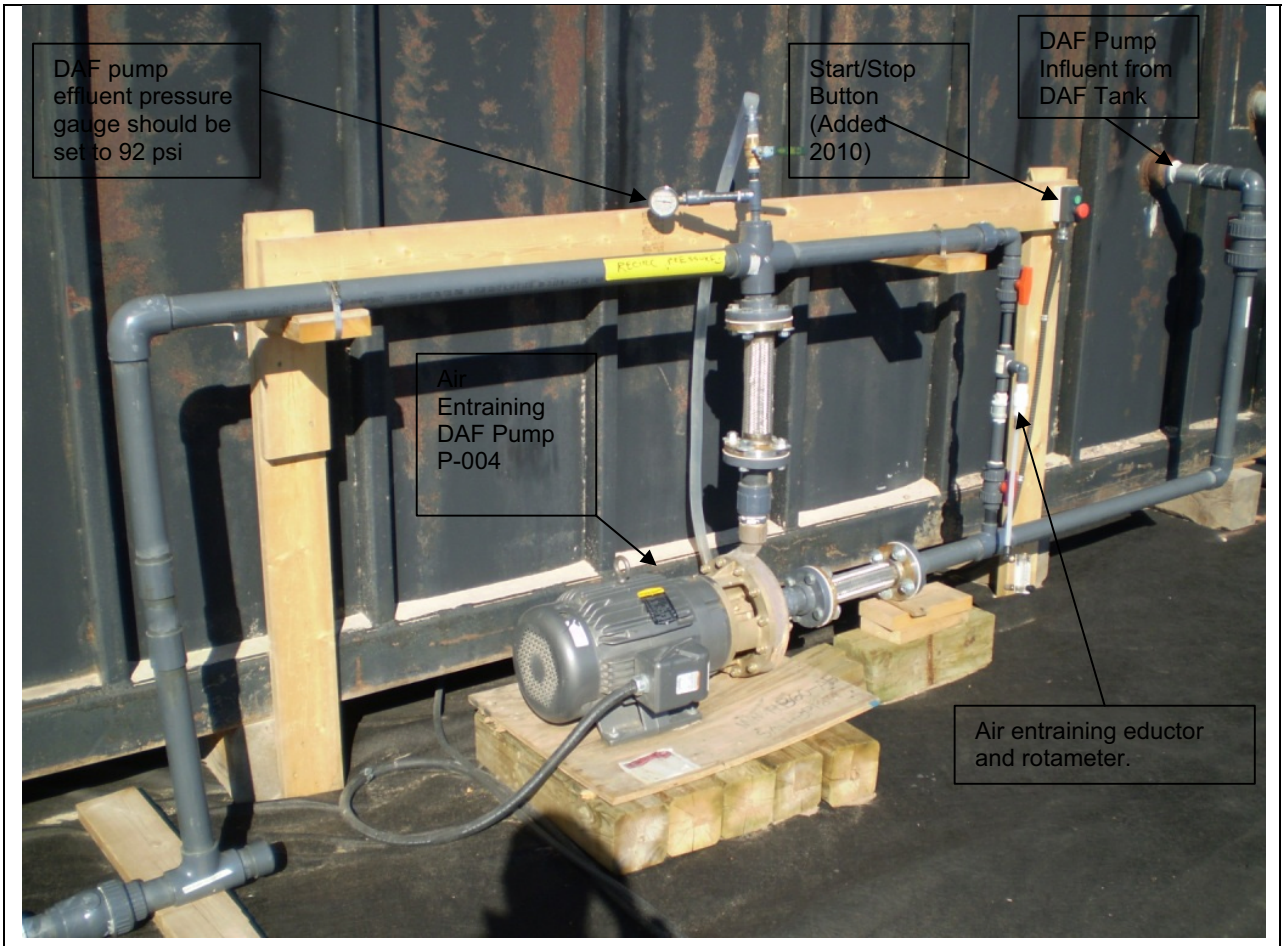


Photo 10 – DAF Recirculation Pump and Piping

This photo shows the recirculation line coming from the DAF to the DAF pump. A portion of the pumped water is recirculated through the eductor loop which draws air from the atmosphere into the system, which is then pressurized by the pump and sent to the DAF influent. The pressure gauge seen here should read 92 psi. A start/stop switch was added to the system in 2010 as well as a better support system. The piping should be supported in a similar way shown here, particularly the eductor loop. The DAF pump will need to be supported with wood and shived so that the piping going to and from it is as level as possible. *The current DAF recirculation pump and inlet/outlet piping at the Mary River site is configured as shown.*

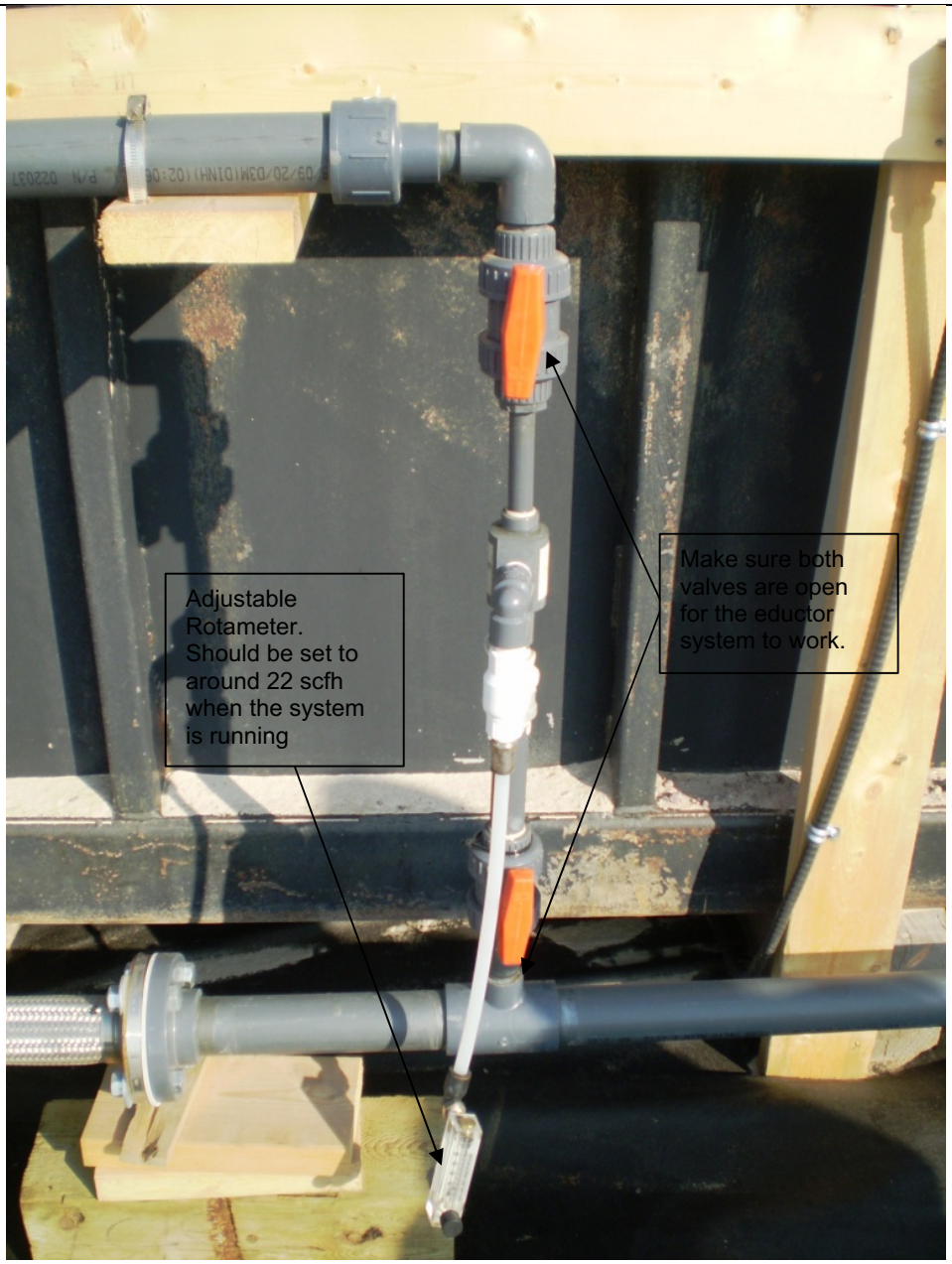


Photo 11 – DAF Eductor Loop

This is the most fragile part of the DAF piping. Careful attention to supporting this unit is needed. A spare eductor loop was purchased in 2010, and not used, so it should still be in the original box from the vendor, and in storage with the other process piping. The rotameter is used to control the amount of air that is pulled by the eductor into the process stream.

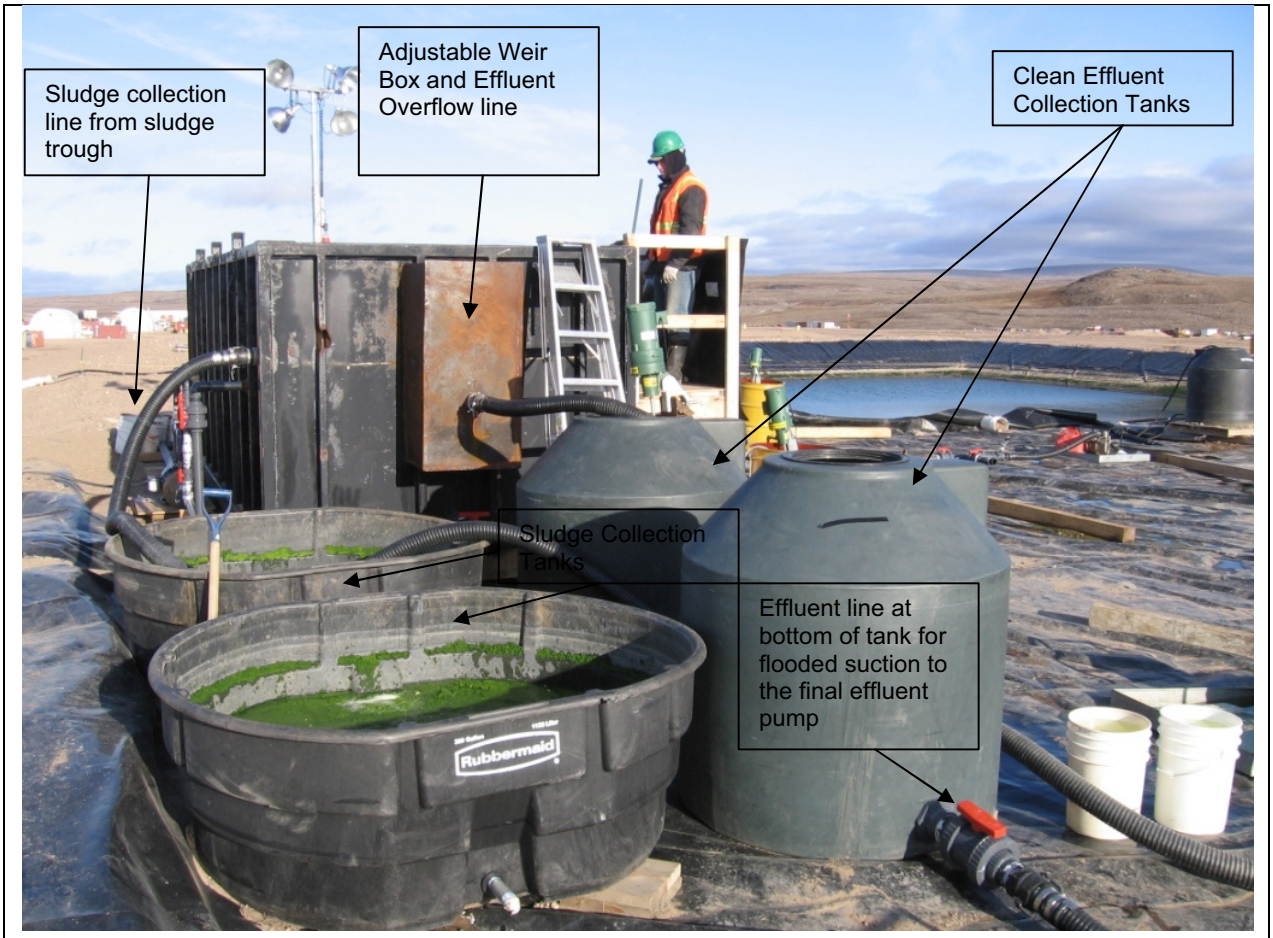


Photo 12 – Sludge Collection and Effluent Tanks

The Rubbermaid tubs here were hydraulically connected to provide extra storage between pumping sludge to Pond 1. The sludge was quite thick, and sometimes needed to be stirred with a shovel to get it to flow. The effluent tanks to the right were also hydraulically connected. The effluent flows by gravity to these tanks. The final effluent pump was tuned so that the level in the final effluent tanks is relatively stable around ¾ of the height of the tanks. This provides flooded suction to the pump and a few minutes of retention time, which will provide a more representative sample for regulatory samples. The adjustable overflow weir is used to set the level in the DAF. The level is also dependant on the flowrate being fed to the system. The design flowrate for 2009 and 2011 was 100 USgpm. Once the system is being fed at this flow rate, the level in the DAF should be set so that the top level of the water is halfway up the beach inside the DAF. Any higher and excess liquid will start to leak into the sludge collection trough. Any lower, and it will be hard to lift solids with the skimmer up the beach into the sludge collection trough.

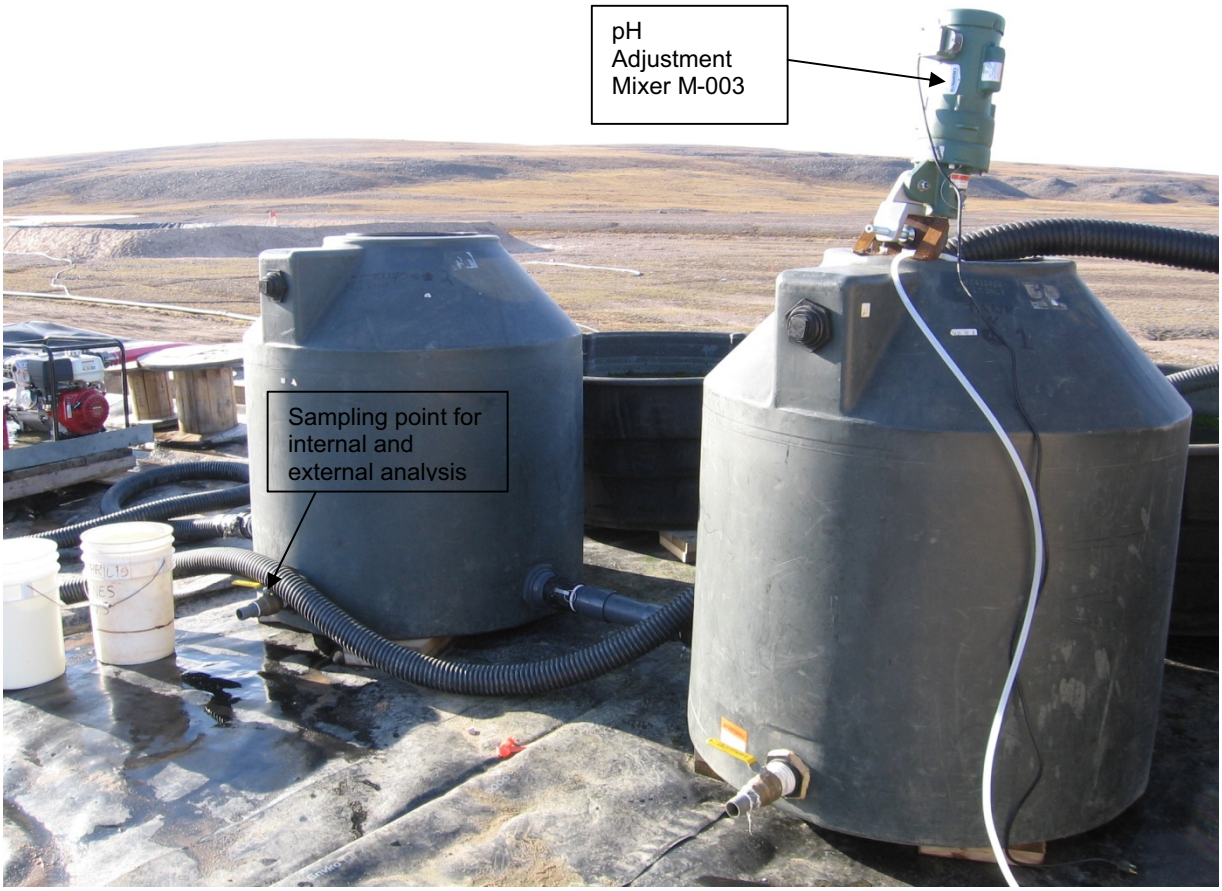


Photo 13 – Final Effluent Clearwells

These tanks collect the clear effluent from the DAF. Water flows by gravity from the DAF to these tanks, and is controlled by the adjustable effluent overflow weir. If sodium bicarbonate is needed for raising pH, it should be added to the tank closest to the DAF by one of the blue chemical dosing pumps (P-005 the smaller of the two), and mixed with one of the green mixers. Effluent compliance samples and pH adjustment verification samples should be taken from the ball valve on the second tank. *Note: In 2011 only two rapid mix mixers could be located. The pH adjustment mixer M-003 was not installed or operated. Sodium bicarbonate was added directly into the treated effluent stream leaving the DAF.*

In 2011, the DAF float/sludge contained in the two low profile sludge collection tanks were intermittently mixed using a 1 HP, 120VAC 1P submersible pump to collapse foam and homogenize the contents prior to periodic transfer to Pond 1 using a 3-inch gas powered pump. The frequency and duration of the mixing operation and the batch transfer was dependent on the quality of the float/sludge and the quantity generated.

Also, two filter housing fitted with cartridge filters were installed between the final effluent pump and the effluent flow meter to remove residual particulate solids. The filters can be operated in parallel or in series. The preferred mode is operating in series using a 10 micron rated cartridge to pre-filter followed by a 1 micron rated final filter.

6.0 SYSTEM OPERATION

Dissolved Air Flotation Treatment Plant Operating Procedures

Process Overview

The Dissolved Air Flotation (DAF) system is designed to remove certain impurities out of the lagoons to improve water quality. The system can be used to remove soluble phosphorous and solids from the water. This will in turn potentially reduce other parameters associated with solids such as Biochemical Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD), Fecal Coliforms, and Total Kjeldahl Nitrogen (TKN). The system cannot remove soluble BOD_5, COD, or ammonia. A series of process steps are described briefly followed by operating details.

Influent Pump and Flow Meter
A pump draws from one of the ponds and feeds water at a design flow of 100 gpm. A flow meter is used to monitor this influent flow. Flow can be controlled by throttling the pump or by opening/closing the 3 inch ball valve that bleeds back into the pond.

Alum Addition
Aluminum sulphate (alum) is added to achieve three goals:

- Precipitation of soluble phosphorous to a solid
- Flocculation of solids
- Reduction of pH

Alum is dosed into the influent line by means of a chemical metering pump and then mixed in the flocculator piping to achieve floc formation.

Polymer Addition
Polymer is added after alum to further enhance the formation of larger solids allowing them to separate more quickly from the bulk liquid once in the DAF tank.

Dissolved Air Flotation System

Water containing alum and polymer is combined with the recycle stream of water containing micro-bubbles which bind to the solids and float them to the surface.

The dissolved air flotation system is comprised of a number of components. The heart of the system is a Hellbender-brand air dissolving pump. This pump is specifically designed to handle large amounts of air, and operates under high pressure to dissolve and shear the air into fine micro bubbles. When the high pressure, air rich, stream meets the lower pressure flocculated influent water, dissolved air is released, and the small bubbles attach to the flocculated solids causing them to rise to the surface once inside the skimming tank.

Water is distributed across the width of the skimming tank through a large 6' distribution header to minimize the entrance velocity and facilitate quiescence of the water in the tank. Solids are periodically skimmed off the top of the tank, over a collection beach into a sludge trough where they are fed by gravity to two large totes for disposal. Clarified water is collected across the entire width of the tank at the opposite end of the tank through a 4 inch effluent header located halfway up the height of the tank. From the effluent header, clarified water travels up and cascades over an adjustable standpipe which allows for adjustment of the tank level by changing the length of the 4 inch pipe at the top of the standpipe. Clarified water then flows to two effluent clear wells that are connected in series where the water can be pH adjusted with sodium bicarbonate if needed. Clarified water is then pumped by a 4-inch gas powered pump through two filter housing fitted with cartridge filters and a final effluent flow meter prior to connecting into the Sheardown Lake discharge line.

The following are detailed procedures required for successful operation of the DAF system.

Preparation

- Ensure all pumps are filled with fuel
- Make sure a full alum barrel has been made up (see procedure below)
- Make sure a full polymer barrel has been made up (see procedure below)

DAF pump start-up

- Ensure that the DAF tank level is full enough so that the inlet to the DAF pump is submerged
- Ensure that the DAF pump is flooded by opening the 2 inch ball valve on the suction side of the DAF pump line, making sure the globe let down valve is at least partially open and verifying water is flowing out of the sample port on the 6 inch influent header (sample port 5) and the ball valve at the 4 way tee located on the effluent side of the DAF pump.
- Open the air eductor loop valves keeping the rotameter off initially.

- As soon as the pump is turned on, adjust the globe valve so that the pressurized side reads approximately 86 psi at the valve and 92 psi at the pump outlet. This is necessary for proper DAF pump function, and will allow sufficient back pressure in the DAF pump to shear and dissolve air into the fine bubbles that aid in solids separation. Read the Hellbender manual for more detail on the DAF pump operation.
- Slowly open the rotameter and begin introducing air into the pump. 20-30 scfh appears to be sufficient to achieve the dissolved air requirements. If a gravel-like sound can be heard in the pump, turn down the air or shut it off. Wait for the sound to disappear, and slowly introduce air again.
- While starting up the influent to the system, make sure someone is watching the backpressure valve. If the pressure drops off quickly, immediately shut the eductor loops. If this does not bring the pressure up, the pump has lost prime, and needs to be immediately shut down, flooded, and started again.
- During the 2010 season, the re-plumbing of the DAF significantly reduced operating issues with the DAF pump.
- The pump will cavitate if there is insufficient back-pressure on the pump.

Influent Start-up

- Prime the pump by using flow from the DAF pump, opening the influent line to the influent pump, and removing the plug at the top of the pump. Close the valve to isolate the pump. Start the pump, and watch for the water to move up the suction line. Repeat the priming process if needed.
- Once water is flowing into the system, measure the flow rate on the flowmeter and ensure that the flow is 100 gpm.
- Open the alum line and turn on the alum pump
- Open the polymer line and turn on the polymer pump
- Take a sample from the alum sample port, and measure the pH, and observe the water for formation of floc.
- For Pond 3 the target pH was around 7.15 in 2009 (Use treatability test results to determine this target for the given year)
- Adjust the alum dosing pump as needed to achieve this pH.
- Take a sample from the polymer sample port, and observe for coagulation of floc. Compare the alum sample and the polymer sample and verify that the polymer is increasing the floc size and decreasing the formation time.
- Initially take frequent pH readings to ensure consistent alum dose.

Alum Make Down

- New alum solution will likely have to be made up every 4-8 hours. Check the alum level in the tank every hour.
- When the level drops to 75% full, fill the barrel with water and add one bag of alum (22.7 kg)
- Mix the alum right away to prevent formation of an alum paste that is harder to dissolve. Continue to mix for 20 minutes to ensure all dry powder has been dissolved.
- Run mixer for 5 minutes every hour to minimize stratification.
- The 75% capacity level should be marked on the tank, and the new alum and water should be added at this same point every time as best as possible to ensure a consistent alum solution is being dosed. Always check that the influent pH has not changed after making up a new alum solution. Adjust the alum dose to maintain the same pH if the concentration of the dosed solution has shifted the pH one way or the other.

Polymer Make Down

- The target polymer dose in 2009 was 1 ppm for Pond 3. The polymer dosing pump appears to have an upper limit of about 10 L/hr. Therefore, at 100 gpm, a polymer concentration of 2500 mg/L is needed to achieve this dose. This is equivalent to 750 g of dry polymer per 300 L barrel
- Polymer works best when it has aged for a few hours at least. To achieve this, and remain operating, add 50g of polymer per 20L bucket of water added. Try not to let the barrel empty too much. Ideally only 40 L should be added at a time, which will be needed about every 4 hours.
- Polymer needs to be added slowly so it doesn't form into large clumps that are difficult to dissolve. When adding the polymer, make sure the mixer is running, and sprinkle the dry polymer over the surface of the barrel. Watch that clumps are not forming. If clumps form, slow down the addition even further. Keep the polymer agitated, but shut the mixer off periodically so that the motor does not overheat.

Sludge Skimming and Removal

The sludge that comes to the surface in the DAF tank has to be skimmed off frequently. Once the mat has progressed to about ¾ of the length of the tank, it is time to skim. Use a large piece of styrofoam to pull the sludge up the beach and into the sludge trough. Watch the levels of sludge in the totes and pump them out when full. This will likely be no more than once per hour if good skimming techniques are employed and the water level is not too high in the tank.

Refueling

- When refueling a pump, make sure it is turned off. If the influent pumps is being refueled, turn off the alum and polymer dosing pumps, and close the injection point valves
- The DAF pump should still be left on and can just re-circulate in the tank.
- When refueling the effluent pumps, disconnect the effluent hose from the clear well, and send the effluent to the pond while refueling

Shut down

- If shutting down for any reason, the following sequence should occur:
- Shut down the final effluent pumps, and disconnect the pumps, allowing the tank to empty back to the pond
- Turn off the alum pump and close the injection valve
- Turn off the polymer pump and close the injection valve
- Turn off the influent pump
- Shut down the DAF pump as per the Hellbender pump manual
- Open the air break point at the top of the influent header to prevent siphoning of the DAF tank.
- If freezing is a risk, disconnect and drain all lines.
- Close the DAF pump recirculation valve

Sampling and Monitoring

- Frequent sampling and monitoring of the system is needed to document consistent operation of the system.
- Upon start-up, pH measurements should be taken at the influent every 5 minutes for half an hour and adjustments to the alum dose made accordingly.
- Once a steady influent pH and has been achieved, and good flocculation of particles is observed, this can be measured less frequently.
- The volume of the DAF tank is approximately 5300 gallons when running. At 100 gpm the hydraulic retention time is 53 mins. Therefore it will take two hours and 40 minutes to achieve steady state (ie. Influent = Effluent). Effluent samples should be taken from the second clearwell tank at the bottom sample port. When taking samples, open the valve and let the water run for 10 seconds before taking a sample. See the attached sampling schedule for the frequency and type of samples that are needed. If any significant

process changes are made (ie. Start-up/shutdown, changing the air dose, polymer dose, or alum dose) ensure that 3 hours passes before taking any compliance samples. Small adjustments don't require this.

7.0 SYSTEM SAMPLING AND EFFLUENT MONITORING REQUIREMENTS

NOTE: IT IS IMPORTANT THAT THERE ALWAYS BE AT LEAST ONE EXPERIENCED OPERATOR PHYSICALLY AT THE SYSTEM AT ALL TIMES, AND OTHER THAN SHORT PERIODS OF TIME (NO MORE THAN 45 MINUTES), TWO OPERATORS ARE NEEDED FOR THE SAFE AND PROPER OPERATION, MONITORING, AND SAMPLING OF THE SYSTEM.

A crucial component to the successful operation of the system and discharge of effluent that meets all compliance standards is careful monitoring of both the physical process itself as well as sampling water at all stages of treatment. This section summarizes the major process variables that had to be monitored as well as the water samples that were taken to ensure optimal operation of the entire treatment system.

7.1 Water Sampling

Table 7.1 is the original effluent monitoring schedule used in 2009. There is some room for discussion on the frequency of sampling particularly for external lab analysis depending on how long the discharge period is going to be. If, for example, another 3000 m3 is processed during the next processing period, it is still recommended to send lab samples every day as the entire treatment period may only take 10 days from when forward flow to Sheardown Lake begins.

Table 7.2 is the on-site analysis and monitoring frequency. Additionally, it is important to keep a summary sheet of the data from each shift so that trends in the data can be tracked on a regular basis. Table 7.3 is the off-site analysis and monitoring frequency.

In 2009 there were not capabilities to analyze TSS onsite, and turbidity was used to estimate TSS. It was proposed that a correlation between TSS and turbidity be developed using pond water and a series of dilutions submitted to Exova so that a field reading of turbidity can be used to estimate an Exova result. In 2009, 5 NTUs was approximately 20 mg/L TSS and was used as a cut-off point for discharge. In 2011 it was observed that this correlation was not reliable. It is thought that turbidity as measured in NTU's is dependent on the type and composition of the solids in the collected sample and can change over time. A rigorous correlation over a series of dilutions using the current pond water fluid is recommended. This can be used in conjunction with in-house TSS testing now that the necessary basic equipment is available on site.

Table 7.1: Effluent Monitoring Requirements (2009)

Sampling/Analytical Schedule for PWSPs No. 2 and 3 Treatment and Discharge

In House Analysis	Pre Discharge	Middle of Discharge	End of Discharge	Daily	Hourly
pH	✓	✓	✓	✓	✓
Temperature	✓	✓	✓	✓	✓
Turbidity	✓	✓	✓	✓	✓
TP	✓	✓	✓	✓	
Ammonia	✓	✓	✓	✓	
COD	✓	✓	✓	✓	
External Lab Analysis					
BOD	✓			✓	
COD	✓			✓	
TSS	✓			✓	
TP	✓			✓	
Fecal Coliforms	✓			✓	
Toxicity		✓	✓		
O&G	✓			✓	
Notes:					

1. Samples to be collected from clear tank at end of process.
2. Pre-discharge external lab results must meet Water Licence requirements for pH, TSS, TP, Faecal Coliforms, and Oil & Grease prior to commencement of discharge from each PWSP. BOD will be estimated by dividing COD results by a factor of 3.
3. Authorization must be received in writing from Jim Millard, Cheryl Wray, or Matthew Pickard prior to commencement of discharge.
4. pH and turbidity field meters must be calibrated daily. This needs to be documented.
5. One field duplicate, field blank, and travel blank to be collected during discharge for each pond as part of the external lab analytical program. Deionized lab water to be used for blanks.
6. See SD personnel for instructions on number/types of bottles and on correct sampling protocols.

Table 7.2: On-site lab analysis parameters and schedule

In House Analysis	Daily (onsite lab)	Hourly (in field)
pH	✓	✓
Temperature	✓	✓
Turbidity	✓	✓
TP	✓	
Ammonia	✓	
COD	✓	

Table 7.3: External lab analysis parameters and schedule

External Lab Analysis	Pre Discharge	Middle of Discharge	Every Week
BOD	✓		✓
COD	✓		✓
TSS	✓		✓
TP	✓		✓
Fecal Coliforms	✓		✓
Toxicity	✓	✓	
O&G	✓		✓

7.2 Sample Collection

Proper sampling procedures should be followed both for internal and external sample collection. For internal samples, used clean or cleaned containers. Hourly field samples can be taken with the same sample container provided it is rinsed before and after each sample is taken with treated effluent. Clean sample containers and proper sampling procedures should be followed for all compliance samples.

7.3 Process Monitoring

In addition to the water samples taken, it is important to monitor the process itself by making frequent qualitative observations, and recording quantitative information as well. There are two operating modes, one with filtration but no chemical treatment during the spring discharge period, and the other using the DAF and the addition of chemical reagents during the summer discharge. Daily Field Log Sheets that list process parameters that need to be monitored and recorded from an operational standpoint are included in Appendix F.

From a table like this, graphs can be generated to see how influent, process, and effluent quality is moving, which can be helpful for troubleshooting efforts. For example, if turbidity has been slowly increasing over a period of days one could look at the influent turbidity and COD to see if this has been increasing as well. Adjustments to the chemical doses could be made accordingly, or it may be determined that sludge has been building up in the DAF and is now carrying over into the effluent. Filling in a master spreadsheet at the end of every shift will be very useful for deciding where problems may be coming from and deciding the appropriate course of action.

8.0 TROUBLESHOOTING

This section is a compilation of lessons learned from the 2009 and 2011 treatment season and is intended to assist operators who have not operated this particular system to become more familiar with some of the potential challenges that can be faced, and to expedite the learning process. Consult the operating manuals in Appendix C for more detailed troubleshooting details

associated with a particular piece of equipment. Contacting the original vendor can be helpful as well if the manual does not cover the issue that is being experienced.

The Influent Pump is not Pumping

Check to make sure the pump still has fuel, and whether the line has lost its prime. Check to ensure that the intake is completely submerged and that the inlet is not drawing too much air from a vortex. When first priming the pump, it may be helpful to have a tank with a hose to fill the line while the pump is initially trying to draw fluid up from the pond. This was needed particularly when a pond was very low as the suction head required to lift the water to the pump was quite high. It may also be helpful to add a 3" ball valve partway down the slope of the pond, fill the line from the pump to the valve, start the pump, and open the valve at the same time. If the DAF is running, it is helpful to use the recirculation Tee to isolate the DAF from the influent pump, and using the recirculation valve to aid in priming the pump. It is also helpful as an indicator as to whether the pump has started to draw water from the pond. Be sure to isolate the influent from the DAF before using the recirculation Tee for this purpose as you may actually be siphoning water from the DAF if it is not isolated.

Water Isn't Flocculating

- Make sure alum is being dosed – The ball check in the alum pump frequently got stuck and prevented alum from being dosed to the system. This was one of the most frequent causes of poor flocculation.
- An easy way to tell if alum is not being added is poor flocculation or a pH that is similar to the pH of the pond.
- Make sure polymer is actually being dosed--make sure that the ball valve is open, and that there are no clogs in the tubing.
- If it is determined that the alum or polymer should be adjusted, make small changes and see whether there is an improvement. More is not always better, and you can sometimes overdose alum, polymer, or both. It may take a few hours to tune the alum to the optimal level, so some patience is necessary.

Loss of Prime/Pressure in the DAF Recirculation Pump

- This was a frequent operational problem in 2009. The re-configuration of the piping in the 2010 OWS version of the DAF appears to have eliminated this problem. This modified piping arrangement was incorporated into the 2011 design and no mechanical or operations concerns were reported during the treatment period. If this problem does occur check the following:
- The gate valve at the combination Tee is sufficiently closed to create a backpressure on the pump. If this is not the case, the pump will draw excessive flow and air causing

cavitation, and vibration. It is essential to keep this gate valve set so that the effluent pressure from the DAF pump is 92 psi. Eventually, this valve will need to be replaced as the high friction losses that occur in it will eventually wear the valve out. This valve has now been used for about 60 – 70 days. During assembly, a visual inspection of the valve is recommended, and if the gate is significantly eroded, it should be replaced. A new spare valve is currently in storage at site.

- Make sure that the rotameter on the eductor loop is only drawing around 22 scfh, and reduce flow to this level if it is higher. Ensure that the air eductor loop is properly connected and isn't drawing air from somewhere other than the rotameter.
- Make sure there are no leaks in the recirculation piping.
- Make sure the level of the DAF is well above the intake for the DAF pump and that a vortex at the DAF surface is not entraining excess air into the DAF pump.

No Fine Air in the DAF tank

Make sure the DAF pump is on, and that the recirculation line to the pump is open, and that the pressure at the pump is 92 psi. Check if the rotameter is open, and make sure it has not become clogged or obstructed and is reading 22 scfh, and that both the eductor loop gate valves are open.

Large bubbles in the DAF tank

This means that more air is getting into the piping. Close the air relief valve on the top of the 6 inch influent piping going into the DAF. This will eliminate a lot of excess air. Only open this valve when the system is being shut down as an air break to prevent back siphoning of the DAF into the influent piping. A small amount of large air bubbles will not disrupt the process enough to be of any concern. However, the majority of the DAF should be fairly still and cloudy looking due to the presence of the very fine bubbles in the water.

Excess Air in the DAF

To check if excess air is being drawn into the system, completely close the rotameter with the process running and observe the DAF tank. Are there large bubbles/small bubbles, or both? If there are large bubbles, air is likely leaking downstream of the of DAF pump. If there is still white water in the DAF, it means there is a leak in the eductor unit itself, or upstream of the pump influent. This is not necessarily a bad thing, but you may need to adjust the rotameter below the 22 scfh target to compensate for the excess air.

Flow meter has stopped reading flow or totalizing

In 2009, both flow meters ended up failing mechanically due to materials getting trapped in them. If new piping is added to the system, flush the system thoroughly before adding the flow meters to remove any shavings and materials that may be in the piping. It is recommended that a coarse duplex strainer be used on the influent to prevent any large solids from entering the

process piping and potentially damaging the flow meters. This concern was addressed by modifications in 2011. The turbine type flow influent flow meter was upgraded to a magnetic flow meter and particulate filters were added upstream of the final effluent flow meter.

Floc looks good coming from the polymer sample port, but is smaller in the DAF tank

This was a common observation during the 2009 treatment season and is believed to be caused by the flocculated particles being partially sheared apart in the 6 inch combination tee where the high pressure/high velocity reciculation line combines with the influent from the ponds. This could potentially be mitigated by the use of a pressure break tank, and may be necessary if the effluent performance is affected significantly enough. This is likely the reason why a higher polymer dosage was needed than the original jar tests indicated.

pH meter appears to be measuring inconsistently

Rinse the pH meter with clean water. Use a kimwipe to clean the glass surface. It may have some polymer stuck to it which could be interfering with the measurement. Never use your fingers or a cloth to clean the surface. Stick the meter in the buffer solutions to see what it reads. Recalibrate if necessary.

Increasing turbidity readings

- In 2009 turbidity readings did fluctuate, but not drastically, and were a quick way of determining if the effluent was in compliance. Based on the treatability testing results, a turbidity of 5.0 NTU was determined to be approximately 20 ppm of TSS. Typically, effluent turbidity was around 1-2NTU, but occasionally it would start to creep up. During the 2011 operating season it was observed that turbidity was not a reliable indicator of actual TSS concentrations in raw pond water or treated effluent. The correlation between turbidity as measured in NTU's and TSS as measured in mg/L was very dependent on the type and composition of the solids in the sample. The site now has the basic equipment to perform field tests for total suspended solids. Confidence in the accuracy of field results will increase after comparison with independent 3rd party test results of split samples. If effluent turbidity or field TSS results begin to increase the following things can be checked:
- Check the influent floc and make sure it is forming well.
- Look at the DAF tank itself. Can you see floc and the cloudy water that indicates the presence of the tiny air bubbles?
- Has any maintenance been done on the inside of the DAF tank? Is there a place where particles have built up, and now may be escaping into the effluent? This was the case with the cavity under the wooden beach. One of the recommended changes to the system is to seal this area up to prevent significant accumulation of solids in this area.

- Often, the problem that caused the turbidity increase will have already been caught by routine checks of the influent. Remember that at 100 gpm, hydraulic retention time of the system is about one hour, and it takes three hydraulic retention times for steady state to be achieved. Therefore, if a problem occurred 2 hours ago, the effluent concentration will still be affected by that previous issue for up to 3 hours from when the problem was found and solved. This raises an important point. If a significant process problem happens; for instance, the alum pump stopped delivering alum to the system, depending on how long this condition has occurred will determine whether the effluent should be diverted back to the ponds, or whether discharge can continue. Obviously, there is a level of judgement associated with making this decision, and caution should be chosen over schedule or other performance indicators. However, it is important to note that due to the large retention time of the system, there is a little bit of breathing room for troubleshooting. This is why it is crucial to constantly monitor the influent, flocculating system, DAF tank, and effluent. If a problem is observed in the effluent, it is already too late.

9.0 RECOMMENDED IMPROVEMENTS

The following are some recommended improvements that could be made to improve the effluent quality, and increase the efficiency of the process. They have been classified into two categories:

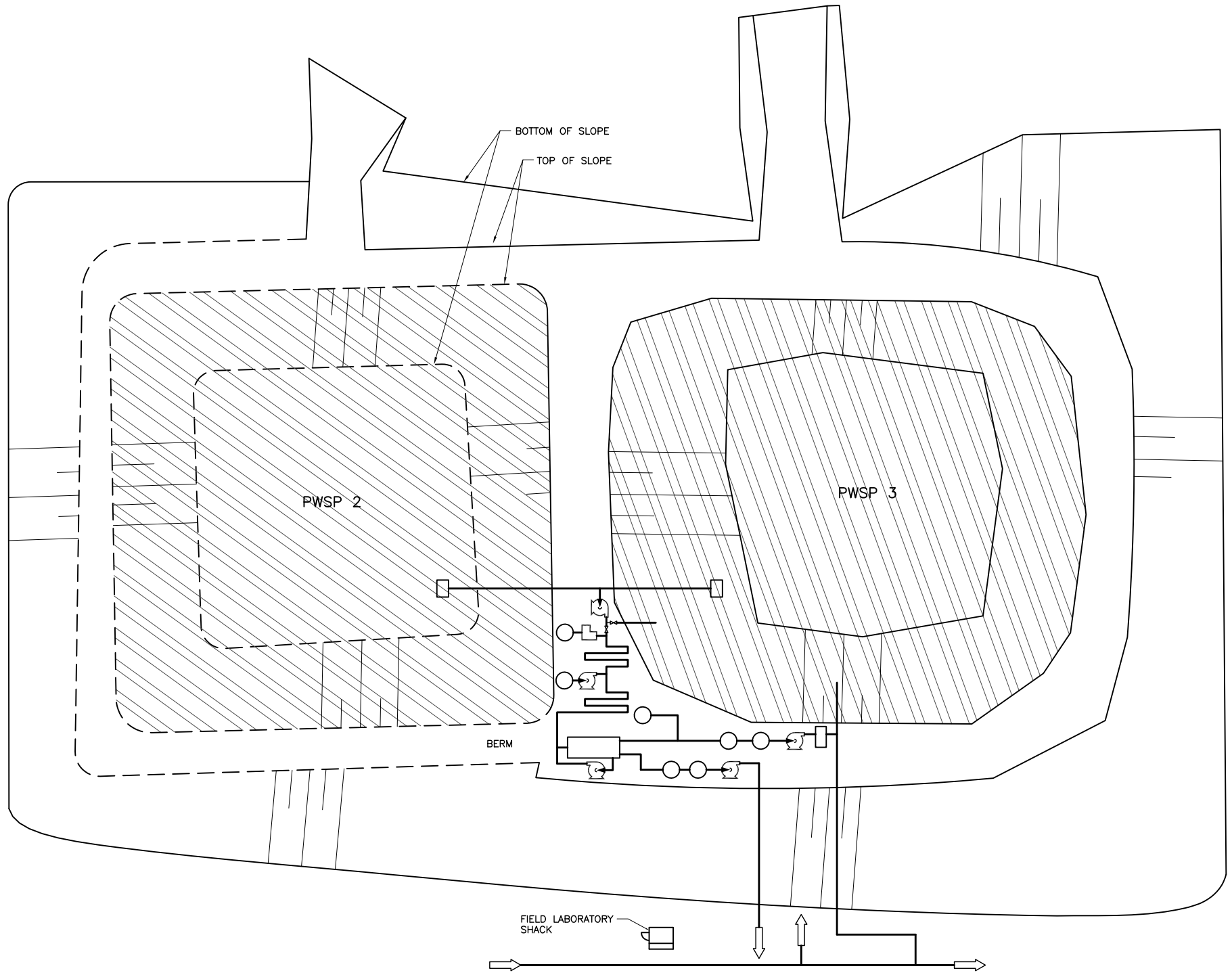
- SR- Strongly recommended, or
- R- Recommended, but not necessary.

9.1 Consideration of alternate ph adjustment chemicals - R

During the 2011 operating season, it was noted that amount of alum required to lower the pH of the raw feed was much higher than reported in 2009 even though the influent water pH was much higher. Not all of the alum added is required for precipitation and flocculation and aluminium hydroxide is being formed. This aluminium hydroxide is not being removed in the DAF and as a result is contributing to the TSS levels in the final effluent. The use of an alternate reagent to lower pH would allow the alum dosing to be reduced. It is acknowledged that there are a variety of non-trivial issues associated with the use of typical pH adjustment reagents, such as concentrated sulphuric acid. These would include health and safety requirements involving the transport, storage, containment and handling of a hazardous material, and possible environmental/regulatory concerns. However, it is expected that the volume of reagent required to treat the feed stream will be relatively small.

It was also noted during the 2011 operating season that the addition of sodium bicarbonate to raise the pH of the treated effluent to meet the required discharge levels was flow limited and was having a significant effect on the sodium levels in the discharge stream. The use of a more traditional reagent, such as sodium hydroxide, would address both issues.

APPENDIX A
DRAWINGS



WASTE STABILIZATION POND 2 & 3 PLAN VIEW

1 : 300

SCALE BAR
0 5m 10m 15m

CAUTION: THIS PLAN MAY BE REDUCED 0 25mm 50mm ORIGINAL SCALE

NO.	REVISION	DATE	APRVD
0	O&M REVISIONS	08/10	

DRAWN JR AUG 2010
DESIGNED JW AUG 2010
CHECKED
REVIEWED

Baffinland Iron Mines Corporation

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CIVIL
BAFFINLAND IRON MINES
POND LAYOUT

DATE: MARCH 2012
SCALE: 1 : 300
SHEET: 1 OF 1 SHEETS
PROJ No: TR1662
C-01

Filepath: T:\Pete\Geomatics\2012\122684-I Baffinland (TR)\TR1662-C01-02.dwg
Plot Time: Mar 23, 2012 - 11:40am, Plotted By: Dell Survey2

PWSP 2

PWSP 3

FLOATING INTAKE

FLOATING INTAKE

FEED PUMP

RETURN TO POND

ALUM FLOCCULATOR

POLYMER FLOCCULATOR

BIOCARBONATE ADDITION DRUM

FINAL EFFLUENT CLEARWELL 2x300 GALLON TANKS

RECYCLE TO POND

BERM

FILTER (2)

DISSOLVED AIR FLOATATION TANK

SLUDGE COLLECTION TOTES, 2x250 GALLON RUBBERMAID TOTES

TRASH PUMP

FIELD LABORATORY SHACK

TO PWSP 1

TO PWSP 2/3

INSULATED/TRACED LINE FROM RBC

INSULATED/TRACED LINE TO SHEARDOWN LAKE

WASTE STABILIZATION POND 2 & 3 PLAN VIEW

1 : 150

F4-238 of 486

CAUTION: THIS PLAN MAY BE REDUCED 0 25mm 50mm ORIGINAL SCALE

SCALE BAR 0 2.5m 5.0m 7.5m

NO.	REVISION	DATE	APRVD
0	O&M REVISIONS	08/10	

DRAWN JR AUG 2010
DESIGNED JW AUG 2010
CHECKED
REVIEWED

Baffinland Iron Mines Corporation

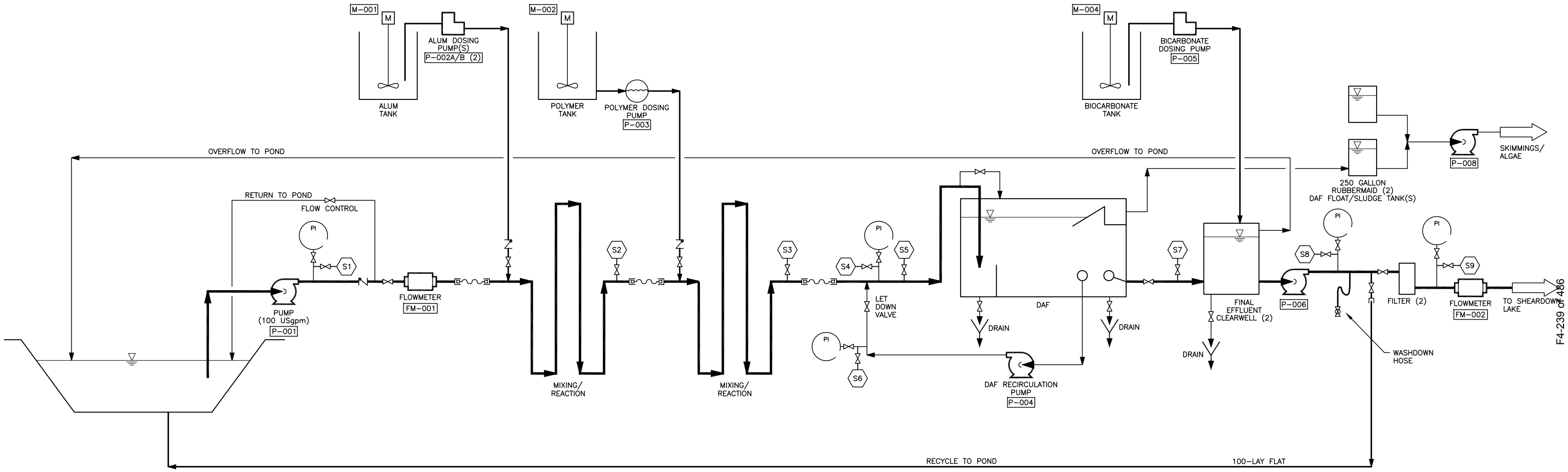
AMEC ENVIRONMENTAL AND INFRASTRUCTURE
900 MAPLE GROVE ROAD
UNIT 10
CAMBRIDGE, ONT, Canada N3H 4R7
Fax: (519) 653-6554
Phone: (519) 650-7100

CIVIL

BAFFINLAND IRON MINES
NEW EQUIPMENT LAYOUT

DATE: MARCH 2012
SCALE: 1 : 150
SHEET: 1 OF 1 SHEETS
PROJ No: TR1662
C-02

Filepath: T:\Pete\Geomatics\2012\12684-1 Baffinland (TR\TR1662-C01-02.dwg
Plot Time: Mar 23, 2012 - 11:41am, Plotted By: Dell Survey2



F4-239 OF 486

CAUTION: THIS PLAN MAY BE REDUCED 0 25mm 50mm ORIGINAL SCALE

NO.	REVISION	DATE	APRVD
0	O&M REVISIONS	08/10	

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DESIGNED JW AUG 2010
CHECKED
REVIEWED

Baffinland Iron Mines Corporation

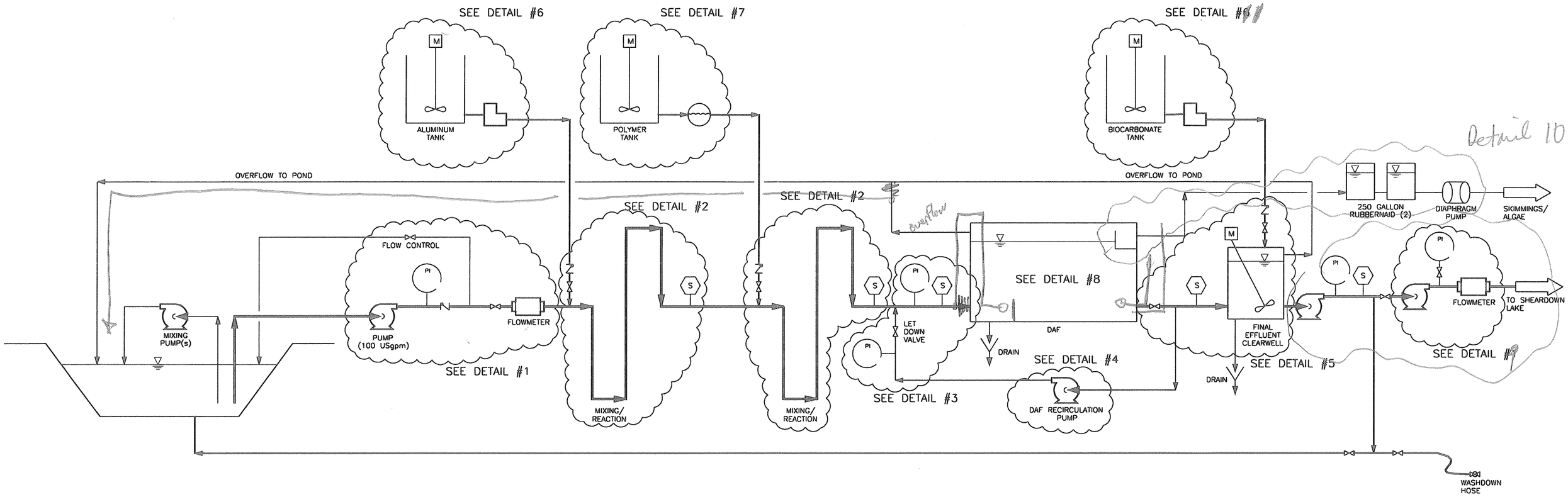
AMEC ENVIRONMENTAL AND INFRASTRUCTURE
900 MAPLE GROVE ROAD
UNIT 10
CAMBRIDGE, ONT, Canada N3H 4R7
Fax: (519) 653-6554
Phone: (519) 650-7100

PROCESS FLOW AND INSTRUMENTATION DIAGRAM
BAFFINLAND IRON MINES
POND WASTEWATER TREATMENT
DISSOLVED AIR FLOATATION SYSTEM

DATE: MARCH 2012
SCALE: N.T.S.
SHEET: 1 OF 1 SHEETS
PROJ No: TR1662
P&ID-01

Filepath: T:\Pete\Geomatrix\2012\122684-1 Baffinland (TR\TR1662-P&ID01.dwg
Plot Time: Mar 23, 2012 - 11:43am, Plotted By: Dell Survey2

APPENDIX B
ORIGINAL SYSTEM DETAILS



CAUTION: THIS PLAN MAY BE REDUCED 0 25mm 50mm ORIGINAL SCALE

NO.	REVISION	DATE	APRVD

DRAWN JR JULY 2009
DESIGNED JW JULY 2009
CHECKED
REVIEWED

AMEC Geomatrix
AMEC Geomatrix Limited
420 Weber Street, North, Unit G
Waterloo, Ontario N2L 4E7
(519) 886-7500

F4-241 of 486

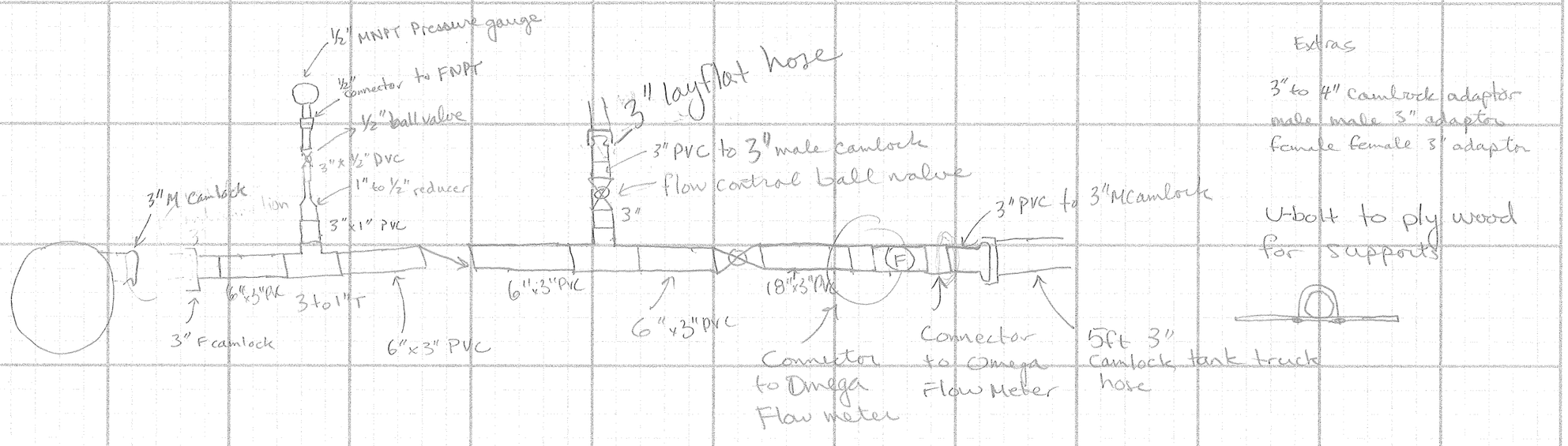
PROCESS FLOW DIAGRAM

BAFFINLAND IRON MINES
POND WASTEWATER TREATMENT

DATE: JULY 2009
SCALE: N.T.S.
SHEET: 1 OF 1 SHEETS
PROJ No: W01446
PFD-01

Jul 27, 2009 - 11:02am, Plotted By: Dell Survey2
Plot Time:

Detail #1


½" MNPT Pressure gauge
½" connector to FNPT
½" ball valve
3" x ½" PVC
1" to ½" reducer
3" x 1" PVC
3" M camlock
3" F camlock
6" x 3" PVC
3 to 1" T
6" x 3" PVC
3" layflat hose
3" PVC to 3" male camlock
Flow control ball valve
3"
6" x 3" PVC
6" x 3" PVC
Connector to Omega Flow meter
3" PVC to 3" M camlock
Connector to Omega Flow Meter
5ft 3" camlock tank truck hose
Extras
3" to 4" camlock adaptor
male male 3" adaptor
female female 3" adaptor
U-bolt to ply wood for supports

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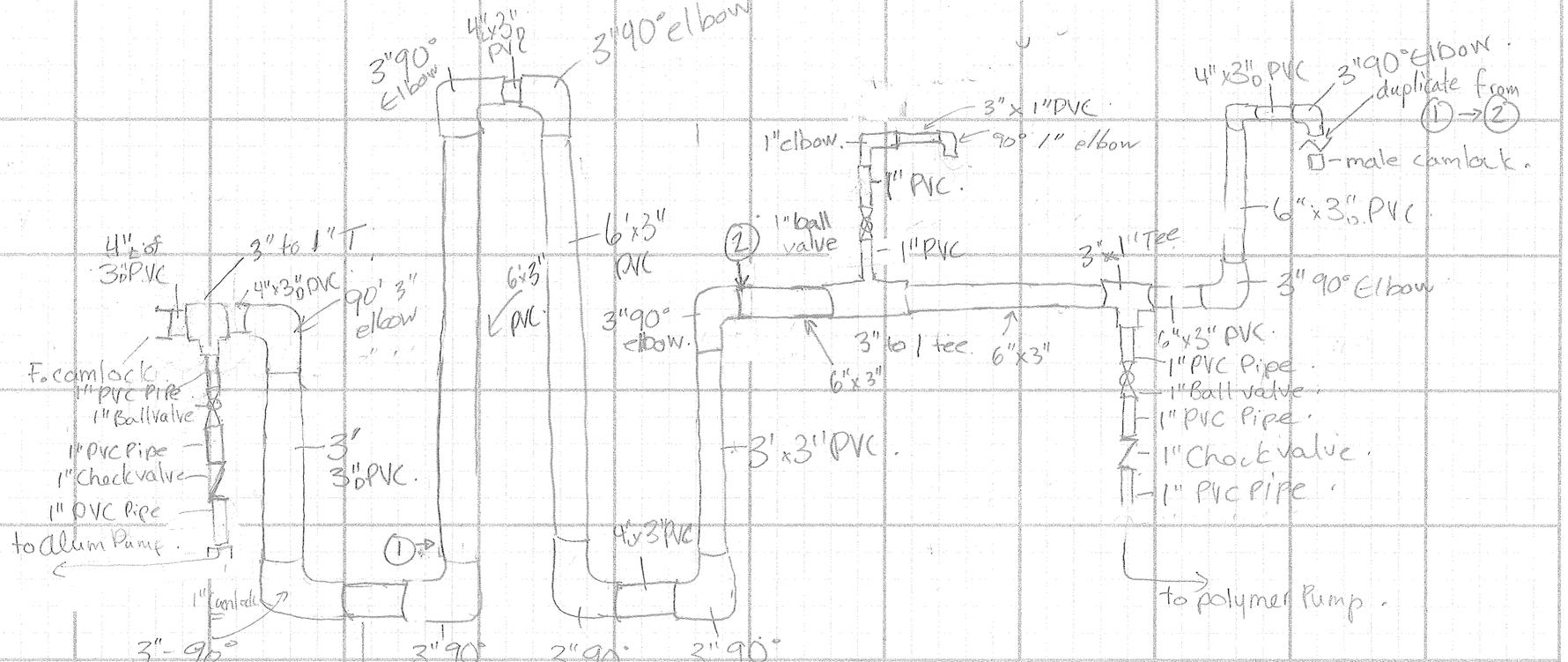
Engineers, Geologists and Environmental Scientists

SUBJECT .....
.....
.....

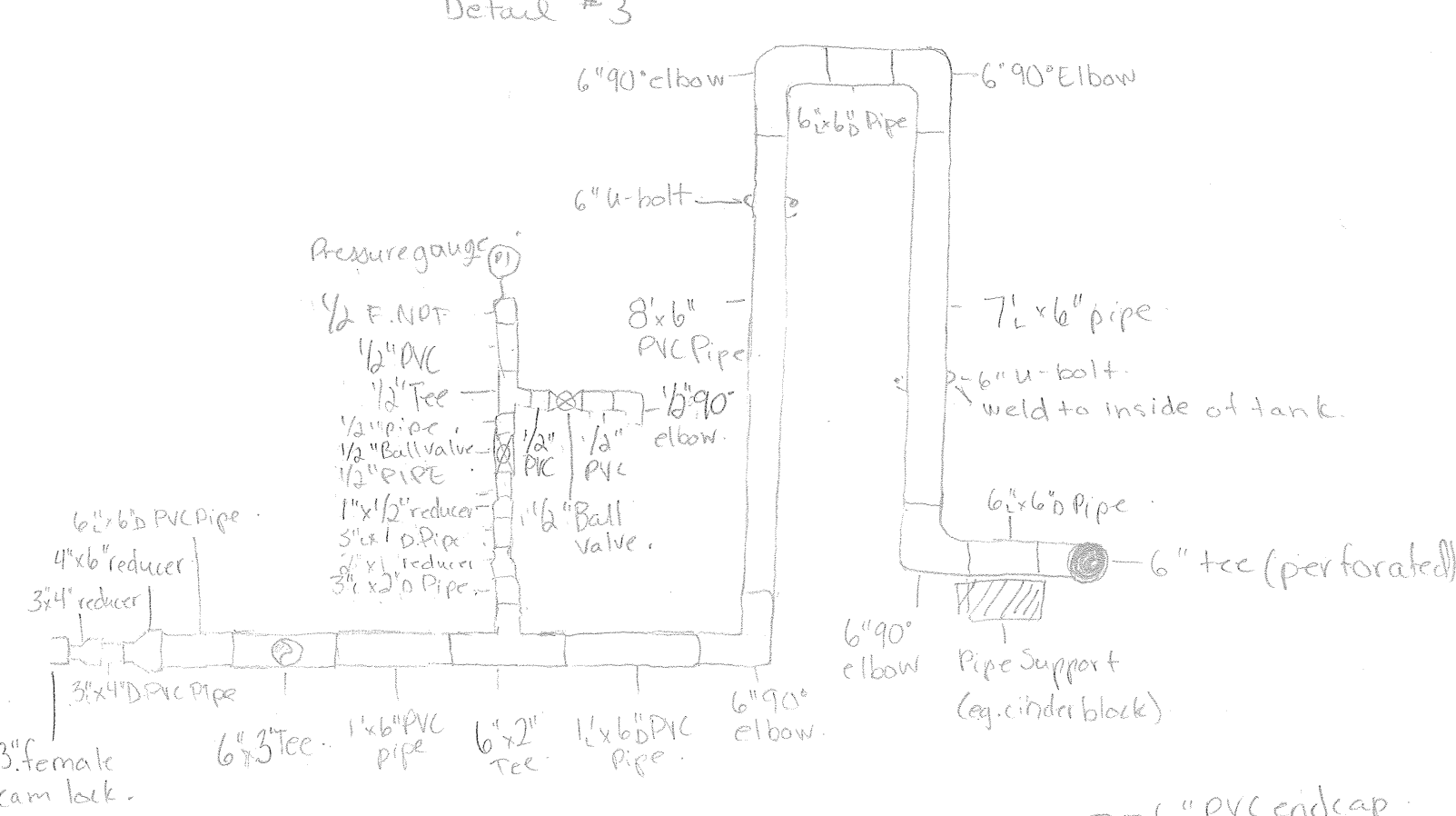
BY ..... DATE .....
SHEET NO. ..... OF .....
PROJECT NO . .....

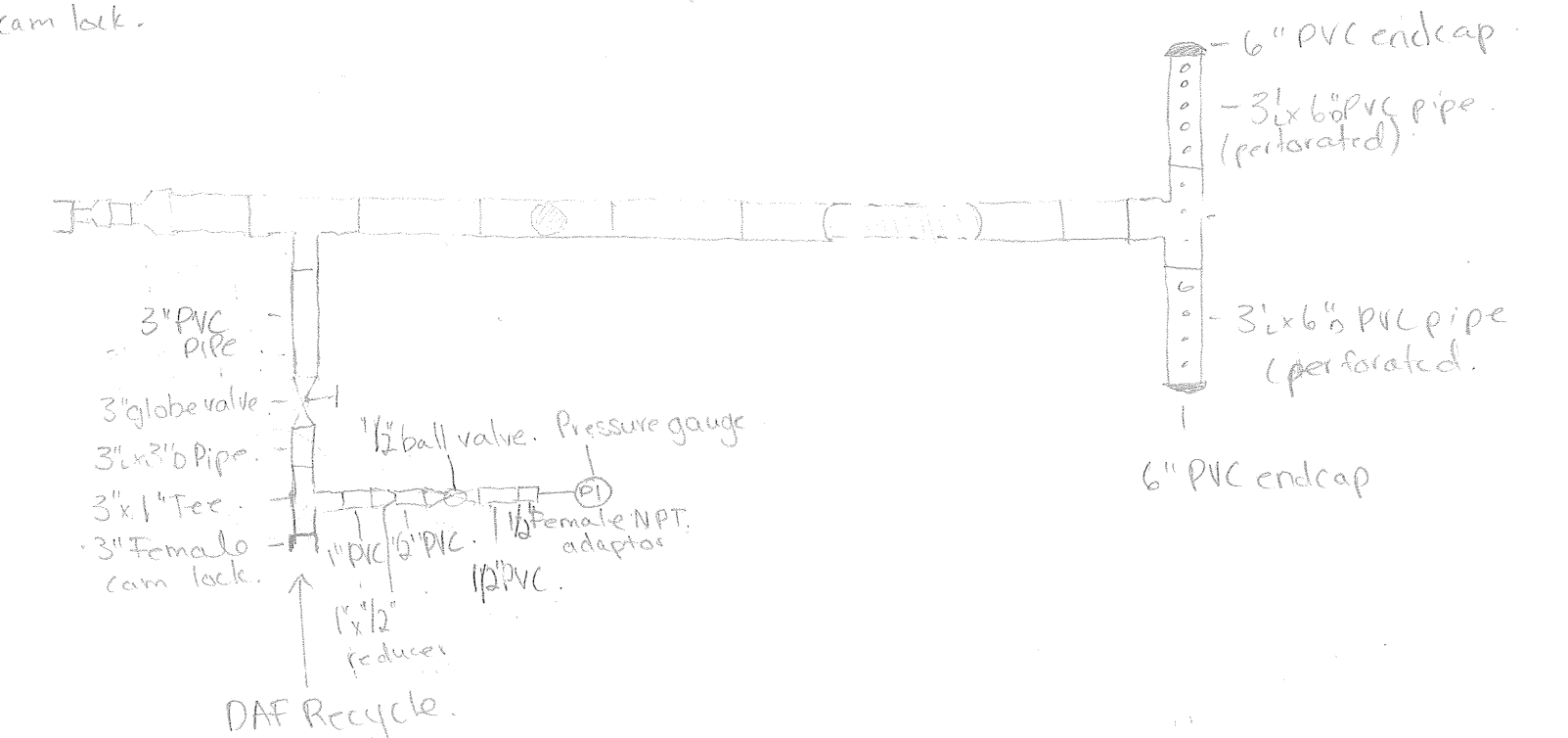
Flocculator Detail #2



July 28/09.

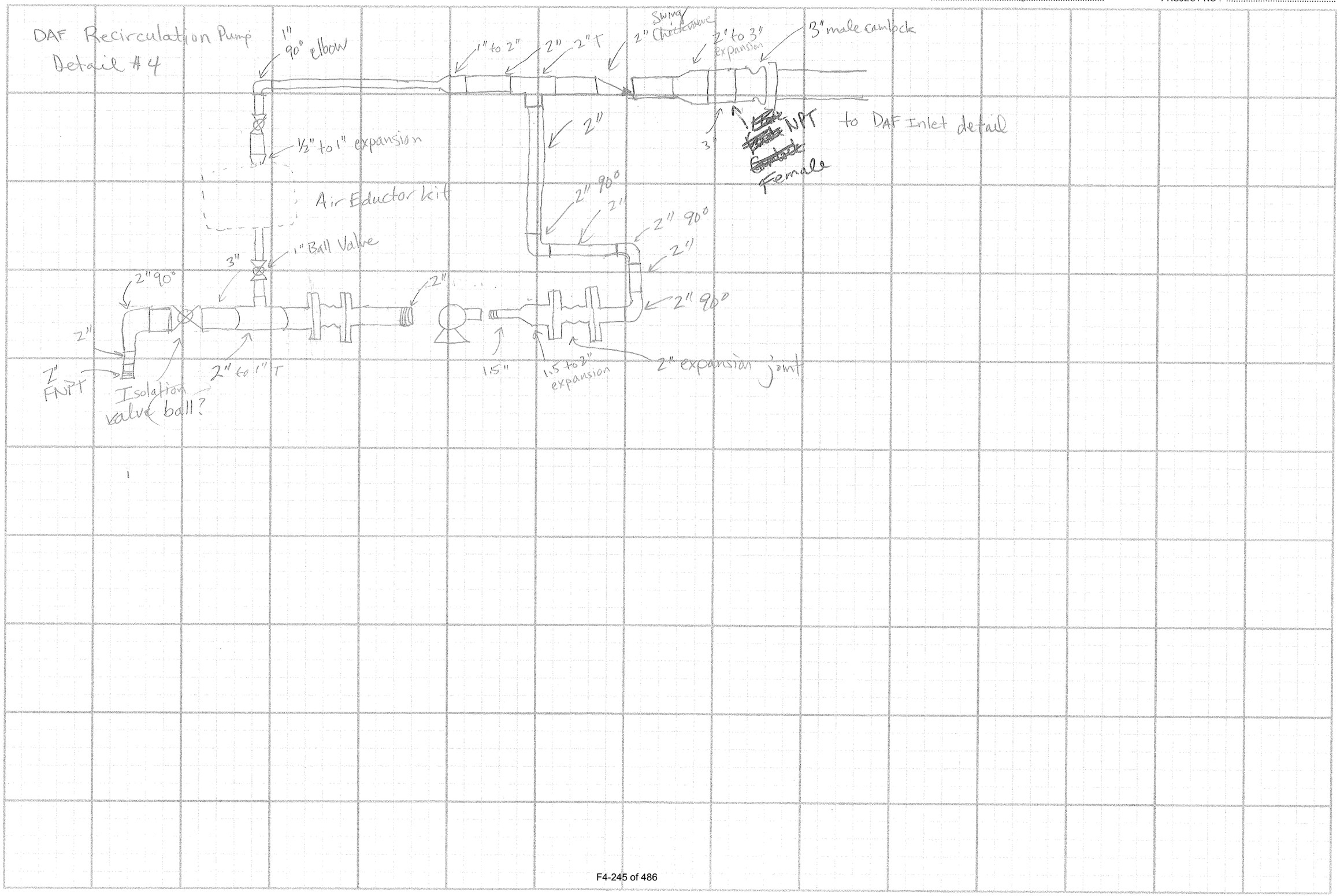
Detail #3



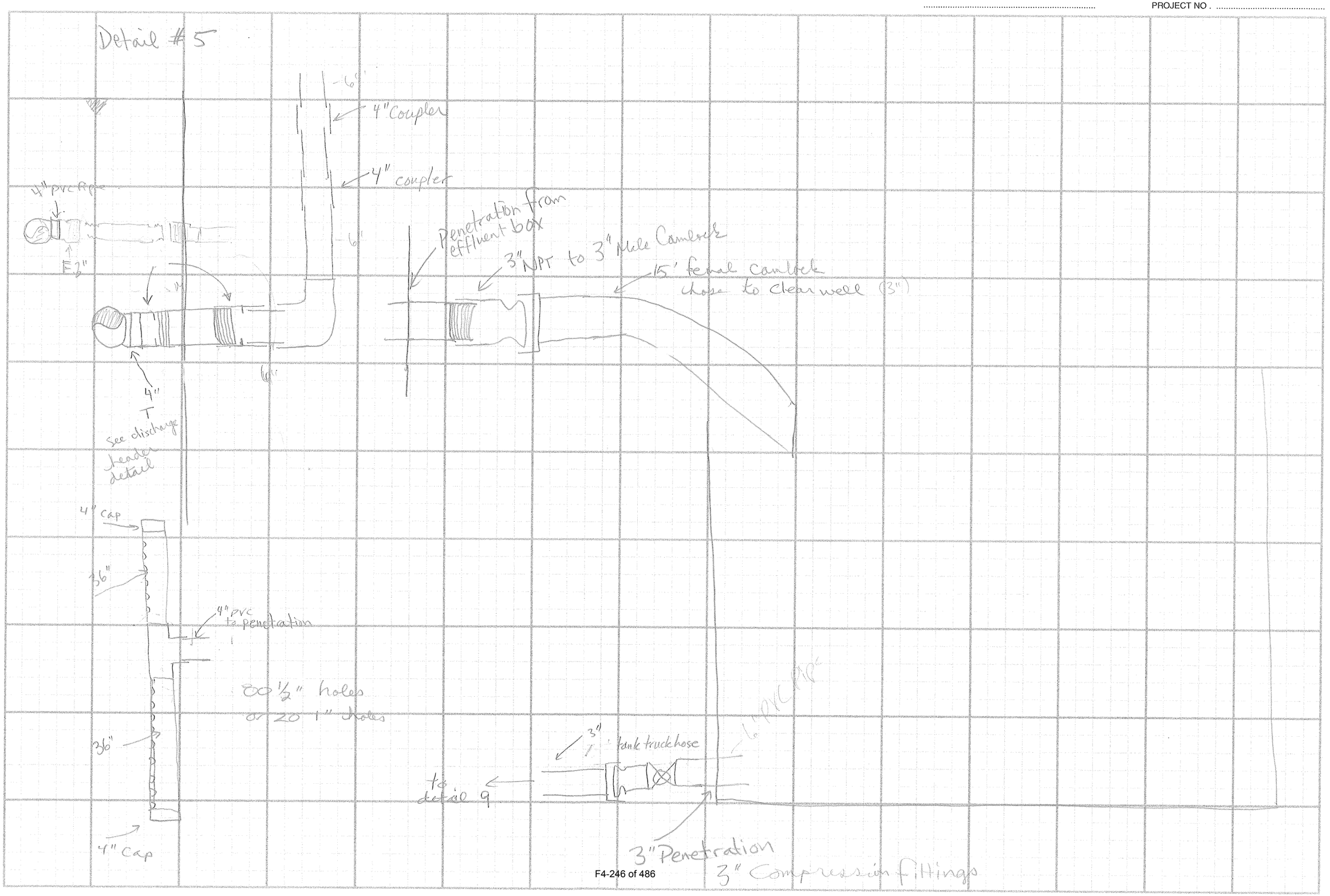


DAF Rec / Header Detail.

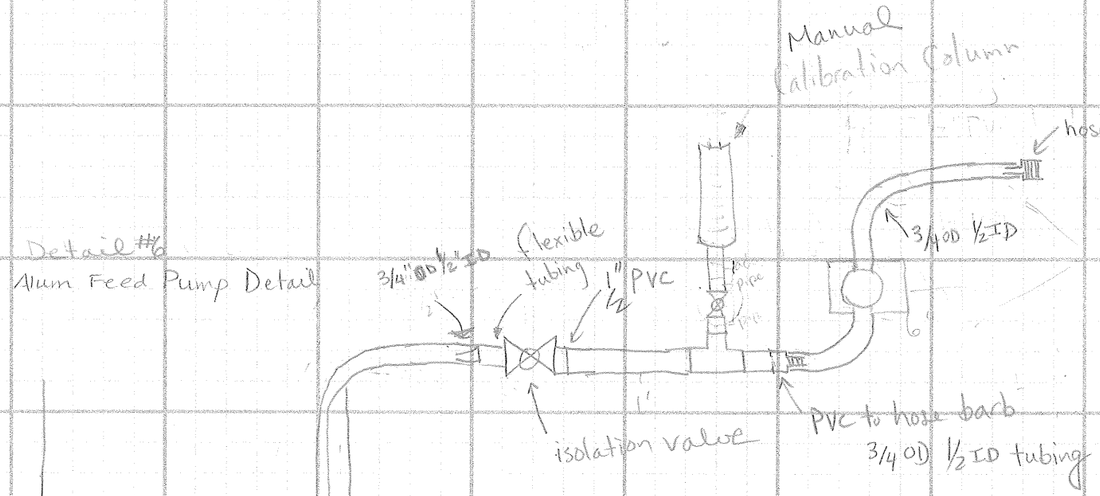
July 2009.


DAF Recirculation Pump
Detail #4
1" 90° elbow
1" to 2"
2"
2" T
Swing Check valve
2" to 3" expansion
3" male camlock
½" to 1" expansion
2"
3"
NPT to DAF Inlet detail
Female
Air Eductor kit
2" 90°
2"
2" 90°
2"
1" Ball Valve
3"
2" 90°
2"
2"
2" 90°
2"
FNPT
Isolation valve ball?
2" to 1" T
1.5"
1.5 to 2" expansion
2" expansion joint

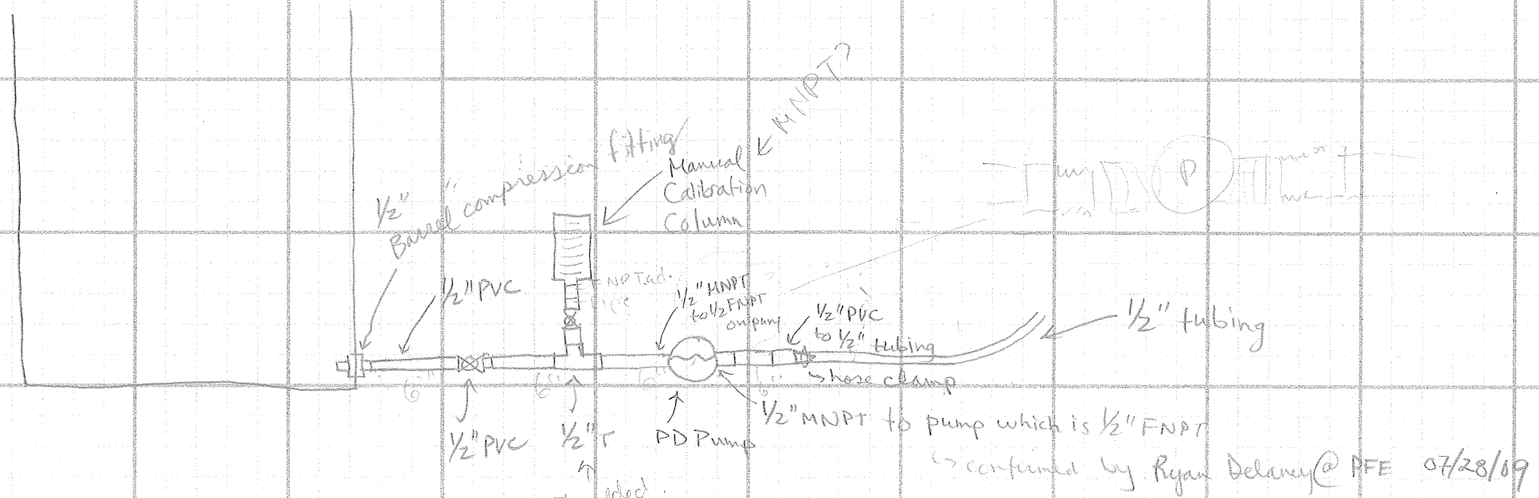
Detail #5


4" coupler
4" coupler
4" PVC
6"
Penetration from effluent box
3" NPT to 3" Male Camlock
15' female camlock hose to clear well (3")
4"
T
See discharge header detail
4" Cap
36"
4" PVC penetration
80 ½" holes or 20 1" holes
36"
4" Cap
3"
Tank truck hose
to detail 9
3" PVC
3" Penetration
3" Compression fittings

Detail #6
Alum Feed Pump Detail



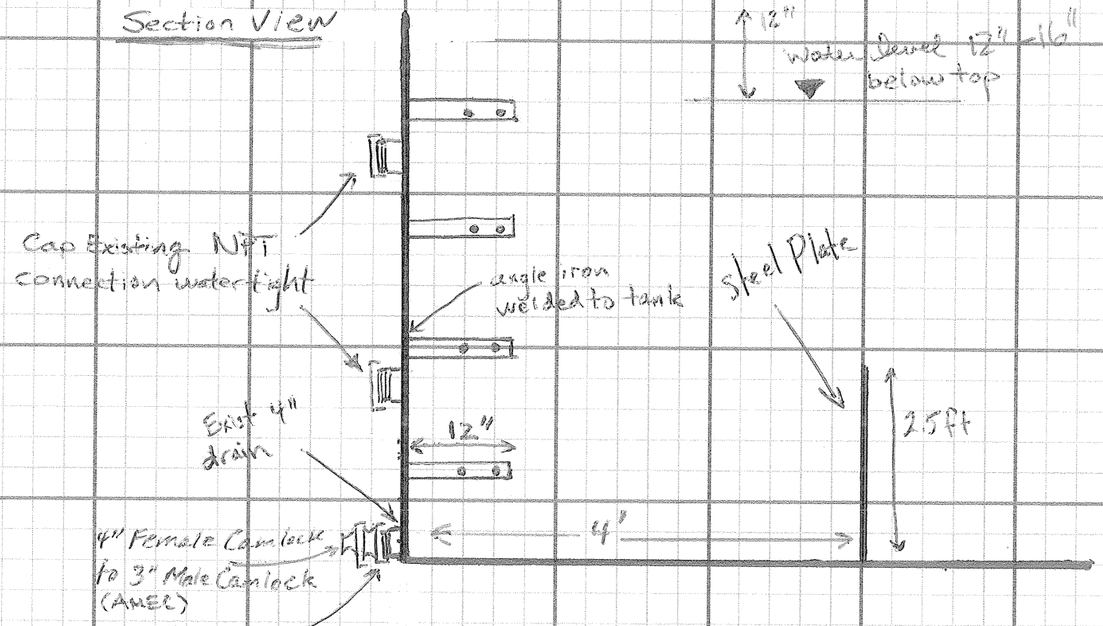
Detail #7



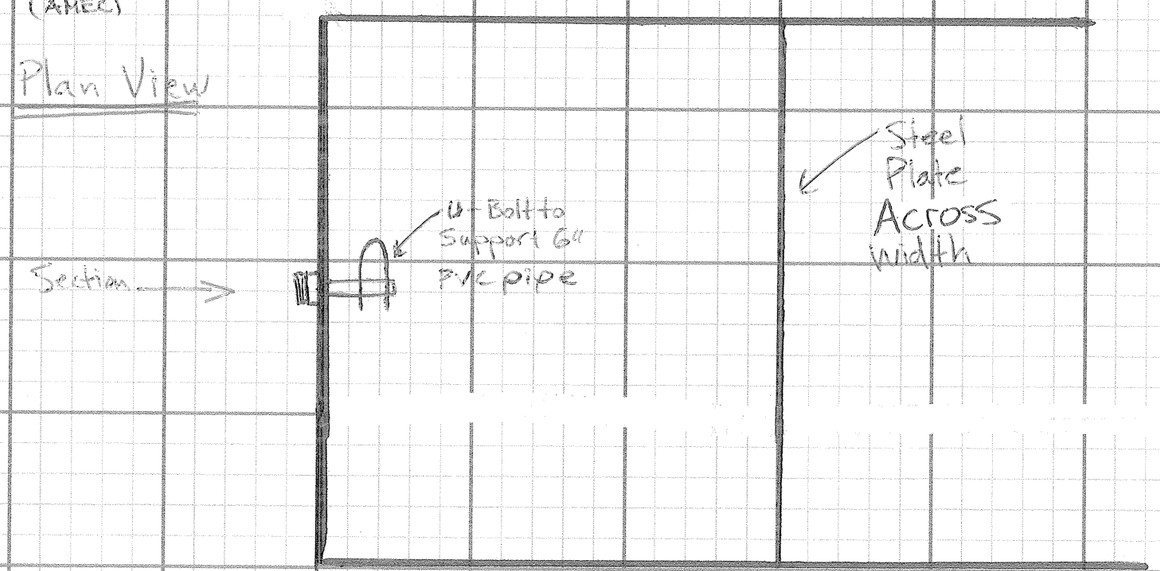
confirmed by Ryan Delaney @ PFE 07/28/09

Detail 8a Skimming Tank Influent

Section View

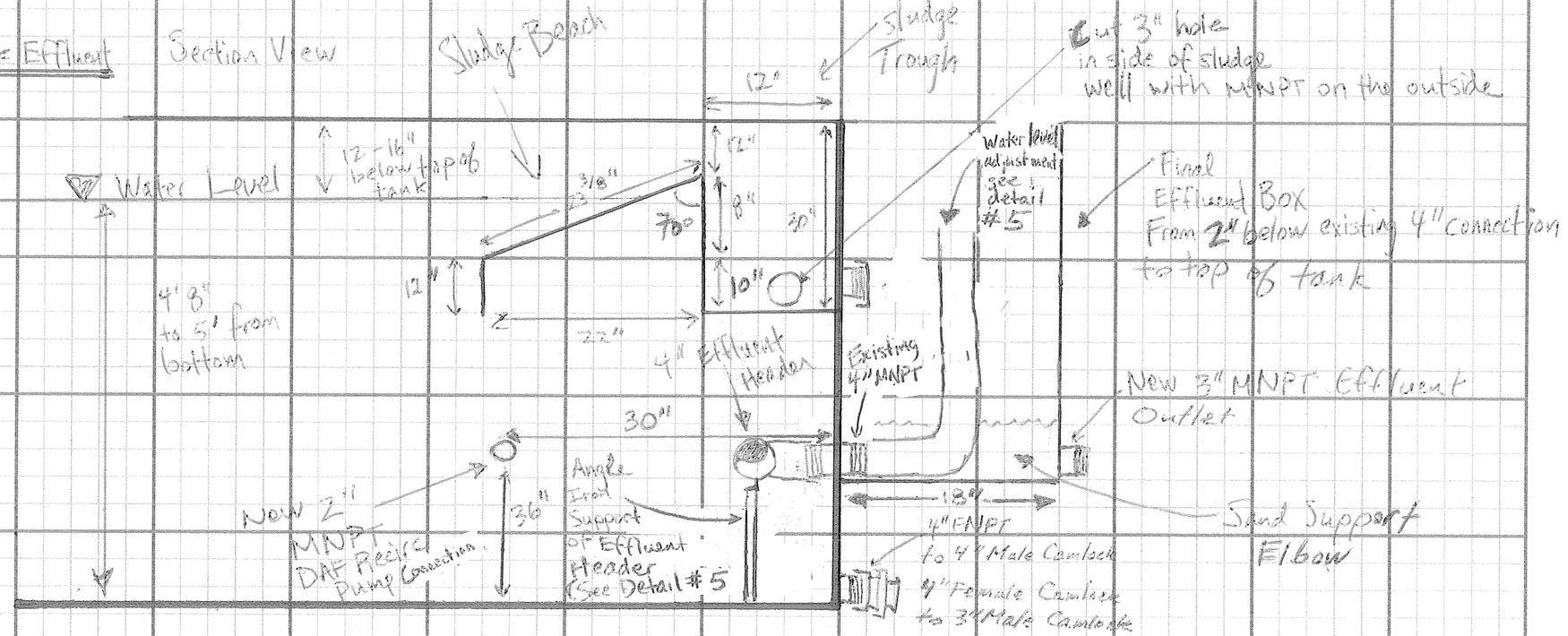


Plan View

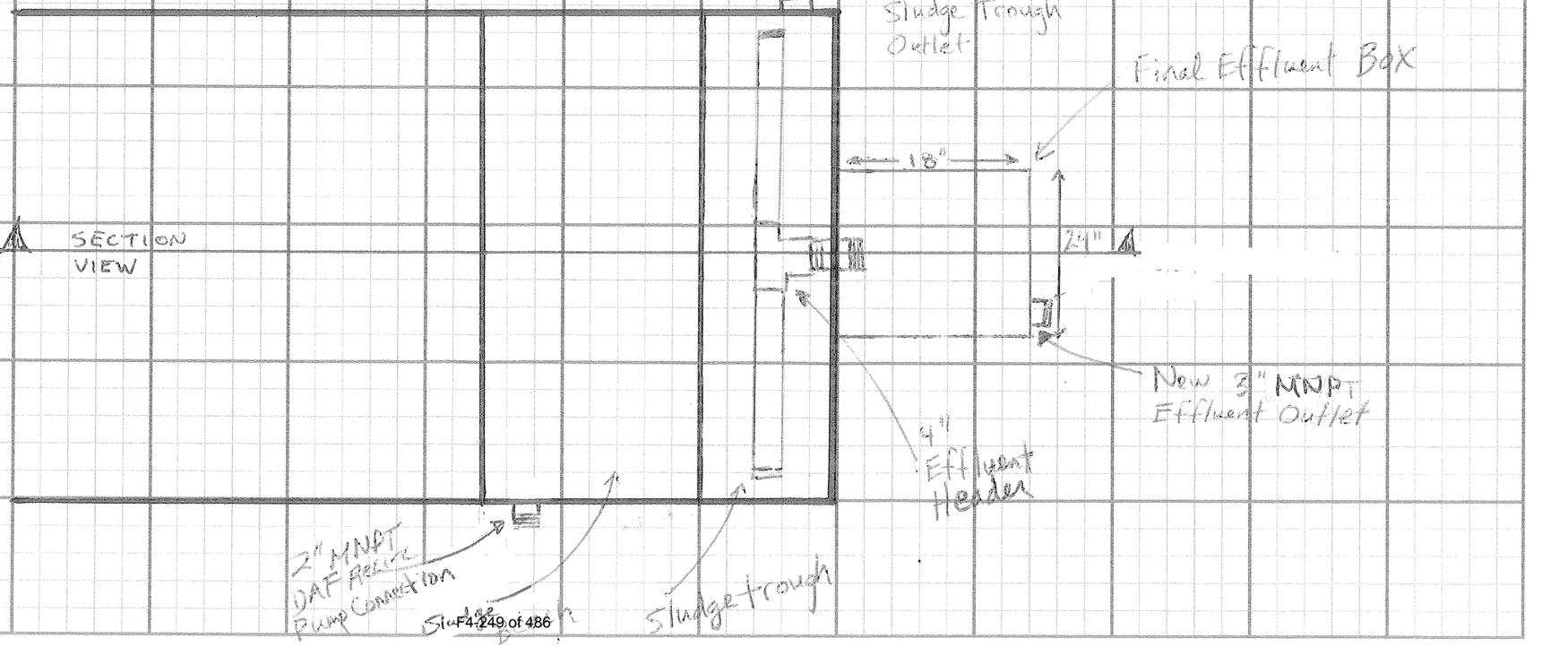


Detail B1b Skimming Tank Effluent

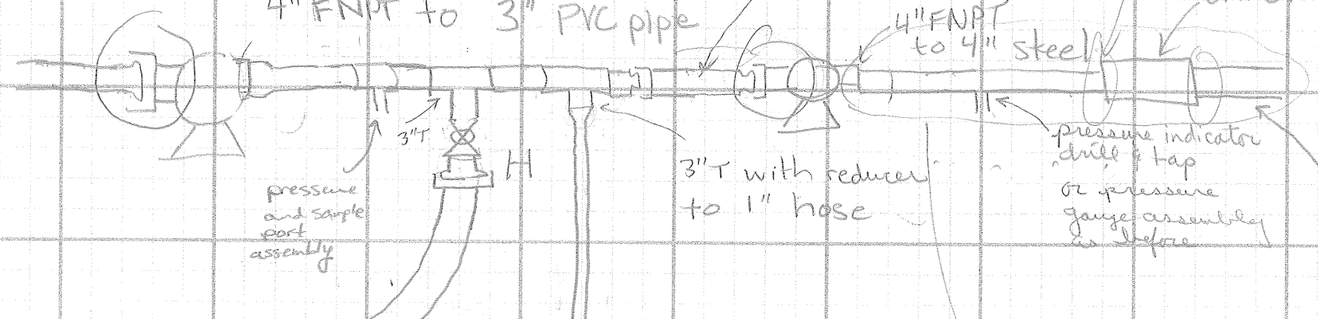
Section View



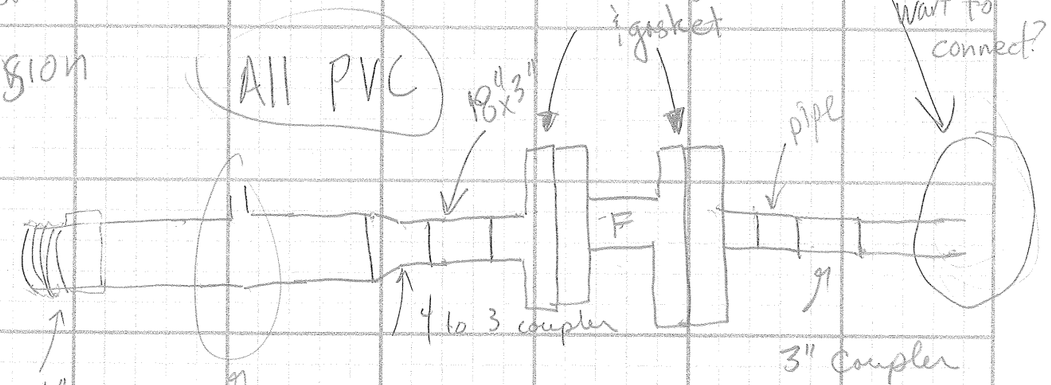
Plan View



Final Effluent detail #9



Possible Revision



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SUBJECT .....
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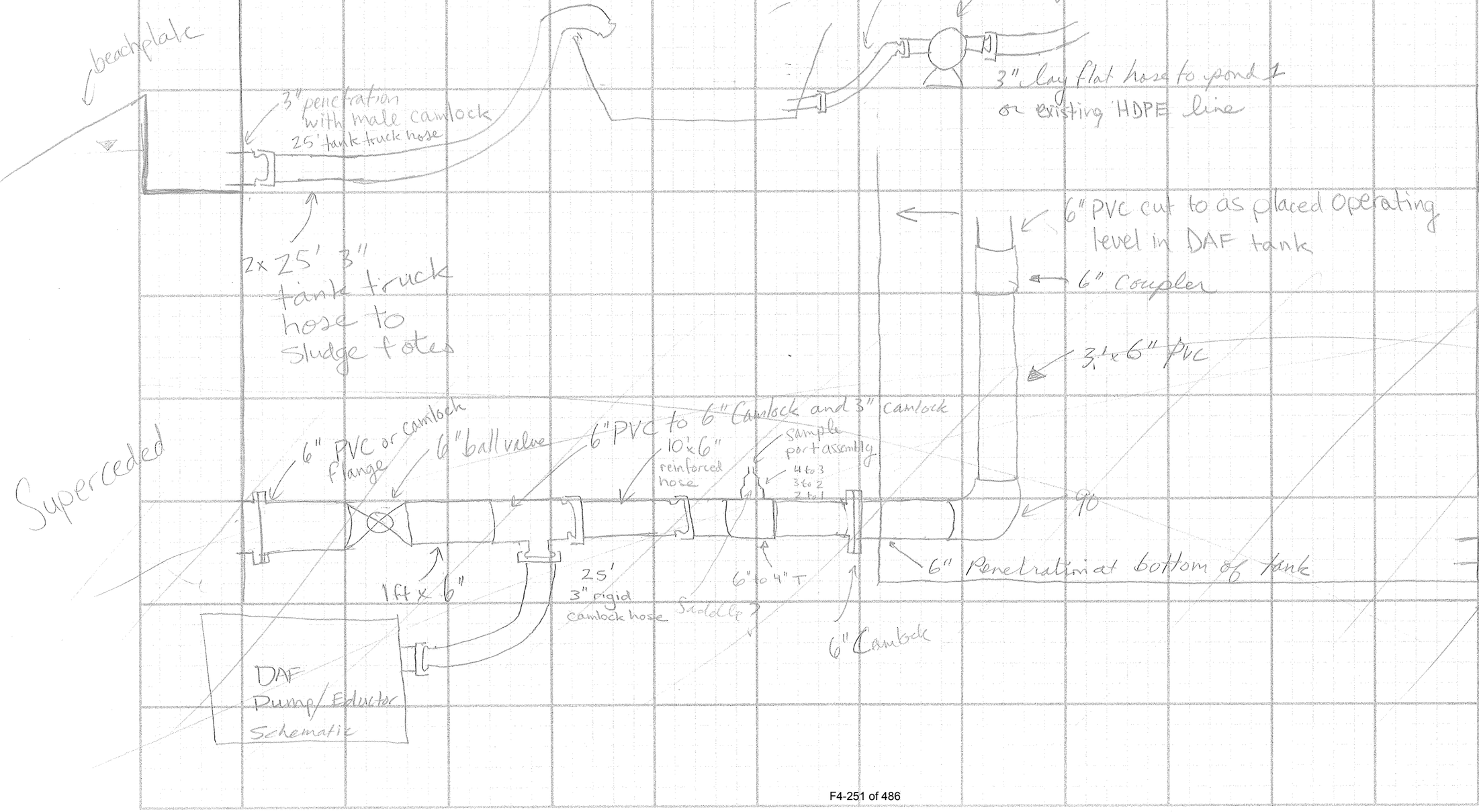
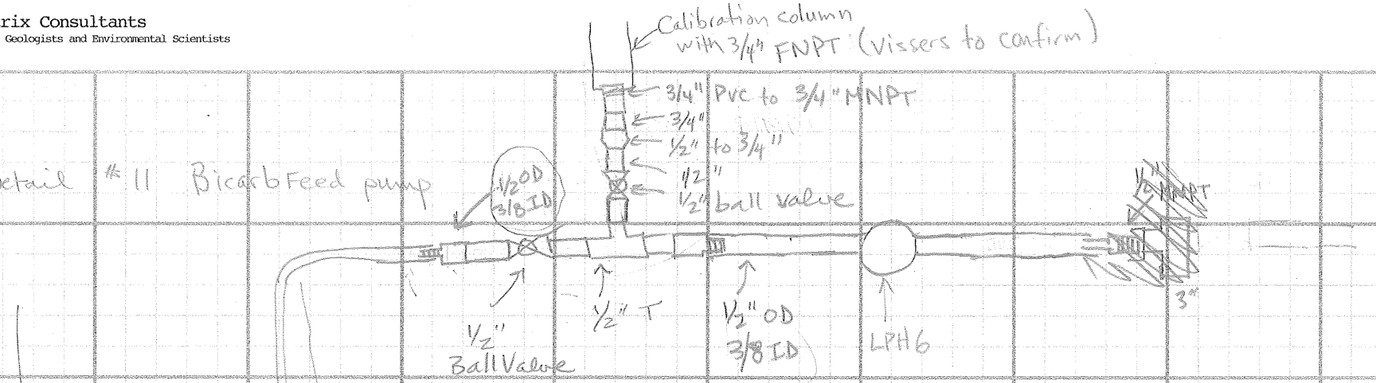
BY JW DATE July 29, 2009
SHEET NO. ..... OF .....
PROJECT NO . .....

DAF Discharge Detail #10



Detail #11 Bicarb Feed pump



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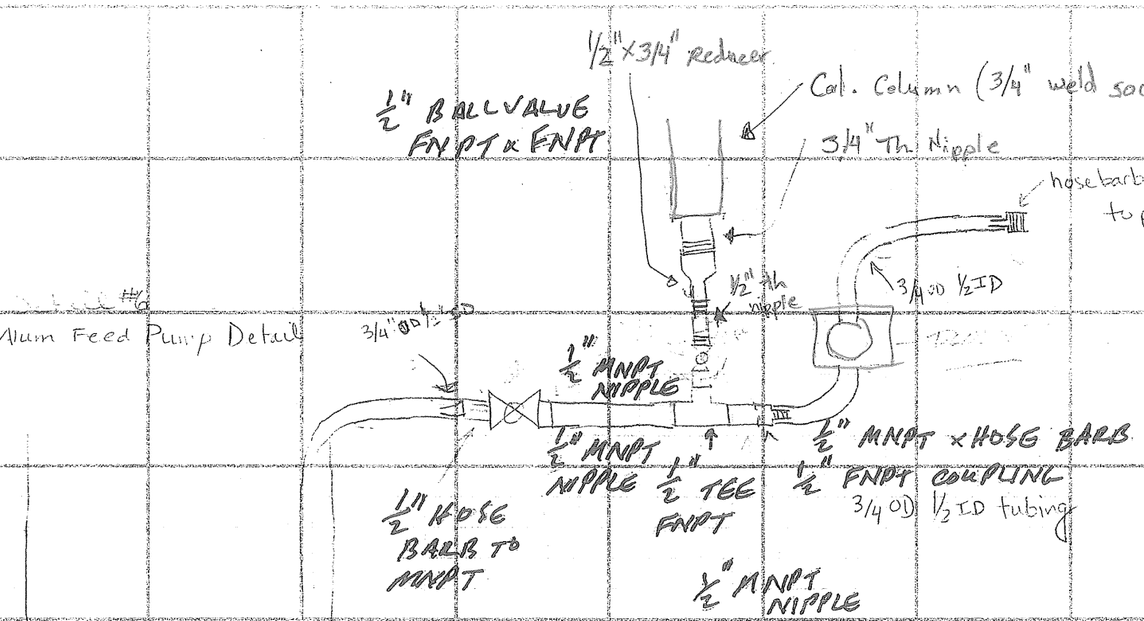
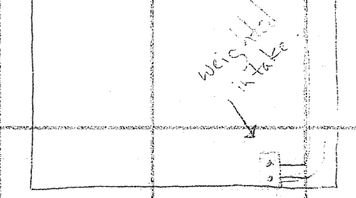
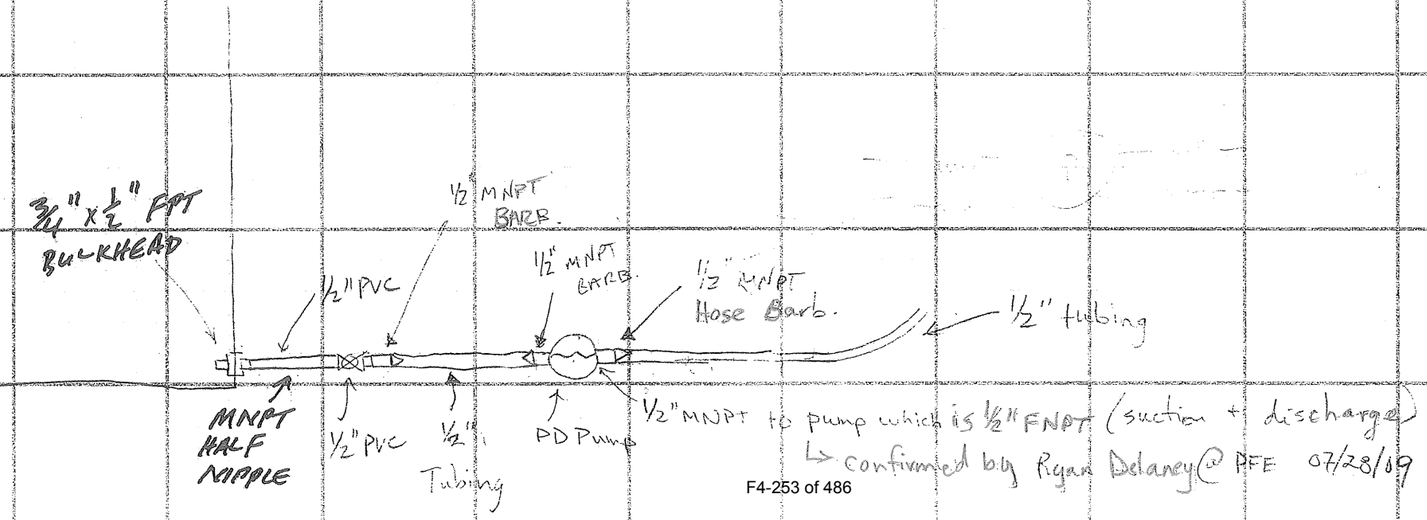
SUBJECT BAFFINLAND WW TREATMENT DETAILS 6 & 7
BY JL/SS DATE AUG 8/09
SHEET NO. 1 OF 1
PROJECT NO. W01446

Detail # 6
Alum Feed Pump Detail





Detail # 7



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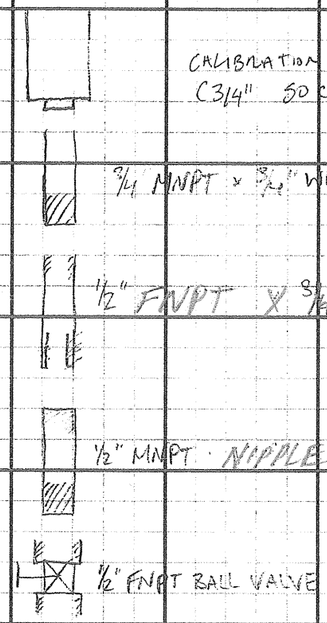
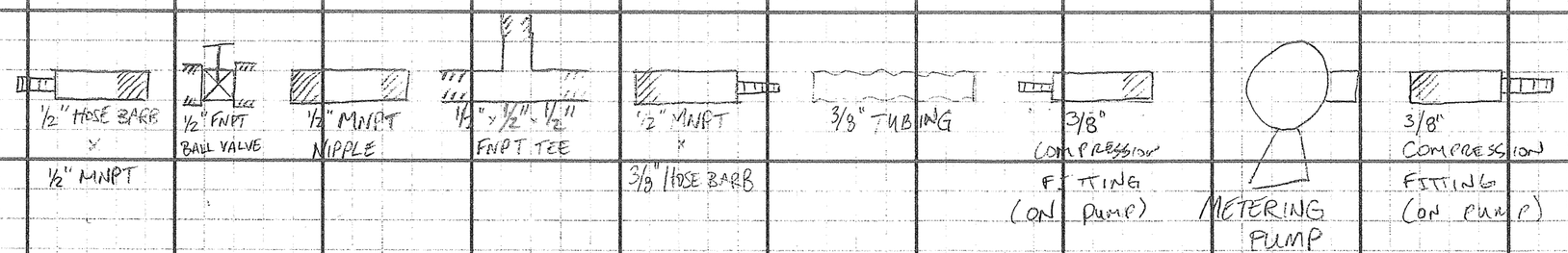
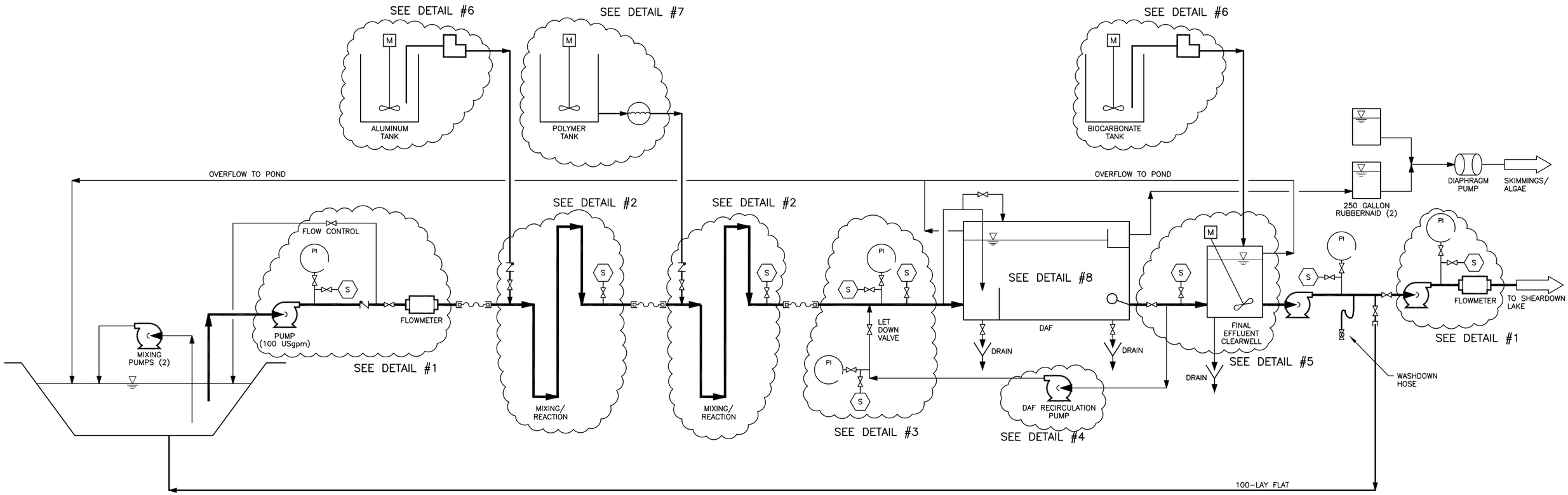
SUBJECT Baffinland
Wastewater Treatment
Detail 11

BY GK DATE Aug 7/19
SHEET NO. 1 OF 1
PROJECT NO. W01445







CAUTION: THIS PLAN MAY BE REDUCED 0 25mm 50mm ORIGINAL SCALE

NO.	REVISION	DATE	APRVD

DRAWN JR JULY 2009
DESIGNED JW JULY 2009
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REVIEWED

AMEC Geomatrix
AMEC Geomatrix Limited
420 Weber Street, North, Unit G
Waterloo, Ontario N2L 4E7
(519) 886-7500

PROCESS FLOW AND INSTRUMENTATION DIAGRAM

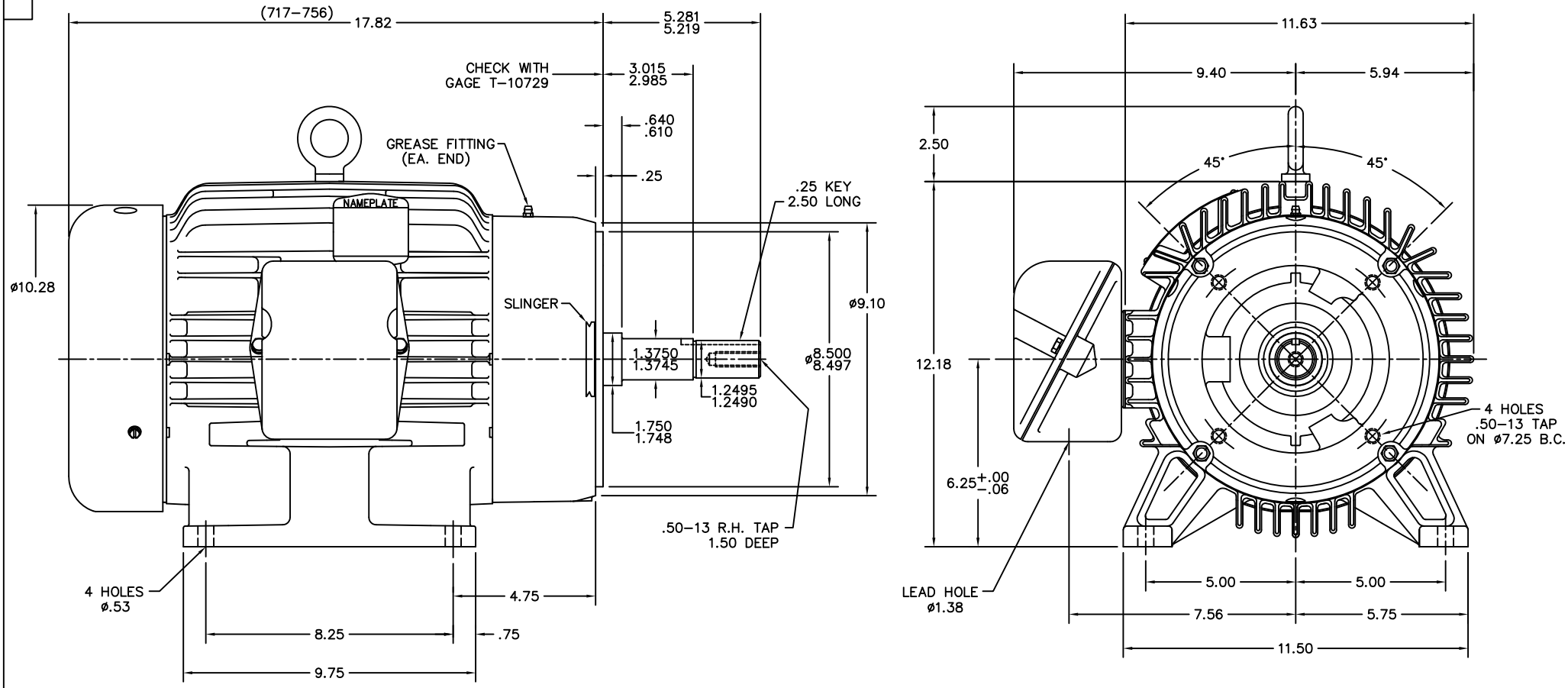
BAFFINLAND IRON MINES
POND WASTEWATER TREATMENT

DATE: JULY 2009
SCALE: N.T.S.
SHEET: 1 OF 1 SHEETS
PROJ No: W01446
P&ID–01

Filepath: T:\ Pete Geomatrix 2009 (09225-E Baffinland (W01446) W01446-PID.dwg
Plot Time: Jul 28, 2009 - 3:18pm, Plotted By: Dell Survey2

APPENDIX C
VENDOR MANUALS

07LYH300



CUSTOMER IS RESPONSIBLE FOR DETERMINING THAT MOTOR PERFORMANCE IS SUITABLE IN THE APPLICATION.

REV. DESC: CORRECT T–GAGE NOTE			
REV. LTR: F	BY: OD	REVISED: 10:07:21 12/15/2000	TDR: 227133
FILE: AAA00008912			REF: 07LYH300
MTL: –			

BALDOR ELECTRIC Co.

STD HORZ 254JM 07M TEFC 309 BRG.

07LYH300

BALDOR • RELIANCE

Integral Horsepower
AC Induction Motors

Installation & Operating Manual

2/09 MN400

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Table of Contents

Section 1
General Information 1-1
Overview 1-1
Limited Warranty 1-1
Safety Notice 1-1
Receiving 1-2
Handling 1-2
Storage 1-3
Removal From Storage 1-4
Section 2
Installation & Operation 2-1
Overview 2-1
Location 2-1
Mounting 2-1
Alignment 2-1
Doweling & Bolting 2-2
Guarding 2-2
Power Connection 2-2
Conduit Box 2-2
AC Power 2-2
Rotation 2-3
First Time Start Up 2-4
Coupled Start Up 2-4
Jogging and Repeated Starts 2-4
Section 3
Maintenance & Troubleshooting 3-1
General Inspection 3-1
Relubrication & Bearings 3-1
Type of Grease 3-1
Relubrication Intervals 3-1
Relubrication Procedure 3-3
Troubleshooting Chart 3-4
Suggested bearing and winding RTD setting guidelines 3-5

Section 1
General Information

Overview This manual contains general procedures that apply to Baldor Motor products. Be sure to read and understand the Safety Notice statements in this manual. For your protection, do not install, operate or attempt to perform maintenance procedures until you understand the Warning and Caution statements.
A Warning statement indicates a possible unsafe condition that can cause harm to personnel.
A Caution statement indicates a condition that can cause damage to equipment.

Important: **This instruction manual is not intended to include a comprehensive listing of all details for all procedures required for installation, operation and maintenance. This manual describes general guidelines that apply to most of the motor products shipped by Baldor. If you have a question about a procedure or are uncertain about any detail, Do Not Proceed. Please contact your Baldor distributor for more information or clarification.**

Before you install, operate or perform maintenance, become familiar with the following:

- NEMA Publication MG-2, Safety Standard for Construction and guide for Selection, Installation and Use of Electric Motors and Generators.
- The National Electrical Code
- Local codes and Practices

Limited Warranty

www.baldor.com/support/warranty_standard.asp

Safety Notice: This equipment contains high voltage! Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt installation, operation and maintenance of electrical equipment.

Be sure that you are completely familiar with NEMA publication MG-2, safety standards for construction and guide for selection, installation and use of electric motors and generators, the National Electrical Code and local codes and practices. Unsafe installation or use can cause conditions that lead to serious or fatal injury. Only qualified personnel should attempt the installation, operation and maintenance of this equipment.

WARNING: **Do not touch electrical connections before you first ensure that power has been disconnected. Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the installation, operation and maintenance of this equipment.**

WARNING: **Disconnect all electrical power from the motor windings and accessory devices before disassembly of the motor. Electrical shock can cause serious or fatal injury.**

WARNING: **Be sure the system is properly grounded before applying power. Do not apply AC power before you ensure that all grounding instructions have been followed. Electrical shock can cause serious or fatal injury. National Electrical Code and Local codes must be carefully followed.**

WARNING: **Avoid extended exposure to machinery with high noise levels. Be sure to wear ear protective devices to reduce harmful effects to your hearing.**

WARNING: **Surface temperatures of motor enclosures may reach temperatures which can cause discomfort or injury to personnel accidentally coming into contact with hot surfaces. When installing, protection should be provided by the user to protect against accidental contact with hot surfaces. Failure to observe this precaution could result in bodily injury.**

WARNING: **This equipment may be connected to other machinery that has rotating parts or parts that are driven by this equipment. Improper use can cause serious or fatal injury. Only qualified personnel should attempt to install operate or maintain this equipment.**

WARNING: **Do not by-pass or disable protective devices or safety guards. Safety features are designed to prevent damage to personnel or equipment. These devices can only provide protection if they remain operative.**

WARNING: **Avoid the use of automatic reset devices if the automatic restarting of equipment can be hazardous to personnel or equipment.**

WARNING: **Be sure the load is properly coupled to the motor shaft before applying power. The shaft key must be fully captive by the load device. Improper coupling can cause harm to personnel or equipment if the load decouples from the shaft during operation.**

WARNING: **Use proper care and procedures that are safe during handling, lifting, installing, operating and maintaining operations. Improper methods may cause muscle strain or other harm.**

WARNING: **Thermostat contacts automatically reset when the motor has slightly cooled down. To prevent injury or damage, the control circuit should be designed so that automatic starting of the motor is not possible when the thermostat resets.**

Safety Notice Continued

WARNING: **UL Listed motors must only be serviced by UL Approved Authorized Baldor Service Centers if these motors are to be returned to a hazardous and/or explosive atmosphere.**

WARNING: **Pacemaker danger – Magnetic and electromagnetic fields in the vicinity of current carrying carrying conductors and permanent magnet motors can result result in a serious health hazard to persons with cardiac pacemakers, metal implants, and hearing aids. To avoid risk, stay way from the area surrounding a permanent magnet motor.**

WARNING: **Before performing any motor maintenance procedure, be sure that the equipment connected to the motor shaft cannot cause shaft rotation. If the load can cause shaft rotation, disconnect the load from the motor shaft before maintenance is performed. Unexpected mechanical rotation of the motor parts can cause injury or motor damage.**

WARNING: **Use only UL/CSA listed explosion proof motors in the presence of flammable or combustible vapors or dust.**

WARNING: **Motors that are to be used in flammable and/or explosive atmospheres must display the UL label on the nameplate along with CSA listed logo. Specific service conditions for these motors are defined in NFPA 70 (NEC) Article 500.**

WARNING: **Guards must be installed for rotating parts such as couplings, pulleys, external fans, and unused shaft extensions, should be permanently guarded to prevent accidental contact by personnel. Accidental contact with body parts or clothing can cause serious or fatal injury.**

Caution: **To prevent premature equipment failure or damage, only qualified maintenance personnel should perform maintenance.**

Caution: **Do not over–lubricate motor as this may cause premature bearing failure.**

Caution: **Do not over tension belts. Excess tension may damage the motor or driven equipment.**

Caution: **Do not lift the motor and its driven load by the motor lifting hardware. The motor lifting hardware is adequate for lifting only the motor. Disconnect the load (gears, pumps, compressors, or other driven equipment) from the motor shaft before lifting the motor.**

Caution: **If eye bolts are used for lifting a motor, be sure they are securely tightened. The lifting direction should not exceed a 20° angle from the shank of the eye bolt or lifting lug. Excessive lifting angles can cause damage.**

Caution: **To prevent equipment damage, be sure that the electrical service is not capable of delivering more than the maximum motor rated amps listed on the rating plate.**

Caution: **If a HI POT test (High Potential Insulation test) must be performed, follow the precautions and procedure in NEMA MG1 and MG2 standards to avoid equipment damage.**

If you have any questions or are uncertain about any statement or procedure, or if you require additional information please contact your Baldor distributor or an Authorized Baldor Service Center.

Receiving

Each Baldor Electric Motor is thoroughly tested at the factory and carefully packaged for shipment. When you receive your motor, there are several things you should do immediately.

1. Observe the condition of the shipping container and report any damage immediately to the commercial carrier that delivered your motor.
2. Verify that the part number of the motor you received is the same as the part number listed on your purchase order.

Handling

The motor should be lifted using the lifting lugs or eye bolts provided.

Caution: **Do not lift the motor and its driven load by the motor lifting hardware. The motor lifting hardware is adequate for lifting only the motor. Disconnect the load (gears, pumps, compressors, or other driven equipment) from the motor shaft before lifting the motor.**

1. Use the lugs or eye bolts provided to lift the motor. Never attempt to lift the motor and additional equipment connected to the motor by this method. The lugs or eye bolts provided are designed to lift only the motor. Never lift the motor by the motor shaft or the hood of a WPII motor.
2. To avoid condensation inside the motor, do not unpack until the motor has reached room temperature. (Room temperature is the temperature of the room in which it will be installed). The packing provides insulation from temperature changes during transportation.
3. When lifting a WPII (Weather Proof Type 2) motor, do not lift the motor by inserting lifting lugs into holes on top of the cooling hood. These lugs are to be used for hood removal only. A spreader bar should be used to lift the motor by the cast lifting lugs located on the motor frame.

4. If the motor must be mounted to a plate with the driven equipment such as pump, compressor etc., it may not be possible to lift the motor alone. For this case, the assembly should be lifted by a sling around the mounting base. The entire assembly can be lifted as an assembly for installation.

   Do not lift the assembly using the motor lugs or eye bolts provided. Lugs or eye bolts are designed to lift motor only. If the load is unbalanced (as with couplings or additional attachments) additional slings or other means must be used to prevent tipping. In any event, the load must be secure before lifting. If the load is unbalanced (as with couplings or additional attachments) additional slings or other means must be used to prevent tipping. In any event, the load must be secure before lifting.

Storage

Storage requirements for motors and generators that will not be placed in service for at least six months from date of shipment.

Improper motor storage will result in seriously reduced reliability and failure. An electric motor that does not experience regular usage while being exposed to normally humid atmospheric conditions is likely to develop rust in the bearings or rust particles from surrounding surfaces may contaminate the bearings. The electrical insulation may absorb an excessive amount of moisture leading to the motor winding failure.

A wooden crate “shell” should be constructed to secure the motor during storage. This is similar to an export box but the sides & top must be secured to the wooden base with lag bolts (not nailed as export boxes are) to allow opening and reclosing many times without damage to the “shell”.

Minimum resistance of motor winding insulation is 5 Meg ohms or the calculated minimum, which ever is greater. Minimum resistance is calculated as follows: **Rm = kV + 1**

where: (Rm is minimum resistance to ground in Meg−Ohms and
kV is rated nameplate voltage defined as Kilo−Volts.)

Example: For a 480VAC rated motor Rm =1.48 meg−ohms (use 5 MΩ).
For a 4160VAC rated motor Rm = 5.16 meg−ohms.

Preparation for Storage

1. Some motors have a shipping brace attached to the shaft to prevent damage during transportation. The shipping brace, if provided, must be removed and stored for future use. The brace must be reinstalled to hold the shaft firmly in place against the bearing before the motor is moved.
2. Store in a clean, dry, protected warehouse where control is maintained as follows:
   a. Shock or vibration must not exceed 2 mils maximum at 60 hertz, to prevent the bearings from brinelling. If shock or vibration exceeds this limit vibration isolation pads must be used.
   b. Storage temperatures of 10°C (50°F) to 49°C (120°F) must be maintained.
   c. Relative humidity must not exceed 60%.
   d. Motor space heaters (when present) are to be connected and energized whenever there is a possibility that the storage ambient conditions will reach the dew point. Space heaters are optional.

   Note: Remove motor from containers when heaters are energized, reprotect if necessary.
3. Measure and record the resistance of the winding insulation (dielectric withstand) every 30 days of storage.
   a. If motor insulation resistance decreases below the minimum resistance, contact your Baldor District office.
   b. Place new desiccant inside the vapor bag and re−seal by taping it closed.
   c. If a zipper−closing type bag is used instead of the heat−sealed type bag, zip the bag closed instead of taping it. Be sure to place new desiccant inside bag after each monthly inspection.
   d. Place the shell over the motor and secure with lag bolts.
4. Where motors are mounted to machinery, the mounting must be such that the drains and breathers are fully operable and are at the lowest point of the motor. Vertical motors must be stored in the vertical position. Storage environment must be maintained as stated in step 2.

5. Motors with anti−friction bearings are to be greased at the time of going into extended storage with periodic service as follows:
   a. Motors marked “Do Not Lubricate” on the nameplate do not need to be greased before or during storage.
   b. Ball and roller bearing (anti−friction) motor shafts are to be rotated manually every 3 months and greased every 6 months in accordance with the Maintenance section of this manual.
   c. Sleeve bearing (oil lube) motors are drained of oil prior to shipment. The oil reservoirs must be refilled to the indicated level with the specified lubricant, (see Maintenance). The shaft should be rotated monthly by hand at least 10 to 15 revolutions to distribute oil to bearing surfaces.
   d. “Provisions for oil mist lubrication” − These motors are packed with grease. Storage procedures are the same as paragraph 5b.
   e. “Oil Mist Lubricated” − These bearings are protected for temporary storage by a corrosion inhibitor. If stored for greater than 3 months or outdoor storage is anticipated, connected to the oil mist system while in storage. If this is not possible, add the amount of grease indicated under “Standard Condition” in Section 3, then rotate the shaft 15 times by hand.
6. All breather drains are to be fully operable while in storage (drain plugs removed). The motors must be stored so that the drain is at the lowest point. All breathers and automatic “T” drains must be operable to allow breathing and draining at points other than through the bearings around the shaft. Vertical motors should be stored in a safe stable vertical position.
7. Coat all external machined surfaces with a rust preventing material. An acceptable product for this purpose is Exxon Rust Ban # 392.

Non−Regreaseable Motors

Non−regreasable motors with “Do Not Lubricate” on the nameplate should have the motor shaft rotated 15 times to redistribute the grease within the bearing every 3 months or more often.

All Other Motor Types

Before storage, the following procedure must be performed.

1. Remove the grease drain plug, if supplied, (opposite the grease fitting) on the bottom of each bracket prior to lubricating the motor.
2. The motor with regreasable bearing must be greased as instructed in Section 3 of this manual.
3. Replace the grease drain plug after greasing.
4. The motor shaft must be rotated a minimum of 15 times after greasing.
5. Motor Shafts are to be rotated at least 15 revolutions manually every 3 months and additional grease added every nine months (see Section 3) to each bearing.
6. Bearings are to be greased at the time of removal from storage.

Removal From Storage

1. Remove all packing material.
2. Measure and record the electrical resistance of the winding insulation resistance meter at the time of removal from storage. The insulation resistance must not be less than 50% from the initial reading recorded when the motor was placed into storage. A decrease in resistance indicates moisture in the windings and necessitates electrical or mechanical drying before the motor can be placed into service. If resistance is low, contact your Baldor District office.
3. Regrease the bearings as instructed in Section 3 of this manual.
4. Reinstall the original shipping brace if motor is to be moved. This will hold the shaft firmly against the bearing and prevent damage during movement.

Section 2
Installation & Operation

Overview Installation should conform to the National Electrical Code as well as local codes and practices. When other devices are coupled to the motor shaft, be sure to install protective devices to prevent future accidents. Some protective devices include, coupling, belt guard, chain guard, shaft covers etc. These protect against accidental contact with moving parts. Machinery that is accessible to personnel should provide further protection in the form of guard rails, screening, warning signs etc.

Location It is important that motors be installed in locations that are compatible with motor enclosure and ambient conditions. Improper selection of the motor enclosure and ambient conditions can lead to reduced operating life of the motor.

Proper ventilation for the motor must be provided. Obstructed airflow can lead to reduction of motor life.

1. **Open Drip−Proof/WPI** motors are intended for use indoors where atmosphere is relatively clean, dry, well ventilated and non−corrosive.
2. **Totally Enclosed and WPII** motors may be installed where dirt, moisture or dust are present and in outdoor locations.

Severe Duty, IEEE 841 and Washdown Duty enclosed motors are designed for installations with high corrosion or excessive moisture conditions. These motors should not be placed into an environment where there is the presence of flammable or combustible vapors, dust or any combustible material, unless specifically designed for this type of service.

Hazardous Locations are those where there is a risk of ignition or explosion due to the presence of combustible gases, vapors, dust, fibers, or flyings. Facilities requiring special equipment for hazardous locations are typically classified in accordance with local requirements. In the US market, guidance is provided by the National Electric Code.

Caution: **Do not lift the motor and its driven load by the motor lifting hardware. The motor lifting hardware is adequate for lifting only the motor. Disconnect the load (gears, pumps, compressors, or other driven equipment) from the motor shaft before lifting the motor.**

Mounting The motor must be securely installed to a rigid foundation or mounting surface to minimize vibration and maintain alignment between the motor and shaft load. Failure to provide a proper mounting surface may cause vibration, misalignment and bearing damage.

Foundation caps and sole plates are designed to act as spacers for the equipment they support. If these devices are used, be sure that they are evenly supported by the foundation or mounting surface.

After installation is complete and accurate alignment of the motor and load is accomplished, the base should be grouted to the foundation to maintain this alignment.

The standard motor base is designed for horizontal or vertical mounting. Adjustable or sliding rails are designed for horizontal mounting only. Consult your Baldor distributor or authorized Baldor Service Center for further information.

Alignment Accurate alignment of the motor with the driven equipment is extremely important. The pulley, sprocket, or gear used in the drive should be located on the shaft as close to the shaft shoulder as possible. It is recommended to heat the pulley, sprocket, or gear before installing on the motor shaft. Forcibly driving a unit on the motor shaft will damage the bearings.

1. **Direct Coupling**
   For direct drive, use flexible couplings if possible. Consult the drive or equipment manufacturer for more information. Mechanical vibration and roughness during operation may indicate poor alignment. Use dial indicators to check alignment. The space between coupling hubs should be maintained as recommended by the coupling manufacturer.
2. **End-Play Adjustment**
   The axial position of the motor frame with respect to its load is also extremely important. The motor bearings are not designed for excessive external axial thrust loads. Improper adjustment will cause failure.
3. **Pulley Ratio**
   The pulley ratio should not exceed 8:1.

Caution: **Do not over tension belts. Excess tension may damage the motor or driven equipment.**

4. **Belt Drive**
   Align sheaves carefully to minimize belt wear and axial bearing loads (see End-Play Adjustment). Belt tension should be sufficient to prevent belt slippage at rated speed and load. However, belt slippage may occur during starting.
5. Sleeve bearing motors are only suitable for coupled loads.

Doweling & Bolting After proper alignment is verified, dowel pins should be inserted through the motor feet into the foundation. This will maintain the correct motor position should motor removal be required. (Baldor motors are designed for doweling.)

1. Drill dowel holes in diagonally opposite motor feet in the locations provided.
2. Drill corresponding holes in the foundation.
3. Ream all holes.
4. Install proper fitting dowels.
5. Mounting bolts must be carefully tightened to prevent changes in alignment. Use a flat washer and lock washer under each nut or bolt head to hold the motor feet secure. Flanged nuts or bolts may be used as an alternative to washers.

WARNING: Guards must be installed for rotating parts such as couplings, pulleys, external fans, and unused shaft extensions, should be permanently guarded to prevent accidental contact by personnel. Accidental contact with body parts or clothing can cause serious or fatal injury.

Guarding Guards must be installed for rotating parts such as couplings, pulleys, external fans, and unused shaft extensions. This is particularly important where the parts have surface irregularities such as keys, key ways or set screws. Some satisfactory methods of guarding are:

1. Covering the machine and associated rotating parts with structural or decorative parts of the driven equipment.
2. Providing covers for the rotating parts. Covers should be sufficiently rigid to maintain adequate guarding during normal service.

Power Connection Motor and control wiring, overload protection, disconnects, accessories and grounding should conform to the National Electrical Code and local codes and practices. Flying leads must be insulated with two full wraps of electrical grade insulating tape or heat shrink tubing.

Conduit Box For ease of making connections, an oversize conduit box is provided.
The box can be rotated 360° in 90° increments.
Auxiliary conduit boxes are provided on some motors for accessories such as space heaters, RTD's etc.

AC Power Connect the motor leads as shown on the connection diagram located on the name plate or inside the cover on the conduit box. Be sure the following guidelines are met:

1. AC power is within ±10% of rated voltage with rated frequency. (See motor name plate for ratings).
   OR
2. AC power is within ±5% of rated frequency with rated voltage.
   OR
3. A combined variation in voltage and frequency of ±10% (sum of absolute values) of rated values, provided the frequency variation does not exceed ±5% of rated frequency.

Performance within these voltage and frequency variations are shown in Figure 2-2.

Figure 2-1 Accessory Connections

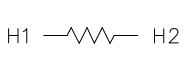
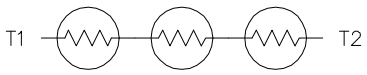
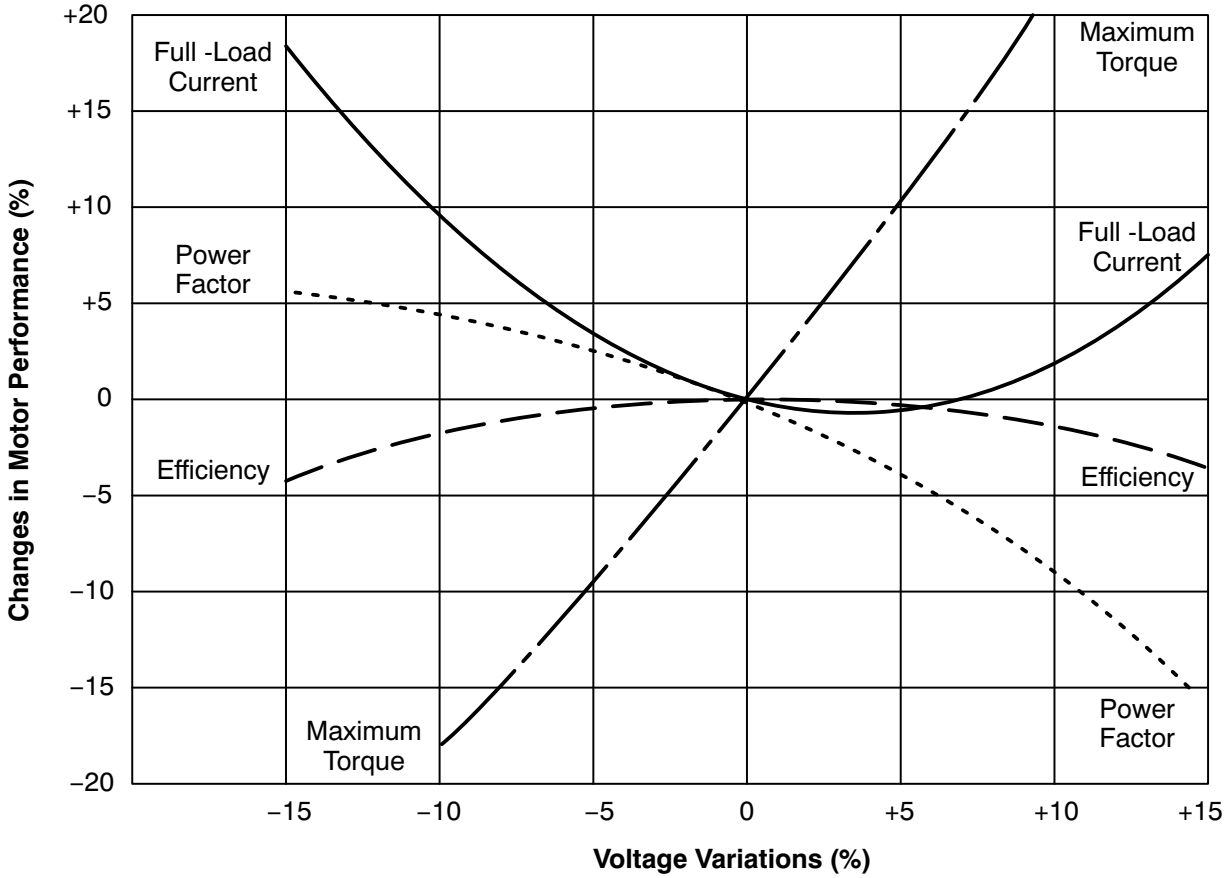
HEATERS 	One heater is installed in each end of motor. Leads for each heater are labeled H1 & H2. (Like numbers should be tied together).
THERMISTORS 	Three thermistors are installed in windings and tied in series. Leads are labeled T1 & T2.
WINDING RTDS 	Winding RTDs are installed in windings (2) per phase. Each set of leads is labeled W1, W2, W3, W4, W5, & W6.
BEARING RTD 	* One bearing RTD is installed in Drive endplate (PUEP), leads are labeled RTDDE. * One bearing RTD is installed in Opposite Drive endplate (FREP), leads are labeled RTDODE. * Note RTD may have 2–Red/1–White leads; or 2–White/1–Red Lead.

Figure 2-2 Typical Motor Performance VS Voltage Variations



Rotation All three phase motors are reversible. To reverse the direction of rotation, disconnect and lock out power and interchange any two of the three line leads for three phase motors. For single phase motors, check the connection diagram to determine if the motor is reversible and follow the connection instructions for lead numbers to be interchanged. Not all single phase motors are reversible.

Adjustable Frequency Power Inverters used to supply adjustable frequency power to induction motors produce wave forms with lower order harmonics with voltage spikes superimposed. Turn−to−turn, phase−to−phase, and ground insulation of stator windings are subject to the resulting dielectric stresses. Suitable precautions should be taken in the design of these drive systems to minimize the magnitude of these voltage spikes. Consult the drive instructions for maximum acceptable motor lead lengths, and proper grounding.

First Time Start Up Be sure that all power to motor and accessories is off. Be sure the motor shaft is disconnected from the load and will not cause mechanical rotation of the motor shaft.

1. Make sure that the mechanical installation is secure. All bolts and nuts are tightened etc.
2. If motor has been in storage or idle for some time, check winding insulation integrity.
3. Inspect all electrical connections for proper termination, clearance, mechanical strength and electrical continuity.
4. Be sure all shipping materials and braces (if used) are removed from motor shaft.
5. Manually rotate the motor shaft to ensure that it rotates freely.
6. Replace all panels and covers that were removed during installation.
7. Momentarily apply power and check the direction of rotation of the motor shaft.
8. If motor rotation is wrong, be sure power is off and change the motor lead connections. Verify rotation direction before you continue.
9. Start the motor and ensure operation is smooth without excessive vibration or noise. If so, run the motor for 1 hour with no load connected.
10. After 1 hour of operation, disconnect power and connect the load to the motor shaft. Verify all coupling guards and protective devices are installed. Ensure motor is properly ventilated.

Coupled Start Up This procedure assumes a coupled start up. Also, that the first time start up procedure was successful.

1. Check the coupling and ensure that all guards and protective devices are installed.
2. Check that the coupling is properly aligned and not binding.
3. The first coupled start up should be with no load. Apply power and verify that the load is not transmitting excessive vibration back to the motor though the coupling or the foundation. Vibration should be at an acceptable level.
4. Run for approximately 1 hour with the driven equipment in an unloaded condition.

The equipment can now be loaded and operated within specified limits. Do not exceed the name plate ratings for amperes for steady continuous loads.

Jogging and Repeated Starts Repeated starts and/or jogs of induction motors generally reduce the life of the motor winding insulation. A much greater amount of heat is produced by each acceleration or jog than by the same motor under full load. If it is necessary to repeatedly start or jog the motor, it is advisable to check the application with your local Baldor distributor or Baldor Service Center.

Heating - Duty rating and maximum ambient temperature are stated on the motor name plate. Do not exceed these values. If there is any question regarding safe operation, contact your local Baldor District Office or Baldor Service Center.

Section 3
Maintenance & Troubleshooting

WARNING: UL Listed motors must only be serviced by UL Approved Authorized Baldor Service Centers if these motors are to be returned to a hazardous and/or explosive atmosphere.

General Inspection Inspect the motor at regular intervals, approximately every 500 hours of operation or every 3 months, whichever occurs first. Keep the motor clean and the ventilation openings clear. The following steps should be performed at each inspection:

WARNING: Do not touch electrical connections before you first ensure that power has been disconnected. Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the installation, operation and maintenance of this equipment.

1. Check that the motor is clean. Check that the interior and exterior of the motor is free of dirt, oil, grease, water, etc. Oily vapor, paper pulp, textile lint, etc. can accumulate and block motor ventilation. If the motor is not properly ventilated, overheating can occur and cause early motor failure.
2. Use a “Megger” periodically to ensure that the integrity of the winding insulation has been maintained. Record the Megger readings. Immediately investigate any significant drop in insulation resistance.
3. Check all electrical connectors to be sure that they are tight.

Relubrication & Bearings Bearing grease will lose its lubricating ability over time, not suddenly. The lubricating ability of a grease (over time) depends primarily on the type of grease, the size of the bearing, the speed at which the bearing operates and the severity of the operating conditions. Good results can be obtained if the following recommendations are used in your maintenance program.

Type of Grease A high grade ball or roller bearing grease should be used. Recommended grease for standard service conditions is **Polyrex EM (Mobil)**. Do not mix greases unless compatibility has been checked and verified.

Equivalent and compatible greases include:
Texaco Polystar, Rykon Premium #2, Pennzoil Pen 2 Lube and Chevron SRI.

Relubrication Intervals Recommended relubrication intervals are shown in Table 3-1. It is important to realize that the recommended intervals of Table 3-1 are based on average use.

Refer to additional information contained in Tables 3-2, 3-3 and 3-4.

Table 3-1 Relubrication Intervals *

NEMA / (IEC) Frame Size	Rated Speed - RPM					
	10000	6000	3600	1800	1200	900
Up to 210 incl. (132)	**	2700 Hrs.	5500 Hrs.	12000 Hrs.	18000 Hrs.	22000 Hrs.
Over 210 to 280 incl. (180)		**	3600 Hrs.	9500 Hrs.	15000 Hrs.	18000 Hrs.
Over 280 to 360 incl. (225)		**	* 2200 Hrs.	7400 Hrs.	12000 Hrs.	15000 Hrs.
Over 360 to 5800 incl. (300)		**	*2200 Hrs.	3500 Hrs.	7400 Hrs.	10500 Hrs.

* Relubrication intervals are for ball bearings.
For vertically mounted motors and roller bearings, divide the relubrication interval by 2.

** For motors operating at speeds greater than 3600 RPM, contact Baldor for relubrication recommendations.

Table 3-2 Service Conditions

Severity of Service	Hours per day of Operation	Ambient Temperature Maximum	Atmospheric Contamination
Standard	8	40° C	Clean, Little Corrosion
Severe	16 Plus	50° C	Moderate dirt, Corrosion
Extreme	16 Plus	>50° C* or Class H Insulation	Severe dirt, Abrasive dust, Corrosion, Heavy Shock or Vibration
Low Temperature		<–29° C **	

* Special high temperature grease is recommended (Dow Corning DC44). Note that Dow Corning DC44 grease does not mix with other grease types. Thoroughly clean bearing & cavity before adding grease.

** Special low temperature grease is recommended (Aeroshell 7).

Table 3-3 Relubrication Interval Multiplier

Severity of Service	Multiplier
Standard	1.0
Severe	0.5
Extreme	0.1
Low Temperature	1.0

Some motor designs use different bearings on each motor end. This is normally indicated on the motor nameplate. In this case, the larger bearing is installed on the motor Drive endplate. For best relubrication results, only use the appropriate amount of grease for each bearing size (not the same for both).

Table 3-4 Bearings Sizes and Types

Frame Size NEMA (IEC)	Bearing Description (These are the "Large" bearings (Shaft End) in each frame size)			
	Bearing	Weight of Grease to add * oz (Grams)	Volume of grease to be added	
			in^3	teaspoon
56 to 140 (90)	6203	0.08 (2.4)	0.15	0.5
140 (90)	6205	0.15 (3.9)	0.2	0.8
180 (100–112)	6206	0.19 (5.0)	0.3	1.0
210 (132)	6307	0.30 (8.4)	0.6	2.0
250 (160)	6309	0.47 (12.5)	0.7	2.5
280 (180)	6311	0.61 (17)	1.2	3.9
320 (200)	6312	0.76 (20.1)	1.2	4.0
360 (225)	6313	0.81 (23)	1.5	5.2
400 (250)	6316	1.25 (33)	2.0	6.6
440 (280)	6319	2.12 (60)	4.1	13.4
5000 to 5800 (315–450)	6328	4.70 (130)	9.2	30.0
5000 to 5800 (315–450)	NU328	4.70 (130)	9.2	30.0
360 to 449 (225–280)	NU319	2.12 (60)	4.1	13.4
AC Induction Servo				
76 Frame 180 (112)	6207	0.22 (6.1)	0.44	1.4
77 Frame 210 (132)	6210	0.32 (9.0)	0.64	2.1
80 Frame 250(160)	6213	0.49 (14.0)	0.99	3.3

* Weight in grams = .005 DB of grease to be added

Note: Not all bearing sizes are listed. For intermediate bearing sizes, use the grease volume for the next larger size bearing.

Caution: To avoid damage to motor bearings, grease must be kept free of dirt. For an extremely dirty environment, contact your Baldor distributor or an authorized Baldor Service Center for additional information.

Relubrication Procedure Be sure that the grease you are adding to the motor is compatible with the grease already in the motor. Consult your Baldor distributor or an authorized service center if a grease other than the recommended type is to be used.

Caution: Do not over−lubricate motor as this may cause premature bearing failure.

With Grease Outlet Plug

1. With the motor stopped, clean all grease fittings with a clean cloth.
2. Remove grease outlet plug.

Caution: Over−lubricating can cause excessive bearing temperatures, premature lubrication breakdown and bearing failure.

3. Add the recommended amount of grease.
4. Operate the motor for 15 minutes with grease plug removed. This allows excess grease to purge.
5. Re-install grease outlet plug.

Without Grease Provisions

Note: Only a Baldor authorized and UL or CSA certified service center can disassemble a UL/CSA listed explosion proof motor to maintain it's UL/CSA listing.

1. Disassemble the motor.
2. Add recommended amount of grease to bearing and bearing cavity. (Bearing should be about 1/3 full of grease and outboard bearing cavity should be about 1/2 full of grease.)
3. Assemble the motor.

Sample Relubrication Determination

Assume - NEMA 286T (IEC 180), 1750 RPM motor driving an exhaust fan in an ambient temperature of 43° C and the atmosphere is moderately corrosive.

1. Table 3-1 list 9500 hours for standard conditions.
2. Table 3-2 classifies severity of service as "Severe".
3. Table 3-4 shows that 1.2 in^3 or 3.9 teaspoon of grease is to be added.

Note: Smaller bearings in size category may require reduced amounts of grease.

Table 3-5 Troubleshooting Chart

Symptom	Possible Causes	Possible Solutions
Motor will not start	Usually caused by line trouble, such as, single phasing at the starter.	Check source of power. Check overloads, fuses, controls, etc.
Excessive humming	High Voltage.	Check input line connections.
	Eccentric air gap.	Have motor serviced at local Baldor service center.
Motor Over Heating	Overload. Compare actual amps (measured) with nameplate rating.	Locate and remove source of excessive friction in motor or load. Reduce load or replace with motor of greater capacity.
	Single Phasing.	Check current at all phases (should be approximately equal) to isolate and correct the problem.
	Improper ventilation.	Check external cooling fan to be sure air is moving properly across cooling fins. Excessive dirt build-up on motor. Clean motor.
	Unbalanced voltage.	Check voltage at all phases (should be approximately equal) to isolate and correct the problem.
	Rotor rubbing on stator.	Check air gap clearance and bearings.
		Tighten “Thru Bolts”.
	Over voltage or under voltage.	Check input voltage at each phase to motor.
	Open stator winding.	Check stator resistance at all three phases for balance.
	Grounded winding.	Perform dielectric test and repair as required.
	Improper connections.	Inspect all electrical connections for proper termination, clearance, mechanical strength and electrical continuity. Refer to motor lead connection diagram.
Bearing Over Heating	Misalignment.	Check and align motor and driven equipment.
	Excessive belt tension.	Reduce belt tension to proper point for load.
	Excessive end thrust.	Reduce the end thrust from driven machine.
	Excessive grease in bearing.	Remove grease until cavity is approximately $^3/_4$ filled.
	Insufficient grease in bearing.	Add grease until cavity is approximately $^3/_4$ filled.
	Dirt in bearing.	Clean bearing cavity and bearing. Repack with correct grease until cavity is approximately $^3/_4$ filled.
Vibration	Misalignment.	Check and align motor and driven equipment.
	Rubbing between rotating parts and stationary parts.	Isolate and eliminate cause of rubbing.
	Rotor out of balance.	Have rotor balance checked are repaired at your Baldor Service Center.
	Resonance.	Tune system or contact your Baldor Service Center for assistance.
Noise	Foreign material in air gap or ventilation openings.	Remove rotor and foreign material. Reinstall rotor. Check insulation integrity. Clean ventilation openings.
Growling or whining	Bad bearing.	Replace bearing. Clean all grease from cavity and new bearing. Repack with correct grease until cavity is approximately $^3/_4$ filled.

Suggested bearing and winding RTD setting guidelines

Most large frame AC Baldor motors with a 1.15 service factor are designed to operate below a Class B (80°C) temperature rise at rated load and are built with a Class H winding insulation system. Based on this low temperature rise, RTD (Resistance Temperature Detectors) settings for Class B rise should be used as a starting point. Some motors with 1.0 service factor have Class F temperature rise.

The following tables show the suggested alarm and trip settings for RTDs. Proper bearing and winding RTD alarm and trip settings should be selected based on these tables unless otherwise specified for specific applications.

If the driven load is found to operate well below the initial temperature settings under normal conditions, the alarm and trip settings may be reduced so that an abnormal machine load will be identified.

The temperature limits are based on the installation of the winding RTDs imbedded in the winding as specified by NEMA. Bearing RTDs should be installed so they are in contact with the outer race on ball or roller bearings or in direct contact with the sleeve bearing shell.

Winding RTDs – Temperature Limit In °C (40°C Maximum Ambient)

Motor Load	Class B Temp Rise ≤ 80°C (Typical Design)		Class F Temp Rise ≤ 105°C		Class H Temp Rise ≤ 125°C	
	Alarm	Trip	Alarm	Trip	Alarm	Trip
≤ Rated Load	130	140	155	165	175	185
Rated Load to 1.15 S.F.	140	150	160	165	180	185

Note: • Winding RTDs are factory production installed, not from Mod–Express.
• When Class H temperatures are used, consider bearing temperatures and relubrication requirements.

Bearing RTDs – Temperature Limit In °C (40°C Maximum Ambient)

Bearing Type Oil or Grease	Anti–Friction		Sleeve	
	Alarm	Trip	Alarm	Trip
Standard*	95	100	85	95
High Temperature**	110	115	105	110

Note: * Bearing temperature limits are for standard design motors operating at Class B temperature rise.
** High temperature lubricants include some special synthetic oils and greases.

Greases that may be substituted that are compatible with Polyrex EM (but considered as “standard” lubricants) include the following:

- Texaco Polystar
- Mobilith SHC–100
- Darmex 707
- Rykon Premium #2
- Pennzoil Pennzlube EM–2
- Darmex 711
- Chevron SRI #2
- Chevron Black Pearl
- Petro–Canada Peerless LLG

See the motor nameplate for replacement grease or oil recommendation.
Contact Baldor application engineering for special lubricants or further clarifications.

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MN400
2/09

Specifications: JMM2394T-5

SPEC. NUMBER:	07H300W678
CATALOG NUMBER:	JMM2394T-5
FL AMPS:	13.5
208V AMPS:	--
BEARING-DRIVE-END:	6309
BEARING-OPP-DRIVE-END:	6307
DESIGN CODE:	A
DOE-CODE:	010A
FL EFFICIENCY:	90.2
ENCLOSURE:	TEFC
FRAME:	254JM
HERTZ:	60
INSULATION-CLASS:	F
KVA-CODE:	K
SPEED [rpm]:	3450
OUTPUT [hp]:	15
PHASE:	3
POWER-FACTOR:	91
RATING:	40C AMB-CONT
SERIAL-NUMBER:	--
SERVICE FACTOR:	1.15
VOLTAGE:	575

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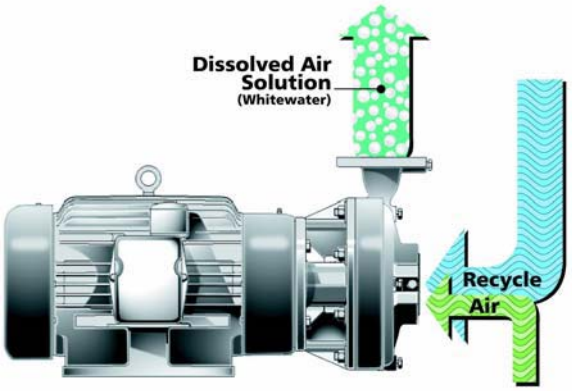
DISSOLVED AIR FLOTATION PUMPS

THE NEW STANDARD FOR INDUSTRIAL AND MUNICIPAL WASTEWATER TREATMENT

What is a HELLBENDER© DAF Pump, and how is it used?

- Specially designed to be used in dissolved air flotation (DAF) systems, which are used to remove solids, oils, and greases from water, wastewater, and other waste streams.
- Clarified effluent from a DAF unit is pumped by the DAF pump under high pressure. Air is introduced into the pump suction either by an eductor loop or by compressed air. The air is sheared into small bubbles by the pump and then dissolved into the water by the high pressure.
- When this air-water solution is released into the incoming waste stream at atmospheric pressure, the air comes out of solution in the form of tiny (~10-50 micron) bubbles. These tiny bubbles attach to oil, grease, and solid particles and float them to the surface of the DAF unit. The floated material is then removed from the surface by a skimming device.



How is the HELLBENDER© DAF Pump different from a regular centrifugal pump?

- Specially designed to operate at high (~100 psi) pressures and pump water with entrained air ***without cavitating.***
- Capable of achieving 100% of theoretical air-in-water saturation.
- Higher air dissolving efficiency vs. standard centrifugal pumps due to high pressure and unique design.
- Efficiently shears incoming air into smaller bubbles, allowing for large amounts of air to be entrained in the water.

Features of the HELLBENDER© DAF Pump

- Simple single-stage, single-impeller design
- Reliable, long life
- Available in bronze-fitted or all-bronze models
- Supplied with mechanical seals and rugged Baldor motors
- Superior whitewater production with very fine bubbles
- Available as a replacement recycle pump for existing DAF systems, or can be packaged as part of a complete whitewater system for gravity settler/skimmer retrofits

The HELLBENDER© DAF Pump vs. other DAF pumps

- **Made in the USA**
- Pumps and parts in stock for quick delivery
- Enclosed impeller allows for **greater solids handling capability** than other DAF pumps
- Replaceable wear ring prevents erosion of pump casing due to high velocities in suction area of pump
- **No intake throttling required, eliminating cavitation due to throttling and extending pump life**
- Single impeller reduces capital and maintenance costs and simplifies maintenance
- Can be used either with an eductor loop or with a compressed air source
- **Application assistance from highly experienced technical staff**
- Close-coupled, eliminating the need for alignment and an external coupling and baseplate
- Compact footprint

Distributed Worldwide by Environmental Treatment Systems, Inc.
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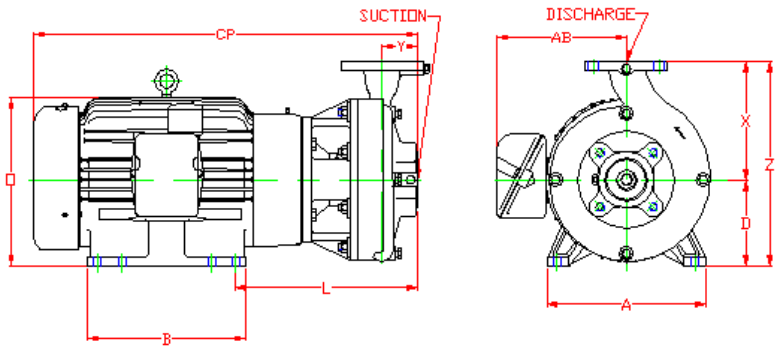

NOTES:
1. ALL DIMENSIONS +/-.030, UNLESS OTHERWISE SPECIFIED.
2. DIMENSIONS SHOWN ARE APPROXIMATE DIMENSIONS FOR STANDARD PUMPS EQUIPPED WITH TEFC MOTORS. DO NOT USE FOR CONSTRUCTION PURPOSES.

Dimensions

PUMP	SUCT	DISC	A	AB	B	CP	D	L	O	X	Y	Z
HB-60	2	1½	11-1/2	9-13/32	9-3/4	26-3/8	6-1/4	13-1/2	12-3/16	9	3	15-1/4
HB-90	2	1½	11-1/2	9-13/32	9-3/4	26-3/8	6-1/4	13-1/2	12-3/16	9	3	15-1/4
HB-150	2½	2	11-1/2	9 -13/32	11-1/2	27-3/4	6-1/4	13-5/32	12-3/16	8-1/2	2-9/16	14-3/4
HB-250	2½	2	12-3/4	13-1/8	12-7/8	31-1/2	7	13-5/32	14-7/16	8-1/2	2-9/16	15-1/2

Note: Dimensional drawing shows flanged pump; however, HB-60 and HB-90 are supplied with NPT, not flanged, connections.

Performance and Features

PUMP MODEL	HB-60	HB-90	HB-150	HB-250
PERFORMANCE				
Flow, nominal	60 GPM	90 GPM	150 GPM	250 GPM
Pressure, nominal	100 PSI	100 PSI	100 PSI	100 PSI
Max Solids Size	3/16"	3/16"	3/8"	3/8"
PHYSICAL CHARACTERISTICS				
Motor Size	15 HP	15 HP	20 HP	30 HP
Motor Speed	3500 RPM	3500 RPM	3500 RPM	3500 RPM
Motor Design	TEFC, 230/460 V, 60 Hz	TEFC, 230/460 V, 60Hz	TEFC, 230/460 V, 60Hz	TEFC, 230/460 V, 60Hz
Suction	2" NPT	2" NPT	2½" ANSI 125#	2½" ANSI 125#
Discharge	1½" NPT	1½" NPT	2" ANSI 125# FF	2" ANSI 125# FF
Weight w/ motor	279 lb	279 lb	330 lb	495 lb

Materials of Construction

MODEL	CASING	IMPELLER	WEAR RING	SHAFT/SLEEVE	MECHANICAL SEAL
Bronze-Fitted	Cast Iron	Bronze	Bronze	Steel/Bronze	Carbon/Ceramic/Buna,Viton,EPT
All-Bronze	Bronze	Bronze	Bronze	Steel/Bronze	Carbon/Ceramic/Buna,Viton,EPT

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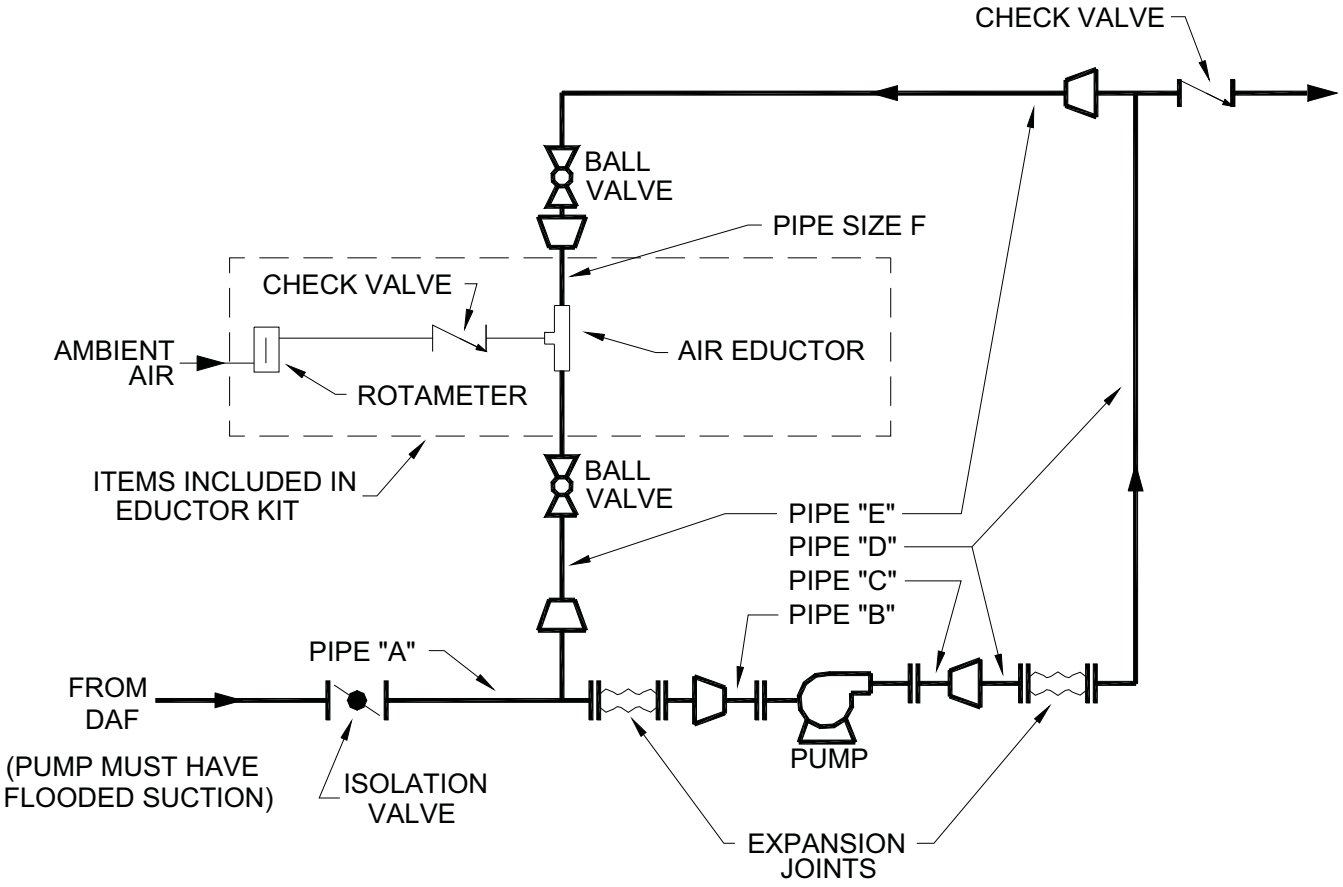
INSTALLATION

The line diagrams below show two suggested installation options. The first (Figure 1) uses an eductor loop with ambient or compressed air, while the second (Figure 2) uses regulated compressed air without an eductor loop. Table 1 below the diagrams shows suggested line sizes for each pump size. These line sizes are general guidelines only; the customer must select and/or verify the line sizes needed for each application.

NOTE: The pump must be installed with flooded suction.

Figure 1. Suggested Installation WITH an eductor loop



INSTALLATION DIAGRAM - AIR INJECTION WITH AIR EDUCTOR

HELLBENDER© DAF Pumps

INSTALLATION, OPERATING, AND MAINTENANCE INSTRUCTIONS

HB-60, HB-90, HB-150, HB-250

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TABLE OF CONTENTS

SAFETY 1

INSTALLATION 2

OPERATION 4

ACCESSORIES 6

MAINTENANCE 7

SAFETY RECOMMENDATIONS

GENERAL

1. Most accidents can be avoided by using common sense.
2. Read the operations and maintenance manual supplied with the pump.
3. Do not wear loose clothing that can become entangled in moving parts.
4. This pump is designed to handle materials which could cause injury, illness, or disease through direct exposure. Wear adequate protective clothing when working on the pump or piping.

PUMP

1. The pump builds up heat and pressure during operation. Allow time for the pump to cool down before handling or servicing.
2. Only qualified and trained personnel should install, operate, and repair the pump.
3. Keep clear of suction and discharge openings. Do not insert fingers into the pump with the power connected.
4. Do not pump flammable materials, or other materials for which the pump was not designed.
5. Do not exceed the manufacturer's recommendations for performance.
6. Do not operate the pump without guards or safety devices in place.
7. For hazardous locations, use pumps that are listed and classified for such locations.
8. Always replace safety devices that have been removed during service or repair.

ELECTRICAL

1. To reduce the risk of electric shock, the pump must be properly grounded in accordance with the National Electric Code and all applicable state and local codes and ordinances.
2. To reduce the risk of electrical shock, disconnect the pump from the power source before handling or servicing.
3. Wiring of pumps should be performed by a qualified electrician.

INSTALLATION

The line diagrams below show two suggested installation options. The first (Figure 1) uses an eductor loop with ambient or compressed air, while the second (Figure 2) uses regulated compressed air without an eductor loop. Table 1 below the diagrams shows suggested line sizes for each pump size. These line sizes are general guidelines only; the customer must select and/or verify the line sizes needed for each application.

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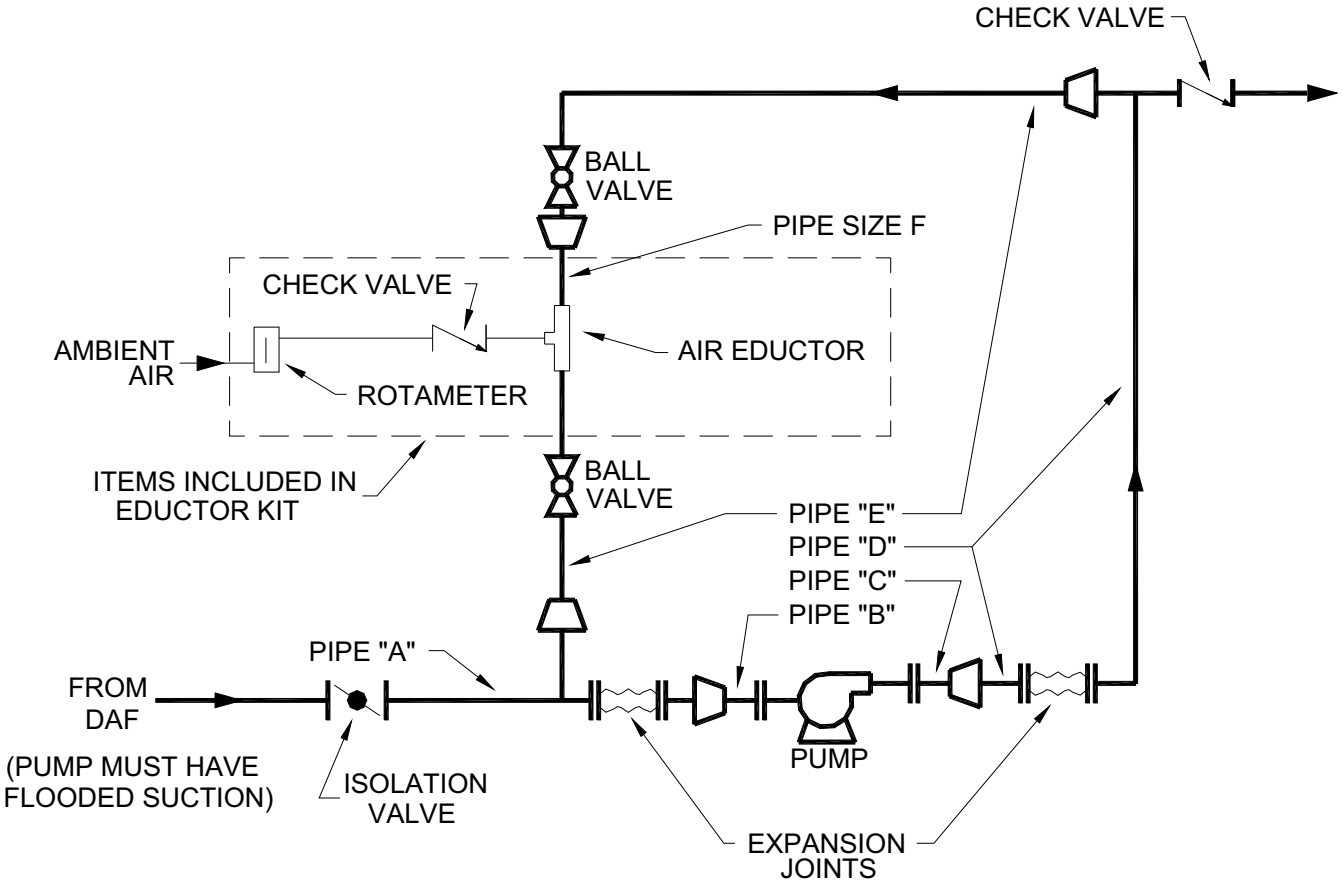
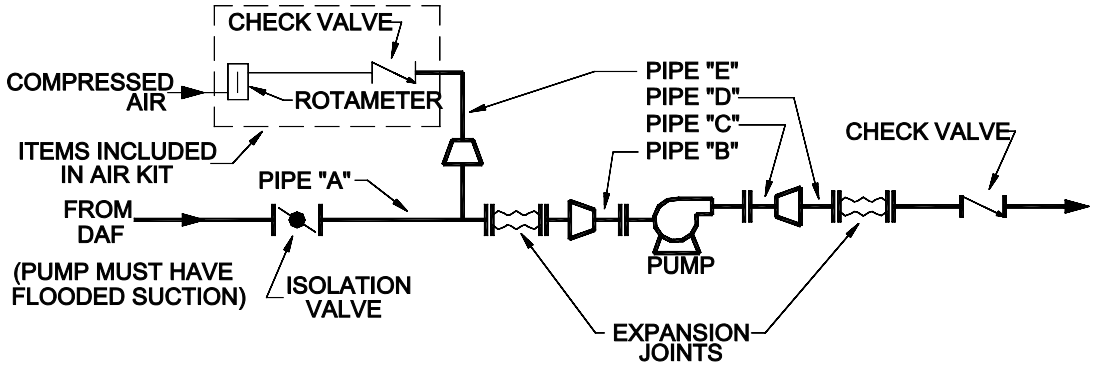


INSTALLATION DIAGRAM - AIR INJECTION WITH AIR EDUCTOR

Figure 2. Suggested Installation WITHOUT an eductor loop

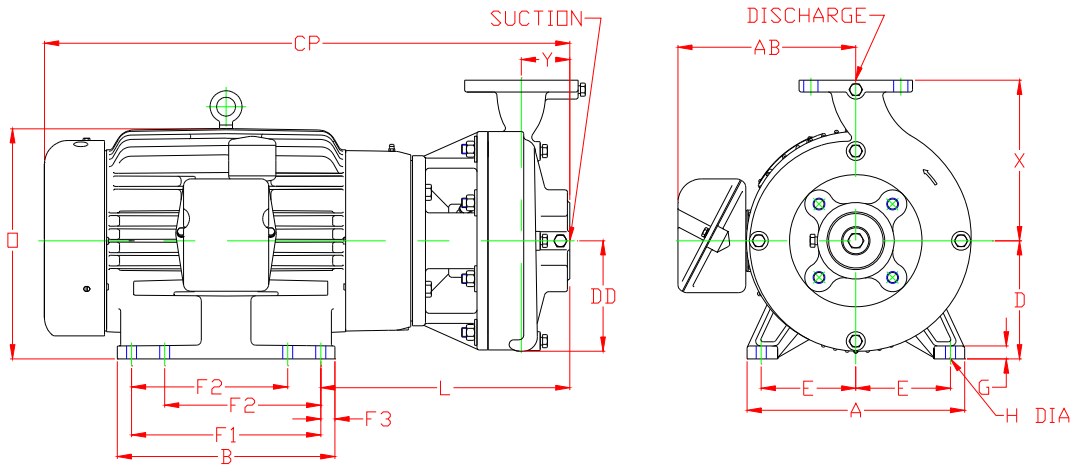


INSTALLATION DIAGRAM - AIR INJECTION WITHOUT AIR EDUCTOR

Table 1. Recommended Pipe Sizes

Pipe	HB-60	HB-90	HB-150	HB-250
A	3"	3"	4"	4"
B	2"	2"	2.5"	2.5"
C	1.5"	1.5"	2"	2"
D	2"	3"	3"	4"
E	1"	1"	1"	1.5"
F	½"	½"	3/4"	1"

Figure 3. Pump Dimensions



NOTES:
1. ALL DIMENSIONS +/-.030, UNLESS OTHERWISE SPECIFIED.
2. DIMENSIONS SHOWN ARE APPROXIMATE DIMENSIONS FOR STANDARD PUMPS EQUIPPED WITH TEFC MOTORS. DO NOT USE FOR CONSTRUCTION PURPOSES.

Table 2. Pump Dimensions (Note: HB-60 and HB-90 pumps feature FPT connections, not flanges)

PUMP	SUCT	DISC	A	AB	B	CP	D	DD	E	F1	F2	F3	G	H	L	O	X	Y
HBP-60	2	1½	11 1/2	9 13/32	9 3/4	26 3/8	6 1/4	5 25/32	5	8 1/4	N/A	N/A	11/16	17/32	13 1/2	12 3/16	9	3
HBP-90	2	1½	11 1/2	9 13/32	9 3/4	26 3/8	6 1/4	5 25/32	5	8 1/4	N/A	N/A	11/16	17/32	13 1/2	12 3/16	9	3
HBP-150	2½	2	11 1/2	9 13/32	11 1/2	27 3/4	6 1/4	5 27/32	5	10	8 1/4	3/4	11/16	17/32	13 5/32	12 3/16	8 1/2	2 9/16
HBP-250	2½	2	12 3/4	13 1/8	12 7/8	31 1/2	7	5 27/32	5 1/2	11	9 1/2	15/16	7/8	21/32	13 5/32	14 7/16	8 1/2	2 9/16

OPERATION

Start-up

1. Before starting the pump, verify that all suction and discharge-side valves are fully open and that any air supply lines, air flow control valves, and eductor loops are fully closed.
2. If starting the pump for the first time, or after the pump has been drained, verify that the pump is primed (i.e., the casing is full of the liquid to be pumped) and that adequate water exists in the DAF to fill the recycle piping.
3. If starting the pump for the first time, or after working on any of the power wiring, "bump" the control power to check the rotation of the pump.
4. Start the pump. As the pump comes to full speed the discharge pressure should rise.
5. Once the pressure has stabilized, increase the pressure on the system to the desired value (the exact method for doing this will depend on the equipment installed).
6. Open the eductor loop valves (if present), keeping the air control valve closed. Readjust the system pressure if needed.
6. Open the air control valve to the desired air flow rate.
7. Readjust the system pressure if needed.

Shutdown

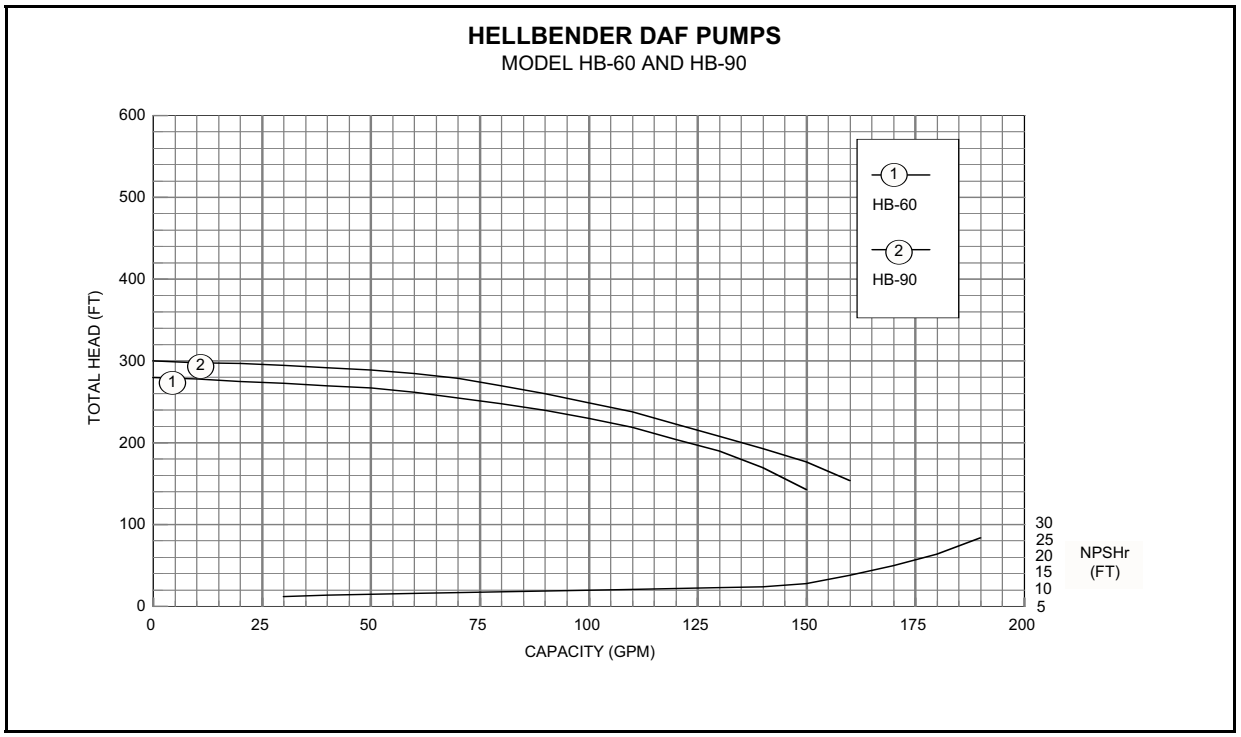
1. Close the air control valve.
2. Fully open all discharge valves.
3. Stop the pump.

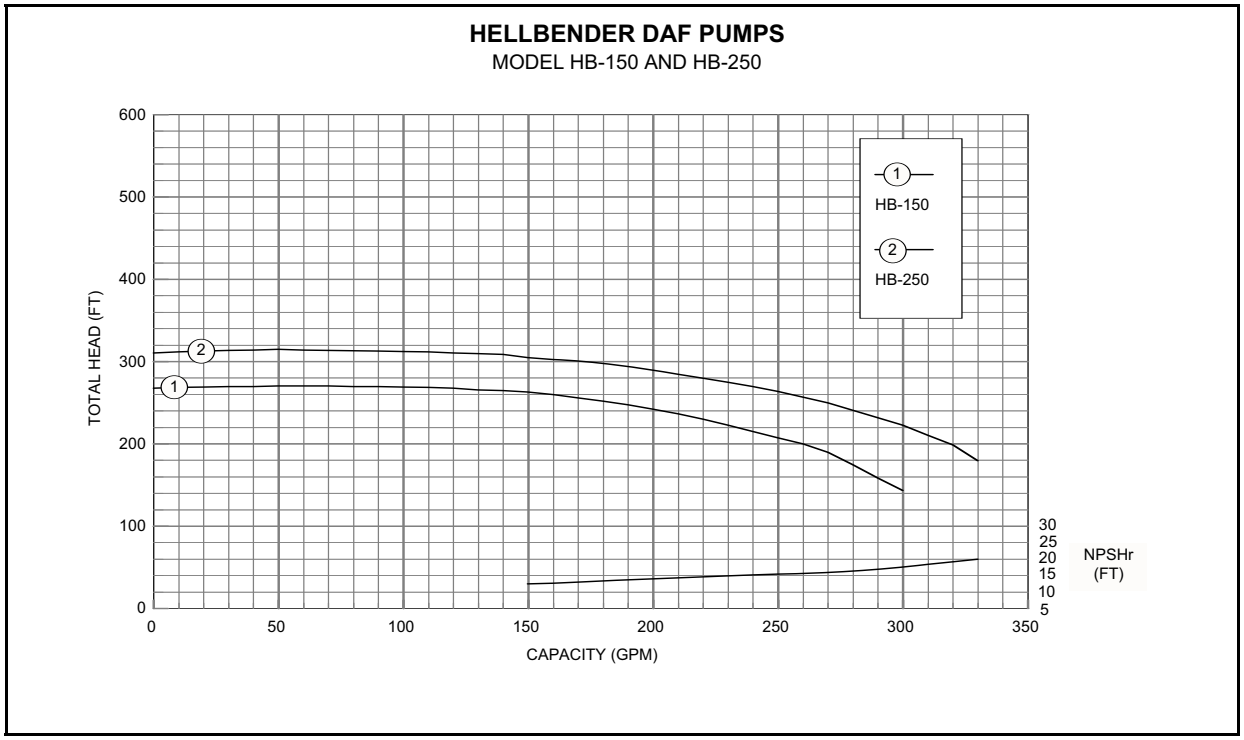
Table 3. Suggested air flow and pressure ranges **(for pump installed with eductor as shown in Figure 1)**

Model	Air flow	Pressure at DAF Inlet (Typical)
HB-60	36 - 48 SCFH	90 psig
HB-90	54 - 72 SCFH	90 psig
HB-150	90 - 120 SCFH	90 psig
HB-250	150 - 200 SCFH	90 psig

Note: Pressures at the pump discharge will be higher than pressures at the DAF listed above. The pressure at the pump should never exceed 115 psi. In addition, it is recommended that the user install a 125 psi relief valve to protect the pump.

Figure 4. Pump Curves





ACCESSORIES

Table 4. Accessory Kit and Eductor Information

	HB-60	HB-90	HB-150	HB-250
Eductor Kit P/N	HB60-EAK	HB90-EAK	HB150-EAK	HB250-EAK
Air Kit P/N	HB60-AAK	HB90-AAK	HB150-AAK	HB250-AAK
Eductor Size	3/4"	3/4"	1"	1.25"
Eductor Intake	½" FPT	½" FPT	3/4" FPT	1" FPT
Eductor Discharge	3/4" MPT	3/4" MPT	1" MPT	1.25" MPT
Rotameter Range	15-100 SCFH	15-100 SCFH	20-180 SCFH	0.4-4.0 SCFM

Notes:
1. Eductor kits include a rotameter, eductor, air check valve, and all fittings and tubing (10 ft) required to connect the rotameter to the check valve and the check valve to the eductor.
2. Air kits include a rotameter, air check valve, and all fittings required to connect the rotameter to the check valve. The check valve has a ½" FPT discharge for connection by the user to the piping system.

MAINTENANCE

Routine maintenance of the pump is not required. Depending on the motor supplied, greasing of the motor may be required. The operator should observe the pump frequently to check for any of the conditions in the Troubleshooting section below.

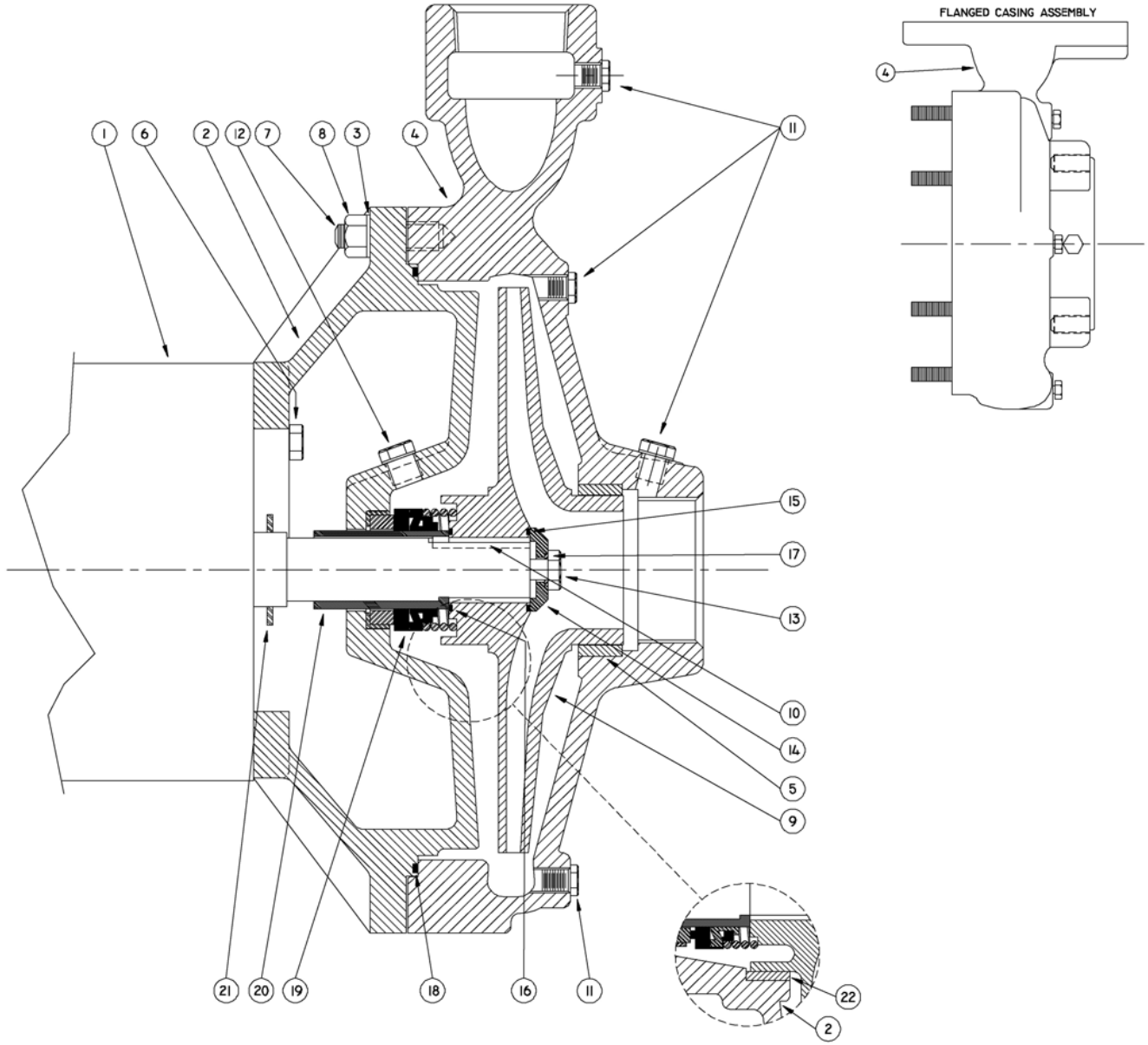
TROUBLESHOOTING

PROBLEM	CAUSE	SOLUTION
Pump is not running	Starter or motor is tripped	Investigate cause, correct, and reset
Pump not running in correct direction	Incoming phases reversed	Reverse any two wires at starter or motor
System relief valve operating excessively	System pressure too high	Open valves on discharge side of pump
Gravelly sound in pump	Pump is cavitating	Increase pump discharge pressure to recommended range
		Adjust air flow to pump to within recommended range
		If using compressed air, reduce incoming air pressure until just high enough to achieve needed air flow
		Check for sufficient flow to pump suction
No air flow	Air valve is closed	Open air valve
	Check valve is plugged	Inspect and clean or replace
	Water in air line	Inspect and clean
	Eductor loop is closed	Adjust valves as needed
	Eductor is plugged	Inspect and clean or replace
		Monitor solids in recycle stream, filter if necessary
	Compressed air supply is off	Check and adjust
Insufficient air flow	Air valve is closed	Open air valve more
	Rotameter is plugged	Clean or replace

TROUBLESHOOTING continued

PROBLEM	CAUSE	SOLUTION
	Debris/water in check valve or air line	Clean or replace
	Eductor loop closed	Open valves as needed to increase motive force in eductor loop
Pump is not achieving desired pressure	Not enough restriction on discharge side of pump	Throttle discharge valves
	Pump casing or impeller is worn	Replace or rebuild pump
No whitewater in DAF	No or insufficient air flow	See above
	No forward flow	See above
Large disruptive bubbles in whitewater	Poor air dissolution due to system design	Adjust system design as needed
	Excessive air flow	Reduce air flow to recommended range
Mechanical seal leaking	Normal wear	Adjust or replace
	Seal broken	Determine cause; replace
Water temperature in eductor loop is high	Insufficient forward flow	Adjust eductor loop
		Rebuild or replace pump

Figure 4. Parts Breakout



SYMBOL NUMBER	QUANTITY	DESCRIPTION
1	1	Motor, 15 HP 3500 RPM TEFC, 254JM Frame, for HB-60 & HB-90
	1	Motor, 20 HP 3500 RPM TEFC, 256JM Frame, for HB-150
	1	Motor, 30 HP 3500 RPM TEFC, 286JM Frame, for HB-250
2	1	Adapter - HB-60, HB-90, HB-150, Bronze Fitted Pumps
	1	Adapter - HB-60, HB-90, HB-150, All Bronze Pumps
	1	Adapter - HB-250, Bronze Fitted Pumps
	1	Adapter - HB-250, All Bronze Pumps
3	12	Lockwasher - SS
4 *	1	Casing Assy. - HB-60, HB-90 Bronze Fitted Pumps
	1	Casing Assy. - HB-60, HB-90 All Bronze Pumps
	1	Casing Assy. - HB-150, HB-250, Bronze Fitted Pumps
	1	Casing Assy. - HB-150, HB-250, All Bronze Pumps
	1	Casing Assy. - HB-150, HB-250 (Flanged), Bronze Fitted Pumps
	1	Casing Assy. - HB-150, HB-250 (Flanged), All Bronze Pumps
5 *	1	Casing Wear Ring, Bronze - HB-60, HB-90
	1	Casing Wear Ring, Bronze - HB-150, HB-250
6	4	Capscrew - HB-60, HB-90, HB-150 Bronze Fitted Pumps
	4	Capscrew - HB-60, HB-90, HB-150 All Bronze Pumps
	4	Capscrew - HB-250
7 *	12	Stud
8	12	Nut
9	1	Impeller - HB-60
	1	Impeller - HB-90
	1	Impeller - HB-150
	1	Impeller - HB-250
10	1	Key
11 *	6	Plug, 1/8" Pipe - Bronze
12	1	Plug, 1/4" Pipe - Bronze

SYMBOL NUMBER	QUANTITY	DESCRIPTION
13	1	Capscrew , SS - For Bronze Fitted Pumps
	1	Capscrew , Bronze - For All Bronze Pumps
14	1	Washer - Bronze
15 +	1	Flat Gasket
	1	O-Ring Gasket - Buna N (Std.)
	1	O-Ring Gasket - Viton
	1	O-Ring Gasket - EPT **
	1	O-Ring Gasket - Teflon
16 +	1	Flat Gasket
	1	O-Ring Gasket - Buna N (Std.)
	1	O-Ring Gasket - Viton
	1	O-Ring Gasket - EPT **
	1	O-Ring Gasket - Teflon
17 +	1	O-Ring Gasket - Buna N (Std.)
	1	O-Ring Gasket - Viton
	1	O-Ring Gasket - EPT **
	1	O-Ring Gasket - Teflon
18 +	1	Flat Gasket
	1	O-Ring Gasket - Buna N (Std.)
	1	O-Ring Gasket - Viton
	1	O-Ring Gasket - EPT **
	1	O-Ring Gasket - Teflon
19 +	1	Mechanical Seal - Buna N (Std.)
	1	Mechanical Seal - Viton
	1	Mechanical Seal - EPT **
20	1	Shaft Sleeve, Bronze
21	1	Slinger Washer

* Casing Assy. Includes Symbols 5, 7, and 11 ** For hot water or caustic service.
\+ Standard HB pumps are supplied with Buna N O-ring type gaskets.

TERMS AND CONDITIONS OF SALE
HELLBENDER DAF PUMPS

OUR ACCEPTANCE OF YOUR ORDER IS EXPRESSLY CONDITIONED ON THE GENERAL TERMS AND CONDITIONS SET FORTH BELOW AND ALL TERMS STATED ON THE FACE OF THIS FORM. THE CONTRACT SHALL NOT INCLUDE ANY DEVIATING OR ADDITIONAL TERMS UNLESS EXPRESSLY AGREED TO IN WRITING AND SIGNED BY AN OFFICER OF OUR COMPANY.

PRICES: All prices are subject to change without notice, and all shipments will be invoiced at the price in effect at the time of shipment, except when otherwise agreed to in writing by our authorized representative. Published prices are for products of our standard design and construction, and any item not covered by the most recent published price list must be referred to us for special pricing. Prices do not include freight. Any weights given in product literature are approximate shipping weights. The amount of any applicable present or future tax or other government charge upon the production, sale, shipment, or use of goods ordered or sold is not included in the price and will be added to billing unless you provide us with an appropriate exemption certificate.

QUOTATIONS: Prices quoted by us are valid for 30 days from the date of quotation unless we have otherwise specified in writing. Clerical errors on quotations are subject to our correction, and such errors will not be binding.

CANCELLATION AND REVISIONS: No purchase orders accepted and acknowledged by us may canceled or revised by you except with our prior written consent and upon payment of reasonable cancellation charges compensating us for all cost incurred in work done and material purchased. We reserve the right to determine what constitutes reasonable cancellation charges.

RETURN OF EQUIPMENT: No equipment shall be returned to us without first obtaining a written Returned Goods Authorization and shipping instructions from us. The returner must prepay the charges in full for transportation to our facility. Credit allowed for new, undamaged equipment of current standard design will be 80% of the invoiced price or the current billing price, whichever is less. Equipment which has been used, however slightly, will not be accepted. Authorization will not be given for return of equipment (1) which would, in our opinion, result in an excess in the amount of stock we normally carry, (2) not invoiced within the last 12 months, or (3) which is non-standard and manufactured specifically to a buyer's specifications. For non-standard equipment not of our manufacture, the only credit allowed will be such credit as may be allowed by the manufacturer of such equipment. Equipment must be returned within 30 days of issuance of the Returned Goods Authorization. No item with a net value of less than $35.00 will be authorized for return. Unauthorized returns may be refused and/or returned freight collect.

CREDIT AND PAYMENT: Payment is due as noted on our invoice. Overdue accounts are subject to a service charge. All orders are subject to approval of our Credit Department, and we may require full or partial payment in advance. *Pro rata* payments shall become due as shipments are made. If the shipments are delayed by you for any cause, payments shall become due from the date on which we are prepared to make shipment, and storage shall be at your risk and expense. If manufacture is delayed by you for any cause, a partial payment based upon the proportion of the order completed shall become due from the date on which we are notified of the delay.

SECURITY INTEREST: We shall have a lien on all goods sold as security for payment on the invoice price, and upon request you shall provide and execute a financing statement showing such a lien.

DELIVERY: We will make reasonable effort to meet your delivery requirement, provided that you provide us, on a timely basis, with all approvals, technical data, instructions, and credit approval requirements needed for release of the shipment. However, all delivery and/or shipment dates are estimates only unless we have expressly guaranteed delivery of such dates in writing at your specific request. In no event shall we have any liability if delivery is delayed by strikes, labor disturbances, material shortages, plant calamities or disaster, acts of God, government actions, civil disturbance, the failure of any pre-supposed condition of the contract, withholding shipments due to credit clearance, or other interferences beyond our reasonable control, and the date of delivery shall be extended for a period of time equal to the time lost because of any such reason.

SHIPPING: Unless you specify in writing and we acknowledge in writing, (A) goods will be boxed or crated as we may deem proper for protection against normal handling and for domestic shipment, and (B) routing and manner of shipment will be at our discretion, and may be insured at your expense. An extra charge will be made for special handling. All shipments are F.O.B. our facility, freight prepaid and added, unless otherwise stated. Delivery of goods to the initial carrier will constitute delivery to you, and all goods will be shipped at your risk. A claim for loss or damage in transit must be entered with the carrier and prosecuted by you. Acceptance of material from a common carrier constitutes a waiver of any claims against us for delay, damage, or loss.

GOVERNING LAW: It is understood that these Terms and Conditions of Sale shall be interpreted under and pursuant to the laws of the State of Georgia. You agree that any action at law or suit which is related to any contract of sale brought against us shall be filed in a federal or state court located in the State of Georgia.

LIMITED WARRANTY:
Materials and Workmanship: We warrant to our immediate customer and to the ultimate consumer that products of our manufacture will be free of defects in material and workmanship under normal use and service for the following time period, when installed and maintained in accordance with our instructions:

Pump Products: One (1) year from date of installation or twenty-four (24) months from date of shipment, whichever occurs first.

As used herein, “the ultimate consumer” is defined as the purchaser who first uses the product after its initial installation or, in the case of product designed for nonpermanent installation, the first owner who used the product. It is the purchaser’s or any sub-vendee’s obligation to make known to the ultimate consumer the terms and conditions of this warranty. This warranty gives you specific legal rights, and there may also be other rights which vary from state to state. In event the product is covered by the Federal Consumer Product Warranties Law, (1) the duration of any implied warranties associated with the product by virtue of said law is limited to the same duration as stated herein, (2) this warranty is a LIMITED WARRANTY, and (3) no claims of any nature whatsoever shall be made against us, until the ultimate consumer, his successor, or assigns, notifies us in writing of the defect, and delivers the product and/or defective part(s) freight prepaid to our facility or authorized repair station. Some states do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply.

THE SOLE AND EXCLUSIVE REMEDY FOR BREACH OF ANY AND ALL WARRANTIES WITH RESPECT TO ANY PRODUCT SHALL BE TO REPLACE OR REPAIR AT OUR ELECTION, F.O.B. OUR FACILITY OR AUTHORIZED REPAIR STATION, SUCH PRODUCTS AND/OR PARTS AS PROVEN DEFECTIVE. THERE SHALL BE NO FURTHER LIABILITY, WHETHER BASED ON WARRANTY, NEGLIGENCE, OR OTHERWISE.

Unless expressly stated otherwise, guarantees in the nature of performance specifications furnished in addition to the foregoing material and workmanship warranties on a product manufactured by us, if any, are subject to laboratory tests corrected for field performance. Any additional guarantees in the nature of performance specifications must be in writing, and such writing must be signed by our authorized representative. Due to inaccuracies in field testing, if a conflict arises between the results of field testing conducted by or for user, and laboratory tests corrected for field performance, the latter shall control. Components or accessories supplied by us but manufactured by others are warranted only to the extent of and by the terms and conditions of the original manufacturer’s warranty.

This warranty shall not apply when damage is caused by (a) improper installation, (b) improper voltage, (c) lightning, (d) sand or other abrasive material, or (e) scale or corrosion build-up due to excessive chemical content. Any modification of the original equipment will also void the warranty. We will not be responsible for loss, damage, or labor cost due to interruption of service caused by defective parts. Neither will we accept charges incurred by others without our prior written approval. This warranty is void if our inspection reveals that the product was used in a manner inconsistent with normal industry practice and/or our specific recommendations. The purchaser is responsible for communication of all necessary information regarding the application and use of the product.

UNDER NO CIRCUMSTANCES WILL WE BE RESPONSIBLE FOR ANY OTHER DIRECT OR CONSEQUENTIAL DAMAGES, INCLUDING BUT NOT LIMITED TO LOST PROFITS, LOST INCOME, LABOR CHARGES, DELAYS IN PRODUCTION, IDLE PRODUCTION, WHICH DAMAGES ARE CAUSED BY ANY DEFECTS IN MATERIAL AND/OR WORKMANSHIP AND/OR DAMAGE OR DELAYS IN SHIPMENT. THIS WARRANTY IS EXPRESSLY IN

LIEU OF ANY OTHER EXPRESS OR IMPLIED WARRANTY, INCLUDING ANY WARRANTY OR MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

No rights extended under this warranty shall be assigned to any other person, whether by operation of law or otherwise, without our prior written approval.

If any litigation is commenced between the parties hereto for the enforcement of any rights hereunder, the successful party in subject litigation shall be entitled to receive from the unsuccessful party all costs incurred in connection therewith, including a reasonable amount for attorney's fees.

YOUR ACCEPTANCE OF ANY GOODS SUPPLIED BY US, OR ON OUR BEHALF, SHALL WITHOUT LIMITATION CONSTITUTE ACCEPTANCE OF ALL TERMS AND CONDITIONS STATED ABOVE.

ENVIRONMENTAL TREATMENT SYSTEMS, INC.

Revised Quotation

To:	*AMEC*
Attn:	*Ali Williams*
Phone	
Fax:	
Email:	*ali.williams@amec.com*

Quotation	qte201105252011-hbp-r1
Date:	May 31, 2011
Quote Valid:	For 30 days from above
Quoted By:	Nathan Welden

Item No.	Description	Qty	Unit Cost	Total Cost
1	**HELLBENDER**© DAF Recycle Pump Head Model HB60-AB. All bronze centrifugal pump head rated for 60 GPM at 100 psi with air-water mixture. Close coupled, mechanical seal, **(WE CURRENTLY HAVE ONE IN STOCK)**	1	$4,890.00	$4,890.00
2	**HELLBENDER**© DAF pump accessory kit #HB60-EAK Kit includes PVC air eductor, air rotameter with control valve, air line check valve, and the required tubing and fittings to connect the rotameter to the eductor.	1	$704.00	$704.00
Terms: **Payment due in full 15 days after delivery.** **Client is responsible for all shipping charges** **Client is responsible for all installation costs** ****Shipping, handling, and installation are not included**** ****Quotation excludes any applicable sales tax****				
			SUBTOTAL	$5,594.00
			TOTAL	**$5,594.00**

HARMSCO® HURRICANE® FILTERS

HARMSCO® Hurricane® Filters provide exceptionally long filter runs, reduced maintenance and lower filtration costs when used as combination centrifugal separator and cartridge filter or in conventional filtration applications.

HOW THEY WORK

Centrifugal Separation to Remove Dense Particles from Liquids

Liquid enters the Hurricane filter's outer chamber tangentially, producing a rotational flow. This flow pattern creates a centrifugal force which is used to separate dense particles such as sand, rust, grit and metal fines from liquids. Heavy particles drop to the bottom of the filter's outer chamber where they are discharged manually, automatically or continuously. With the dense particles removed, liquid and light solids rise up, over and into an inner chamber where the rotational flow is continued.

Up-flow Cartridge Filtration and Angled Pleats for Lightweight Particle Removal

Trapped air is automatically purged due to principal of up-flow filtration. Filtered liquid exits the filter at the highest point, as it is filtered. A secure top plate prevents cross contamination of filtered and unfiltered liquid. This patented up-flow design allows Harmsco to utilize 100% of cartridge surface area, providing efficient filtration. Filter efficiencies are dramatically improved to provide longer filter runs and reduced filtration costs. Harmsco® Hurricane® filter cartridges for the Waterbetter® filters are available in a wide range of micron ratings and may be cleaned and re-used in most applications and most micron ratings.

Models & Specifications

Three Hurricane® Filter models are available for a wide range of applications. Models and specifications are as follows:

SPECIFICATION	HUR 40 HP	HUR 90 HP	HUR 170 HP
Flow rate (GPM)	Up to 50	Up to 100	Up to 150
Filter area (pleated)	40 sq. ft.	90 sq. ft.	170 sq. ft.
Pipe sizes, inlet & outlet	2" NPT	2" NPT	2" NPT
Pipe size, drain	1" NPT	1" NPT	1" NPT
Filter height	21"	31"	41"
Filter diameter	13"	13"	13"
Floor space required	15"x15"	15"x15"	15"x15"
Service height clearance	31"	51"	72"
Shipping weight (approx.)	40 lbs.	51 lbs.	64 lbs.
Temperature rating*	140° (60°C)	140° (60°C)	140° (60°C)

**Varies based on pressure and time under load.*

Features

Product features include:

- 304 stainless steel filter housings
- Electro-polished for superior finish
- Resistant coatings available
- Fail-safe lids with individual studs for security
- Brass wing-nuts for convenience
- 90˚ elbow and 45˚ sweep on outlet for in-line vertical installation
- CPVC standpipe for up-flow design
- Choice of cartridges available

HUR 40 HP

HUR 90 HP

HUR 170 HP

Temperature & Pressure Ratings

Hurricane® Filters are rated for pressures to 150 psi and temperatures to 140°F.

Sizing

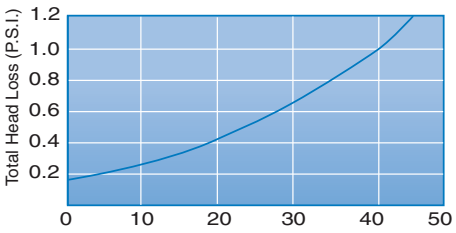
Use the chart shown below to size Hurricane® Filters for your application:

Flow Rate	Recommended Model	Pleated Filter Area
Up to 50 GPM	HUR 40 HP	40 sq. ft.
Up to 100 GPM	HUR 90 HP	90 sq. ft.
Up to 150 GPM	HUR 170 HP	170 sq. ft.
Up to 300 GPM	HUR 170 HP (two filters*)	340 sq. ft. (two filters*)
Up to 450 GPM	HUR 170 HP (three filters*)	510 sq. ft. (three filters*)
Up to 600 GPM	HUR 170 HP (four filters*)	680 sq. ft. (four filters*)
Up to 750 GPM	HUR 170 HP (five filters*)	850 sq. ft. (five filters*)

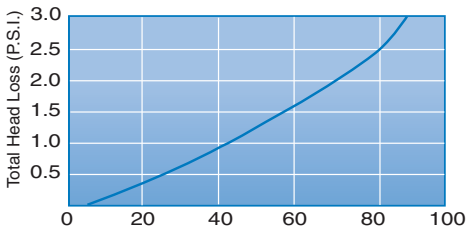
**Parallel installation with valves to isolate filters for service while other filters are operational.*

Pressure Drop

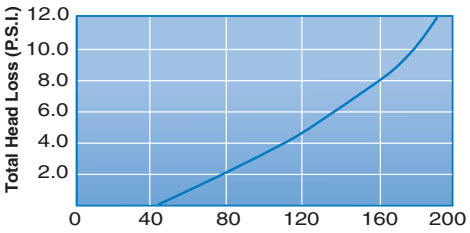
The total head loss data shown below was developed by NSF International and indicates pressure drop with Hurricane® Filter and one micron filter cartridge in clean water.



Pressure drop HUR 40 HP



Pressure drop HUR 90 HP



Pressure drop HUR 170 HP

Harmsco® Hurricane® Replacement Cartridges

Hurricane® replacement cartridges are available in a wide range of nominal ratings, shown right.

Cartridges are rated for temperatures to 140˚F and may be used to separate solids in liquids with a pH of 3 to 11.

Packaged one cartridge per carton.

Filter Model	Cartridge Product Code	Nominal Micron	Cartridge Dimensions			Ship Wt./Ctn. (One Cartridge)
HUR 40 HP	HC/40-0.35	0.35	9 5/8”	7 3/4”	3” FPT	4 lbs.
	HC/40-1	1	9 5/8”	7 3/4”	3” FPT	4 lbs.
	HC/40-5	5	9 5/8”	7 3/4”	3” FPT	4 lbs.
	HC/40-10	10	9 5/8”	7 3/4”	3” FPT	4 lbs.
	HC/40-20	20	9 5/8”	7 3/4”	3” FPT	4 lbs.
	HC/40-50	50	9 5/8”	7 3/4”	3” FPT	4 lbs.
	HC/40-100	100	9 5/8”	7 3/4”	3” FPT	4 lbs.
	HC/40-150	150	9 5/8”	7 3/4”	3” FPT	4 lbs.
	HC/40-EZ-CLEAN	NR*	9 5/8”	7 3/4”	3” FPT	4 lbs.
HUR 90 HP	HC/90-0.35	0.35	19 1/2”	7 3/4”	3” FPT	7 lbs.
	HC/90-1	1	19 1/2”	7 3/4”	3” FPT	7 lbs.
	HC/90-5	5	19 1/2”	7 3/4”	3” FPT	7 lbs.
	HC/90-10	10	19 1/2”	7 3/4”	3” FPT	7 lbs.
	HC/90-20	20	19 1/2”	7 3/4”	3” FPT	7 lbs.
	HC/90-50	50	19 1/2”	7 3/4”	3” FPT	7 lbs.
	HC/90-100	100	19 1/2”	7 3/4”	3” FPT	7 lbs.
	HC/90-150	150	19 1/2”	7 3/4”	3” FPT	7 lbs.
	HC/90-EZ-CLEAN	NR*	19 1/2”	7 3/4”	3” FPT	7 lbs.
HUR 170 HP	HC/170-0.35	0.35	30 3/4”	7 3/4”	3” FPT	10 lbs.
	HC/170-1	1	30 3/4”	7 3/4”	3” FPT	10 lbs.
	HC/170-5	5	30 3/4”	7 3/4”	3” FPT	10 lbs.
	HC/170-10	10	30 3/4”	7 3/4”	3” FPT	10 lbs.
	HC/170-20	20	30 3/4”	7 3/4”	3” FPT	10 lbs.
	HC/170-50	50	30 3/4”	7 3/4”	3” FPT	10 lbs.
	HC/170-100	100	30 3/4”	7 3/4”	3” FPT	10 lbs.
	HC/170-150	150	30 3/4”	7 3/4”	3” FPT	10 lbs.
	HC/170-EZ-CLEAN	NR*	30 3/4”	30 3/4”	3” FPT	10 lbs.

Activated carbon and Poly-Pleat 380 and 400® cartridges available. Please see catalog. * NR - not rated

Cartridge Cleaning Instructions

Hurricane® cartridges are made of Polyester Plus™, a proprietary blend of polyester fibers which can be cleaned in most applications and micron ratings to make Hurricane® filter elements reusable! For best results, follow the directions described below:

When Cartridge Cleaning is Possible

Clean cartridge when pressure differential is 12 psi above startup differential.

Non-cleanable Applications

Replace cartridge when pressure differential is 30 psi above start-up differential or when flow has diminished to an unacceptable level, indicating cartridge is at capacity.

Cartridge Removal

To remove filter cartridge, drain filter housing. Remove wing-nuts and lid. Hold cross-bar in retainer nut and pull upward to remove filter cartridge and top plate from filter housing. Follow cleaning instructions described herein.

Lid Replacement

Replace wing-nuts systematically, rotating around filter. "Finger tight" is normally sufficient. However, in extreme duty applications it may be necessary to tighten to 75 inch lbs. of torque. Overtightening can cause damage to the rim gasket.

Cartridge Cleaning in Aqueous Applications

For best results, clean cartridges with pressure nozzle using standard hose. Direct spray at an angle to remove particulate (see photo). Follow these directions to remove oils, organic matter, algae and mineral deposits.

OILS: Soak cartridge in a solution of tri-sodium phosphate or similar strong detergent (2 lbs. to 10 gallons of water). Soak up to 12 hours for best results. Rinse after bath.

Caution: Do not rinse cartridges with acid until oils and organic matter are removed. Use detergent first and follow with acid bath for mineral removal. Flush cartridges with water after muriatic or tri-sodium phosphate baths.

ORGANIC MATTER, ALGAE: Use tri-sodium phosphate solution as described above, plus 1 pint of liquid chlorine to kill organic matter and algae. Soak cartridge one hour or longer until surface is no longer "slippery." Rinse after bath.

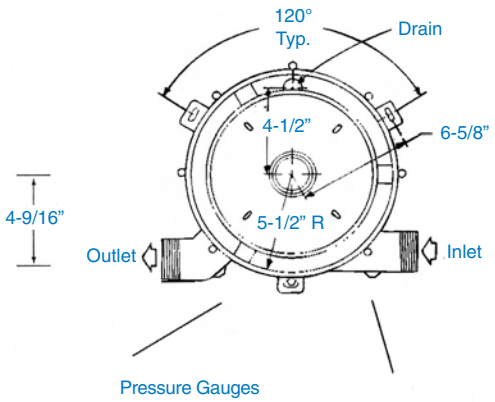
CALCIUM MINERAL DEPOSITS: Follow directions for "oils" described above. Soak cartridge for approximately ten minutes in a solution of one part of muriatic acid to twenty parts of water. Rinse cartridge thoroughly with water.

When Cartridge Cleaning is Not Possible

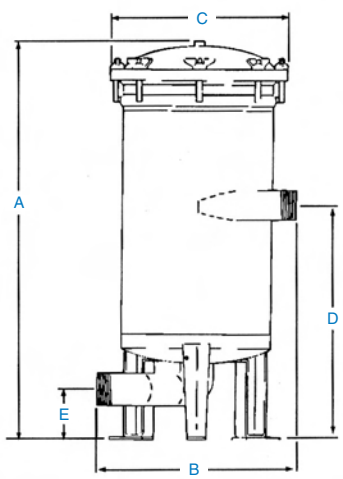
Generally, it is not possible to clean Hurricane® filter cartridges when filtering petroleum-base liquids, toxic substances, and one and below micron applications.

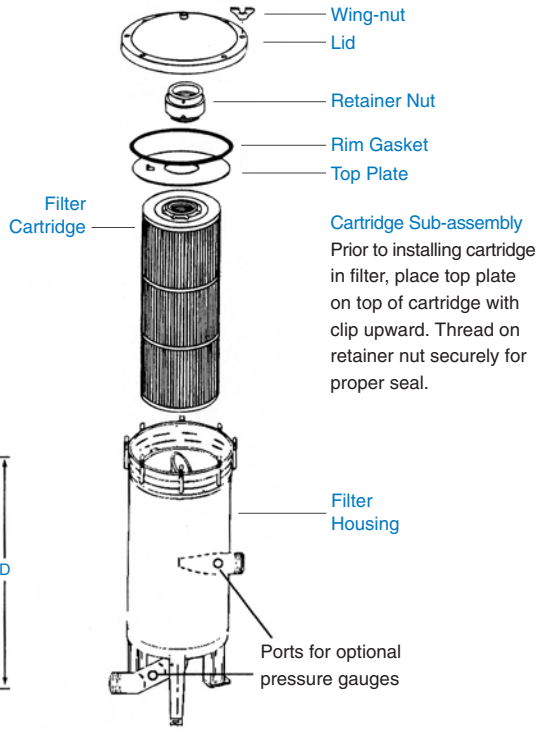
Note: Pressure gauges are recommended to indicate when cartridge cleaning or replacement is necessary.

Model	A Height	B Width	C Diameter	D Inlet	E Outlet
HUR 40 HP	19 1/2"	14 5/8"	13"	12 3/4"	3 7/16"
HUR 90 HP	29 7/8"	14 5/8"	13"	17 3/4"	3 7/16"
HUR 170 HP	40 1/2"	14 5/8"	13"	23 5/8"	3 7/16"



Pressure Gauges
Install optional pressure gauges in gauge ports as shown above. Use pressure differential to indicate when to clean or replace cartridge.





Cartridge Sub-assembly
Prior to installing cartridge in filter, place top plate on top of cartridge with clip upward. Thread on retainer nut securely for proper seal.

Installation

Install filter using 2” couplers for inlet and outlet with 1” coupler for drain pipe. Shut-off valves should be installed on inlet, outlet and on drain pipe to be able to service the filter and isolate it when necessary.
Pressure gauges are also recommended before and after the filter to easily calculate the pressure differential and to know when cartridge should be cleaned or replaced. Threaded flanged fittings for inlet and outlet are available by special order.

1/4” FPT Lid Fitting

One-quarter inch FPT fittings are installed in Waterbetter® Filter lids for a number of customer supplied options, including petcock for pressure relief, pressure gauge, sensor, thermocouple, etc. This fitting should be plugged at time of installation if one of these options is not installed.

Harmsco, Inc. Industrial Filters Limited Warranty

1. Harmsco, Inc. warrants its line of Industrial Filters to be free of defects in material and workmanship for a period of one year from the date of installation.
2. The warranty for Industrial Filters ordered with special coatings is limited only to the recoating of the defective parts due to failure in materials or workmanship for one year from date of installation.
3. This warranty does not cover any equipment purchased for use in applications in which the product is not suited. It is the responsibility of the buyer to determine if a product is suitable for a particular application.
4. THIS WARRANTY EXCLUDES THE FOLLOWING:
   a. Any fresh water unit installed for salt water use.
   b. Damage caused by improper installation, operation or care.
   c. Chemical attack.
   d. Rubber type parts and normal wear items, i.e. “o” rings, rim gaskets, wing nuts, pipe caps, holding rods.
   e. Any costs of labor or expenses incurred in the removal and/or installation of Unit, or any surrounding device.
   f. Damage caused by galvanic or electrolytic attack.
   g. Altering or removing the Harmsco, Inc. information label.
   h. Any unit not grounded.
5. Service under this warranty is to be provided by the dealer/distributor who sold the unit to the distributor. If the dealer/distributor is unable to provide warranty service, contact:

Harmsco, Inc. P.O. Box 14066
North Palm Beach, Florida 33408, U.S.A.
Phone (561) 848-9628 • Fax (561) 845-2474

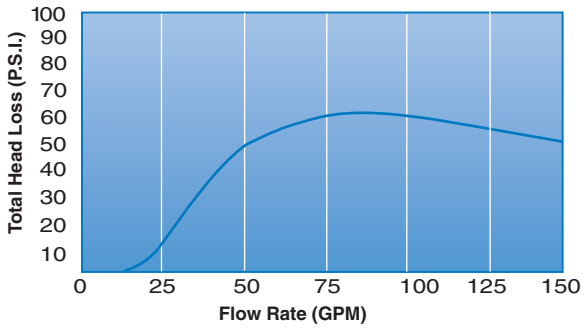
A Returned Goods Authorization (RGA) number must be received from the above office and placed on all shipments to and correspondence with Harmsco, Inc. Please be prepared with the following information:

1. Model number and serial number
2. Date of installation
3. Name of installer
4. Nature of problem
5. Your address and telephone number.

Particle Separation

Particle separation with Hurricane® filters is influenced by particle weight and flow rate. For optimum separation, the drain valve should be opened routinely by hand or automatically using a timer actuated valve. Automatic purge valves are not available from Harmsco. However, for more information regarding this equipment, please contact the Authorized Harmsco Distributor in your area.

The data shown below was developed through tests conducted with Hurricane® filters and twenty micron filter cartridges to determine optimum flow rates for particle separation. Sand was used as the test’s particulate with a specific gravity of 2.6 relative to water at 1.0. This data is provided for general sizing purposes only. Results vary and depend on the particulate being filtered, viscosity and other variables.



Tests indicate the separation of performance of all three Hurricane® filters were essentially the same up to the rated flow rate of each model.

Part List

Hurricane® Filter parts and components are listed below:

Part No.	Material	Description
550-E	EPDM	Rim gasket to seal filter
905-P	PVC	Retainer nut for filter cartridge
309SS	Stainless steel	Top plate
312	PVC	Retainer nut insert
530-AC	Stainless steel	Lid with vent
316-C	CPVC	Standpipe for HUR 40 HP
317-C	CPVC	Standpipe for HUR 90 HP
315-C	CPVC	Standpipe for HUR 170 HP
202-B	Brass	Wing-nut
329	CPVC	Inner vessel isolator
330	Stainless steel	Screw 1/4” x 1/2” for isolator
Options:		
550-B	Buna-N	Rim gasket to seal filter
550-V	Viton	Rim gasket to seal filter
327	Stainless steel	2” Flange fittings (set of 2)

Available From:

HARMSCO® Filtration Products
www.harmsco.com
P.O. Box 14066 • North Palm Beach, FL 33408
800.327.3248 • 561.848.9628 • Fax: 561.845.2474 • E-mail: sales@harmsco.com

MADE IN U.S.A.

003 4/07

HARMSCO®

HURRICANE® FILTERS

Combination centrifugal separator and up-flow cartridge filter in a single compact design with one single cartridge for easy installation, removal and service.

Harmsco® Hurricane filters provide unsurpassed performance because they separate dense solids prior to cartridge filtration for extended filter life, increased dirt holding capacity and reduced maintenance costs. In many respects Harmsco® Hurricane filters are two filters in one!

NSF Certified to ANSI-NSF 61

Models HUR 40 HP, HUR 170 HP and HUR 90 HP

Features:

- *316 stainless steel filter housings*
- *Electro polished for superior finish*
- *Optional chemical resistant coatings available*
- *Fail-safe lids with individual studs for security*
- *Brass wing nuts for easy maintenance- no tools needed*
- *90° elbow and 45° sweep on outlet for staggered in-line vertical installation*
- *CPVC standpipe for up-flow design*

Specifications:

- *316 Stainless Steel*
- *Rim Gaskets - EPDM, (Buna-N, Viton available)*
- *Wingnuts - Brass*
- *Standpipe - CPVC - 316 Stainless Steel optional*
- *Pressure - 150 psi (max.)*
- *BSTP optional*
- *Temperature - 140˚F (max.) - Up to 250˚F with optional stainless steel standpipe and high temperature cartridges installed*

Model	Flow rate (GPM)	Flow rate (LPM)	Flow rate (M^3/HR)	Pipe Size (NPT)	Drain (NPT)	Filter height	Floor space req	Service height	Shipping weight
HUR 40 HP	Up to 50	Up to 189	Up to 12	2”	1”	21” / 54 cm	15” x 15”	31” / 79 cm	40 lbs. / 18 kg
HUR 90 HP	Up to 100	Up to 378	Up to 24	2”	1”	31” / 79 cm	15” x 15”	51” / 130 cm	51 lbs. / 23 kg
HUR 170 HP	Up to 150	Up to 568	Up to 36	2”	1”	41” / 105 cm	15” x 15”	72” / 183 cm	64 lbs. / 29 kg

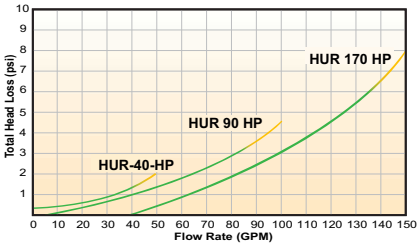
* For best centrifugal separation, flow rates should exceed 35 GPM.

Harmsco® Filtration Products
P.O. Box 14066, North Palm Beach, FL 33408
(561) 848-9628 • Toll Free: (800) 327-5248 • Fax: (561) 845-2474 • e-mail: sales@harmsco.com

MADE IN U.S.A.

10M-0802

Pleated Polyester Sediment Cartridges



Pressure drop shown above is for filter housing and 20 micron filter cartridge in clean water. Data developed by NSF International

HARMSCO® HURRICANE

Replacement Cartridges

Cartridges rated for temperatures to 140°F (60°C). Polyester-Plus™ filter media is cleanable and cartridges are reusable in most applications and micron ratings.Cartridges can separate solids in liquids with a pH of 3 to 11. Packaged one per carton.

Filter Model	Cartridge Product Code	Nominal Micron	Cartridge Dimensions L x OD x ID	Ship wt./ctn. (One cartridge)
HUR 40 HP	HC-40-0.35	0.35	9-5/8" 7-3/4" 3" FPT	4 lbs.
	HC-40-1	1	9-5/8" 7-3/4" 3" FPT	4 lbs.
	HC-40-5	5	9-5/8" 7-3/4" 3" FPT	4 lbs.
	HC-40-10	10	9-5/8" 7-3/4" 3" FPT	4 lbs.
	HC-40-20	20	9-5/8" 7-3/4" 3" FPT	4 lbs.
	HC-40-50	50	9-5/8" 7-3/4" 3" FPT	4 lbs.
	HC-40-100	100	9-5/8" 7-3/4" 3" FPT	4 lbs.
	HC-40-150	150	9-5/8" 7-3/4" 3" FPT	4 lbs.
	HC-40-EZ-CLEAN**	N.R.	9-5/8" 7-3/4" 3" FPT	4 lbs.
HUR 90 HP	HC/90-0.35	0.35	19-1/2" 7-3/4" 3" FPT	7 lbs.
	HC/90-1	1	19-1/2" 7-3/4" 3" FPT	7 lbs.
	HC/90-5	5	19-1/2" 7-3/4" 3" FPT	7 lbs.
	HC/90-10	10	19-1/2" 7-3/4" 3" FPT	7 lbs.
	HC/90-20	20	19-1/2" 7-3/4" 3" FPT	7 lbs.
	HC/90-50	50	19-1/2" 7-3/4" 3" FPT	7 lbs.
	HC/90-100	100	19-1/2" 7-3/4" 3" FPT	7 lbs.
	HC/90-150	150	19-1/2" 7-3/4" 3" FPT	7 lbs.
	HC/90-EZ-CLEAN**	N.R.	19-1/2" 7-3/4" 3" FPT	7 lbs.
HUR 170 HP	HC/170-0.35	0.35	30-3/4" 7-3/4" 3" FPT	10 lbs.
	HC/170-1	1	30-3/4" 7-3/4" 3" FPT	10 lbs.
	HC/170-5	5	30-3/4" 7-3/4" 3" FPT	10 lbs.
	HC/170-10	10	30-3/4" 7-3/4" 3" FPT	10 lbs.
	HC/170-20	20	30-3/4" 7-3/4" 3" FPT	10 lbs.
	HC/170-50	50	30-3/4" 7-3/4" 3" FPT	10 lbs.
	HC/170-100	100	30-3/4" 7-3/4" 3" FPT	10 lbs.
	HC/170-150	150	30-3/4" 7-3/4" 3" FPT	10 lbs.
	HC/170-EZ-CLEAN**	N.R.	30-3/4" 7-3/4" 3" FPT	10 lbs.

**100% Synthetic media to prefilter organic matter and particulate.

Poly-Pleat™ Cartridges

Poly-Pleat™ Cartridges are designed for drinking water applications to remove **Cryptosporidium** and **Giardia Cysts** and when one micron absolute rated filtration is required. Cartridges are rated for temperatures to 140°F (60°C).* Polypropylene filter media also offers compatibility with many aggressive chemicals. Check compatibility charts for polypropylene media, PVC center tubes and end caps.

NSF Certified to ANSI-NSF 61

Filter Model	Cartridge Product Code	Absolute Micron	Cartridge Dimensions L x OD x ID	Ship wt./ctn. (One cartridge)
HUR 40 HP	PP-HC/40-1	1	9-1/8" 7-3/4" 3" FPT	4 lbs.
HUR 90 HP	PP-HC/90-1	1	19-1/2" 7-3/4" 3" FPT	7 lbs.
HUR 170 HP	PP-HC/170-1	1	30-3/4" 7-3/4" 3" FPT	10 lbs.

* Temperature limits vary and depend on pressure and time under load.

Activated Carbon Cartridges

Activated Carbon Cartridges for Hurricane Filter Housings

With outer wrap of pleated five micron polyester media to extend filter life.

Activated carbon cartridges for Hurricane filter housings for taste, odor and chlorine removal. High carbon content for extended throughput. Outer wrap of pleated five micron Polyester-PlusTM filter media to protect the carbon by removing sediment and extend filter life. Not recommended in drinking water applications where water is not micro-biologically safe.

Specifications

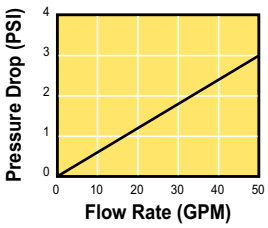
Carbon	High performance extruded activated carbon block
Outer wrap	Five micron pleated polyester media
End caps	Plastisol (pliable PVC)
Directional Flow	Radial (outside to in) for low pressure drop
Temperature	Rated to 125°F (52°C).
Flow rate	10 GPM for optimum performance
Dimensions	See above. (Same as standard Hurricane cartridges)

Product code	Carbon content (lbs.)**	Capacity (gals.)**	Chlorine reduction*
HC/40-AC-5	3	15,000	90%-95% at 5 GPM
HC/90-AC-5	6.25	30,000	90%-95% at 10 GPM
HC/170-AC-5	10	100,000	90%-95% at 15 GPM

*Results may vary and are based on flow and other factors. **Approx.

Note: as with any fluid application involving carbon medias, "slower is better". As a result, Harmsco, Inc. recommends limiting flow rates to allow for effective contact time. The above listed data indicates potential chlorine reduction for a volume of chlorinated water at given flow rates.

Hurricane A/C cartridge



Initial pressure drop in clean water (HC/170-AC-5).

Harmsco® Filtration Products

P.O. Box 14066, North Palm Beach, FL 33408
(561) 848-9628 • Toll Free: (800) 327-3248 • Fax: (561) 845-2474
e-mail: sales@harmsco.com

MADE IN U.S.A.

J & M ENGINEERING & SALES LTD.

50 VENTURE DRIVE, UNIT #8
SCARBOROUGH, ONTARIO M1B 3L6
TEL: 416-665-2300 FAX: 416-665-7530 E-MAIL: sales@jandmengineering.com

INVOICE

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INVOICE NO.: 28984

BILL TO:
ATTN: ACCOUNTS PAYABLE DEPT.
AMEC
EARTH AND ENVIRONMENTAL
900 MAPLE GROVE ROAD, UNIT # 10
CAMBRIDGE, ONTARIO N3H 4R7

SHIP TO:
AMEC
EARTH AND ENVIRONMENTAL
900 MAPLE GROVE ROAD, UNIT # 10
CAMBRIDGE, ONTARIO N3H 4R7
TAG: TR1111022-2000

TERMS: NET 30 DAYS. Past Due Accounts Subject to Interest Charge of 1-3/4% Per Month.

DATE INVOICED	PURCHASE ORDER NO.	DATE SHIPPED	SHIPPED VIA
JULY 27/11	TR1111022-2000 JDE	JULY 27/11	CANPAR PREPAID & CHARGE

ITEM #	QTY.	DESCRIPTION	SHIPPED	B/O	UNIT PRICE	TOTAL
1	1	BADGER 2" MODEL 2000 MAG METER WITH TEFON LINER, 150# FLANGES AND A METER MOUNTED AMPLIFIER.	1	0	1,840.00	$ 1,840.00
2	1	BADGER 2" INDUSTRIAL TURBO WITH CAST IRON HOUSING, 125# FLANGES AND A METER MOUNTED ER-10 INDICATOR.	0	1	1,495.00	$ -

$ 750 00

ENTERED AUG 0 5 2011

G.S.T. #R102667532

SUB TOTAL	$ 1,840.00
SHIP'G/INSR/HNDL'G	$ 16.08
Taxes: H.S.T. 13%	$ 241.29
TOTAL:	$ 2,097.37

ALL RETURNS SUBJECT TO APPROVAL AND RESTOCKING CHARGE.
CLAIMS FOR SHORTAGE NON-DELIVERY OR DAMAGE WILL BE CONSIDERED ONLY WITHIN 10 DAYS
IF TAX EXEMPT, DEDUCT & FURNISH EXEMPTION CERTIFICATE WITH PAYMENT

FILE COPY

Where You Get Old Fashioned Service

Badger M-Series Mag Meter	Model M-2000 Detector	Technical Brief

GENERAL

The Badger® M-Series® mag meter model M-2000 detector is the result of years of research and field use in electromagnetic flow meters. Based on Faraday's law of induction, these meters can measure almost any liquid, slurry or paste that has minimum electrical conductivity.

Designed, developed and manufactured under strict quality standards, the M-Series meter features sophisticated, processor-based signal conversion with accuracies of ±0.25 percent. The wide selection of liner and electrode materials helps ensure maximum compatibility and minimum maintenance over a long operating period.

OPERATION

The flow meter is a stainless steel tube lined with a nonconductive material. Outside the tube, two DC powered electromagnetic coils are positioned diametrically opposing each other. Perpendicular to these coils, two electrodes are inserted into the flow tube. Energized coils create a magnetic field across the whole diameter of the pipe.

As a conductive fluid flows through the magnetic field, a voltage is induced across the electrodes. This voltage is proportional to the average flow velocity of the fluid and is measured by the two electrodes. This induced voltage is then amplified and processed digitally by the converter to produce an accurate analog or digital signal. The signal can then be used to indicate flow rate and totalization or to communicate to remote sensors and controllers.

This technology provides many advantages. With no parts in the flow stream, there is no pressure loss. Also, accuracy is not affected by temperature, pressure, viscosity, density or flow profile. Finally, with no moving parts, there is practically no maintenance required.

APPLICATION

Because of its inherent advantages over other more conventional technologies, this meter can be used in the majority of industrial flow applications. Whether the fluid is water or highly corrosive, very viscous, contains a moderate amount of solids or requires special handling, this meter can accurately measure fluid flow. Today, magnetic meters are successfully used in industries including food and beverage, pharmaceutical, water and wastewater, and chemical.

M-2000 Detector

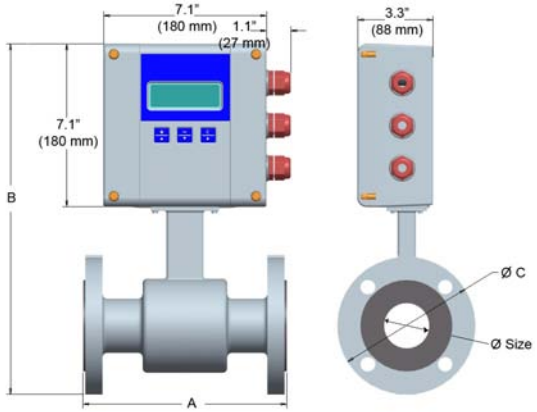
FEATURES

- ±0.25 percent accuracy independent of fluid viscosity, density and temperature
- Unaffected by most solids contained in fluids
- Pulsed DC magnetic field for zero point stability
- No pressure loss for low operational costs
- Corrosion resistant liners for long life
- Calibrated in state-of-the art facilities
- Integral and remote signal converter availability
- Optional grounding rings or grounding electrode
- Measurement largely independent of flow profile
- NSF listed

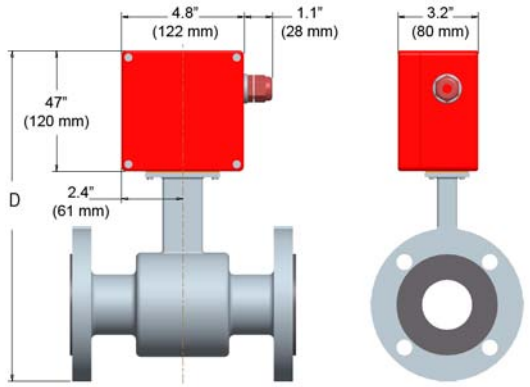
ELECTRODES

When looking from the end of the meter into the inside bore, the two measuring electrodes are positioned at three o'clock and nine o'clock. M-2000 mag meters have an "empty pipe detection" feature. This is accomplished with a third electrode positioned in the meter between twelve o'clock and one o'clock. If this electrode is not covered by fluid for a minimum five-second duration, the meter will display an "empty pipe detection" condition, send out an error message if desired, and stop measuring to maintain accuracy. When the electrode again becomes covered with fluid, the error message will disappear and the meter will continue measuring.

As an option to using grounding rings, a grounding electrode (fourth electrode) can be built into the meter during manufacturing to assure proper grounding. The position of this electrode is at five o'clock.



Meter with M-2000 Amplifier



Meter with junction box for remote M-2000 Amplifier

Size		A		B		C		D		Est. Weight with M-2000		Flow Range LPM		Flow Range GPM	
inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	Lbs	Kg	Min	Max	Min	Max
1/4	6	6.7	170	14.0	356	3.5	89	11.4	288	10	4.5	0.063	20	0.02	5
5/16	8	6.7	170	14.0	356	3.5	89	11.4	288	10	4.5	0.114	34	0.03	9
3/8	10	6.7	170	14.0	356	3.5	89	11.4	288	10	4.5	0.177	53	0.05	14
1/2	15	6.7	170	14.0	356	3.5	89	11.4	288	10	4.5	0.416	125	0.11	33
3/4	20	6.7	170	14.2	361	3.9	99	11.5	293	13	5.5	0.75	225	0.2	59
1	25	8.9	225	14.4	366	4.3	108	11.7	298	18	8.0	1.20	350	0.3	93
1 1/4	32	8.9	225	15.2	386	4.6	117	12.5	318	20	9.0	2.00	575	0.5	152
1 1/2	40	8.9	225	15.4	390	5.0	127	12.7	322	21	9.5	3.00	900	0.8	239
2	50	8.9	225	15.9	403	6.0	152	13.2	335	26	11.5	4.70	1400	1	373
2 1/2	65	11.0	280	17.1	434	7.0	178	14.4	366	52	23.5	8	2400	2	631
3	80	11.0	280	17.3	440	7.5	191	14.7	372	54	24.5	12	3600	3	956
4	100	11.0	280	18.4	466	9.0	229	15.7	398	56	25.5	19	5600	5	1493
5	125	15.8	400	19.6	498	10.0	254	16.9	430	58	26.0	30	8800	8	2334
6	150	15.8	400	20.6	524	11.0	279	17.9	456	60	27.0	40	12700	11	3361
8	200	15.8	400	22.5	572	13.5	343	20.4	518	86	39.0	75	22600	20	5975
10	250	19.7	500	26.8	681	16.0	406	24.1	613	178	81.0	120	35300	30	9336
12	300	19.7	500	28.9	734	19.0	483	26.2	666	207	94.0	170	50800	45	13444
14	350	19.7	500	30.8	782	21.0	533	28.2	716	258	117	230	69200	60	18299
16	400	23.6	590	33.7	856	23.5	597	31.0	788	306	139	300	90400	80	23901
18	450	23.6	590	35.0	890	25.0	635	32.4	822	400	181	380	114000	100	30250
20	500	23.6	590	38.2	969	27.5	699	35.5	901	493	224	470	140000	125	37346
22	550	23.6	590	39.6	1005	29.5	749	36.9	937	523	237	570	170000	150	45188
24	600	23.6	590	42.2	1071	32.0	813	39.5	1003	552	251	680	200000	180	53778
28	700	23.6	590	46.2	1173	36.5	927	44.0	1118	648	294	920	275000	240	73100
30	750	31.5	800	48.3	1228	39.0	984	45.7	1161	702	319	1060	315000	280	84000
32	800	31.5	800	52.2	1325	41.4	1015	49.5	1257	768	349	1200	361000	320	95600
36	900	31.5	800	55.3	1405	46.0	1168	54.1	1374	848	385	1500	457000	400	121000
40	1000	31.5	800	60.0	1525	50.2	1230	57.4	1457	922	419	1900	565000	500	149300
42	1050	36.0	914	66.0	1675	53.0	1346	63.4	1610	1198	499	2100	620000	550	164600
48	1200	39.4	1000	69.9	1775	59.4	1455	67.2	1707	1208	549	2700	814000	720	215100
54	1400	39.4	1000	78.5	1995	68.4	1675	75.9	1927	1362	619	3700	1100000	980	292700

SPECIFICATIONS - Detector

Flow Range: 0.1 - 39.4 fps (0.03-12 m/s)
Sizes: 1/4 inch to 54 inches (6 mm to 1400 mm)
Min. Conductivity: ≥ 5 micromhos/cm
Accuracy:
± 0.25 percent of rate for velocities greater than 1.64 ft/s (0.50 m/s)
± 0.004 ft/s (± 0.001 m/s) for velocities less than1.64 ft/s (0.50 m/s)
Electrode Materials: Standard: Alloy C
Optional: 316 stainless steel, gold/platinum plated, tantalum, platinum/rhodium
Liner Material: PFA up to 3/8 inch, PTFE 1/2 inch to 24 inches, Soft and Hard Rubber from 1 to 54 inches, Halar® from 14 to 40 inches
NSF Listed: Models with hard rubber liner 4-inch size and up; PTFE liner - All sizes.

Fluid Temperature:
With Remote Amplifier:
PFA, PTFE & Halar 311°F (155°C)
Rubber 178°F, (80°C)
With Meter Mounted Amplifier:
PFA, PTFE & Halar 212°F (100°C)
Rubber 178°F, (80°C)
Pressure Limits:
Maximum allowable non-shock pressure and temperature ratings for steel pipe flanges, according to American National Standard ANSI B16.5. (Example: 150-pound flanges, rated 285 PSI at ambient temperature.) (Example: 300-pound flange rated 740 PSI at ambient temperature.
Coil Power: Pulsed DC
Ambient Temperature: -4°F to 140°F (-20°C to 60°C)

Pipe Spool Material: 316 stainless steel
Meter Housing Material: Carbon steel welded
Flanges: Carbon steel - Standard (ANSI B16.5 Class 150 RF) 316 stainless steel - Optional
Meter Enclosure Classification: NEMA 4X (IP66)
Optional: Submersible NEMA 6P (remote amplifier required)
Junction Box Enclosure Protection:
(for remote amplifier option) Powder coated die-cast aluminum, NEMA 4 (IP65)
Cable Entries: 1/2-inch NPT Cord Grip
Optional Stainless Steel Grounding Rings:

Meter Size	Thickness (of one ring)
up through 10 inches	.135 inch
12 to 20 inches	.187 inch

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Only products bearing the NSF Mark are Certified.

Please see our Web site at
www.badgermeter.com
for specific contacts.

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Milwaukee, WI 53224-9536
800-876-3837
infocentral@badgermeter.com • www.badgermeter.com

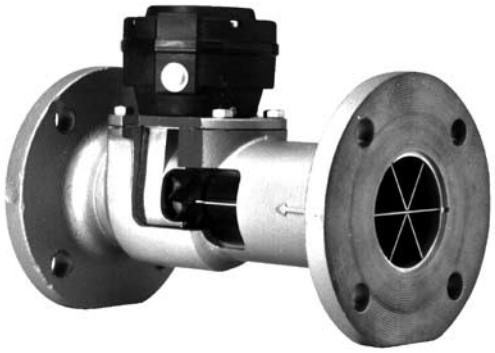
Model Industrial Turbo	Turbine Meter	Technical Brief

GENERAL

Badger's Industrial Turbine is a rugged, reliable meter ideally suited for chemical or industrial fluid applications. Its' compact size and ease of serviceability without removal from the line, coupled with a choice of materials, make this a cost effective selection. Designed with performance in mind, the meter provides a high level of accuracy over a wide flow range with a minimum of pressure loss.

The Badger Meter Turbine is available in line sizes of 2", 3", 4" and 6" with a choice of flange ratings and three different body materials including stainless steel. Its' unique straight through flow profile and ceramic bearing design optimize performance.

To complement the meter, Badger offers a complete line of accessories that includes mechanical, pneumatic, electromechanical and state-of-the-art electronic transmitters, totalizers, indicators and process controllers.



OPERATION

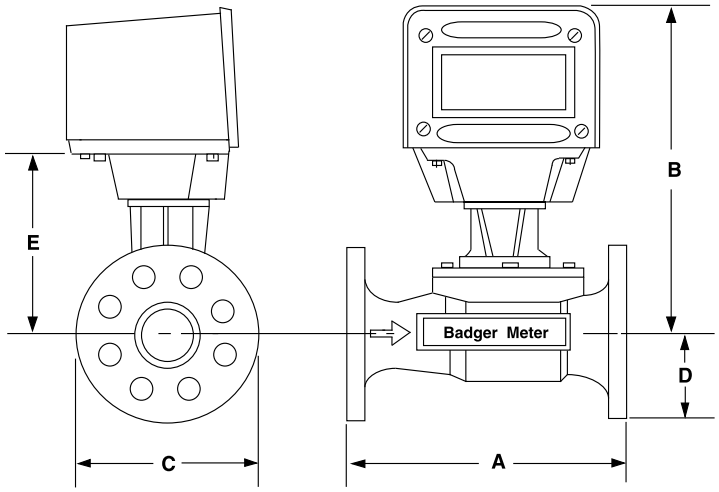
The Badger Meter Industrial Turbine is a volumetric liquid flow meter which works on the time proven principle of a rotor turning at an angular velocity proportional to the fluid velocity through the turbine. The meter has straightening vanes and a nose cone in the inlet side which minimize upstream turbulence and direct the flow to the rotor effectively. Electronic pickups generate signals from the rotor magnet. This is translated to 4-20 mA and/or open collector-transistor pulse outputs. Mechanical pickups and electromechanical outputs are also available.

APPLICATIONS

Badger's Turbo meter is used in a wide range of fluid applications covering from water to oils, solvents to acids. The meter has been used in water treatment systems, loading and unloading of tankers or rail cars, batching systems, or simply inventory control of a process fluid. Anywhere high volume and/or high flow rates are at least sometimes required in the application, the Turbo meter is likely the right choice.

FEATURES

- **Long Lasting Ceramic Bearings**
- **Simple In-Line Serviceability**
- **Three (3) Housing Materials Available**
- **1.5% Accuracy**
- **0.25% Repeatability**
- **Low Pressure Loss**



Dimensions shown are of meter with a PC 100 meter mount. Dimensions for other system configurations will vary. Please consult with the factory.

Installation Dimensions

	2"	3"	4"	6"
A	10.00	12.00	14.00	18.00
B	13.67	13.67	15.34	16.84
C - 150#	6.00	7.50	9.00	11.00
C - 300#	6.50	8.25	10.00	12.50
D - 150#	2.75	3.50	4.25	5.25
D - 300#	3.00	3.87	4.75	6.00
E	6.86	6.86	8.53	10.03
Estimated Weight per Unit in Lbs.	30 - 40	40 - 50	60 - 75	100 - 125

All dimensions are in inches.

METER SPECIFICATIONS

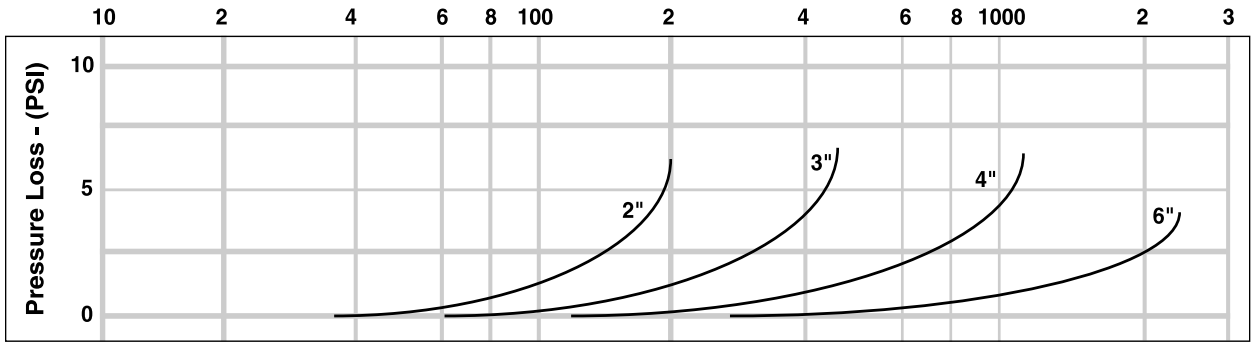
Accuracy:	**± 1.5%**	
Repeatability*:	**± 0.25%**	
Temperature Range (° F):	**-30 to 250**	
Flow Range - GPM:	**2"**	**8 - 160**
	3"	**10 - 350**
	4"	**25 - 1000**
	6"	**40 - 2000**
Maximum Operating Pressure (PSI):	**125/150 psi, standard** **250/300 psi, optional (cast iron / bronze only)**	

* Reading over full range tested with potable water at 60° F.

Flange Face Configurations: (ANSI Standards)
Flat Faced Flanges: 125 lb. Cast Iron, 150 lb. and 300 lb. Bronze Housings
Raised Face Flanges: 250 lb. Cast Iron, 150 lb. Stainless Steel Housings

Housing Materials:	Cast Iron Bronze 316 Stainless Steel
Head Materials:	Bronze Stainless Steel
Rotor and Nose Cone:	Ryton
Bearings:	Ceramic
Straightening Vanes:	316 Stainless Steel
"O" Ring and Tetraseal:	Buna N (Standard) EPR Viton
Head Gasket:	• Nitrile Binder (Used with Buna N Seals) • Chloroprene Binder (Used with EPR and Viton Seals)

Industrial Turbine Meter Pressure Loss Chart
Rate of Flow in Gallons Per Minute



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P.O. Box 245036, Milwaukee, WI 53224-9536
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Model ER-10 and ER-10/R (Remote)	Digital Resettable Totalizer and Digital Rate of Flow Indicator	Technical Brief

GENERAL

Badger® Model ER-10 electronic register is a meter mounted totalizer/rate indicator designed for use with all of Badger's meter product lines. The ER-10/R is the remote version and can be used with any Badger flow meter if equipped with a compatible pulse transmitter. A rear adapter plate is provided with the remote version for attachment to a wall or other suitable surface. The ER-10 series electronic register is available with one or two indicators. With two indicators, you can simultaneously see a display of rate-of-flow and totalization. If this is not required, a single indicator will provide both indications by the simple push of a button.

The unit is battery powered. Optical sensors and other electronic sensors with open collector outputs must be externally powered.

DESCRIPTION

An easy-to-read, 8-digit numeric LCD display is used for the totalizing function. The rate mode is a similar 4-digit display. Step-by-step independent programming of scale factors for the rate and totalization functions allows you to program any meaningful engineering unit such as gallons per minute and total gallons.

When the indicator is used as a totalizer, the display can be reset to zero from the front panel button or from an external switch wired directly to a rear terminal. The front panel reset button can be inhibited.

Backlighting of the display is available by connecting a DC power source to the unit.

OPERATION

Flow through the meter causes pulses to be generated by the sensor or transmitter. Each pulse represents a specific volume of fluid. Using the Model 25 Disc meter as an example, 198 pulses are generated every time one gallon of fluid passes through the meter. Entering an appropriate scale factor independently for the rate and totalization modes will result in the pulse indication on the display to be a meaningful unit of measure for each.

FEATURES

- **All solid-state components for long life**
- **Battery powered**
- **Corrosion resistant plastic housing built to NEMA 4X specifications**
- **Programmable for rate of flow and totalization**
- **Backlighting of display available**
- **Front panel totalizer reset switch can be disabled**
- **Reprogramming can be inhibited**

SPECIFICATIONS

POWER

Internal battery: 3V, Lithium
Battery life expectancy: 5 years
Replacement Part #: 65765-001
External DC Power Source (10-30 VDC)
(max. current draw = 30 mA)

BACKLIGHT

Requires 10-30VDC power input (max. current draw: 30 mA
(Derate operating temperature 1°C/Volt above 17VDC)
Reverse polarity protected

PHYSICAL

Operating Temperatures:
32°F (0°C) to 130°F (55°C)
Storage Temperature:
-4°F (-20°C) to 160°F (70°C)
Operating Humidity: 60% Non-condensing
Weight: 2.2 oz. net
Display Size: .43" high
Front Panel Rating: NEMA 4X when mounted with gasket provided
Case Material: Cycolac X-17

TOTALIZER

Digits: 8
Scaler: 0.0001 - 99.999
Decimal Point: 5 positions, programmable

RATE INDICATOR

Digits: 4/5, (4 calculated, 5 displayed with fixed 0 in LSD.)
Scaler Range: .001to 9999
Decimal Point: 5 positions, programmable
Accuracy: +/-0.2%
Update Time: .7 seconds
Zero Time: 10 seconds

DC COMMON (Terminal 1)

COUNT INPUT (Terminal 2)

Speed: 0 to 100 hz
Min. Low Time: 3.3 mS
Min. High Time: 6.7 mS
Impedance: 101K ohm
Voltage Thresholds: Low: 0 to 0.4 VDC
High: 2.0 to 28 VDC
Max: High 28 VDC

RESET INPUT (Terminal 4)

Resets totalizer to zero when connected to DC common.
Min. Low Time: 0.25 to 1.0 sec. (maintained)
The required pulse width varies with count speed, scale factor and number of digits displayed.
Voltage Thresholds: Low: 0 to 0.4 VDC
High: 2.0 to 28 VDC

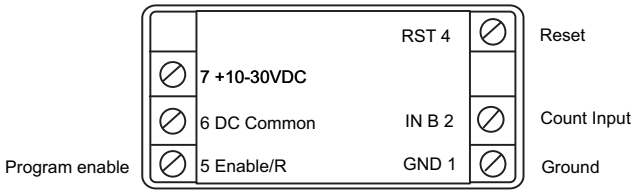
PROGRAM ENABLE INPUT (Terminal 5)

Operation: Level sensitive (maintained)

COUNT ACCURACY

100% when operated within specifications

WIRING TERMINALS



Terminal	Function	Operation
1	Ground	
2	Input B Count Input	Count Input Contact Closure or NPN 100 Hz. Max.
3		Not Used
4	Reset	Connect to Ground to Reset Totalizer. This is a maintained or Level Sensitive Reset.
5	Program Enable	Connect to Ground to Enter Program Mode
6	Backlight Common	
7	Backlight Power	Connect to Power to Light Display

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J & M ENGINEERING & SALES LTD.

50 VENTURE DRIVE, UNIT #8
SCARBOROUGH, ONTARIO M1B 3L6
TEL: 416-665-2300 FAX: 416-665-7530 E-MAIL: sales@jandmengineering.com

INVOICE

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INVOICE NO.: 28984

BILL TO:
ATTN: ACCOUNTS PAYABLE DEPT.
AMEC
EARTH AND ENVIRONMENTAL
900 MAPLE GROVE ROAD, UNIT # 10
CAMBRIDGE, ONTARIO N3H 4R7

SHIP TO:
AMEC
EARTH AND ENVIRONMENTAL
900 MAPLE GROVE ROAD, UNIT # 10
CAMBRIDGE, ONTARIO N3H 4R7
TAG: TR1111022-2000

TERMS: NET 30 DAYS. Past Due Accounts Subject to Interest Charge of 1-3/4% Per Month.

DATE INVOICED	PURCHASE ORDER NO.	DATE SHIPPED	SHIPPED VIA
JULY 27/11	TR1111022-2000 JDE	JULY 27/11	CANPAR PREPAID & CHARGE

ITEM #	QTY.	DESCRIPTION	SHIPPED	B/O	UNIT PRICE	TOTAL
1	1	BADGER 2" MODEL 2000 MAG METER WITH TEFON LINER, 150# FLANGES AND A METER MOUNTED AMPLIFIER.	1	0	1,840.00	$ 1,840.00
2	1	BADGER 2" INDUSTRIAL TURBO WITH CAST IRON HOUSING, 125# FLANGES AND A METER MOUNTED ER-10 INDICATOR.	0	1	1,495.00	$ -
		$750.00 ENTERED AUG 0 5 2011				
		G.S.T. #R102667532				

SUB TOTAL	$ 1,840.00
SHIP'G/INSR/HNDL'G	$ 16.08
Taxes: H.S.T. 13%	$ 241.29
TOTAL:	$ 2,097.37

ALL RETURNS SUBJECT TO APPROVAL AND RESTOCKING CHARGE.
CLAIMS FOR SHORTAGE NON-DELIVERY OR DAMAGE WILL BE CONSIDERED ONLY WITHIN 10 DAYS
IF TAX EXEMPT, DEDUCT & FURNISH EXEMPTION CERTIFICATE WITH PAYMENT

FILE COPY

Where You Get Old Fashioned Service

ITEM NO.	QTY REQD	DESCRIPTION	MATERIAL
1	1	BEARING SUPPORT HOUSING	ALUM.
2	1	MOTOR; HP 1/4 RPM 1725	
		HZ 60 PH 1 FRAME 56C	
		ENCLOSURE; TEFC	
3	1	GEAR BOX ; 5:1 RATIO	
4	1	SWIVEL "C" CLAMP	C.I.
6	1	SHAFT; DIA 3/4"	316SS
		EXTENSION (DIM. "L") 36"	316SS
7	1	IMPELLER TYPE; PROP	
		DIA 11"	316SS
8		STABILIZER (OPTIONAL)	

MOTOR SPECIFICATIONS

MIXER MODEL	UNIT HP	UNIT RPM	1PH-60CY 115/230V MAX DIMENSIONS "A"	1PH-60CY 115/230V MAX DIMENSIONS "B"	3PH-60CY 230/460V MAX DIMENSIONS "A"	3PH-60CY 230/460V MAX DIMENSIONS "B"	"A"	"B"
CG-1	1/4	1725	16.00	6.5	15.38	6.5		
CG-2	1/3	1725	16.00	6.5	15.38	6.5		
CG-3	1/2	1725	16.50	7.6	15.88	7.6		

CUSTOMER:

TAG: CG-1

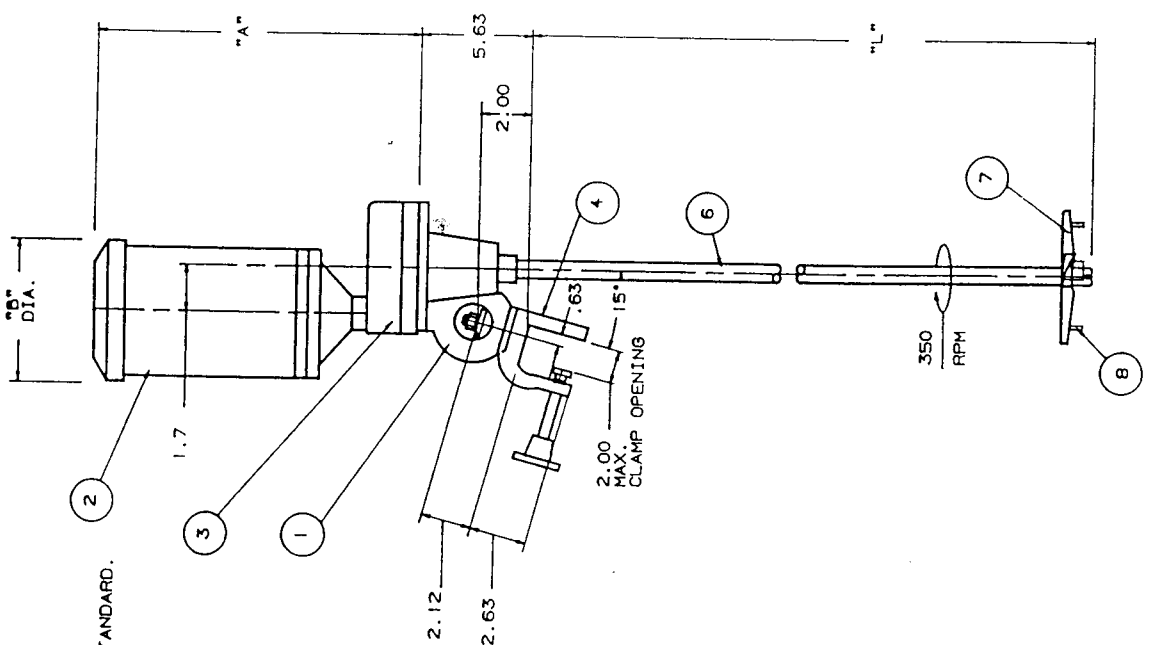
QTY REQ:

EMI incorporated
EMI MIXING TECHNOLOGY GROUP
CLEVELAND MIXER
EASTERN MIXER
STATIC MIXING SYSTEMS
Heritage Park Rd. Box 812
Clinton, CT 06413-0812

DWG TITLE PORTABLE MIXER, MODEL CG-1
GEAR DRIVE

SHEET 1 OF 1 SIZE DWG. NO. REV.

CAD FILE: CGC



NOTES

1. STABILIZER SUPPLIED AS REQ'D.
2. XTF-3 HYDROFOIL IMPELLERS ARE STANDARD.
3. ALL DIMENSIONS IN INCHES.

EASTERN MIXERS - Responsive toYour Mixing Needs

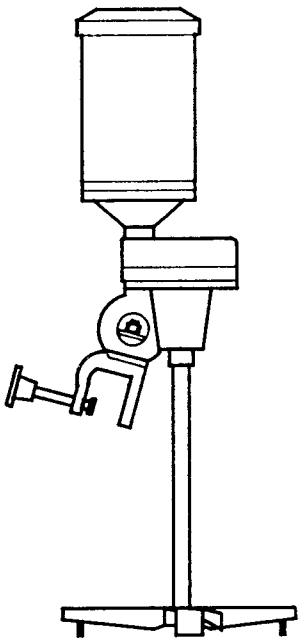
CG & CAG SERIES PORTABLE GEAR DRIVEN MIXERS

MODEL

GEAR DRIVE models have shaft speeds of 350 or 230 rpm w/optional 1150 rpm motor.

XTF-3 HIGH EFFICIENCY impellers are standard, square pitch propellers available as an option.

Recommended for high flow and low shear applications.



MOTORS

- 115/230/1/60 or 208/230/460/3/60, TEFC, EXP, Chem. Duty, Washdown, High Efficiency
- 50 Hz and Special Voltages Available
- AC & DC Variable Speed Drives

FEATURES

- 100% Process Guarantee
- 3 Year Mechanical Warranty
- All Motors are Standard NEMA C-Face Design
- Gears are Rated for Min. 1.3 Service Factor
- C-Clamp Mount or Optional Cup Plate Mount
- Impellers and Shafts are 316SS
- Coatings (PVC, Rubber /Others on Request)
- USDA Approved Sanitary Versions Available
- OSHA Approved for Safety

MODEL	NET WT. (lbs.)	SHAFT RPM	HP	STD SHAFT (Inches)	STD. FOILS DIA. (Inches)	
					Single	Dual
CG-1	56	350	1/4	3/4 x 36	12	11
CG-2	58	350	1/3	3/4 x 36	13	12
CG-3	62	350	1/2	3/4 x 48	14	13
AIR MODELS						
CAG-2	47	Max. 350	1/3	3/4 x 36	13	12
CAG-3	47	Max. 350	1/2	3/4 x 48	14	13

Cleveland Eastern Mixers
DIVISION OF
EMI INC. TECHNOLOGY GROUP
Heritage Park Rd, Box 912, Clinton, CT 06413
Tel: 800-243-1188 Fax: 860-669-7461

Represented by:

LIGHTNIN

INSTRUCTION MANUAL
MODEL EV1P

BOOK NUMBER 1563

TABLE OF CONTENTS

TITLE	PAGE
SAFETY CHECK LIST	1
DIMENSION DRAWING	2
ASSEMBLY DRAWING	3
“EV” SERIES MIXER BUNG ADAPTER	4
GENERAL INSTRUCTIONS “EV” SERIES MIXER DIRECT DRIVE	5
SECTION 1 – INITIAL INSPECTION, SHIPPING ARRANGEMENTS	5
SECTION 2 – MIXER INSTALLATION	5
SECTION 3 – SHAFT AND IMPELLER INSTALLATION	6
SECTION 4 – SHAFT REMOVAL	7
SECTION 5 – MIXER OPERATION	7
SECTION 6 – LUBRICATION	8
SECTION 7 – DISASSEMBLY INSTRUCTIONS	8
SECTION 8 – ASSEMBLY INSTRUCTIONS	9
SECTION 9 – AIR MOTOR REQUIREMENTS	10
SECTION 10 – AIR MOTOR LUBRICATION	10
MODEL NO. 2 AND 4 AIR MOTOR DRIVE ASSEMBLY	12
NON–LUBRICATED AIR MOTOR INSTRUCTIONS	13
SECTION 1 – AIR MOTOR REQUIREMENTS	13
SECTION 2 – USE OF AIR MOTORS IN HAZARDOUS ATMOSPHERES	15
ELECTRIC MOTOR INSTRUCTIONS	16
SECTION 1 – INITIAL INSPECTION	16
SECTION 2 – MOTOR MAINTENANCE AND STORAGE	17
OPERATING INSTRUCTIONS ***LIGHTNIN*** VARI–MIX DRIVE (VM SERIES)	19
SECTION 1 – GENERAL	19
SECTION 2 – SPECIFICATIONS	19
SECTION 3 – INSTALLATION & OPERATION	20
RECOMMENDED SPARE PARTS EV “P” SERIES DIRECT DRIVE	23

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INSTRUCTION MANUAL
MODEL EV1P

BOOK NUMBER 1563

TABLE OF CONTENTS

TITLE **PAGE**

AFTERMARKET SERVICE PROGRAMS 24

LIGHTNIN U.S. SALES OFFICE DIRECTORY 26

SAFETY CHECK LIST

IMPORTANT

All *LIGHTNIN* Mixers and Aerators are provided with properly designed lifting devices and safety covers to avoid potential injury and/or equipment damage. The following SAFETY CHECK LIST should be THOROUGHLY REVIEWED AND ADHERED TO before operating or performing maintenance on the mixer. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN SERIOUS INJURY.

1. Use only the lifting device provided on your unit to install the mixer. Use shouldered eyebolts and tighten securely to handle component parts. We strongly recommend that the hoist rings be of safety swivel type with 360° rotational capability.

2. DO NOT connect the motor to the power source until all components are assembled, the mixer is installed, and all hardware is tightened to the proper torque which is specified in the operation and maintenance manuals supplied by *LIGHTNIN.*

3. DO NOT operate shaft sealing devices at temperatures or pressures higher than those specified in the manual or on the nameplates.

4. DO NOT service the mixer until you have followed your ”Control of Hazardous Energy Sources” (lockout, tagout procedure) as required by OSHA 29 CFR Part 1910.

5. DO NOT touch rotating mixer parts.

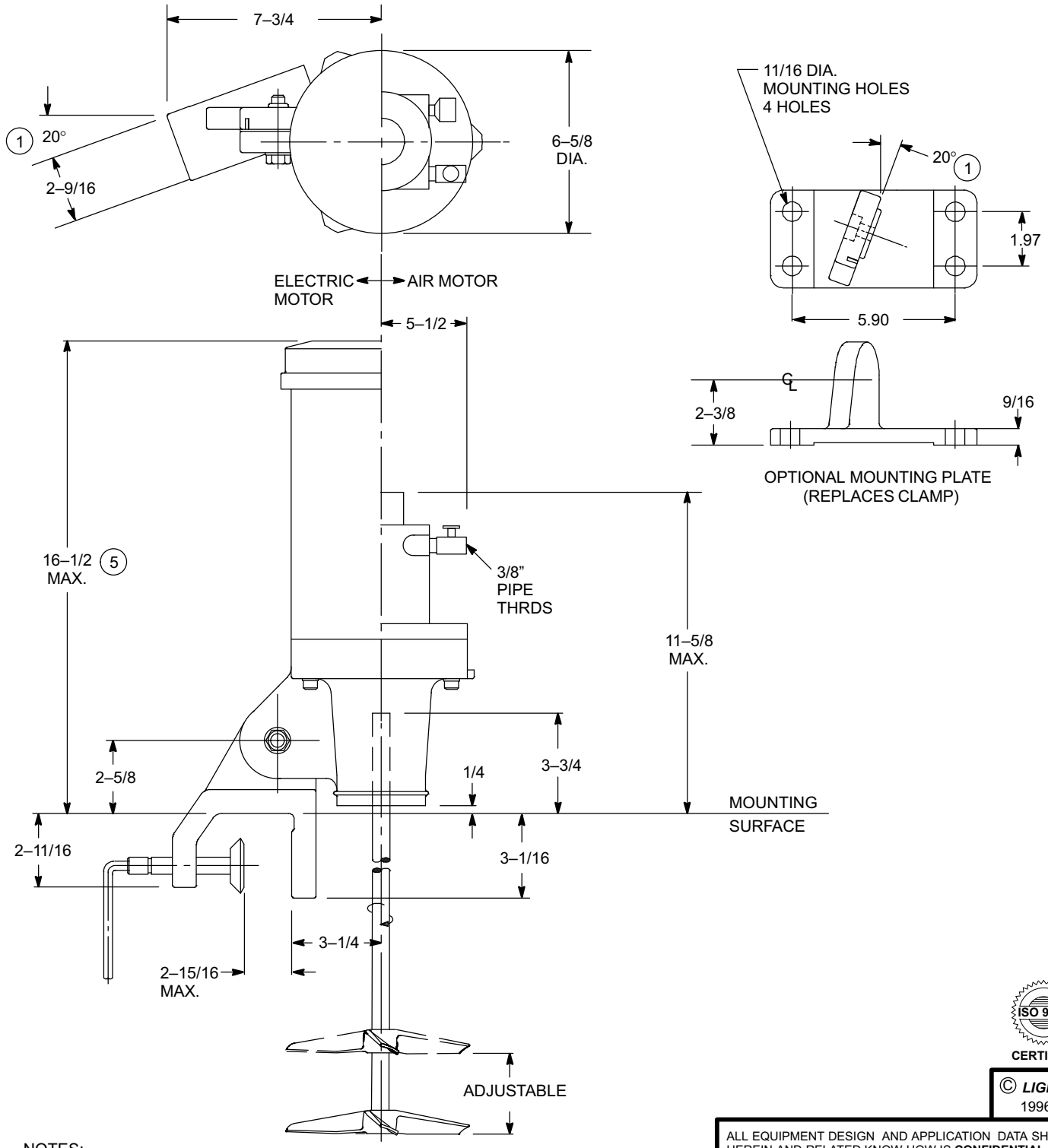
6. DO NOT operate mixer for service other than its intended use.

7. DO NOT make any field changes or modifications (horsepower, output speed, shaft lengths, impellers, etc.) without reviewing the changes with your *LIGHTNIN* Sales Representative or the *LIGHTNIN* Customer Service Department.

8. DO NOT install an aftermarket Variable Frequency Drive without first consulting your *LIGHTNIN* Sales Representative or the *LIGHTNIN* Customer Service Department to determine the compatibility of the existing motor with the Variable Frequency Drive.

9. DO NOT operate mixer until you have checked the following items:
   - A. Make sure the mixer is properly grounded.
   - B. Ensure all protective guards and covers are installed.
   - C. Ensure all detachable components are securely coupled to the mixer.
   - D. Thoroughly REVIEW and ADHERE TO the mixer operating instructions supplied by *LIGHTNIN*.
   - E. Ensure the mixer output shaft rotates freely by hand.
   - F. Ensure all personnel and equipment are clear of rotating parts.
   - G. Ensure all external connections (electrical, hydraulic, pneumatic, etc.) have been completed in accordance with all applicable codes and regulations.

10. DO NOT enter the mixing vessel UNLESS:
    - A. The mixer power supply is locked out (follow Item number 4).
    - B. The mixer shaft is firmly attached to the mixer drive or the shaft is supported securely from below.
    - C. You have followed applicable confined space regulations.



NOTES:

1. UNIT OFFSET 20° HORIZONTALLY AND ADJUSTABLE 10° (OR MORE) VERTICALLY. UNIT ALSO AVAILABLE WITH 0° OFFSET.
2. WEIGHT (LESS SHAFT AND IMPELLERS):
   DIRECT DRIVE WITH ELECTRIC MOTOR : 44 LBS MAX.
   DIRECT DRIVE WITH AIR MOTOR: 29 LBS MAX.
3. DIMENSIONS ARE FOR REFERENCE ONLY UNLESS CERTIFIED.
4. ALL DIMENSIONS IN INCHES.
5. ADD APPROX. 2–1/4" TO HEIGHT WHEN USING 1/4 HP VARIABLE SPEED MOTOR 123998PSP.

ISO 9001
CERTIFIED

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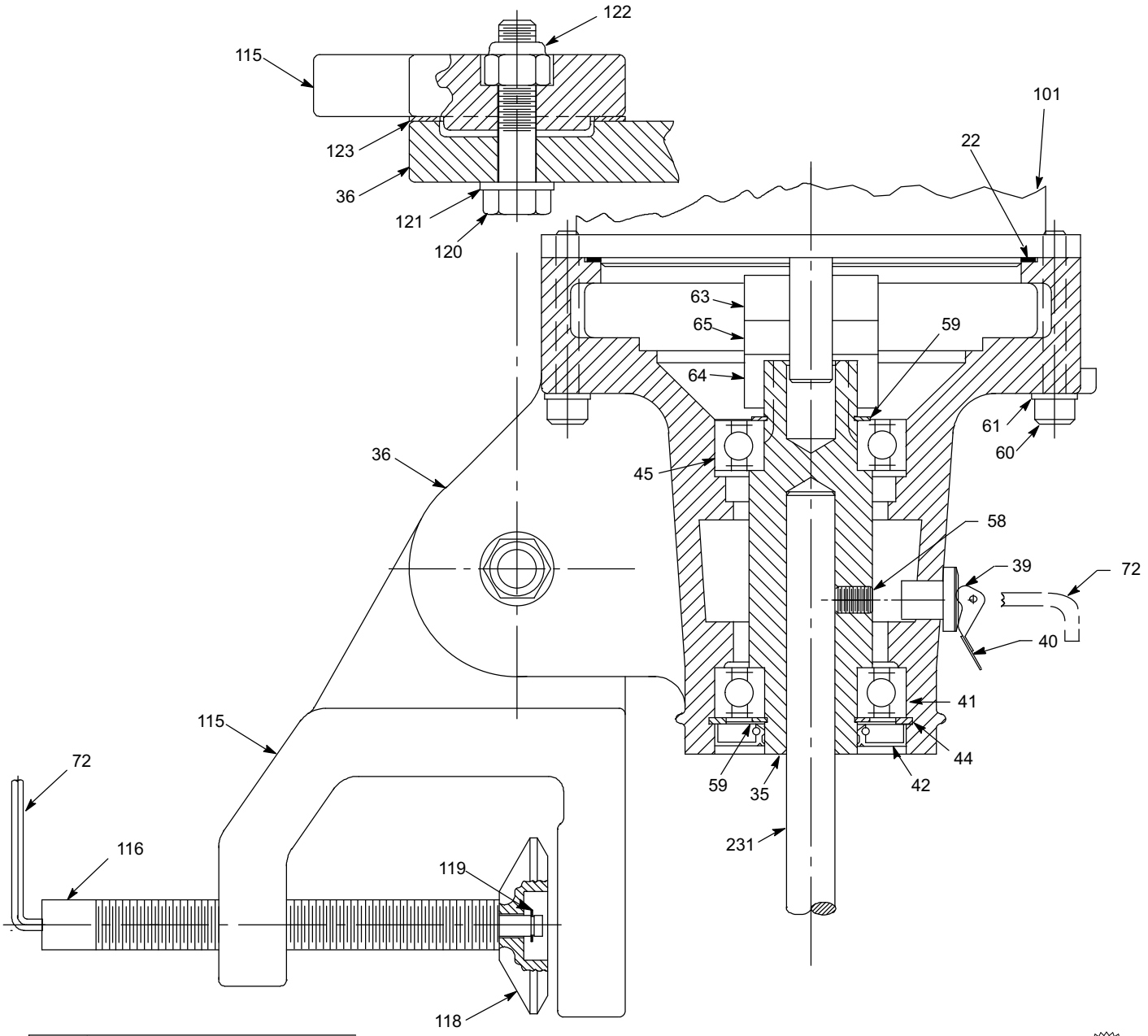
MIXERS AND AERATORS
DIMENSION DRAWING

EV "P" SERIES MIXER
DIRECT DRIVE
AIR OR ELECTRIC MOTORS

DRAWING NO. DS–P–70A



ITEM	PART NAME	ITEM	PART NAME
231	MIXER SHAFT		
123	ROTATIONAL INSERT	61	FLAT WASHER (4)
122	HEX LOCKNUT	60	SOCKET HEAD CAP SCREW (4)
121	FLAT WASHER	59	RETAINING RING
120	HEX HEAD CAP SCREW	58	HEX SOCKET SET SCREW – NYLOK
119	RETAINING RING	45	BALL BEARING
118	CUP WASHER	44	RETAINING RING
116	CLAMP SCREW	42	OIL SEAL
115	TANK CLAMP	41	BALL BEARING
101	MOTOR	40	LANYARD
72	HEX WRENCH	39	EXPANSION PLUG
65	MOTOR COUPLING INSERT	36	HOUSING
64	MOTOR COUPLING HALF	35	DRIVE QUILL
63	MOTOR COUPLING HALF	22	GASKET

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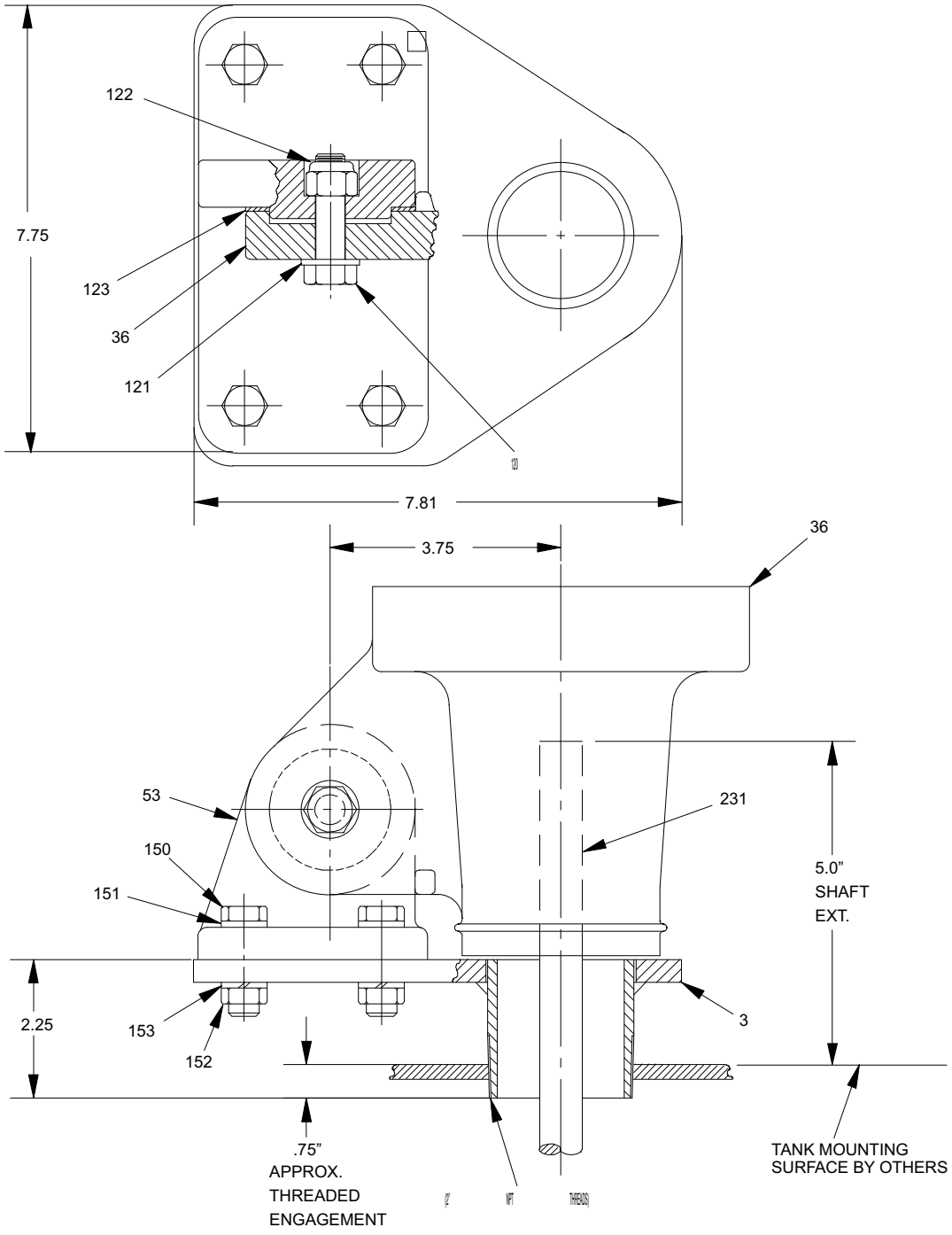
MIXERS AND AERATORS
ASSEMBLY DRAWING

EV "P" SERIES MIXER
DIRECT DRIVE
BEARING HOUSING ASSEMBLY

DRAWING NO. L–17094B



ITEM	PART NAME
231	MIXER SHAFT
153	LOCKWASHER
152	HEX NUT
151	PLAIN WASHER
150	HX HD CAP SCREW
123	INSERT
122	LOCK NUT
121	PLAIN WASHER
120	HX HD CAP SCREW
53	MOUNTING PLATE
36	HOUSING
3	BUNG ADAPTER

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ALL DIMENSIONS IN INCHES.

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MIXERS AND AERATORS
DIMENSION DRAWING

"EV" SERIES MIXER BUNG ADAPTER

DRAWING NO. DS–P–72A

GENERAL INSTRUCTIONS
"EV" SERIES MIXER
DIRECT DRIVE

SECTION 1 – INITIAL INSPECTION, SHIPPING ARRANGEMENTS

1. 1 Check the shipping crates and your ***LIGHTNIN*** equipment for possible shipping damage. Report any damage immediately to the carrier and our factory.

1. 2 The mixer and impellers are packed together. The mixer shaft, if over 48 inches long, is packed in a separate container.

1. 3 Do not remove any protective coatings or wrappings until the mixer is ready to be put into service. If the mixer is to be stored, store only in an indoor, clean, dry location with controlled temperatures of 15° C to 40° C (59° F to 104° F).

SECTION 2 – MIXER INSTALLATION

2. 1 Refer to Installation drawing for:

a. Proper mixer mounting and location.

b. Proper minimum impeller off–bottom and relative spacing for dual impeller applications.

2. 2 Lock–out power before positioning mixer, and review safety instructions before starting mixer.

2. 3 The clamp and beamplate are cast offset at recommended 20° horizontal plane and adjustable 0–10° in the vertical plane. Clamp and beamplate are also available with zero degree offset in the horizontal plane and adjustable 0–10° in the vertical plane. Refer to Table 1 for recommended angular positions.

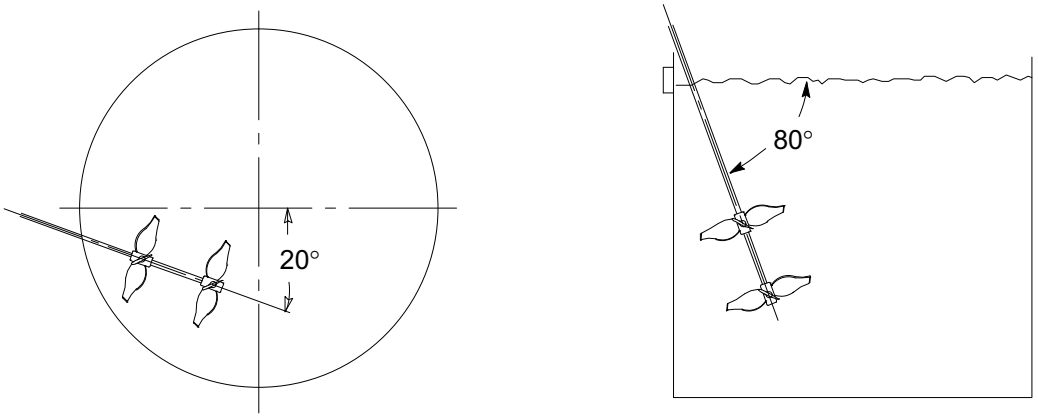


Table 1 – Mixer positioning

2. 4 BOLT TIGHTENING TORQUE RECOMMENDATIONS

a. Inadequately or improperly tightened hardware can loosen due to vibration or the reactions imposed by fluid forces. This can result in reduced equipment service life or damage and failure.

b. Recommended torques for tightening the bolts and screws on your ***LIGHTNIN*** mixer are listed with assembly instructions. Use of a torque wrench is recommended to ensure compliance with torque recommendations.

c. The amount of torque required to maintain a tight connection can vary considerable for bolts of the same size under different operating conditions. Variations such as basic joint design, compression factors, type and strength of base and hardware material, surface finish of mating parts and lubrication are only some of the factors that influence the tightness of bolted connections for given torque values.

d. All bolts should be coated with oil, grease, or an anti–seize compound whenever possible. The threads and bearing face of bolt heads and/or nuts should be lubricated.

e. **ALL BOLTS SHOULD BE RETIGHTENED AFTER THE UNIT HAS BEEN RUN UNDER LOAD FOR TWO (2) WEEKS, AND AT EACH SCHEDULED SHUT–DOWN THEREAFTER.**

f. Unless otherwise specified, it is recommended that metric commercial standard class 8.8 bolts and screws, and class 8 nuts be used for all bolted connections. For inch hardware use GR5.

SECTION 3 – SHAFT AND IMPELLER INSTALLATION

3. 1 Install the impeller(s) on the mixer shaft (231) by tightening the set screws in the impeller hub. Refer to the installation drawing for recommended dual impeller spacing if two impellers are supplied. Refer to Impeller Assembly drawing for general impeller orientation.

3. 2 Clean the mixer shaft (231) end and drive quill (51) thoroughly.

3. 3 Orient the drive quill so that the set screw (58) aligns with the hole in the bearing housing (36). Align quill shaft by inserting lower shaft (231) into quill and rotate quill manually.

3. 4 Grasp mixer shaft approximately 20 inches below the shaft top and insert the mixer shaft completely into the drive quill, until it contacts the top of the quill bore. Align flat on shaft with set screw (58). Tighten set screw (58).

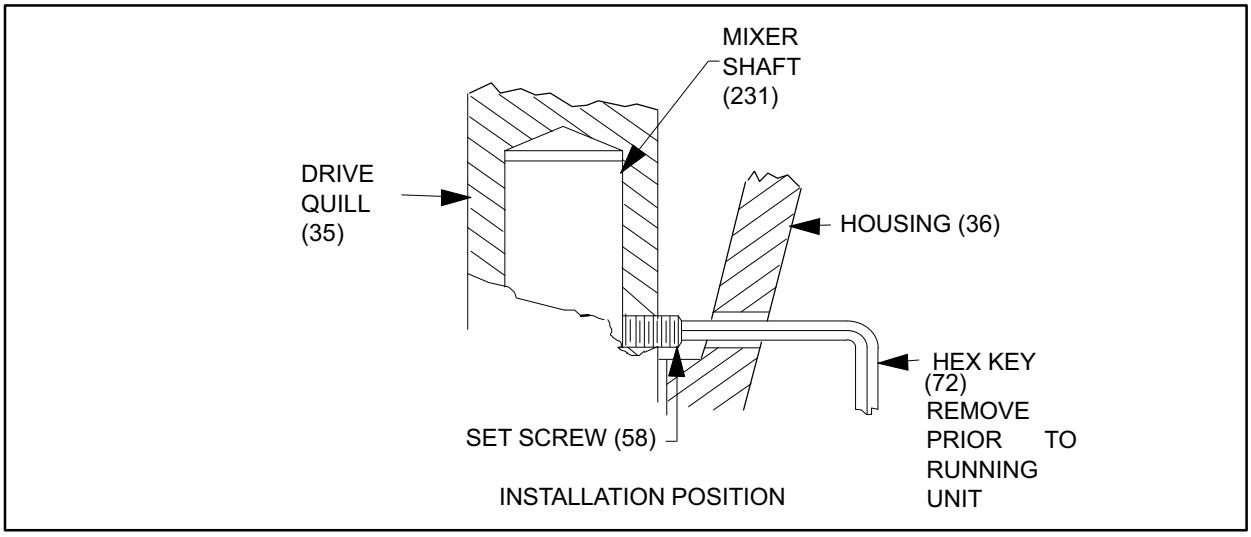


Figure 1 – Shaft Installation

3. 5 DRIVE QUILL ORIENTATION

a. NORMAL LIGHT CONDITIONS – Rotate the drive quill until the set screw (58) aligns with the access hole in the housing (36). Rotate drive quill by inserting lower shaft into drive quill and rotating by hand.

b. LOW LIGHT CONDITIONS – If the mixer shaft is being installed in low light conditions, the drive quill can be oriented by feel. Insert lower shaft into drive quill and rotate the drive quill (35) by hand until the set screw (58) can be felt with the hex wrench through the access opening.

3. 6 With the drive quill oriented, insert the 7/32” hex key (72) provided into the housing opening and tighten the set screw (58) to (15–30 ft–lbs). **DO NOT IMPACT THE WRENCH OR USE AN EXTENSION.**

3. 7 Check for free movement of all components by rotating the mixer shaft.

SECTION 4 – SHAFT REMOVAL

CAUTION: THE UPPER PORTION OF THE MIXER SHAFT (231) MAY BE HOT TO THE TOUCH. ONCE REMOVED FROM THE DRIVE QUILL (35), DO NOT GRASP THE UPPER 20" OF THE MIXER SHAFT.

It is recommended that the mixer be removed from the tank before shaft or shaft and impeller are removed.

a. Make sure all electrical power is disconnected.

b. Grasp impeller by hand (or shaft with a strap wrench) and rotate mixer shaft (231) until the drive quill set screw (58) aligns with the access hole in the housing (36). See Caution above.

c. With hex key (72) loosen set screw (58) and back out two (2) turns. See Figure 2.

d. Remove mixer shaft from quill. See Caution above.

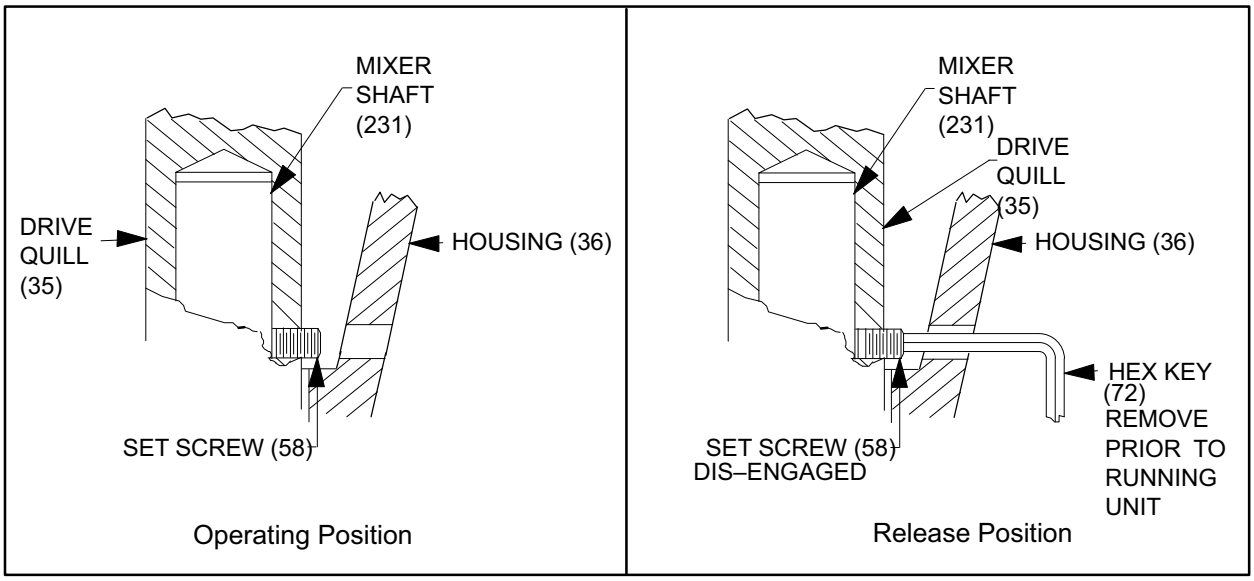


Figure 2 – Shaft Removal

SECTION 5 – MIXER OPERATION

5. 1 This ***LIGHTNIN*** mixer is designed for continuous operation and normally needs no additional maintenance.

CAUTION: IT IS NOT RECOMMENDED TO OPERATE THE MIXER WITH EXTREME VORTEXING OR SURGING OF THE LIQUID BEING MIXED.

5. 2 At the end of two weeks service, check all hardware for tightness.

WARNING: AT THE END OF THE MIXING CYCLE, IT IS GOOD PRACTICE TO TURN OFF THE MIXER BEFORE THE TANK HAS BEEN DRAINED TO A LEVEL WHICH WILL RESULT IN EXCESSIVE SPLASHING. THIS MAY RESULT IN SHAFT DAMAGE.

SECTION 6 – LUBRICATION

All mixer bearings are the sealed type and are pre–packed with lubricant. Relubrication of these bearings is not necessary.

SECTION 7 – DISASSEMBLY INSTRUCTIONS

WARNING: DISCONNECT MOTOR LEADS OR OTHERWISE LOCK–OUT POWER SUPPLY BEFORE SERVICING THE MIXER. EYE PROTECTION MUST BE WORN.

7. 1 This mixer is precision manufactured and assembled to provide long trouble free service when properly maintained. If it becomes necessary to disassemble the unit, careful precise reassembly is necessary.

7. 2 Refer to the assembly drawings for location of parts.

7. 3 Equipment that will be required to service the mixer, in addition to standard mechanics tools is, a rubber mallet, retaining ring pliers, metric and ”inch” allen wrenches, arbor press and torque wrench.

7. 4 When disassembling the mixer, clean external surfaces adjacent to prevent dirt from entering the housings.

7. 5 It is recommended that oil seals and gaskets be replaced when the mixer is disassembled.

7. 6 SEAL REPLACEMENT

Inspect oil seals and gaskets for nicks, gouges and deformities. When replacing seals:

a. Coat the lips of seals with bearing grease.

b. Install oil seal with lip facing up as shown in Figure 3.

c. Coat the section of shaft sealing surface with oil.

7. 7 BEARING REPLACEMENT

a. Old bearings can be removed with a puller or an arbor press.

b. New bearings can be pressed on the shafts. Be careful to apply load only to the inner race.

c. Make sure the bearings are tightly seated against the shaft or housing shoulders with no clearance.

7. 8 SHAFT REMOVAL

Loosen set screw (58) and remove mixer shaft (231) as outlined in Section 4.

7. 9 MOTOR REMOVAL

a. Remove the mixer from the tank and remove the mixer shaft (231) as outlined in Section 4.

b. Tip the mixer upside down on a workbench.

c. Remove the four socket head cap screws (60) holding the bearing housing (36) to the motor (101).

d. Lift the bearing housing off the motor. It may be necessary to tap the bearing housing GENTLY with a rubber mallet to get the bearing housing to separate from the motor.

e. Remove motor coupling half (63) and insert (65) from motor shaft.

7. 10 BEARING MODULE DISASSEMBLY

a. Remove the oil seal (42) from the drive quill (35). This oil seal will be damaged and a new oil seal must be installed when reassembled.

b. Remove retaining ring (44).

c. Remove upper retaining ring (59).

d. Place the bearing housing upright in a press, and press out the drive quill (35) and lower bearing (41).

e. Remove lower retaining ring (59) and bearing (41) from the drive quill (35).

f. Remove upper bearing (41) from housing (36).

g. Inspect bearing (41) for excessive wear. Replace if necessary.

SECTION 8 – ASSEMBLY INSTRUCTIONS

8. 1 QUILL ASSEMBLY

Insert the set screw (58) into the drive quill (35) until it is flush with the bore of the quill.

8. 2 BEARING MODULE ASSEMBLY

a. Press the lower bearing (41) onto the drive quill (35) bearing journal. The bearing must seat against the drive quill shaft shoulder with no visible gap.

b. Install the lower external retaining ring (59).

c. Press the drive quill assembly into the bearing housing (36) from the bottom until the bearing seats on the housing shoulder.

d. Install lower retaining ring (44).

e. Press oil seal (42) in place with the seal cavity facing as shown in Figure 3. Make sure the oil seal has the internal spring removed. This is a non–lubricated seal, and will run hot and have a shortened life if the spring is not removed.

f. Turn the bearing housing over, support the assembly on the quill shaft (35) and install the upper bearing (45) by pressing it into the bearing housing and onto the quill shaft.

g. Install the upper retaining ring (59).

h. Support the bearing housing assembly in an upright position and press the drive quill downward until the bearing (41) shoulders on the retaining ring (59). This will relieve any locked in axial load on the bearing created during assembly.

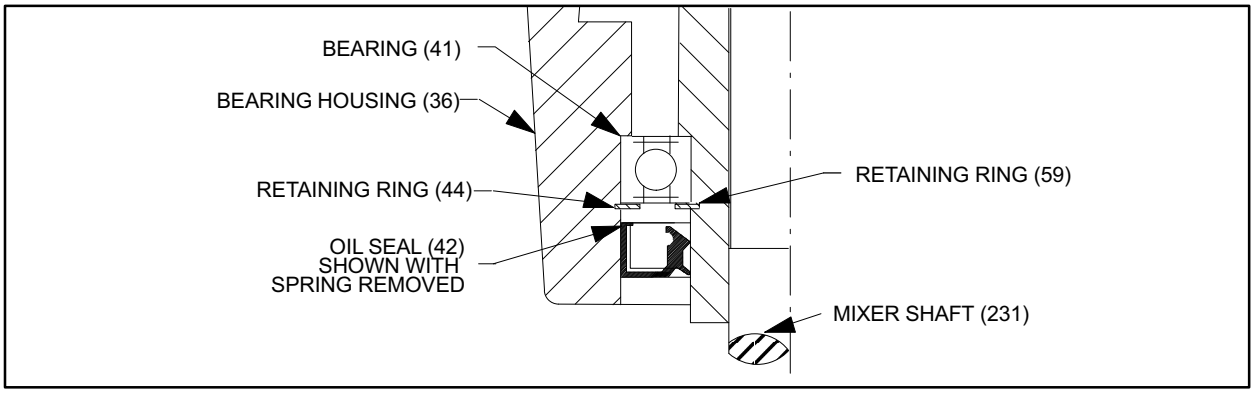


Figure 3– Oil Seal Installation

8. 3 FINAL ASSEMBLY (Refer to assembly drawing L–17094).

a. Install gasket (22) around the bearing housing (36).

b. Assemble mixer coupling hub (64) to the quill shaft (35), until it seats against the upper retaining ring (59). Tighten the mixer hub set screw to 5 ft–lbs. Install the insert (65) on the mixer hub.

c. With the motor upside down on a workbench, assemble the motor coupling hub (63) to the motor shaft as shown in Figure 4. Align motor coupling hub keyway 180° opposite motor output shaft keyway. Motor coupling hub set screw is tightened against motor output shaft (key is not used in the assembly). Tighten the motor hub set screw to 5 ft–lbs.

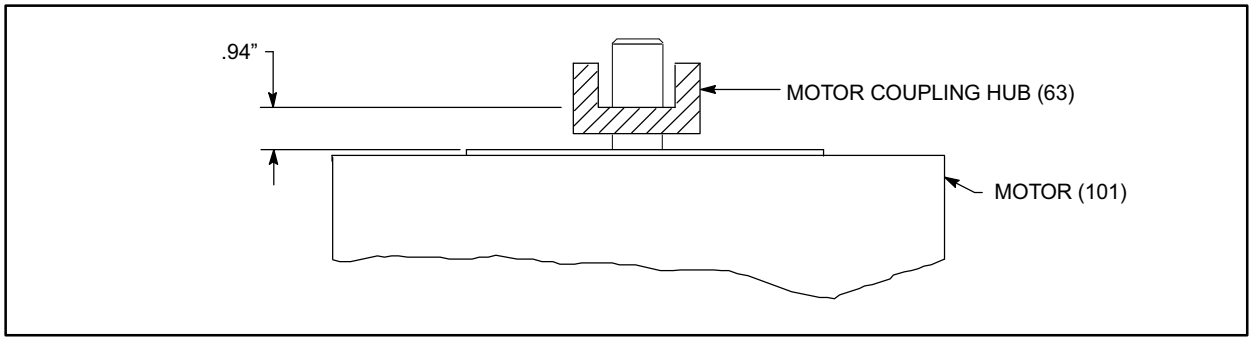


Figure 4 – Motor Coupling Hub Installation

d. Align coupling hubs and assemble the bearing housing to the motor, using care so as not to damage the flexible element (65) or the gasket (22).

e. Bolt the bearing housing (36) to the motor (101), using socket head cap screws (60) and washers (61). Alternately tighten the hardware to 9 ft–lbs to ensure that all components are drawn evenly together.

f. Install mixer shaft (231) as outlined in Section 3.

SECTION 9 – AIR MOTOR REQUIREMENTS

Be sure your compressor has capacity for both pressure and the proper cubic feet per minute air displacement. Wet air, and low pressure will cause sticking of the motor, requiring hand starting. It is important to use an air filter and moisture trap near the motor for removal of foreign matter. Maximum recommended operating pressure is 100 P.S.I.

AIR PRESSURE / AIR CONSUMPTION GUIDE
FOR AIR MOTOR DRIVEN MIXER
(AIR MOTOR OPERATING AT 1800 RPM)

			PRESSURE CONSUMPTION REQUIRED	
H.P.	GAST MOTOR #	SHAFT RPM	* (PSIG)	** (CFM FREE AIR)
1/3	#2	1800	60	15
1/3	#2	360	60	15
1	#4	1800	85	30
1	#4	360	85	30

* Live pressure should be approximately 1–1/2 times the operating pressure of the air motor. The full line pressure will then be available for overloads and startup.

** CFM free air refers to air at atmospheric conditions measured at the inlet of the compressor.

Table 2

SECTION 10 – AIR MOTOR LUBRICATION

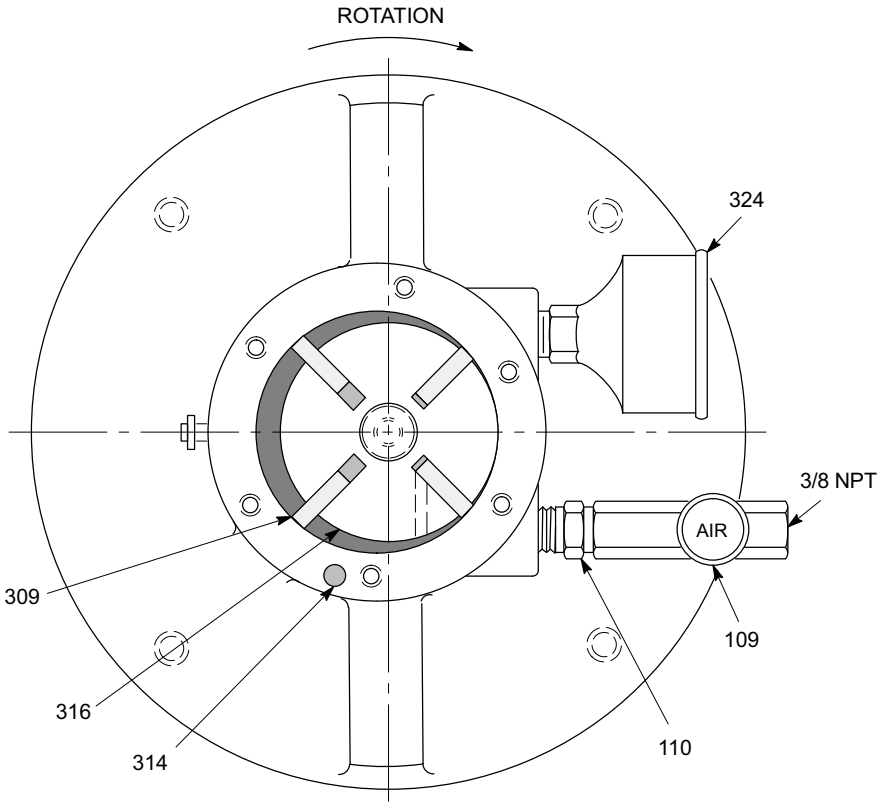
10. 1 Use only a high detergent lubricant of the recommended viscosity. Recommended oils are shown in Table 3.

10. 2 For continuous duty or high speed operation, it is recommended that an automatic lubricating device in the air line be provided to feed 1 to 3 drops per minute to the motor. If required request optional air–line lubricator (part # 151030psp).

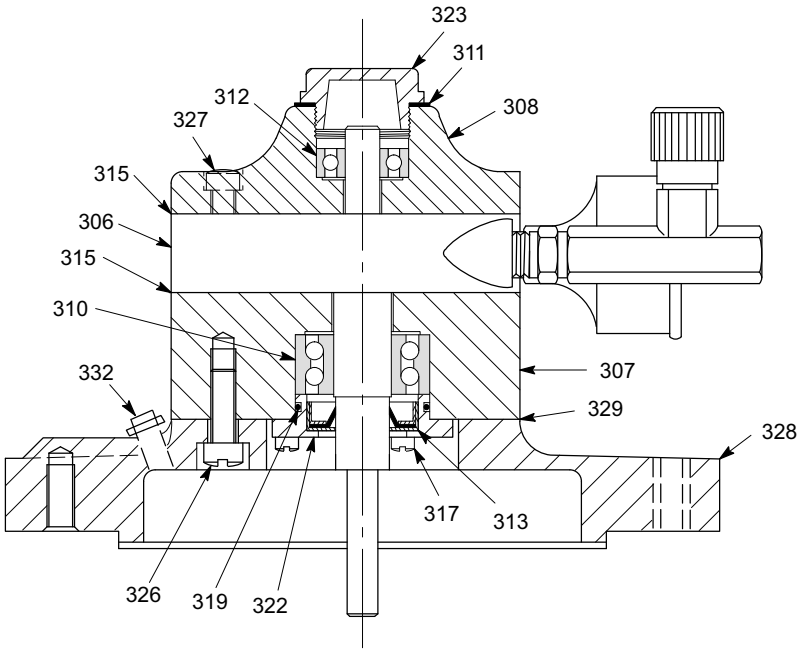
10. 3 For manual oiling, remove the oil cap at the top of the motor, and add one squirt of oil at the end of each 8 hours of operation.

RECOMMENDED LUBRICANT	AMBIENT TEMPERATURE	GRADE OF OIL
GAST AD 220 (SAE #10) OR A HIGH DETERGENT AUTOMOTIVE ENGINE OIL DESIGNED FOR ANY ONE OR MORE OF THE FOLLOWING API SERVICE RATINGS SB, SC, SD, SE, CB, CC, CD.	BELOW 32° F	DILUTE SAE #10 OIL WITH 25% KEROSENE
	32° F TO 100° F	SAE #10 OIL
A HIGH DETERGENT AUTOMOTIVE ENGINE OIL DESIGNATED FOR ANY ONE OR MORE OF THE FOLLOWING API SERVICE RATINGS – SB, SC, CD, CE, CB, CC, CD.	101° F TO 200° F	SAE #20 OIL

Table 3 – Motor Lubrication



SECTION THRU ROTOR HOUSING



(1) FURNISHED ON 2 SIZE DIRECT DRIVE UNITS ONLY.

WHEN ORDERING PARTS, SPECIFY: MOTOR SERIAL NO., ITEM NO. AND DRAWING NO.

ITEM	PART NAME
332	PRESSURE RELIEF VALVE
329	GASKET
328	FLANGE
327	FILLISTER HEAD MACHINE SCREW
326	FILLISTER HEAD MACHINE SCREW
324	MUFFLER
323	END CAP ASSEMBLY
322	BEARING RETAINER
319	O–RING
317	FILLISTER HEAD MACHINE SCREW
316	ROTOR & DRIVE SHAFT ASSY
315	GASKET
314	DOWEL PIN
313	SHAFT SEAL
312	UPPER BALL BEARING
311	GASKET
310	DOUBLE ROW BALL BEARING
309	ROTOR VANE (4 REQ'D)
308	UPPER BEARING HOUSING
307	LOWER BEARING HOUSING
306	ROTOR HOUSING
110	PIPE NIPPLE
109	NEEDLE VALVE

ISO 9001 CERTIFIED

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LIGHTNIN

MIXERS AND AERATORS
ASSEMBLY DRAWING

MODEL NO. 2 AND 4 AIR MOTOR DRIVE ASSEMBLY

NON–LUBRICATED AIR MOTOR INSTRUCTIONS

WARNING: MOTOR CANNOT EXCEED 1800 RPM.

WARNING: To prevent explosive hazard, DO NOT drive this air motor with combustible gases. Injury and/or property damage can result.

WARNING: DO NOT USE KEROSENE OR OTHER COMBUSTIBLE SOLVENTS.

WARNING: EYE PROTECTION IS REQUIRED. Keep face away from exhaust port, and DO NOT flush unit with any flammable solvent.

WARNING: Foreign material exiting the air motor can be hazardous.

CAUTION: Do not drive the air motor in excess of recommended speeds.

SECTION 1 – AIR MOTOR REQUIREMENTS

1.1 In order to insure maximum performance and life from this motor, it is essential that the following points be observed.

1.2 Be sure your compressor has capacity for both pressure and the proper dm^3/s (CFM) air displacement. Wet air, and low pressure will cause sticking of the motor. It is important to use an air filter and moisture trap in the air line ahead of the motor for removal of foreign matter.

1.3 Maximum operating pressure is 550 kPa (80 PSI).

1.4 This motor may be operated at any altitude, provided adequate air line lubrication is supplied. Being totally enclosed, it can be used in any environment within the temperature limits of –7° C to +80° C (+20° F to +175° F).

1.5 The speed of the air motor increases as the load is reduced. Shaft vibration may occur while operating under light load, such as running in air. If excessive vibration occurs, adjust the speed up or down with the air valve until the vibration diminishes. Running the motor at no load and excessive speeds can also cause excessive internal heat build–up. Loss of internal clearances and rapid motor damage will result.

1.6 Motor may be run continuously at speeds up to the rated running conditions shown in the performance data sheets. These sheets give the output power – torque based on running conditions with the actual pressure measured at the motor inlet ports.

1.7 Before final connection to the motor, blow out the air lines to remove any loose scale, swarf or abrasive dust which may be present.

1.8 A muffler is supplied with the motor. Do not operate the air motor with the exhaust port either unguarded or without a muffler. When the muffler is installed, ensure that condensation cannot run back into the motor port.

1.9 The air supply must be clean and relatively dry. Excessive moisture in the air line can cause rust formation in the motor and might also cause ice to form in the muffler. An air line filter should be fitted in the air supply line and located before the first control valve of the system.

1.10 For short length pipe runs, (for example up to 1800mm / six feet), the supply lines should be the same size as the inlet and exhaust ports, and larger for longer runs.

1.11 Refer to Table 1 for air pressure / air consumption guide for air driven motors.

H.P.	SPEED CODE (1)	REQUIRED PRESSURE CONSUMPTION (2) (3)			
		kPa	PSIG	dm^3/s FREE AIR	CFM FREE AIR
1/4	EV1	415	60	7	14
1/3	EV5				
1/2	EV6	415	60	17	35
3/4					

(1) SPEED CODE / MIXER OUTPUT RPM
EV1 = 1725
EV5 = 350
EV6 = 280

(2) LINE PRESSURE SHOULD BE APPROXIMATELY 1.5 TIMES THE OPERATING PRESSURE OF THE AIR MOTOR. THE FULL LINE PRESSURE WILL THEN BE AVAILABLE FOR OVER-LOADS AND STARTUP.

(3) dm^3/s (CFM) FREE AIR REFERS TO AIR AT ATMOSPHERIC CONDITIONS, MEASURED AT THE INLET OF THE COMPRESSOR.

TABLE 1 – Air Pressure/ Air Consumption Guide (Air Motor Operating at 1725 RPM)

1.12 Air line filtration for lubricated service:

a . Use 64 micron filter or better.

b . The air line filter should be drained regularly and the element examined for signs of clogging.

1.13 Air motor lubrication requirements:

The air motor will operate with or without lubrication, and generally speaking, performance will improve with lubrication.

1.14 SERVICING

If the motor is sluggish or inefficient, flush it with solvent (refer to Table 2 for recommended solvents). To flush a unit, disconnect air line and muffler and add several teaspoons of solvent directly into the motor. Rotate the shaft by hand in both directions for a few minutes, reconnect the air line, and SLOWLY apply pressure until there is no trace of solvent in the exhaust air. FLUSH UNIT IN A WELL VENTILATED AREA. Relubricate the motor with a squirt of oil in the chamber. If the vanes need replacing, or foreign materials are present in the motor chamber, an experienced mechanic may remove the end plate opposite the drive shaft end. DO NOT PRY WITH A SCREWDRIVER. It will dent the surface of the plate and body, causing leaks. A puller tool should be used which will remove the end plate while maintaining the position of the shaft. New vanes should have the edge with the corners cut on an angle facing towards the bottom of the vane slot.

MANUFACTURER	PRODUCT
GAST	FLUSHING SOLVENT #AH255 or AH255A
W.W. GRAINGER, INC.	DEM–KOTE 2X726
LOCTITE CORP.	LOCTITE SAFETY SOLVENT
PENETONE CORP.	INHIBISOL SAFETY SOLVENT
DOW CHEMICAL	CHLOROTHANE

TABLE 2 – Recommended Flushing Solvent

SECTION 2 – USE OF AIR MOTORS IN HAZARDOUS ATMOSPHERES

2.1 At the present time, there are no known standards governing the operation of air motors in hazardous atmospheres. However, there are several points regarding the safety of air motors.

2.2 An air motor is not a source of electric sparks. However, it is possible that an article which is not part of the air motor (e.g., wrenches, hammers, etc.) could create a spark by sharply impacting a cast iron or aluminum case or the steel shaft of the air motor. Note that electric motor enclosures for both Class I and II hazardous locations can be made of iron, steel, copper, bronze or aluminum.

2.3 An air motor housing is not designed to contain an internal explosion as is an explosion–proof electric motor. The only possible internal source of ignition in an air motor is a contact between the stationary housing components and the rotating elements that might create a spark. The likelihood of this occurring is reduced by the fact that the contact must be made at precisely the same time as a flammable or explosive gas is introduced into the air motor in a sufficient quantity to achieve a flammable or explosive mixture, while overcoming the positive pressure of the driving gas. In other words, although highly improbable, an internal explosion in an air motor is possible.

2.4 An air motor is designed to be operated by compressed air, the expansion of which in normal operation creates a cooling effect. As a result, the temperature of the air motor will not exceed the higher of the temperatures of the surrounding atmosphere or the air delivered to the inlet.

2.5 ***LIGHTNIN*** does not guarantee the safety of every application, but to ensure the safe operation of an air motor in your application, always follow the product directions and consult your ***LIGHTNIN*** representative.

ELECTRIC MOTOR INSTRUCTIONS

SECTION 1 – INITIAL INSPECTION

1.1 Care is taken at the factory to assure that the motor arrives at its destination in first class condition. If there is evidence of rough handling or damage in shipment, file a claim at once with the carrier and notify our factory.

Examine the outside of the motor carefully for damage, with particular attention to the conduit box, fans and covers. Check nameplate for correct speed, kilowatt, voltage, hertz and phase for conformance with power supply. See Section 1.3 for warning on explosion–proof motors.

1.2 GENERAL DATA:

a .Single phase totally enclosed motors are wired at our factory for correct rotation.

b .All three phase and explosion-proof motors must be field wired for proper rotation. If rotation does not agree with nameplate, reverse any two line leads.

c .Dual voltage motors must be wired for the desired voltage. Refer to the connection diagrams provided on the motor nameplate, inside the conduit box cover or in this manual.

d .Refer to Section 2 for motor maintenance and storage instructions.

1.3 WARNING

• EXPLOSION–PROOF MOTORS – These motors are constructed to comply with the U.L. Label Service Procedure manual. When repairing and reassembling a motor that has an Underwriter's Label, it is imperative that the unit be reinspected and;

a .All original fits and tolerances must be maintained

b .All plugs and hardware to be securely fastened

c .Any part replacements, including hardware, be accurate duplicates of the originals

REPAIR WORK ON EXPLOSION–PROOF MOTORS CAN ONLY BE DONE BY THE ORIGINAL MANUFACTURER. VIOLATIONS OF ANY OF THE ABOVE ITEMS WILL INVALIDATE THE SIGNIFICANCE OF THE U.L. LABEL.

EXPLOSION-PROOF MOTORS ARE EQUIPPED WITH AN INTERNAL CIRCUIT INTERRUPTING DEVICE WHICH TRIPS WHEN OVER HEATING OCCURS. THIS THERMAL PROTECTION CIRCUIT WILL RESET AUTOMATICALLY WHEN UNIT COOLS.

• If the thermal protector continues to trip, some abnormal condition exists. This condition must be corrected before motor will operate normally.

• **ALWAYS DISCONNECT POWER LINE BEFORE SERVICING ANY PART OF THE MIXER**. Unexpected motor start-up may occur after the thermal protection circuit trips.

1.4 After unpacking and inspection to see that all parts are in good condition, turn the shaft by hand to be sure there are no obstructions to free rotation. Equipment which has been in storage should be tested prior to being put into service.

a .It is best to check the insulation resistance of the stator winding with a megohmeter. If resistance is lower than one megaohm, consult ***LIGHTNIN***.

b .Motors are shipped from the factory with sealed, shielded bearings properly packed with grease and ready to operate. Bearings are not regreaseable.

1.5 WIRING – Examine the nameplate data to see that it agrees with the power circuit to which the motor is to be connected. The motor is guaranteed to operate successfully with frequency not more than 5% and voltage not more than 10% above or below the nameplate data, or combined variation of voltage and frequency of not more than 10% above or below nameplate data. Efficiency, power factor and current may vary from nameplate data.

1.6 Connect the motor leads to a power source that matches the line voltage and wiring diagram specified on the motor nameplate.

1.7 Check impeller shaft rotation by jogging the motor until it is determined that rotation is correct.

1.8 **CAUTION**

Repeated trial starts can overheat the motor (particularly for across-the-line starting). If repeated trial starts are made, allow sufficient time between trials to permit heat to dissipate from the windings or rotor to prevent overheating. Starting currents are several times running currents, and heating varies as the square of the current. Do not exceed 12 starts per hour.

1.9 **WARNING**

The frames and other metal exteriors of motors should be grounded to limit their potential to ground in the event of accidental connection or contact between live electrical parts and the metal exteriors. All motors should be grounded through the conduit box. Explosion–proof motors have an integral ground lead for grounding.

1.10 **WARNING**

Before starting motor, remove all unused shaft keys and loose rotating parts to prevent them from flying off.

1.11 Start motor and operate at minimum load prior to filling the tank or basin. Look for any unusual condition.

The motor should run smoothly with little noise. If the motor should fail to start and produces a decided hum, it may be that the load is too great for the motor or that it has been connected improperly. Shut down immediately and investigate for trouble.

SECTION 2 – MOTOR MAINTENANCE AND STORAGE

Electric motors or other prime movers are not prepared by ***LIGHTNIN*** for indoor storage beyond 12 months in a dry ambient atmosphere with controlled temperatures, or 6 months in a dry ambient atmosphere with no temperature control. OUTDOOR STORAGE OF ELECTRIC MOTORS IS NOT RECOMMENDED BY ANY MOTOR MANUFACTURER. For information on storage periods beyond those shown, consult ***LIGHTNIN*** .

2.1 To insure continued reliable operation of electric motors, the following basic rule applies: **KEEP THE MOTOR CLEAN AND DRY.** Motors should be inspected, and output shaft rotated, at a minimum of 6 month intervals with increased frequency as needed depending upon the type of motor and the service.

2.2 Terminal connections and assembly hardware may loosen from vibration during service and should be tightened.

2.3 Insulation resistance should be checked at operative temperature and humidity conditions to determine possible deterioration of insulation due to excessive moisture or extremes in operating environment. If wide variations are detected, motors should be reconditioned.

2.4 LUBRICATION - The ball bearing has deep grooved, double shielded sealed bearings with sufficient lubricant packed into the bearings by the manufacturer for “life lubrication”. The initial lubricant is supplemented by a supply packed into larger reservoirs in the end shield at time of assembly. No grease fittings are provided, as the initial lubrication is adequate for up to 10 years of operation under normal conditions.

2.5 **STORAGE REQUIREMENTS FOR MOTORS –** These extended storage requirements must be followed to allow the submission of a valid warranty claim.

a .The motors, if not mounted, are to be stored in the original containers in a clean, dry, protected warehouse.

b .The storage area is to be free from any vibration and from extremes in temperature.

c .Windings to be megged at the time equipment is put in storage. At the time of removal from storage, the resistance reading must not have dropped more than 50% from the initial reading. Any drop below this point, consult ***LIGHTNIN*** .

d .All external parts and motors subjected to corrosion should be protected by a corrosive resistant coating.

OPERATING INSTRUCTIONS
LIGHTNIN VARI–MIX DRIVE (VM SERIES)

1/3 & 3/4 FRACTIONAL HORSEPOWER TOTALLY ENCLOSED
50 & 60 CYCLE MOTORS ONLY

SECTION 1 – GENERAL

1.1 This supplement pertains to specifications and operation of the ***LIGHTNIN*** "Vari–Mix" motor and control only. For complete mixer installation, operation and maintenance, refer to the instruction manual furnished with the unit.

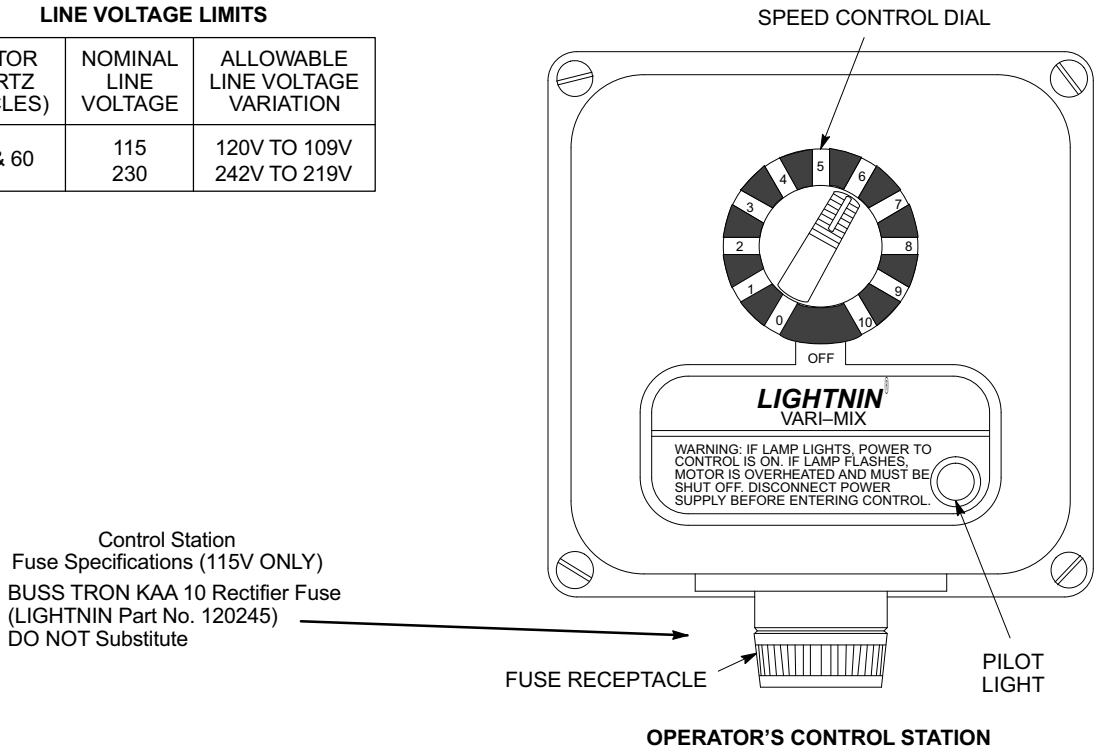
1.2 The motor and control are not watertight and should not be exposed to rain, snow or water sprays. Outdoor use is not recommended unless protection from rain and snow is provided. Maximum ambient temperature is not to exceed 100° F.

SECTION 2 – SPECIFICATIONS

2.1 A.C. line voltage must be within the allowable limits shown in the table. If the performance of the unit is not satisfactory, measure the line voltage. Maximum voltages shown in the table are peak voltages and should not be exceeded. Step up transformers can be obtained from local electrical supply houses if proper line voltages cannot be maintained.

LINE VOLTAGE LIMITS

MOTOR HERTZ (CYCLES)	NOMINAL LINE VOLTAGE	ALLOWABLE LINE VOLTAGE VARIATION
50 & 60	115 230	120V TO 109V 242V TO 219V



OPERATOR'S CONTROL STATION

2.2 Power Connections:

To insure extended motor and mixer life and satisfactory performance, the precautionary measures noted should be followed.

a . DO NOT connect the drive to an AC line that also services heavy motors, starters and contactors. These devices produce transients that can damage the operator control station. Transient voltages can be eliminated by using isolation transformers.

b . Do not over voltage (5% maximum above nameplate voltage) drive on the AC side.

c . It is recommended that a switch (not provided by ***LIGHTNIN***) be installed in the line between the power source and the control station. On 3/4 HP motors, the windings are at full voltage even though the speed control is in the off position. The line switch should be turned off or line plug disconnected if the unit is not operated for periods of one hour or more.

d . DO NOT attempt to reverse the drive by means of an external switch.

e . If the unit is to serviced, disconnect the line to the power source. Turning the speed control to the off position does not isolate the motor or control.

2.3 Mixer Shaft Nominal Speed Ranges:

Direct drive models – 100 to 1750 RPM

Gear drive models – 20 to 350 RPM

Exact speed range depends on AC voltage.

SECTION 3 – INSTALLATION & OPERATION

3.1 An 8 foot power supply cord is furnished by ***LIGHTNIN*** . All motors are wired for the correct shaft rotation.

3.2 Before starting the unit:

a . Make sure the mixer is properly located with relation to tank centerlines and angular requirements or offsets shown in the instruction booklet.

b . Fill the mixing vessel so that the liquid level is at least two impeller diameters above the lower impeller.

c . IMPORTANT: Before applying AC power to the operator’s control station, make sure the speed control dial is in the off position. Switching on the AC line with the speed control dial in the on position can cause control failure.

3.3 To start the unit:

a . Plug the drive into the correct power source as noted in Section 2.1.

b . Turn the speed control dial in a clockwise direction to the desired speed. The pilot light indicates the switch is on.

c . To select a new speed, adjust the speed control dial.

3.4 To stop the drive, turn the speed control full counterclockwise to the off position unit a click is heard and the pilot light goes out. Leaving the control dial on without the motor shaft turning will cause motor damage.

3.5 If the pilot light flashes, the motor is overheated. Stop the drive or reduce speed and allow to cool. Should the pilot light continue to flash, check for overload conditions and/or measure line voltage.

3.6 115V MODELS HAVE A BUSS TRON KAA10 rectifier fuse located in the external fuse receptacle which protects the control electronics from overload. If the unit does not operate, check the fuse and replace if necessary. NOTE: Only BUSS TRON KAA10 fuses are to be used. There are no substitutes. These fuses are available from our factory as ***LIGHTNIN*** Part Number 120245.

3.7 230 volt models have an ABC10 fuse. If the unit does not operate, check the fuse and replace if necessary.

3.8 Precautions during operation:

a . While operating fixed mounting type units in air or during draw–off, the following maximum speeds are not to be exceeded:

All Direct Drive Models – 400 Impeller RPM Max.

All Gear Drive Models – 500 Motor RPM or 100 Impeller RPM Max.

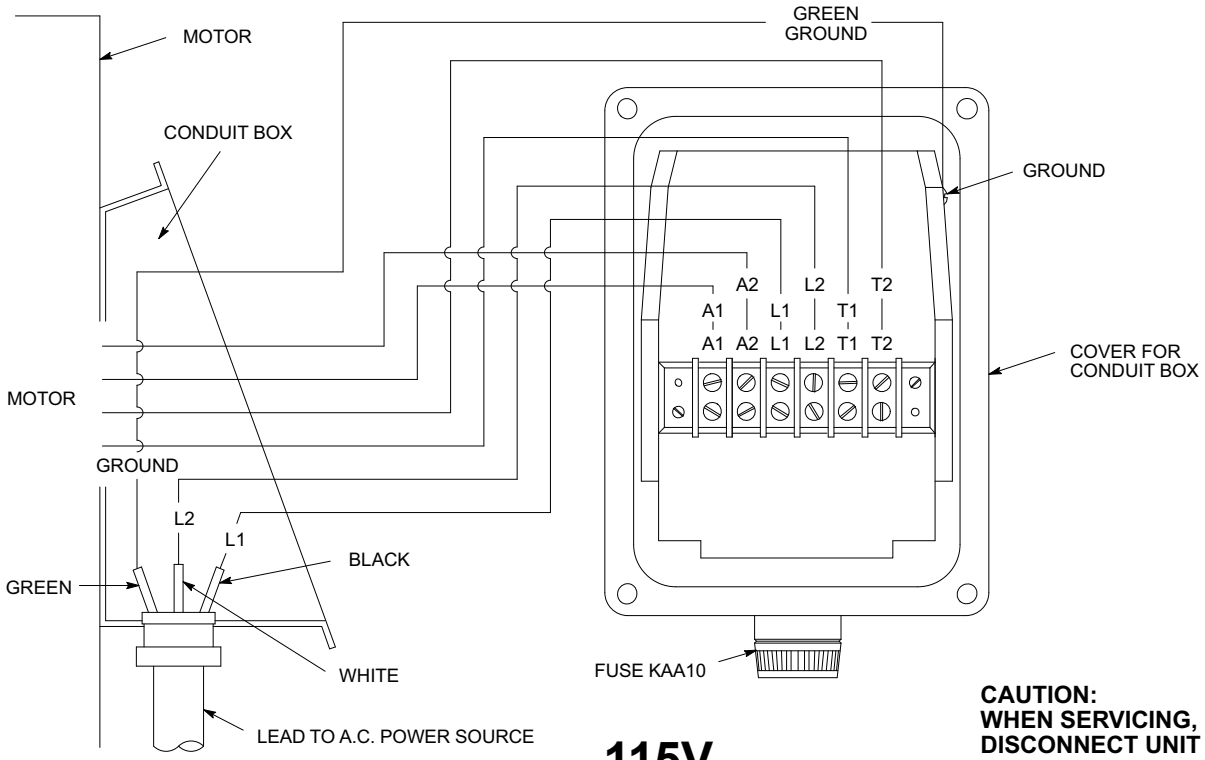
b . XD or XJ Series – Clamp mounted portable mixer shafts may vibrate at certain speeds. If the shaft vibration is excessive, adjust the speed up or down until the vibration diminishes.

c . DO NOT operate under the following adverse conditions unless the control station is protected:

1 . Open outdoor service without protection from rain and snow.

2 . Ambient temperatures over 100° F.

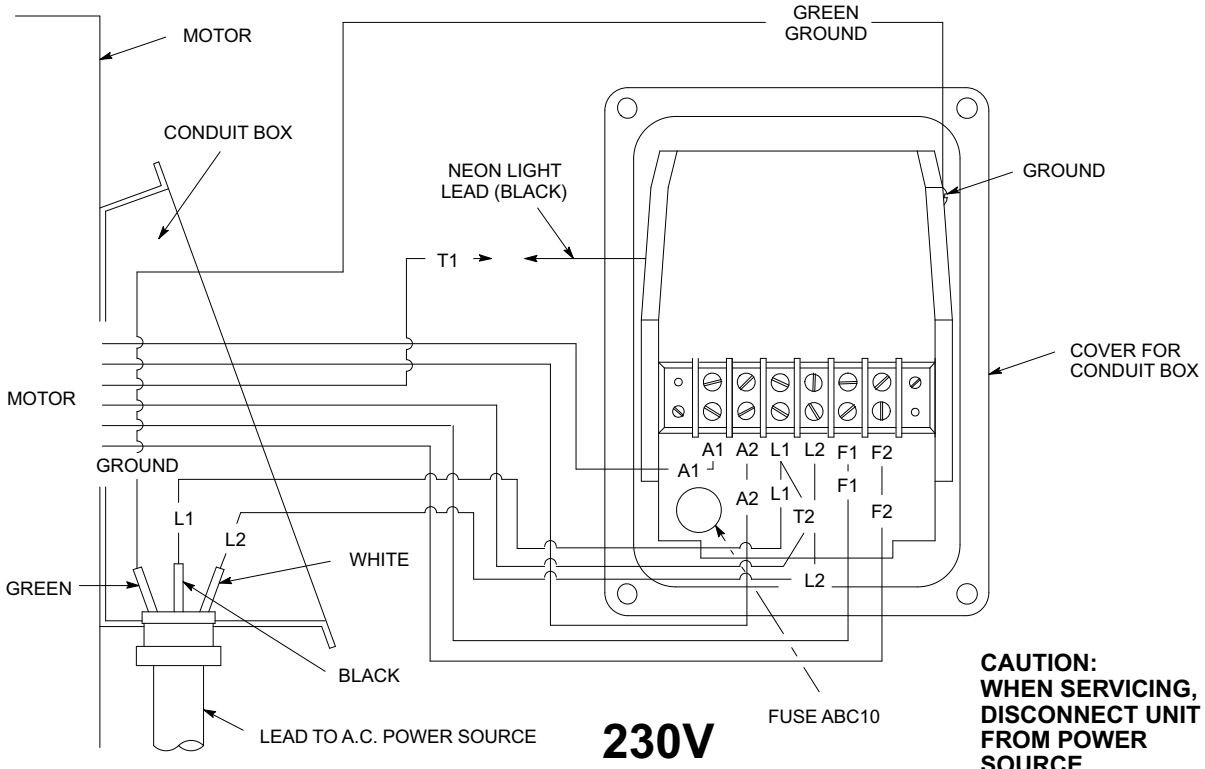
3 . Hot, humid atmospheres such as steam vapors.



115V

VARI–MIX WIRING DIAGRAM

CAUTION:
WHEN SERVICING, DISCONNECT UNIT FROM POWER SOURCE



230V

VARI–MIX WIRING DIAGRAM

CAUTION:
WHEN SERVICING, DISCONNECT UNIT FROM POWER SOURCE

DATE 5–29–98

RECOMMENDED SPARE PARTS
EV "P" SERIES DIRECT DRIVE

For service and repair, call 1–888–MIX BEST (1–888–649–2378)

ITEM NO.	IDENT. CODE ♦		DESCRIPTION Reference Drawing: L–17094	QTY	PART NO.	LIST PRICE (EACH)	SHIPMENT (WEEKS)
NOTE: See mixer nameplate or specification sheet for unit size & ratio. See assembly drawing for item no. identifier.							
3			BUNG ADAPTER	1	271787PSP		
22	*		GASKET	1	271795PSP		
35			DRIVE QUILL 3/4"	1	271781316		
35			DRIVE QUILL 5/8"	1	271754316		
36			HOUSING	1	271838ALF		
39	*		EXPANSION PLUG	1	271868PSP		
40			LANYARD	1	271869PSP		
41	*		BALL BEARING	1	290151PSP		
42	*		OIL SEAL	1	290701PSP		
44	*		RETAINING RING	1	270822PSP		
45	*		BALL BEARING	1	290158PSP		
53			MOUNTING PLATE @ 0°	1	272099ALM		
53			MOUNTNG PLATE @ 20°	1	272098ALM		
58			SET SCREW – NYLOK	1	271757STL		
59	*		RETAINING RING	2	291592PSP		
60			SOCKET CAP SCREW	4	271778GR5		
61			FLAT WASHER	4	112005316		
63			COUPLING HALF	1	292267PSP		
64			COUPLING HALF	1	292269PSP		
65			COUPLING INSERT	1	292256PSP		
72			HEX WRENCH	1	127210BPF		
101			MOTOR	1	PER ORDER		
102			COUPLING	1	292248PSP		
115			TANK CLAMP @ 0°	1	271782ALM		
115			TANK CLAMP @ 20°	1	271755ALM		
116			CLAMP SCREW	1	105413CPR		
118			CUP WASHER	1	112409CPS		
119			RETAINING RING	1	205445PSP		
120			HEX HEAD CAP SCREW	1	100147316		
121			FLAT WASHER	1	112009316		
122			HEX LOCKNUT	1	107407PSP		
123	*		ROTATION INSERT	1	291619PSP		
231			MIXER SHAFT	1	PER ORDER		

♦ **IDENTITY CODE**

* Recommended spare parts

Blank code denotes common parts

REVISION
F

IT–3711
PAGE 1 OF 1

AFTERMARKET SERVICE PROGRAMS
PORTABLE MIXERS

Contact your ***LIGHTNIN*** Representative for additional information regarding any of these programs

MIXER FIXER KITS

A simple, economical option regarding purchasing of parts to rebuild a ***LIGHTNIN*** mixer. Available for all current style ”Classic” and VEKTOR portable units. All parts are labeled for ease of identification..

RECOMMENDED PARTS INVENTORY

A program which compiles a comprehensive list of ***LIGHTNIN*** mixers and advises recommended quantities of spare parts to minimize inventory. The RPI program also provides a cross–reference of parts to other ***LIGHTNIN*** mixers within the plant. The program is offered at no charge.

PIT STOP / REPAIR

A pre–established repair program for all Portable mixer models. There are three (3) levels of repair, the one used depends on the years of service the mixer has experienced. A one (1) year warranty applies to all repairs.

Shipment: 1 week

SERVICE CENTERS

LIGHTNIN has two (2) Service Centers that can repair or rebuild any ***LIGHTNIN*** equipment. Service Centers are located in Wytheville, VA and Chicago, IL

REPAIR DEPOT

The Rochester, NY facility which manufactures all portable mixers also serves as a repair depot for all portable mixers.

SERVICE MECHANICS

LIGHTNIN has a team of qualified personnel which can rebuild any ***LIGHTNIN*** equipment at the customers facility. They can also offer installation and start–up service as well.

MIXER MAINTENANCE VIDEO TAPES

LIGHTNIN has mixer maintenance video tapes to assist customers in the repair or rebuild of ***LIGHTNIN*** equipment. The maintenance tapes for portable mixers are listed below. There is a nominal fee for each tape.

Tape Number	Description
104	XD and XJ Portable Mixers
108	VEKTOR Portable Mixers
109	VEKTOR Standard Conversions

MIXER MAINTENANCE SEMINAR

A mixer maintenance and operation seminar is held for maintenance personnel twice a year at the Wytheville, VA facility. Maintenance and operation for Top Entry, Side Entry and Portable mixers are covered at the seminar. Seminars are held each May and October, each session is 1–1/2 days long. There is a nominal fee for the seminar.

Regional and in–plant seminars are also available.

LIGHTNIN

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He can save you time and money, and provide you with mixers and aerators guaranteed to do the job.

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Fax: 602–275–8042

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Leonard Engineered Products
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Fax: 813–573–0217
FL only: 800–445–2630

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FL only: 800–342–0436

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334–438–3949 (Mobile)
Fax: 850 474–0607

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Fax: 770–998–0119

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Clemco Pacific
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Fax: 808–842–3505

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630–924–1384 (Service Cntr.)

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Fax: 248–478–4074

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Fax: 612–881–4219

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419–874–1359 (Toledo)
Fax: 330–659–4871

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Fax: 49–5144–4807

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Cable: Rangsunder
Telex: 145/7210RATUB
Fax: 91–212–625900

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Kompleks Harmani Plaza
Blk E, 43–44
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Fax: 972–9–741–1951

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Jakarta 12930 Indonesia
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Aeromix Pty. Ltd.
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Bergvlei
2012 Transvaal
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Telex: 4–25681
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Alfa Laval GM
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8302 Kloten
Switzerland
Phone: 41–1–804–6600
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Systems & Equipment
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Headquarters
LIGHTNIN Mixers Ltd.
London Road South
Poynton, Stockport, Cheshire
Postal Code – SK12 1LH. England
Phone: 44–1625–87–6421
Fax: 44–1625–87–2324

Bristol, England
D.L. Shearman & Co., Ltd.
24 Emery Road
Brislington Trading Estate
Bristol, BS4.5PF England
Phone: 44–117–9773746
44–117–9773747
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Headquarters, Rochester, NY
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Customer Satisfaction Team,
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Phone: 716–436–5550
Fax: 716–527–1922

Customer Satisfaction Team,
Asia Pacific – CST #6
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716–527–1742

Export Administration Team
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Centro Comercial Automotriz
Av. Nueva Granada con Av. La Linea
Torre A, Local 1
Caracas 1040, Venezuela
Phone: 58–2–632–47–33
58–2–632–35–11
58–2–632–09–64
58–2–632–44–91
58–2–632–08–02
58–2–632–50–01
58–2–632–00–66
Fax: 58–2–62–51–85
58–2–61–69–90

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See Coneco de Puerto Rico

VISSERS SALES CORP.
220 INDUSTRIAL PARKWAY S, UNIT 19
AURORA, **ONTARIO**, L4G 3V6
TEL: (905) 841-4073
FAX: (905) 841-4018

#102-1628 Fosters Way
Delta **BRITISH COLUMBIA** V3M 6S6
TEL: (604) 523-1798
FAX: (604) 523-1788

QUOTATION

Date	**July 23, 2009**
Reference	**BM072209rev1**
No. of Pages	

Customer: AMEC GEOMATRIX LIMITIED	**Contact JERED MUNRO**
Address:	**Title:**
	Phone: 519-886-7500 EXT 248
	Fax: 519-886-7419

AS DISCUSSED I AM PLEASED TO QUOTE THE FOLLOWING

1) Pulsatron LPH8SAPTCBXXX rated at 94.6 litres per hour @ 30 psi.
Net price $ 1778.00

1) 1000ml cal column CC1000S
Net price $ 127.00

1) Pulsatron LPH6SAPTC3XXX rated at 18.9 liters per hour @ 100 psi
Net price $ 1066.00

1) 500 ml cal column CC0500S
Net price $ 105.00

1) CG3 mixer ½ hp 350 rpm c-clamp style mixer ¾ x 36” shaft single 10” prop
Net price $ 2278.00 (polymer makedown)with 10 foot power cord.

Regards
Barrie.

PRICING / TERMS / DELIVERY		
Terms:	**Net 30 Days O.A.C**	
F.O.B.:	**Aurora, Ontario**	
Taxes:	**Extra**	
Quotation Valid 60 Days		**Quoted By: BARRIE MILES**
Delivery:	**2-3 days**	

Quantity:	**Unit Price:**	**Total Price:**

VISSERS SALES CORP.
220 INDUSTRIAL PARKWAY S, UNIT 19
AURORA, **ONTARIO**, L4G 3V6
TEL: (905) 841-4073
FAX: (905) 841-4018

#102-1628 Fosters Way
Delta **BRITISH COLUMBIA** V3M 6S6
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Net price $ 2278.00 (polymer makedown)with 10 foot power cord.

Regards
Barrie.

PRICING / TERMS / DELIVERY		
Terms:	**Net 30 Days O.A.C**	
F.O.B.:	**Aurora, Ontario**	
Taxes:	**Extra**	
Quotation Valid 60 Days		**Quoted By: BARRIE MILES**
Delivery:	**2-3 days**	

Quantity:	**Unit Price:**	**Total Price:**

WT30XK3C

- Honda GX240 OHV engine
- 76 mm (3") suction and discharge ports
- Pumps 1,208 litres per minute (266 Imp. Gal. per minute)
- Commercial drainage

SPECIFICATIONS

WATER PUMP TYPE	TRASH	**Honda ENGINE**	GX240K1 4-STROKE
PUMP	CENTRIFUGAL	**TYPE**	OHV; AIR-COOLED; SINGLE CYL.
TYPE	SELF-PRIMING	**DISPLACEMENT**	242 CC
SUCTION PORT DIAMETER	76 MM /3.0 IN.	**LUBRICATION SYSTEM**	SPLASH TYPE
DISCHARGE PORT DIAMETER	76 MM /3.0 IN.	**GOVERNOR**	MECHANICAL
LITRES PER MINUTE	1208	**STARTING SYSTEM**	RECOIL
IMP. GAL. PER MINUTE	266	**FUEL TANK CAPACITY**	6 L /1.32 IMP. GAL.
LITRES PER HOUR	72480	**OIL ALERT**	STANDARD
IMP. GAL. PER HOUR	15960	**DRIVE UNIT TYPE**	DIRECT COUPLE / MECH. SEAL
TOTAL HEAD	27 M /89 FT.	**FRAME TYPE**	FULL FRAME
SUCTION HEAD (TOTAL LIFT)	8 M /26 FT.	**LENGTH**	660 MM /26 IN.
PRIMING TIME @ 5M(16.4 FT.)	100 SECONDS	**WIDTH**	495 MM /19.5 IN.
PUMP BODY	ALUMINUM	**HEIGHT**	515 MM /20.3 IN.
IMPELLER	CONICAL CAST IRON	**DRY WEIGHT**	60 KG. /132 LB.

Models and/or colours may not be exactly as shown. Errors and omissions excepted. Specifications are subject to change without notice.
See your Honda Power Equipment dealer for details.

For optimum performance and safety, please read your owner's manual before operating your Honda product. Always wear the appropriate safety gear when operating your Honda.

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Invoice

Date	Page
Aug 12, 2011	1
Invoice Number	
IN00063230	

VISSERS SALES CORP.
220 INDUSTRIAL PARKWAY S., UNIT 19
AURORA, ONTARIO L4G 3V6
TEL.: (905) 841-4073 • FAX: (905) 841-4018
TOLL FREE: 1-800-367-4180

EMAILED
AUG 18 2011

ENTERED AUG 26 2011

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900 Maple Grove Road
Unit 10
Cambridge, ON N3H 4R7
CANADA

FILE COPY

Ship To:

Amec Earth & Environmental
900 Maple Grove Road
Unit 10
Cambridge, ON N3H 4R7
CANADA

Ship Date	F.O.B.	GST Number	PST Number
8/12/2011	Aurora	867621864RT001	

Order No.	Order Date	Customer No.	Salesperson	PO Number	Ship Via	Terms
ORD00033388	Aug 11, 2011	AMEC	TW	TR1111022-2000	UPS	NET30

Qty. Ord.	Qty. Shp.	Qty. B/O	Item Number	Description	Unit Price	UOM	Extended Price
1	1	0	LPH8SAPTCBXXX -	SERIES E+, 500 GPD, 20PSI, PP/TFE/CER	1,778.00	EACH	1,778.00
1	1	0	L3101TCBFPP -	SUCTION VALVE	207.00	EACH	207.00
1	1	0	L3201TCBFPP -	DISCHARGE VALVE	207.00	EACH	207.00
2	2	0	L3101TC3FPP -	SUCTION VALVE ASSY	48.00	EACH	96.00
2	2	0	L3300T03FPP -	BLEED VALVE ASSY	67.00	EACH	134.00
2	2	0	L3201TC3FPP -	DISCHARGE VALVE ASSY	48.00	EACH	96.00
			FREIGH	Freight Charges			23.75

5750-00

BACK ORDERS WILL BE SHIPPED AS SOON AS AVAILABLE UNLESS WE ARE OTHERWISE ADVISED. N/A ITEMS ARE NOT AVAILABLE AND HAVE NOT BEEN BACK ORDERED. VISSERS SALES CORP WILL RETAIN A SECURITY INTEREST IN THE EQUIPMENT SHIPPED UNTIL FULLY PAID FOR. EQUIPMENT WARRANTY APPLIES ONLY TO EQUIPMENT PAID FOR AS PER ABOVE TERMS.

Comments:

Tax summary:

HSTON	330.43

Subtotal	**2,541.75**
Total sales tax	**330.43**
Total amount	**2,872.18**

8.0 POLICIES AND PROCEDURES

8.1 Manufacturers Product Warranty

The manufacturer warrants its equipment of its manufacture to be free of defects in material or workmanship Liability under this policy extends for twenty-four (24) months from the date of purchase or one (1) year from date of installation or whichever comes first. The manufacturer's liability is limited to repair or replacement of any device or part, which is returned, prepaid, to the factory and which is proven defective upon examination. This warranty does not include installation or repair cost and in no event shall the manufacturer's liability exceed its selling price of such part.

The manufacturer disclaims all liability for damage to its products through improper installation, maintenance, use, or attempts to operate such products beyond their functional capacity, intentionally or otherwise, or any unauthorized repair. Replaceable elastomeric parts are expendable and are not covered by any warranty either expressed or implied. The manufacturer is not responsible for consequential or other damages, injuries, or expense incurred through use of its products.

The above warranty is in lieu of any other warranty, either expressed or implied. The manufacturer makes no warranty of fitness or merchantability. No agent of ours is authorized to make any warranty other than the above.

For warranty and service matters within the European Union, contact the seller first or:

Pulsafeeder, Inc. Europe
Units 12 and 13, Edison Road
Eastbourne, East Sussex BN23 6PT

8.2 Returns

The Customer Service Department will issue a Return Authorization (RA) number for all returns. The following information will be required:

1. Billing and a ship-to address.
2. Model and serial number.
3. Contact name and phone number.
4. Reason for return.
5. Purchase order (where applicable).
6. RA number on outside of the carton.

All material must be returned freight prepaid. All merchandise must be properly packaged and free of any corrosive, toxic or otherwise hazardous chemical. All items returned must reference Return Authorization.

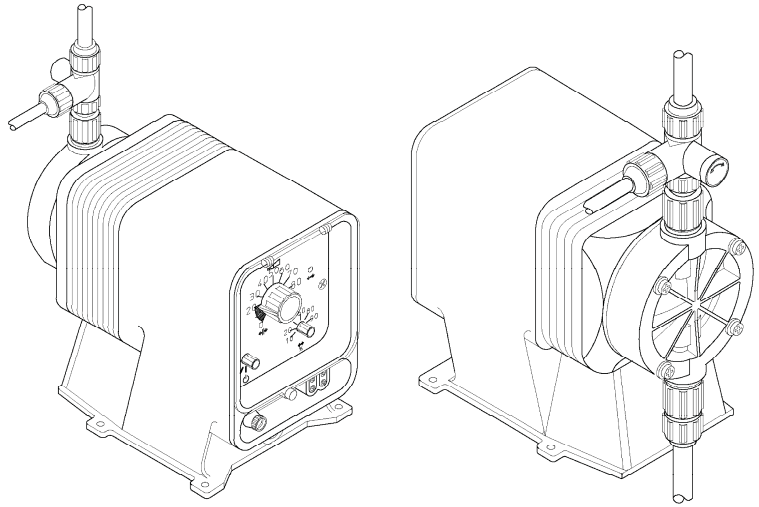
8.3 Credits

No equipment will be accepted beyond six months after date of shipment from the factory. Only unused and undamaged equipment will be accepted for return to stock. All credits are based on acceptance of materials as new and unused by our inspection personnel. A restocking fee will apply. All equipment returned for credit must have a RA number and be returned freight prepaid.

Electronic Metering Pumps

Series C, C+, A+, E, E-DC and E+

Installation
Operation
Maintenance
Instruction



READ ALL WARNINGS CAREFULLY
BEFORE INSTALLING

TABLE OF CONTENTS

1.0 SAFETY INSTRUCTIONS 3
1.1 General Safety Considerations 3
1.2 Safety Operating Procedures 3
2.0 UNPACKING THE PUMP 4
3.0 INTRODUCTION 5
3.1 Principle of Operation 5
3.2 Materials of Construction 5
4.0 INSTALLATION 5
4.1 Mounting 5
4.2 Piping 6
4.3 Wiring 7
4.4 Well Pump System Installation 7
5.0 START UP AND OPERATION 8
5.1 Power 8
5.2 Priming 8
5.3 Capacity Control 8
5.3.1 Stroke Frequency Adjustment 8
5.3.2 Stroke Length Adjustment 9
5.3.3 Controlling Procedure 9
5.4 Control Panel Symbols 9
5.5 Operation By External Input Signals 9
5.5.1 Stop Functions 9
5.5.2 External Pacing Function 10
5.5.3 4-20mA DC Input Function 10
6.0 MAINTENANCE 11
6.1 Routine Maintenance 11
6.2 Disassembly and Assembly Diaphragm Removal 11
6.3 Diaphragm Replacement 11
6.4 Valve Replacement 12
7.0 TROUBLESHOOTING 13
Appendix A 15
8.0 POLICIES AND PROCEDURES 16
8.1 Manufacturer's Product Warranty 16
8.2 Returns 16
8.3 Credits 16

Appendix A

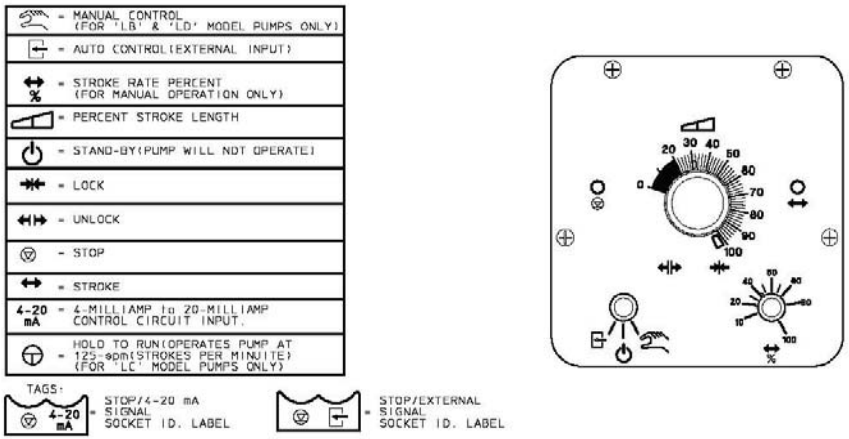


Figure 11

Leakage at Fitting	**1. Loose fittings**	**1. Tighten hand tight. Replace gasket if hand tightening does not stop leakage**
	2. Broken or twisted gasket	**2. Check gaskets and replace if broken or damaged**
	3. Chemical attack	**3. Consult your pump supplier for alternate material**
Pump Loses Prime	**1. Dirty check valve**	**1. Remove and replace or clean off any scale or sediment**
	2. Ball checks not seating or not sealing properly	**2. Check seat and ball checks for chips, clean gently. If deformity or deterioration is noted, replace part with proper material. Resulting crystals can hold check valves open, therefore, the valves must be disassembled and cleaned**
	3. Solution container allowed to run dry	**3. Refill the tank with solution and prime. See 5.0 Start-up and Operation Section**
	4. Chemical out gassing	**4. Bleed gas, use flooded suction and maintain chemical at room temperature (approximately 20˚F) to minimize out gassing**
Pump will not Prime	**1. Too much pressure at discharge**	**1. Turn off all pressure valves, relieve system pressure then loosen outlet tubing connection at discharge point. Remove discharge valve cartridge. Dampen ball check and valve seats with a few drops of solution. Set pump dial to maximum rate. When pump is primed, reconnect all tubing connections**
	2. Check valves not sealing	**2. Disassemble, clean and check for deterioration, damage or swelling. Reassemble and wet the valve assembly, then prime. See 5.0 Start-Up and Operation Section.**
	3. Output dials not set at maximum	**3. Always prime pump with output dial set at maximum rated capacity.**
	4. Suction lift height too much. Maximum 5ft (1.5m)	**4. Decrease suction lift or pull vacuum on pump discharge until pump is primed**
	5. Pump equipped with spring loaded high viscosity valves	**5. Loosen discharge valve to aid in priming, take necessary safety precautions for spills or apply vacuum to pump discharge**

1.0 SAFETY INSTRUCTIONS

WARNING

When using chemical feed pumps, basic safety precautions should always be followed to reduce risk of fire, electric shock, and personal injury. Failure to follow these instructions could result in death or serious injury.

READ ALL INSTRUCTIONS

1.1 General Safety Considerations

Always wear protective clothing including gloves and safety goggles when working on or near chemical metering pumps.

Inspect tubing regularly when replenishing chemical solution for cracking or deterioration and replace as necessary. **(Always wear protective clothing and safety glasses when inspecting tubing.)**

When pump is exposed to direct sunlight use U.V. resistant tubing.

Follow directions and warnings provided with the chemicals from the chemical manufacturer. User is responsible for determining chemical compatibility with chemical feed pump.

Secure chemicals and metering pumps, making them inaccessible to children and pets.

Make sure the voltage on the chemical metering pump matches the voltage at the installation site.

Do not cut plug or the ground lug off of the electrical cord – consult a licensed electrician for proper installation.

Pump is **NOT** to be used to handle flammable liquids.

1.2 Safety Operating Procedures

Each Electronic Metering Pump has been tested to meet prescribed specifications and safety standards.

Proper care in handling, installation and operation will help in ensuring a trouble free installation.

Please read all these cautionary notes prior to installation and start-up of your metering pump.

Important: Pump must be installed and used with supplied back pressure/injection valve. Failure to do so could result in excessive pump output.

Handle the pump with care. Dropping or heavy impact causes not only external damage to the pump, but also to electrical parts inside.

Install the pump in a place where the ambient temperature does not exceed 104ºF (40ºC). The pump is water resistant and dust proof by construction and can be use outdoors, however **do not operate the pump submerged**. To avoid high internal pump temperatures, do not operate in direct sunlight.

CAUTION Solenoid housing, head and pump housing may be hot to touch 160ºF (70ºC).

Install the pump in a place convenient for its future maintenance and inspection, and then secure it to prevent vibration.

Protective caps must be removed prior to installing tubing onto valve assemblies. Use tubing of specified size. Connect the tubing to the suction side securely to prevent the entrance of outside air. Make sure that there is no liquid leakage on the discharge side.

Be careful to check that the voltage of the installation matches voltage indicated on the pump data label. Most pump models are equipped with a three-prong plug. Always be sure the pump is grounded. To disconnect, do not pull wire but grip the plug with fingers and pull out. Do not use the receptacle in common with heavy electrical equipment, which generates surge voltage. It can cause failure of the electronic circuit inside the pump.

Tampering with electrical devices can be potentially hazardous. Always place chemicals and pump installation well out of the reach of children.

Never repair or move the metering pump while operating. Always disconnect electrical power. **For safety, always wear protective clothing (protective gloves and safety glasses) when working on or near chemical metering pumps.**

An air bleed valve is available for most models with tubing connections. Air purges should be performed when the pump-chamber contains no fluid at the time of start-up. As a safety measure, connect the return tubing to the air bleed valve and bypass fluid back to storage tank or a suitable drain.

For accurate volume output, the pump must be calibrated under typical operating conditions.

Chemicals used may be dangerous and should be used carefully and according to warnings on the label. Follow the directions given with each type of chemical. Do not assume chemicals are the same because they look alike. Always store chemicals in a safe location away from children and others. We cannot be responsible for the misuse of chemicals being fed by the pump. Always have the material safety data sheet (MSDS) available for any fluid being pumped.

All pumps are pretested with water before shipment. Remove head and dry thoroughly if you are pumping a material that will react with water, (i.e. sulfuric acid, polymers). Valve seats, ball checks, gaskets, and diaphragm should also be dried. Before placing pump into service, extreme care should be taken to follow this procedure.

Valve cartridges are stamped to indicate fluid flow direction. Always install so that markings read from top to bottom, with the arrow pointing in the direction of flow.

When metering hazardous material **DO NOT** use plastic tubing, strictly use proper rigid pipe. Consult supplier for special adapters or valve assemblies.

Pump is NOT to be used to handle or meter flammable liquids or materials.

Standard white discharge tubing is not recommended for installations exposed to direct sunlight. Consult supplier for special black tubing.

Factory will not be held responsible for improper installation of pump, or plumbing. All cautions are to be read thoroughly prior to hookup and plumbing. For all installations a professional plumber should be consulted. Always adhere to local plumbing codes and requirements.

When using pump with pressurized systems, make sure the pressure of the system does not exceed the maximum pressure rating on the pump data label. Be sure to depressurize system prior to hook up or disconnecting a metering pump.

Electronic power modules are equipped with automatic reset thermal overload devices and may reset unexpectedly.

2.0 UNPACKING THE PUMP

Check all equipment for completeness against the order and for any evidence of shipping damage. Shortages or damages should be reported immediately to the carrier and to the seller of the equipment.

The carton should Contain:

- ✓ Metering Pump
- ✓ Clear Flexible Suction Tubing*
- ✓ Stiff White Discharge Tubing*
- ✓ Foot valve/Strainer Assembly
- ✓ Backpressure Injection Valve Assembly
- ✓ Manual
- ✓ Bleed Valve Assembly*
- ✓ Strainer Weight*

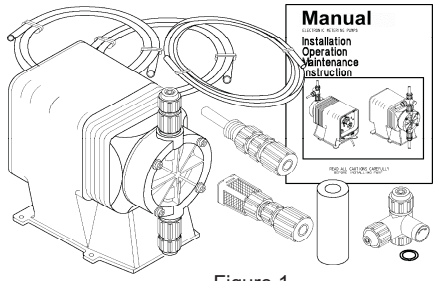


Figure 1

*Items may or may not be included depending on model.

Make sure that all items have been removed from the shipping carton before it is discarded.

7.0 TROUBLESHOOTING

Problem	Probable Cause	Remedy
Failure to Pump	1. Leak in suction side of pump	1. Examine suction tubing. If worn at the end, cut approximately one inch (2.5cm) off and reconnect
	2. Valve seats not sealing	2. Clean valve seats if dirty or replace with alternate material if deterioration is noted
	3. Low setting on pump	3. When pumping against pressure, the dial should be set above 20% capacity for a reliable feed rate
	4. Low suction level	4. Solution must be above foot valve strainer
	5. Diaphragm ruptured	5. Replace diaphragm as shown in 6.0 Maintenance Section. Check for pressure above rated maximum at the injection point. NOTE" Chemical incompatibility with diaphragm material can cause diaphragm rupture and leakage around the pump head
	6. Pump head cracked or broken	6. Replace pump head as shown in 6.0 Maintenance Section. Make sure fitting are hand tight only. Using pliers and wrench can crack pump head. Also, chemical incompatibility can cause cracking and subsequent leakage.
	7. Pump head contains air or chlorine gas	7. Bleed pump head, see 5.0 Start-up and Operation section
	8. Breakdown or disconnection of wiring	8. Connect wiring properly. Check fuse or circuit breaker
	9. Voltage drop	9. Take measures after investigation of cause
	10. Malfunction of electronic control board	10. Contact supplier
Loss of Chemical Residual	1. Pump setting to low	1. Adjust to higher setting (pump must be operating to adjust stroke length knob)
	2. Scale at injection point	2. Clean injection parts with 8% muriatic acid or undiluted vinegar (also, see Maintenance Section)
	3. Solution container allowed to run dry	3. Refill the tank with solution and prime (see Start-up and Operation Section)
Too Much Chemical	1. Pump setting too high	1. Lower pump setting (pump must be operating to adjust stroke length knob)
	2. Chemical in solution tank too rich	2. Dilute chemical solution. NOTE: For chemical that reacts with water, it may be necessary to purchase a more dilute grade of chemical direct from chemical supplier
	3. Siphoning of chemical into well or main line	3. Test for suction or vacuum at the injection point. If suction exists, install an anti-siphon valve
Leakage at Tubing Connections	1. Worn tube ends	1. Cut off end of tubing approximately one inch (2.5cm) and reconnect
	2. Chemical attack	2. Consult your seller for alternate material

Apply grease to areas of the diaphragm that contact the deflection plate.

Slide the diaphragm deflection plate onto the back of the diaphragm stud, radius side towards the diaphragm. Next slide two shims onto the diaphragm threaded stud and screw the diaphragm into the EPM unit. Refer to Figure 14. Turn diaphragm clockwise until deflection plate and shims are tight against solenoid shaft and the diaphragm stops turning. If there is a gap between the adaptor and diaphragm, repeat the procedure removing one shim each time until the diaphragm just touches the adaptor or is slightly recessed.

If not already done, adjust stroke length to 50%. Place the pump head onto the adaptor with valve flow arrows pointing up and install and tighten pump head screws. Tighten screws until pump head pulls up against adaptor.

NOTE: Adjust stroke length only when pump is running!

Adjust stroke length back to 100% for easier priming and place pump back into service.

6.4 Valve Replacement

Flush pump to clean any chemical from pump head.

Unplug pump, release system pressure, and disconnect tubing or piping.

Unscrew valve cartridges and discard. Also remove o-rings down inside the pump head.

Install new valve cartridges with stamped letters reading from top to bottom, and the arrow pointing in the direction of flow. Hand-tighten only, do not use wrenches or pliers.

Reconnect tubing or piping and reinstall the pump.

Check for leaks around newly installed fittings.

3.0 INTRODUCTION

These installation, operation and maintenance instructions cover your electronic metering pump. Refer to the pump data label to determine the actual model.

3.1 Principle of Operation

Diaphragm metering pumps are used to dispense chemicals or fluids. This is achieved by an electromagnetic drive mechanism (solenoid), which is connected to a diaphragm. When the solenoid is pulsed by the control circuit it displaces the diaphragm, which, through the use of check valves, moves the fluid out the discharge under pressure. When the solenoid is de-energized it returns the diaphragm and pulls more fluid into the pump head and the cycle repeats.

The pump stroke rate is controlled by an internal circuit and is changed by turning the rate knob. The mechanical stroke length is controlled by the stroke length knob. Some models do not allow stroke rate control and do not have the stroke rate knob.

3.2 Materials of Construction

The wetted materials (those parts that contact the solution being pumped) available for construction are FPP (glass filled polypropylene), PVC, CSPE, Viton, PTFE or FTF, 316 Stainless Steel, PVDF, Ceramic and Alloy C. These materials are very resistant to most chemicals. However, there are some chemicals, such as strong acids or organic solvents, which cause deterioration of some elastomer and plastic parts, such as the diaphragm, valve seats, or head.

Consult a Chemical Resistance Guide or Supplier for information on chemical compatibility.

Various manufacturers of plastics, elastomers and pumping equipment publish guidelines that aid in the selection of wetted materials for pumping commercially available chemicals and chemical compounds. Two factors must always be considered when using an elastomer or plastic part to pump chemicals. They are:

The temperature of service: Higher temperatures increase the effect of chemicals on wetted materials. The increase varies with the material and the chemical being used. A material quite stable at room temperature might be affected at higher temperatures.

Material choice: Materials with similar properties may differ greatly from one another in performance when exposed to certain chemicals.

4.0 INSTALLATION

The metering pump should be located in an area that allows convenient connections to both the chemical storage tank and the point of injection. The pump is water resistant and dust proof by construction and can be used outdoors, however, **do not operate submerged.** Avoid continuous temperatures in excess of 104˚F (40˚C). To do otherwise could result in damage to the pump.

4.1 Mounting

Typical mounting arrangements are shown in Figures 3, 4, and 5.

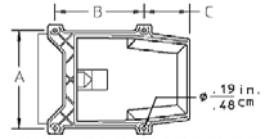
Important: Injection point must be higher than the top of the solution supply tank to prohibit gravity feeding, unless suitable backpressure is always present at the injection point. Installation of an anti-siphon valve will prohibit gravity feeding.

For wall or shelf mounting refer to Figure 3. Connect suction tubing to suction valve of chemical pump. Suction valve is the lower valve. Tubing should be long enough so that the foot valve/strainer assembly hangs about 1-2 inches (2-5 cm) above the bottom of chemical tank. To keep chemical from being contaminated, the tank should have a cover.

Flooded suction mounting (installing the pump at the base of the chemical storage tank, Figure 4) is the most trouble free type of installation and is recommended for very low output requirements. Since the suction tubing is filled with chemical, priming is accomplished quickly and the chance of losing prime is reduced.

To mount pump, drill four holes of .25” (6 mm) diameter in the shelf as shown in the dimension drawing (figure 2). Attach pump securely using four #10 (M5) bolts and nuts.

The pump can be mounted on top of a solution tank as shown in Figure 5. Install chemical pump on the cover. Insert suction tubing through the center hole and cut tubing so foot valve/strainer hangs about 1 or 2 inches (2-5 cm) above the bottom of the tank. Mount the chemical pump rigidly by drilling four .25” (6 mm) holes and using four (4) #10 (M5) screws and nuts.



MOUNTING HOLE DIMENSIONS

HOUSING SIZE	DIMENSIONS (in./cm.) A	B	C
HSG.#1	4.50/11.4	3.00/ 7.6	1.75/4.4
HSG.#2	4.81/12.2	4.38/11.1	2.19/5.6
HSG.#3	5.56/14.1	4.38/11.1	2.19/5.6

FIGURE 2

USE AN ANTI-SIPHON VALVE IN THE DISCHARGE LINE whenever the fluid pressure in the discharge line is below atmospheric pressure. This can occur if the injection point is on the suction side of a water pump or against a "negative" head such as when feeding down into a well.

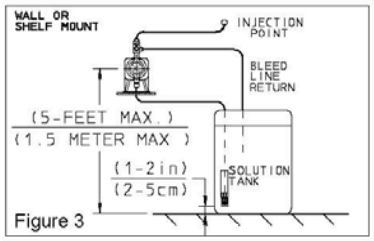


Figure 3

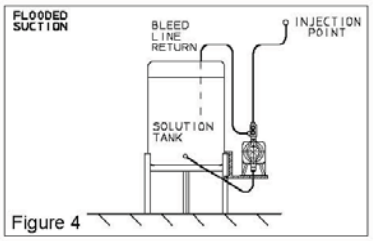


Figure 4

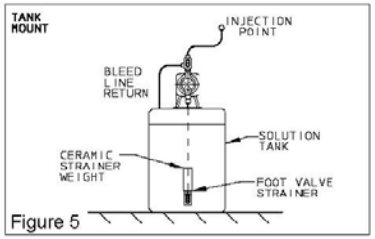


Figure 5

4.2 Piping

Use provided tubing of specified size for connection. Connect tubing securely to prevent leakage of chemical and the entrance of air. Since plastic nuts are used for fittings, they should not be tightened excessively (i.e. hand tighten only). NPT suction and discharge valves must **NOT** be over tightened. Hold fitting in place while adding piping and fittings. NPT suction and discharge valves should only be tightened 25 to 35 in. lbs. (4.5-6.3 kg/cm).

If the air bleed valve assembly is being used, a return line (tubing) should be securely connected and routed back to the storage tank. **To avoid possible injury from chemicals do not attempt to prime using a bleed valve without installing a return line.**

When pump is shelf mounted or top mounted on tank, suction tubing should be kept as short as possible.

To maintain metering performance, a backpressure/injection valve is provided. The spring in the standard injection valve typically adds 17 - 20 PSI (1.17 - 1.38 BAR) to the line pressure, with the exception of the H8 pump, which adds 8 - 10 PSI (.55 - .69 BAR). The injection valve must be installed in the discharge line. Best practice is to install the injection valve at the point of chemical injection.

If the discharge tubing is going to be exposed to direct sunlight, black tubing should be used instead of the standard white translucent tubing supplied with each pump. To obtain, contact supplier.

To prevent clogging or check valve malfunction always install a strainer assembly to the end of the suction tubing (Figure 5). This foot valve/strainer assembly should always be installed 1 to 2 inches (2-5 cm) above the bottom of the chemical tank. This will help prevent clogging the strainer with any solids that may settle on the tank bottom. The chemical tank and foot valve/strainer should be cleaned regularly, to ensure continuous trouble free operation. If the chemical being pumped regularly precipitates out of solution or does not dissolve easily or completely (e.g. calcium hydroxide), a mixer should be used in the chemical tank. These are readily available in many motor configurations and mounting. To obtain, contact supplier.

The signal cord polarity is:

Black = Common
White = Positive
Wrong polarity can result in excess flow.

Signal input impedance is 124 ohms.

Remove cap from pump socket labeled 4-20 mA, use polarized cord supplied with pump to connect control circuit to pump. Plug cord into pump socket labeled 4-20 mA.

6.0 MAINTENANCE

⚠ CAUTION Before performing any maintenance or repairs on chemical metering pumps, be sure to disconnect all electrical connections, insure that all pressure valves are shut off and pressure in the pump and lines has been bled off.

Always wear protective clothing, gloves and safety glasses when performing any maintenance or repairs on chemical metering pumps.

6.1 Routine Maintenance

Routinely check the physical operating condition of the pump. Look for the presence of any abnormal noise, excessive vibration, low flow and pressure output or high temperatures [when running constantly at maximum stroke rate, the pump housing temperature can be up to 160˚F (70˚C)].

For optimum performance, cartridge valves should be changed every 6-12 months. Depending on the application, more frequent changes may be required. Actual operating experience is the best guide in this situation.

Repeated short-term deterioration of valve seats and balls usually indicates a need to review the suitability of wetted materials selected for the application. Contact the supplier for guidance.

Check for leaks around fitting or as a result of deteriorating tubing e.g. when standard white translucent discharge tubing is exposed to direct sunlight. Take appropriate action to correct leak by tightening fittings or replacing components.

Keep the pump free of dirt and debris as this provides insulation and can lead to excessive pump temperatures.

If the pump has been out of service for a month or longer, clear the pump head valve assemblies by pumping fresh water for approximately 30 minutes. If the pump does not operate normally after this “purging run”, replace cartridge valve assemblies.

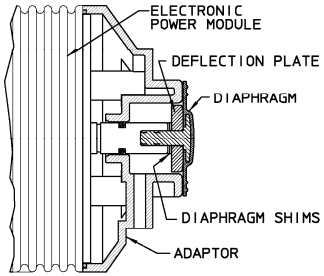
6.2 Disassembly and Assembly

Diaphragm Removal

Flush pump head and valve assemblies out by running pump with water or other suitable neutralizing solution. Wash outside of pump if chemical has dripped on pump. Set stroke length knob of pump to 0% and unplug pump.

Depressurize the system and disconnect tubing or piping from the pump. Remove the four pump head screws and then remove the pump head assembly.

Remove the diaphragm by grasping it at the outer edge and turning it counter clockwise until it unscrews from the electronic power module (EPM). Don’t lose the deflector plate or diaphragm shims which are behind the diaphragm, they are needed for re-assembly. Note shim quantity may be from 0 to 2.



Inspect diaphragm, if it is intended to be used again look for indications of the PTFE face being overstretched, (localized white areas) or the elastomer on the back of the diaphragm being worn. Excessive amounts of either condition require diaphragm replacement.

6.3 Diaphragm Replacement

When replacing the diaphragm, it is always a good idea to replace the valve cartridges and other worn parts. A kit is available from your supplier with all parts necessary to completely rebuild your pump’s wet end. All your supplier needs to know is the “KOPkit No.” on your pump’s data label to supply this kit.

Set pump stroke length at 50% and unplug the pump.

If you kept the shims from the original diaphragm or know the original quantity you can avoid the next step for shimming the diaphragm.

5.5.2 External Pacing Function (E+, A+, C+ and C only)

The pump's stroke rate can be controlled by an external signal input. When the input signal line is connected and the EXTERNAL /OFF /MANUAL switch is in the external position and a contact signal is input to the terminal marked ⊏, the pump makes one discharge stroke.

⚠ CAUTION **Operation of more than one pump from the same contact closure will damage the pump circuits. When such operation is required, the pump circuits must be electrically isolated from one another by means of a multi-contact control relay or similar means**.

When the "ON" signal pulse is input, the pump operates one stroke and the fluid is discharged. In addition, the pump can be operated continuously to its maximum strokes/min. by repeated input of "ON" and "OFF" signals.

After receiving an input signal, the pump generates the necessary power pulse to actuate the solenoid. The external signal input is debounced by the pump circuit. The pump will not stroke in response to a spurious or erratic input signal that follows at a rate greater than its maximum strokes/minute. If the external signal rate exceeds its maximum stokes/minute, the pump will stroke at half the external signal rate to prevent overdosing and to protect the pump from overheating.

The input signal must be in the form of closure of a mechanical relay, other mechanical switching device, or of a solid-state switching device. Voltage signals are prohibited. The switching resistance of either mechanical or solid-state devices must be 100 ohms or below when ON and 1 megohm or above when OFF. If any type of solid-state device is employed, it must be installed with proper polarity, if required for the device; and leakage current must not exceed 200 microamperes to prevent false triggering in the OFF state.

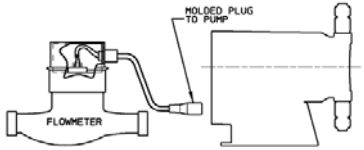


Figure 12

Cycle rate of the input signal should not exceed the maximum stroke/minute speed of the pump.

Typical wiring is shown at right for use with switch closure flow-meters. (Figure 12)

10 millisecond contact time required for each "ON" input signal.

5.5.3 4-20mA DC Input Function (E+ only)

The pump's stroke rate can also be controlled by a 4-20 mA DC signal to the terminal marked [4-20 mA].

For the 4-20 mA input to have any effect on the pump output rate, the AUTO/OFF/MANUAL switch must be in the AUTO position.

The 4-20 mA input signal affects the pump's outputs as per the graph below:

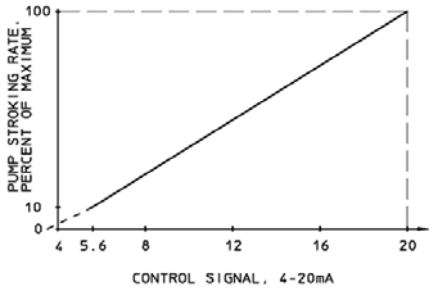


Figure 13

A flooded suction (tank liquid level always at a higher elevation than the pump) is recommended when pumping solutions such as sodium hypochlorite (NaOCl), hydrogen peroxide (H_2O_2), etc., which are likely to produce air bubbles. Maintaining a low liquid temperature will also help eliminate this problem.

Pipe corrosion can result if dilution at the injection point does not occur rapidly. This problem is easily prevented by observing this simple rule: install injection fitting so that the end is in the center of the flow stream of the line being treated. Trim injector tip as required. See Figure 6. Note: Extended injection assemblies are available for large water lines. Consult your supplier for more information.

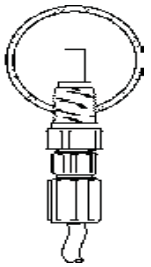


Figure 6

4.3 Wiring

⚠ WARNING **Risk of electrical shock. This pump is supplied with a three-prong grounding type power plug. To reduce risk of electric shock, connect only to a properly grounded, grounding type receptacle.**

The metering pump should be wired to an electrical source, which conforms to those on the pump data label. Applying higher voltage than the pump is rated for will damage the internal circuit.

In the electronic circuit of the control unit, measures for surge voltage are made by means of surge absorbing elements and high voltage semiconductors. Nevertheless, excessive surge voltage may cause failure in some areas. Therefore, the receptacle should not be used in common with heavy electrical equipment, which generates high voltage. If this is unavoidable however, measures should be taken by (a) the installation of a surge-absorbing element (varistor of min. surge resistance 2000A) to the power supply connection of the pump, or (b) the installation of a noise suppression transformer.

Signal input to the external pulse signal input terminals ([EXTERNAL], [STOP]) must be a no-voltage signal from relay-contacts etc. and the input of other signals is prohibited. In the case of relay contacts, 100 ohms or below when ON and 1-meg ohms or above when OFF. The pulse duration of the input signal must be 10 milliseconds or over and the frequency of the input signal must not exceed 125 times per minute. Signal cord is provided with the pump.

4.4 Well Pump System Installation

Ensure that the metering pump voltage matches the voltage of the well pump. Typical well pump electrical circuits are shown in Figure 8. All electric wiring should be installed in accordance to local codes by a licensed electrician.

Install the backpressure/injection (Figure 7) on the discharge side of the metering pump into a tee which is installed into the water line going to the pressure tank.

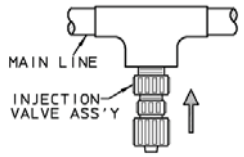


Figure 7

Pumps carrying the or "ETL Sanitation" (tested to NSF Standard-50) marks are listed for swimming pools, spas and hot tubs, and when proper materials are selected, are capable of handling but not limited to the following chemical solutions:

12% ALUMINUM SULPHATE,	5% SODIUM CARBONATE,
2% CALCIUM HYPOCHLORITE,	10% SODIUM HYDROXIDE,
12.5% SODIUM HYPOCHLORITE,	10% HYDROCHLORIC ACID

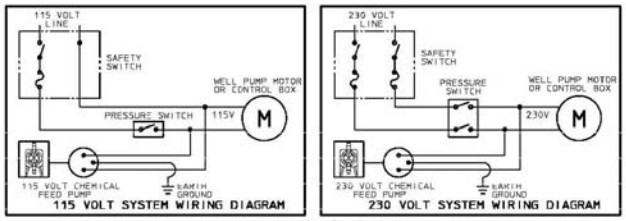


Figure 8

5.0 START UP AND OPERATION

5.1 Power

All metering pumps are available in 115 and 230 volts at 50/60 Hertz, single phase. In addition, certain models are available in 12 volt DC. Prior to start-up always check to insure that the pump voltage/frequency/phase matches that of the power supply.

⚠ CAUTION If pump is fitted with a PVC pump head (7th position of model number is "V" or "W". Note: PVC is gray, not black), uniformly hand tighten the four head screws before use, 18-22 in. lbs. (3.2 -3.9 kg/cm). Periodically tighten after installation.

5.2 Priming

⚠ CAUTION **When working on or around a chemical metering pump installation, protective clothing and gloves and safety glasses should be worn at all times.**

All pumps are tested with water. If the chemical to be pumped reacts when mixed with water (e.g. sulfuric acid, polymer) the pump head should be removed and dried thoroughly along with the diaphragm and valve seats.

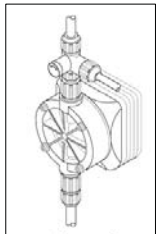


Figure 9

Turn on the power to the pump. The green LED (not available on all models) will light up and flash off each time the pump strokes.

Adjust the stroke rate knob to the 100% setting mark (for more information see Section 5.3, Capacity Control).

Adjust the stroke length knob to the 100% setting mark if applicable (for more information see Section 5.3, Capacity Controls).

If the discharge line is connected directly to a pressurized system it should be temporarily bypassed during priming of the pump. A bleed valve will simplify this operation by allowing easy bypass of the discharge fluid. Air must be purged from the pump-head before the pump will operate against pressure. (See Figure 9)

Air Bleed Operation:

While pump is running, turn adjustment knob counterclockwise.

Run with valve open until a solid stream of fluid comes out of the bypass tubing with no air bubbles.

Close air bleed valve by turning adjustment screw clockwise.

Chemical should reach the pump head after a few minutes of operation. If not, remove the discharge fitting and moisten the discharge valve area (ball check and valve seats) with a few drops of ***chemical being fed to the metering pump.*** For safety, always use protective clothing and gloves, wear safety glasses and use a proper container to hold the chemical.

If the pump continues not to prime, refer to Section 7.0, Troubleshooting, of these instructions.

Once the pump has been primed and is pumping the chemical through the head, turn off the power, reconnect the discharge tubing (if it had been removed) and immediately clean any spilled chemical that is on the pump housing or head.

Turn the power on once more and adjust the pump flow to the desired rate (see Section 5.3.3, Controlling Procedure).

Always check the calibration of the pump after start-up. It's best to calibrate the pump under your typical use conditions.

5.3 Capacity Control

Capacity can be controlled by means of the stroke length adjusting knob and/or stroke rate adjusting knob (except model C pumps). Control knobs provide coarse adjustment; use a calibration column for accurate calibration. Contact your pump supplier for proper calibration equipment.

5.3.1 Stroke Frequency Adjustment (E, E-DC, E+, A+ and C+ only)

Stroke frequency can be controlled from 10 to 100% (12 to 125 strokes per minute on 125SPM models or 25 to 250 strokes per minute on 250SPM models) by means of the electronic circuit.

Stroke frequency can be set by means of the stroke rate adjusting knob even while the pump is in operation (See Figure 10).

5.3.2 Stroke Length Adjustment

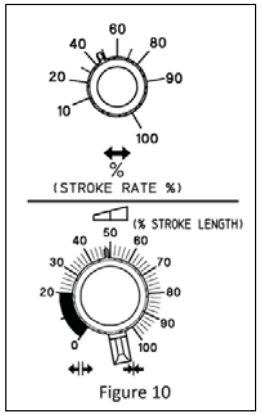


Figure 10

Stroke length can be controlled within 0 to 100% of the diaphragm displacement. It should be controlled within 20 to 100% for practical use.

Stroke length can be set by means of the stroke length adjusting knob while the pump is in operation. Do not turn the knob while the pump is stopped.

5.3.3 Controlling Procedure

Proper set points for stoke length and stroke frequency should be determined after consideration of the pump and characteristics of the fluid. The following procedure is recommended from the viewpoint of pump performance. **Note: The closer the stroke length is to 100%, the better the pump performance will be.**

Set the stroke length to 100% then adjust the stroke frequency for coarse capacity control.

Measure the capacity.

When the measured capacity is less than the required value, increase the stroke frequency and measure the capacity again.

Then, adjust the stroke length for fine capacity control.

Finally, measure the capacity and make sure that the required value is obtained.

Example

Selected Model	=	LPD4
Set Stroke Length	=	100%
Set Stroke Rate	=	100%
Output Capacity (Rated Pressure)	=	21 gallons per day (GPD)*
Desired Flow	=	15 GPD
Adjust Stroke Rate to 80%		
Output Capacity	=	0.80 x 21 = 16.8 GPD*
Stroke Length Setting	=	15 / 16.8 x 100 = 90% approximate

Thus to obtain the desired flow, stroke length is set at 90% and stroke rate is set at 80% i.e. output capacity = 0.90 x 0.80 x 21 = 15.12 GPD*

***IMPORTANT!**

Check these values by measurement. Output capacity is higher when feeding against less than rated pressure

5.4 Control Panel Symbols

The pumps come with universally accepted symbols which is provided in appendix A, page 14.

5.5 Operation By External Input Signals (Options):

The pump can be controlled by three types of input signals. All are fully isolated from AC input and from earth ground. The input socket connections are located at the bottom of the control panel face and the signal cords are provided with the pump. Remove rubber plugs to access plug sockets.

5.5.1 Stop Function (E+, A+, C+ and C only)

Operation of the pump can be stopped by an external signal input. When the external signal is input to the terminal marked Ⓥ which is provided at the bottom of the control panel, the Ⓥ lamp (red) lights up and operation of the pump is stopped. The stop function overrides both manual settings and external input.

⚠ CAUTION **Operation of more than one pump from the same contact closure will damage the pump circuits. When such operation is required, the pump circuits must be electrically isolated from one another by means of a multi-contact control relay or similar means.**

The input signal must be in the form of closure of a mechanical relay or other mechanical switching device, or solid-state relay or other solid-state switching device. Voltage signals are prohibited. The switching resistance of either mechanical or solid-state devices must be 100 ohms or below when ON and 1 megohm or above when OFF. If any type of solid-state device is employed, it must be installed with the proper polarity, if required for the device; and leakage current must not exceed 200 microamperes to prevent false triggering in the OFF state.

The stop function is commonly used in conjunction with a tank float switch. The float switch contacts are normally open but when the tank level falls past a certain point the contacts close and the pump stops.

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pulsafeeder.com

The Pulsatron Series E Plus offers manual control over stroke length and stroke rate as standard with the option to choose between 4-20mA and external pace inputs for automatic control.

Twenty distinct models are available, having pressure capabilities to 300 PSIG (21 BAR) @ 3 GPD (0.5 lph), and flow capacities to 600 GPD (94.6 lph) @ 30 PSIG (2 BAR), with a turndown ratio of 100:1. Metering performance is reproducible to within ± 2% of maximum capacity.
Please refer to the reverse side for Series E PLUS specifications.

Features

- Automatic Control, available with 4-20mADC direct or external pacing, with stop function.
- Manual Control by on-line adjustable stroke rate and stroke length.
- Auto-Off-Manual switch.
- Highly Reliable timing circuit.
- Circuit Protection against voltage and current upsets.
- Panel Mounted Fuse.
- Solenoid Protection by thermal overload with auto-reset.
- Water Resistant, for outdoor and indoor applications.
- Indicator Lights, panel mounted.
- Guided Ball Check Valve Systems, to reduce back flow and enhance outstanding priming characteristics.
- Safe & Easy Priming with durable leak-free bleed valve assembly (standard).

Controls

Manual Stroke Rate
- Turn-Down Ratio 10:1

Manual Stroke Length
- Turn-Down Ratio 10:1

4-20mADC Direct or External Pacing with Stop
- Automatic Control

Operating Benefits

- Reliable metering performance.
- Rated “hot” for continuous duty.
- High viscosity capability.
- Leak-free, sealless, liquid end.

Aftermarket

- KOPkits
- Gauges
- Dampeners
- Pressure Relief Valves
- Tanks
- Pre-Engineered Systems
- Process Controllers (PULSAblue, MicroVision)

PULSAtron® Series E Plus Electronic Metering Pumps

PULSAtron® Series E Plus

Specifications and Model Selection

MODEL		LPK2	LPB2	LPA2	LPD3	LPB3	LPA3	LPK3	LPF4	LPD4	LPB4	LPH4	LPG4	LPE4	LPK5	LPH5	LPH6	LPK7	LPH7	LPJ7	LPH8
Capacity	GPH	0.13	0.21	0.25	0.5	0.50	0.50	0.60	0.85	0.90	1.00	1.70	1.75	1.85	2.50	3.15	5.00	8.00	10.00	10.00	25.00
nominal	GPD	3	5	6	12	12	12	14	20	22	24	41	42	44	60	76	120	192	240	240	600
(max.)	LPH	0.5	0.8	0.9	1.9	1.9	1.9	2.3	3.2	3.4	3.8	6.4	6.6	7	9.5	11.9	18.9	30.3	37.9	37.9	94.6
Pressure	PSIG	300	250	150	250	150	100	100	250	150	100	250	150	100	150	150	100	50	35	80	30
(max.)	BAR	21	17	10	17	10	7	7	17	10	7	17	10	7	10	10	7	3.3	2.4	5.5	2
Connections	Tubing	1/4" ID X 3/8" OD 3/8" ID X 1/2" OD													3/8" ID X 1/2" OD 1/2" ID X 3/4" OD (LPH8 ONLY)						
	Piping	1/4" FNPT													1/4" FNPT 1/2" FNPT						

Engineering Data

Pump Head Materials Available: GFPPL, PVC, PVDF, 316 SS

Diaphragm: PTFE-faced CSPE-backed

Check Valves Materials Available:

Seats/O-Rings: PTFE, CSPE, Viton

Balls: Ceramic, PTFE, 316 SS, Alloy C

Fittings Materials Available: GFPPL, PVC, PVDF

Bleed Valve: Same as fitting and check valve selected, except 316SS

Injection Valve & Foot Valve Assy: Same as fitting and check valve selected

Tubing: Clear PVC, White PE

Important: Material Code - GFPPL=Glass-filled Polypropylene, PVC=Polyvinyl Chloride, PE=Polyethylene, PVDF=Polyvinylidene Fluoride, CSPE=Generic formulation of Hypalon, a registered trademark of E.I. DuPont Company. Viton is a registered trademark of E.I. DuPont Company. PVC wetted end recommended for sodium hypochlorite.

Engineering Data

Reproducibility: +/- 2% at maximum capacity

Viscosity Max CPS :

For viscosity up to 3000 CPS, select connection size 3, 4, B or C with 316SS ball material. Flow rate will determine connection/ball size. Greater than 3000 CPS require spring loaded ball checks. See Selection Guide for proper connection.

Stroke Frequency Max SPM: 125

Stroke Frequency Turn-Down Ratio: 10:1

Stroke Length Turn-Down Ratio: 10:1

Power Input: 115 VAC/50-60 HZ/1 ph, 230 VAC/50-60 HZ/1 ph

Average Current Draw:

@ 115 VAC; Amps: 1.0 Amps

@ 230 VAC; Amps: 0.5 Amps

Peak Input Power: 300 Watts

Average Input Power @ Max SPM: 130 Watts

Custom Engineered Designs – Pre-Engineered Systems

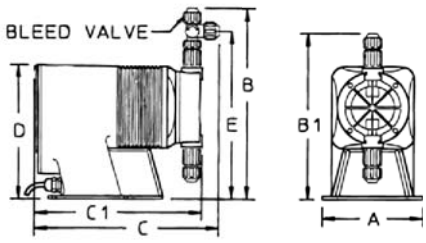
Pre-Engineered Systems

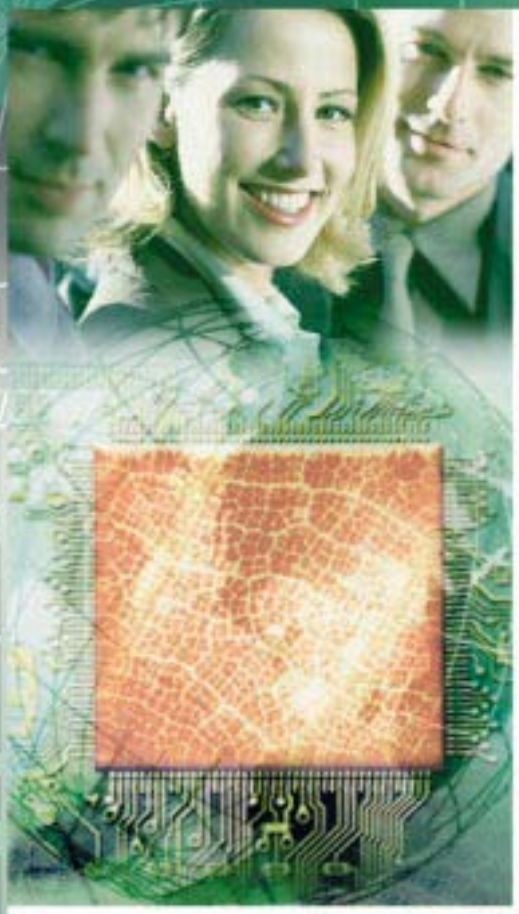
Pulsafeeder's Pre-Engineered Systems are designed to provide complete chemical feed solutions for all electronic metering applications. From stand alone simplex pH control applications to full-featured, redundant sodium hypochlorite disinfection metering, these rugged fabricated assemblies offer turn-key simplicity and industrial-grade durability. The UV-stabilized, high-grade HDPE frame offers maximum chemical compatibility and structural rigidity. Each system is factory assembled and hydrostatically tested prior to shipment.

Dimensions

Series E Plus Dimensions (inches)																	
Model No.	A	B	B1	C	C1	D	E	Shpg Wt	Model No.	A	B	B1	C	C1	D	E	Shpg Wt
LPA2	5.4	10.3	-	10.8	-	7.5	8.9	13	LPH4	6.2	10.9	-	11.2	-	8.2	9.5	21
LPA3	5.4	10.6	-	10.7	-	7.5	9.2	13	LPH5	6.2	11.3	-	11.2	-	8.2	9.9	21
LPB2	5.4	10.3	-	10.8	-	7.5	8.9	13	LPH6	6.2	11.3	-	11.9	-	8.2	9.9	21
LPB3	5.4	10.6	-	10.7	-	7.5	9.2	13	LPH7	6.1	11.7	-	11.9	-	8.2	10.3	21
LPB4	5.4	10.6	-	10.7	-	7.5	9.2	13	LPH8*	6.1	-	10.9	-	11.3	8.2	-	26
LPD3	5.4	10.6	-	11.2	-	7.5	9.2	15	LPK2	5.4	10.3	-	10.8	-	7.5	8.9	13
LPD4	5.4	10.6	-	11.2	-	7.5	9.2	15	LPK3	5.4	10.6	-	10.7	-	7.5	9.2	13
LPE4	5.4	10.6	-	11.2	-	7.5	9.2	15	LPK5	5.4	10.9	-	11.7	-	7.5	9.5	18
LPF4	5.4	10.6	-	11.7	-	7.5	9.2	18	LPK7	6.1	11.7	-	11.2	-	8.2	10.3	21
LPG4	5.4	10.6	-	11.7	-	7.5	9.2	18	LPJ7	6.1	10	-	10.7	-	-	-	21

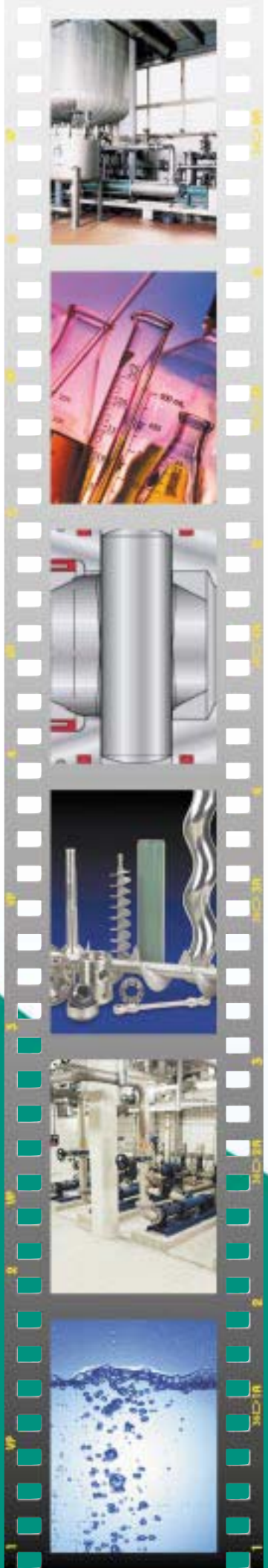
NOTE: Inches X 2.54 = cm /* the LPH8 is designed without a bleed valve available





NETZSCH
The Heart of Your Process

Standard Close Coupled Pump Series



NETZSCH

A Quick Solution at an Ideal Price

From the world leader in pumping technology, NETZSCH NEMO® Pump combines proven technology, engineering excellence, and quality manufacturing to offer you its Standard Close Coupled Pump Series. This reliable series is ideal for a wide variety of applications where cost effectiveness is paramount, installation space is limited and delivery is critical.

Providing consistent quality and performance that our satisfied customers have grown to expect, every Standard Close Coupled Pump provides many value-added benefits:

Cost Efficient

The Close Coupled Series modular design consists of a minimal number of easily maintained components and pre-selected gear reducers and motors. For our customers, this means both guaranteed lower initial investment costs and maintenance expenses.

Easy Installation

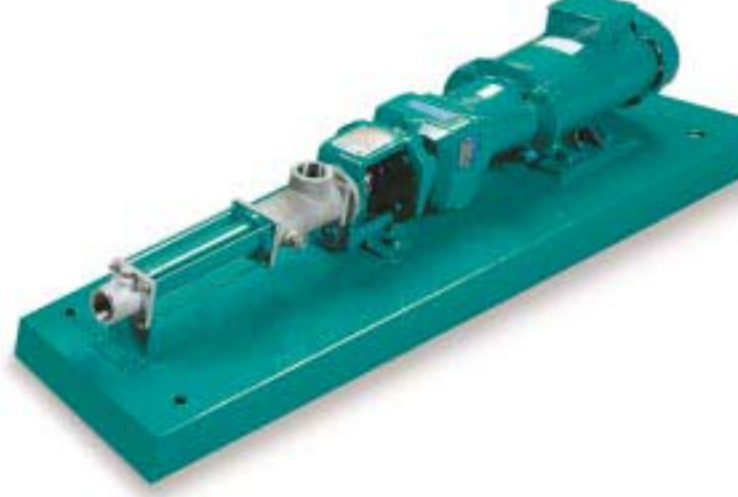
NEMO® recognizes that your installation space is limited. The compact design of our modular Close Coupled Pump Series minimizes your floor space requirements.

Fast Delivery

NEMO® meets all of your immediate pumping requirements by quickly delivering our Standard Close Coupled Series. NEMO® Close Coupled Pumps are stocked in sizes that deliver up to 800 gpm. Pre-configured drives and baseplates are readily available in a variety of sizes. Standard gear reducers and motors are stocked locally throughout North America. Genuine NEMO® standard service parts are inventoried at our Exton, PA manufacturing facility for immediate delivery. Providing replacement parts quickly results in less manufacturing down time to our valued customers.

Low Maintenance

NEMO's® modular designed pumps can be easily and quickly assembled and disassembled for routine maintenance or field modifications. All Standard Series pumps are equipped with NETZSCH patented* SM Sealed Pin Joints which provides extended service life. The totally sealed, oil filled SM Sealed Pin Joints are easy to maintain because of their superior design and minimum number of parts. *Patent #4,305,596



Standard NEMO® Pumps are manufactured with the highest quality components including proven Buna N Stators, high quality Viton® SM Joint Seals, and SM Pin Type Universal Joints for longer service life. These pumps also include packing as a low cost shaft seal and are available in cast iron or stainless steel materials of construction.

Single and two stage geometries are available. NEMO's® S-Geometry is ideal for multiple stage applications or when lower internal velocities are required. NEMO's® L-Geometry delivers twice the volume per cavity, providing greater volumetric efficiency and lower circumferential velocity resulting in less wear when handling aggressive mediums.

This Pump Series offers output capacities up to 2000 gpm and pressure capacities up to 350 psi. Open throat and vertical configurations are also available. *Every Standard Pump can be customized to suit specific applications by selecting from a variety of manufacturing materials.*

NEMO® Standard Close Coupled Pumps can be used in virtually all industry sectors for countless applications. These pumps can handle high viscosity and shear-sensitive materials making NEMO® the pump ideally suited for industrial and municipal applications including waste treatment, chemicals, petrochemicals, food, mining and pulp and paper.

NEMO® Standard Close Coupled Pumps are manufactured to the same highest quality standards as all NETZSCH NEMO® NM Series Pumps. All NEMO® Pumps offer:

- *Low shear rate ensuring less damage to sensitive products*
- *Non-pulsating flow resulting in product consistency and uniformly metered delivery*
- *High volumetric, electrical and mechanical efficiencies promise power consumption savings*
- *Flow rate that is proportional to the pump's operating speed, ensuring consistent and reliable output*
- *High viscosity and solids content pumping capabilities allow a single NEMO® Pump to easily handle materials at various flow rates*

- **Up to 35% Lower Initial Investment and Maintenance Costs Compared to Other Comparably Sized Pumps**
- **Space Saving Installation**
- **Locally Stocked Gear Reducers and Motors for Fast Delivery**

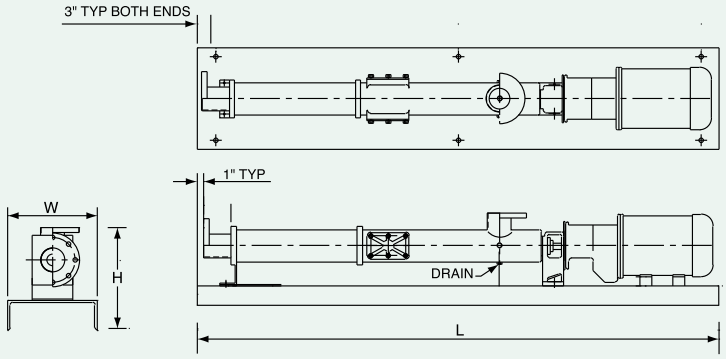
- **On-site Service Parts Inventory Results in Less Customer Downtime**
- **130 Years of Manufacturing Excellence Worldwide**

Typical Dimensions

This NEMO® Standard Close Coupled Pump Typical Dimensions Chart provides a general outline drawing for each pump. Detailed dimensions are available upon request. Please contact your local NEMO® Pump Representative for additional information.

PUMP		W	L	H	HP
NM003-NM011BY		10.00	35.00	7.59	0.5
NM015BY	01L06 / 02S12	12.00	41.00	9.24	0.5
NM021BY	01L06 / 02S12	12.00	45.00	9.24	1.0
NM031BY	01L06 / 02S12	12.00	52.00	11.68	2.0
NM038BY	01L06 / 02S12	12.00	72.00	13.25	5.0
NM045BY	01L06 / 02S12	12.00	85.00	14.35	7.5
NM053BY	01L06 / 02S12	12.00	92.00	16.13	7.5
NM063BY	01L06 / 02S12	15.00	106.00	19.15	10.0
NM076BY	01L06 / 02S12	18.00	117.00	21.08	20.0
NM090BY	01L06 / 02S12	18.00	135.00	22.45	30.0
NM105BY	01L06 / 02S12	18.00	162.00	25.01	50.0

** All dimensions are in inches*
*** All gear motors are supplied with 1750 RPM AC Motors*
**** Open throat dimensions may vary*



General Output Capacities

This General Output Capacity Chart is supplied to estimate pump sizing only. Please contact your local NEMO® Pump Representative with detailed application information to obtain a formal quotation.

Single Stage Pumps	High Abrasion/ High Viscosity (gpm)	Medium Abrasion/ Medium Viscosity (gpm)	Low Abrasion/ Low Viscosity (gpm)	Max. Pressure (psi)	Two Stage Pumps	High Abrasion/ High Viscosity (gpm)	Medium Abrasion/ Medium Viscosity (gpm)	Low Abrasion/ Low Viscosity (gpm)	Max. Pressure (psi)
NM003-NM011BY - See Performance Curves					NM003-NM011BY - See Performance Curves				
NM015BY01L06	0.4	1.5	2.5	90	NM015BY02S12	0.25	0.75	1.25	175
NM021BY01L06	1.2	4.2	7.0	90	NM021BY02S12	0.7	2.1	3.5	175
NM031BY01L06	4.0	12.0	20.0	90	NM031BY02S12	2.0	6.0	10.0	175
NM038BY01L06	11.0	33.0	55.0	90	NM038BY02S12	5.5	16.5	27.5	175
NM045BY01L06	18.0	54.0	90.0	90	NM045BY02S12	9.0	27.0	45.0	175
NM053BY01L06	32.0	96.0	160.0	90	NM053BY02S12	16.0	48.0	80.0	175
NM063BY01L06	54.0	162.0	270.0	90	NM063BY02S12	27.0	81.0	135.0	175
NM076BY01L06	90.0	270.0	450.0	90	NM076BY02S12	45.0	135.0	225.0	175
NM090BY01L06	154.0	462.0	770.0	90	NM090BY02S12	77.0	231.0	385.0	175
NM105BY01L06	230.0	580.0	1000.0	90	NM105BY02S12	115.0	290.0	500.0	175

** Installation Autocad drawings are available upon request*
*** Standard NEMO® Pumps can be mounted vertically when installation space is limited*

The local Sales Representative in your area is:

NETZSCH Incorporated
NETZSCH Pump Division
119 Pickering Way Exton, PA 19341
Tel: 610-363-8010 Fax: 610-363-0971
E-mail: nemopump@netzschusa.com
www.netzschusa.com

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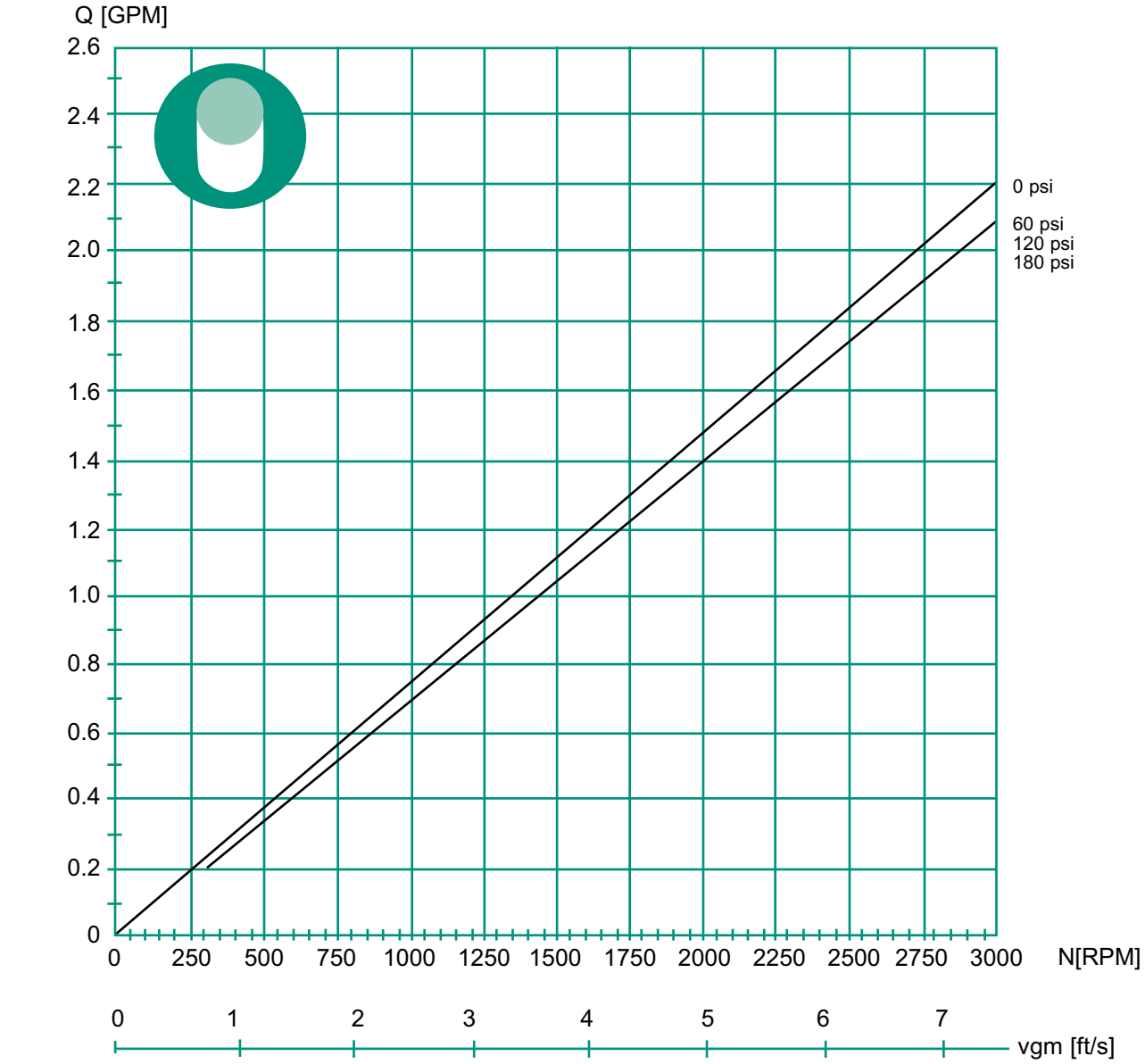
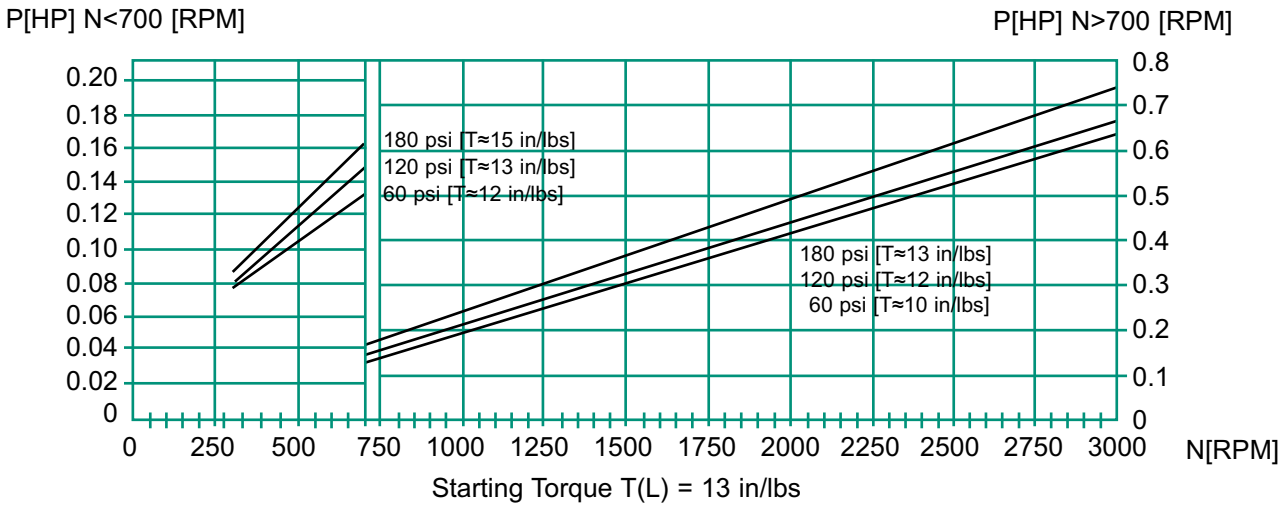
NIL 02 - 12 12/03 5M

Performance Curve
NEMO®-Pump NM 011*2S

Data based on water at 65°F



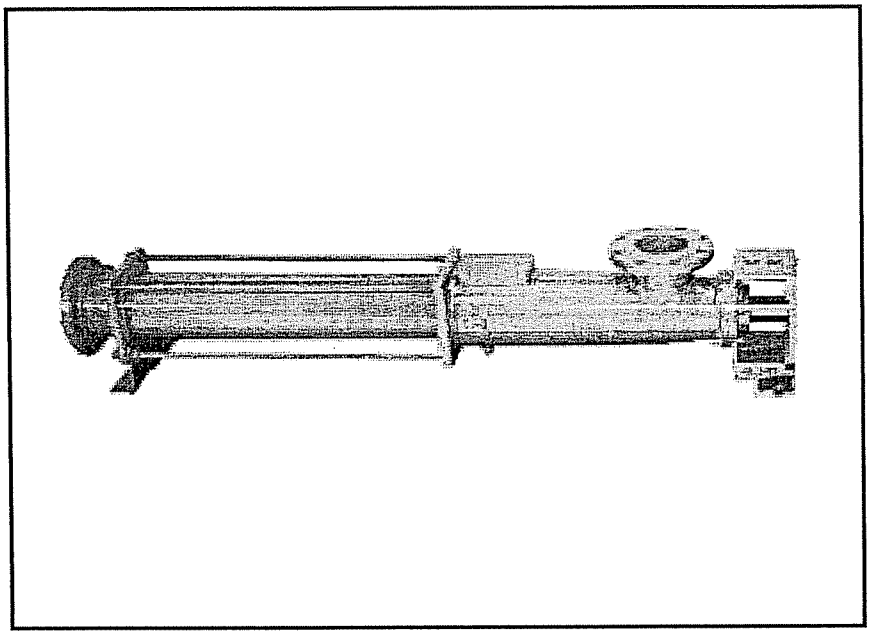


Starting Torque T(L) = 13 in/lbs

Operating and Maintenance Instructions

NETZSCH

NEMO®-Pump



Model Number

Sales Order/Job Number

Machine Number

Date of issue

Important Note

These operating instructions are designed to familiarize the user with the machine and its designated use.

The Instruction Manual

- Contains important information on how to operate the machine safely, properly and efficiently. Observing these instructions help to avoid danger, to reduce repair costs and downtimes and to increase the reliability and life of the machine;
- Must always be available wherever the machine is in use.
- Must be read and applied by any **person in charge** of carrying out work with and on the machine, such as:

  Operation including setting up, troubleshooting in the course of work, evacuation of production waste, care and disposal of fuels and consumables

  Maintenance (servicing, inspection, and/or repair)

  Transport; shall be completed by the end user and authorized personnel with the national requirements in force for the prevention of accidents and the environmental protection.

In addition to the operating instructions and to the mandatory rules and regulations for accident prevention and environmental protection in the country and place of use of the machine, the generally recognized technical rules for safe and proper working must also be observed.

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Quality Pays For Itself NETZSCH

1.)	Safety Precautions	1
2.)	Description	2
3.)	Packing, Transportation, Storage	3
4.)	Installation Instructions	4
5.)	Start-Up	5
6.)	Temporary Shutdown	6
7.)	Maintenance	7
8.)	Trouble-Shooting and Solutions	8
9.)	Disassembly and Assembly of the Pump Housing	9
10.)	Disassembly and Assembly of the Rotating Parts	10
11.)	Disassembly and Assembly of the Connecting Shaft with Seal	11
12.)	Disassembly and Assembly of the Shaft Sealing	12
13.)	Disassembly and Assembly of Special Units	13
14.)	Recommended Spare Parts	14
15.)	Parts List and Sectional Drawing	15

1 Safety Precautions

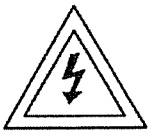
These operating instructions contain essential information which should be observed during installation, operation and maintenance. These operating instructions should be read and understood by the engineer, as well as other responsible operators before assembly and operation. Operating instructions should always be readily available wherever the machine is being used.

The general safety rules detailed under "Safety Precautions", plus the safety precautions set by the end user, must be followed.

1.1 Symbols Relating to Safety Precautions in the Operating Instructions

Personal injury, damage to machines or contamination of the environment can result if the safety precautions contained in this document are not strictly enforced. Following are signs commonly used to signify areas of danger:

Safety Sign
Danger to General Public



Safety Sign
Electrical Hazard

Danger from Possible Injury by Machinery

Danger from Suspended Loads

Damage to Machinery

Continued on Page 1.OR

1 SAFETY PRECAUTIONS

Warning or indication plates attached to the pump which show the correct direction of rotation (or fluid connections) must always be kept in readable condition.

1.2 Qualifications and Training of Personnel

All personnel responsible for service, maintenance, inspection, installation and operation must have the appropriate training. Responsibility and supervision of personnel must be strictly enforced by the end user. If training of personnel is required, it can be provided by the manufacturer/representative. Furthermore, it is the responsibility of the end user to ensure that personnel fully understands the operating instructions.

1.3 Non-Observance of Safety Precautions

Non-observance of the safety rules can result in personal injury, damage to machines or contamination of the environment. Non-observance can void product warranty.

Non-observance can also result in the following:

- Premature failure of components or machine/equipment malfunction.
- Danger to personnel from electrical, mechanical or chemical hazards.
- Danger to the environment from leakage of dangerous materials.

1.4 Safe Operation

The safety precautions outlined in these operating instructions, the existing national regulations on accident prevention and the end user's own operating and safety regulations **must be observed.**

1.5 Safety Precautions

- Hot or cold machine components must be insulated or shielded.
- Guards covering moving parts (i.e. shafts, couplings) must not be removed while machines are in operation.
- Leakage of dangerous materials (i.e. explosives, toxins or hot materials) from the shaft sealing area should be properly contained.
- In order to prevent electrical hazards, applicable local and/or federal regulations must be adhered to.

Continued on Page 1.1

1.6 Safety Precautions for Maintenance, Inspection and Installation Work

The end user must ensure that all maintenance, inspection and installation work is performed by authorized and qualified personnel who understand the operating instructions and are properly trained.

Work on a pump/machine should only be performed when it is disconnected from its power source, pressure has been relieved, and the complete unit has returned to room temperature. It is imperative that these procedures are adhered to before attempting work on the machine.

Pumps or units which transfer dangerous substances must be decontaminated.

Immediately following maintenance work, all safety and protection equipment must be re-installed and safety trips must be tested.

Refer to Section 5.0, "Start-up," before restarting machine/pump.

1.7 Unauthorized Use of Spare Parts and/or Modifications to the Pump

Modifications to the machines and/or its components are permitted only with the manufacturer's consent. Original spare parts and accessories authorized by the manufacturer ensure safety. The use of other components revokes any warranty and liability for consequences which may result.

1.8 Improper Application

Machinery is only guaranteed safe for the use specified.

This machinery was manufactured in accordance to the specifications and the conditions specified by the end user. The machine should not be operated in any way that exceeds design capacities.

1.9 Specific Points for the Use of NEMO® Pumps

NEMO® Pumps should only be used for the application for which they were sold.

If you wish to change the pumping medium, you should check with either the supplier or manufacturer to ensure that the pump will be suitable for the new medium. This is especially important with aggressive, poisonous or otherwise dangerous media.

Criteria for the selection of a pump includes:

1. Compatibility between the medium to be pumped and the materials of all wetted pump parts.
2. Compatibility between elastomeric components and mechanical seal faces.
3. The pressure and temperature rating of the pump.

NEMO® Pumps are of positive displacement progressing cavity design, and have the potential to generate very high pressure.

Continued on Page 1.1R

1 SAFETY PRECAUTIONS

A blockage or closure of a valve in the discharge line can cause a pressure rise **higher than the installation can withstand.** A substantial pressure increase can result in the bursting of pipes and/or damage to other components of pump or drive systems. Extreme caution must be used, especially when dangerous media is present.

Appropriate safety equipment must be installed (i.e.: an emergency stop button, a pressure relief valve or rupture disc).

During maintenance and repair work on the pump, please note the following:

1. No one other than those involved with maintenance and repair should have access to power supply.
2. When dismantling the pump, follow the instructions for handling the medium (e.g.: protective clothing, no smoking, etc.)
3. Before putting the pump back into operation, ensure that all guards and other safety devices (e.g.: drive belt and coupling protection) are properly re-installed.

Always keep safety in mind during operation, maintenance and installation of equipment. Please adhere to applicable federal and local rules and regulations.

Continued on Page 1.2

1.10 Notes on Inspection and Repair

It is the responsibility and obligation of all commercial businesses to enforce safety in the workplace, regulations governing dangerous materials, accident prevention and environmental protection at all times.

People along with the environment must be protected from adverse effects caused by contact with dangerous materials.

The procedures for proper handling, containment and/or disposal of all hazardous materials, including wastewater, must be strictly enforced.

Important:

A Material Safety Data Sheet must accompany any machine/part and a Safety Conformity Certificate must be completed prior to inspection or repair. Please make a duplicate copy and leave the original in the Operation and Maintenance manual.

Where special safety precautions are necessary, in addition to careful emptying and cleaning of the machinery, the necessary information must be given.

Inspection or repair of machinery containing radioactive medium will only be performed by authorized personnel under protection and supervision of the owner.

The Safety Conformity Certificate is part of the inspection/repair service. We reserve the right to refuse acceptance of this order/service for other reasons.

Continued on Page 1.3

Safety Conformity Certificate

This completed Safety Conformity Certificate and a Material Safety Data Sheet must accompany the machine and its accessories when returned to the manufacturer for repair/inspection services.

Pump Model Number _____
Job Number _____
Date of Manufacture _____ Equipment Return Authorization # _____
Machine Number _____

Was carefully emptied and cleaned, both inside and out, in preparation for shipment. ☐ Yes ☐ No

Precautions with regard to health and the environment are to be observed. ☐ Yes ☐ No

This machine came into contact with media hazardous to health and the environment. ☐ Yes ☐ No

The following additional precautions are necessary with regard to the handling of media and the disposal of waste: _____

_____

We confirm the above information is accurate and complete, and shipment will be in accordance with legal requirements:

Company

_____ Telephone No.: _____

_____ Fax No.: _____

Address

_____

_____

Name _____ Date: _____

Position: _____

_____

Company Stamp/Signature

2 Description

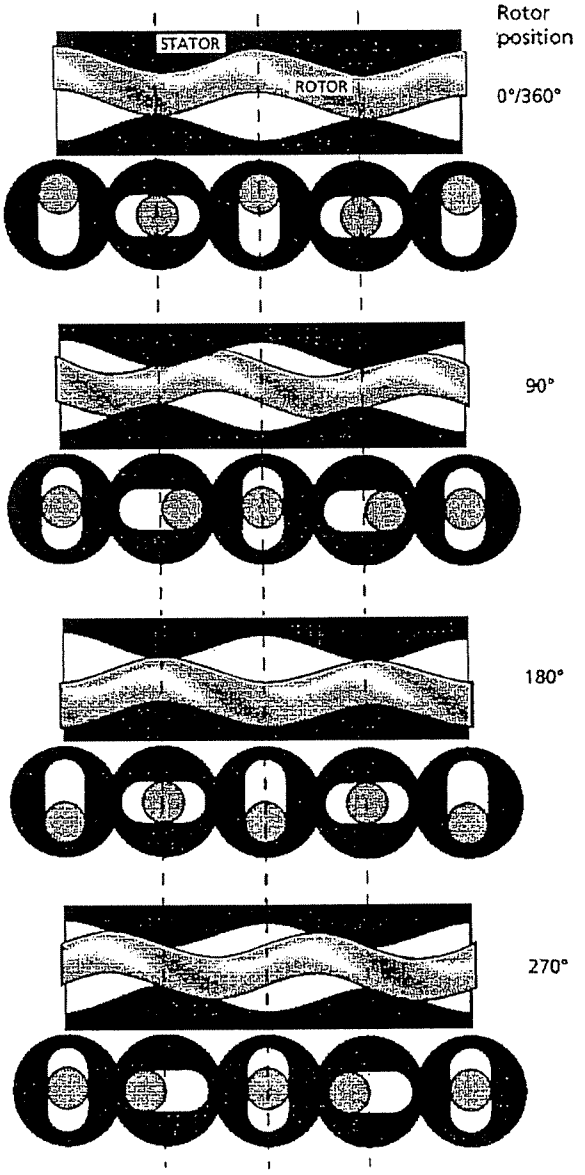
The Nemo® Pump is a positive displacement, progressing cavity-type pump.

The main components of the pump (which was invented by Professor Rene' Moineau) are: a rotating part, called the rotor; and a stationary part, called the stator.

The rotor has a single helix shape and is normally made of a metallic material. The stator is formed as a double-helix with twice the pitch of the rotor and is normally an elastomer. The interference (compression) fit between the rotor and stator creates a series of sealed chambers called cavities. When the rotor turns inside the stator, the medium moves continuously from the inlet to the outlet of the cavities.

The NEMO® Pump principle utilizes many positive characteristics of other pump types:

- Like centrifugal pumps, NEMO® Pumps have no suction or pressure valves, but do have a stable flow rate in proportion to the number of revolutions.
- Like piston pumps, NEMO® Pumps have a suction lift up to 28'. Vacuum capacity is 24-25'.
- Like membrane and peristaltic pumps, NEMO® Pumps can transport all types of media including inhomogeneous, gaseous and abrasive media; as well as those that are not of a liquid consistency, or contain solids and/or fibrous material.
- Like gear pumps and screw pumps, NEMO® Pumps are capable of handling high-viscosity media.
- Like piston, membrane, gear or screw pumps, NEMO® Pumps can be used for metering applications.



Length and cross-sections of the rotor and stator during a rotation.

Continued on Page 2.0R

2.2 General Data

Noise Emissions:

The maximum noise emission level permitted at a workplace is 85 dB (A).

Noise level's are measured in accordance with OSHA CFR 1910.95 to assure that the pump does not exceed 85 dB (A).

Noises generated by the drive and pipes are not included in the above emission value.

In order to maintain a noise emission level of $\leq$ 85 dB (A), the pump must be securely mounted and not allowed to cavitate.

3 Packaging, Transportation, Storage

3.1 Packaging and Transportation

NEMO® Pumps are shipped on skid-mounted wood-framed cardboard enclosures, unless the customer specifies otherwise.

The packages are labeled with any special handling instructions.

Upon receipt, inspect the pump for any transportation damage.

Claims for damages should be reported to the **freight carrier immediately.**

Uncrated horizontal pumps should be lifted using the bolt holes of the frame or the lifting lugs attached to the baseplate.

Vertical pumps should be lifted by using the bolt-down holes, or lifting lugs attached to the mounting plate.

Use caution when lifting top-heavy pumps. The center of gravity may be above the points where the lifting gear is attached. If this is the case, secure additionally to **prevent tipping over!**

Vertical pumps should be stored horizontally **only,** unless they are secured vertically. **This will prevent hazards of tipping!**

Avoid suspending the complete pump unit by the eye bolts of the motor or gear box. These eye bolts should be used for lifting the motor and/or the gear box only.

As when operating any type of equipment, exercise caution and adhere to all applicable instructions, rules and regulations.

Due to the variety of possible pump designs and applications, only general instructions can be given here. These should be adequate for experienced assembly or transportation personnel.

When in doubt, contact the supplier for more detailed information.

Continued on Page 3.0R

3 PACKAGING, TRANSPORTATION, STORAGE

When moving the pump or unit on wheels, strictly adhere to the following:

- Lock out the motor drive to protect against unintended start-up.
- Move the pump unit carefully and slowly, especially where the ground is uneven. **Hazards of tipping!**
- The pump should be stored in a stable position with wheels or rollers locked or otherwise secured.
- Be careful not to allow flexible piping to bend or become kinked. Obstruction of flow will cause excessive discharge pressure.
- Where necessary, secure the pump unit with additional support blocks.

3.2 Storage

Pumps are packaged for transportation and short-term storage. In cases of prolonged storage, the pumps should be protected as follows until installation:

- **Stator:**
  When stored for a long period, the elastomer along the contact line between the rotor and stator may become temporarily distorted (compression-set). This will increase the required starting torque. For this reason, the stator should be removed and stored in a cool, dry place in an air-tight package and protected from light.
- **Shaft Sealing by packing gland:**
  Remove the packing gland and protect the exposed shaft surface with protective grease or oil.
- **Pump parts in stainless steel:** No protection necessary.
- **Other non-protected pump parts:** Protect with grease or oil.
- **Drives:** Observe the instructions of the drive supplier.

Store Room

The environment in which rubber products are being kept must be cool, dry, free of dust and well ventilated, and must not be stored in the open.
Rubber products should be kept in surroundings not having less than minus 10° C (14° F) and not more than plus 15° C (59° F).
Store rooms should not be damp, and it must be ensured that there will be no condensation.
Recommended relative humidity is < 65%.
Rubber products must be protected against light, particularly direct sunlight or artificial light having a high UV portion.
Rubber products should be kept in a sealed package.
As ozone is very aggressive and harmful there should be no store room used which houses equipment likely to produce ozone, i.e. electric motors or other equipment which might bring about sparks or other electrical discharges.
There must be no solvents, oil, grease, lubricants or any chemicals kept in the store room.

- **Rotor**

  Support with wooden blocks and protect against damage from mechanical impact. For tool steel rotors (material number 1.2436): coat the surfaces with protective grease to avoid rusting.

- **Shaft Sealing by packing gland**

  Remove the gland and coat exposed shaft surface with grease or oil.

- **Pump parts in stainless steel**

  No grease coating necessary.

- **Other, non-coated pump parts**

  Protect with grease or oil.

- **Drives**

  Observe instructions of the drive supplier.

4 Installation

If the NEMO® Pump was stored and the rotor grease protected:
Remove the grease before installing the stator.
Clean the rotor thoroughly in order to avoid contamination of the stator and the pumping medium.

Verify all hardware has been properly installed and fastened.

4.1 Direction of Rotation

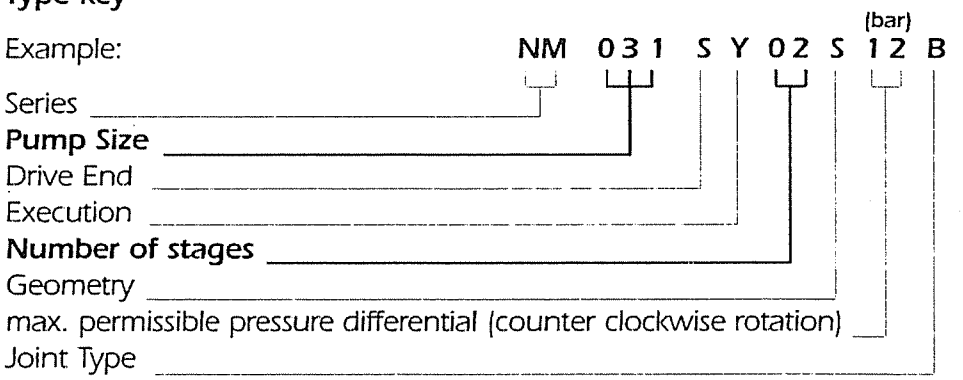
The direction of rotation of the pump is given on the name plate.

4.2 Pressure

Maximum permissible pressure inside the pump housing (A) is 6 bar.

The maximum permissible pressure inside the end flange (B) is 12 bar.

Type key



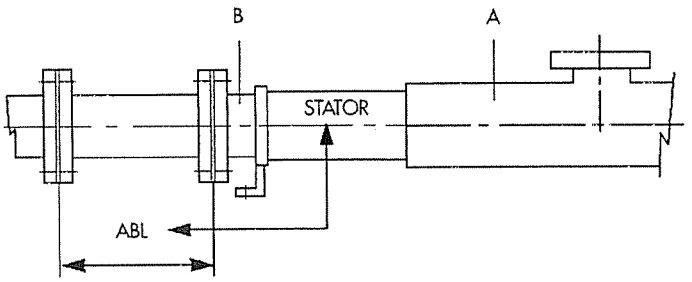
4.3 Shaft Sealing

- Where applicable, ensure that adequate supply lines for the buffer, flushing or quenching fluid for the shaft seals are connected **before** the pump is put into **operation.** For more details see Section 7.4!

Continued on Page 4.0R

4.4 Piping System

- Arrange suction and discharge pipes so that when the pump is not running, the medium is still present. Sufficient medium should remain inside in order to lubricate the pump during restart.
- Clean the pipe work and rinse thoroughly before installing the pump.
- See chart below for recommended disassembly (ABL) dimensions.



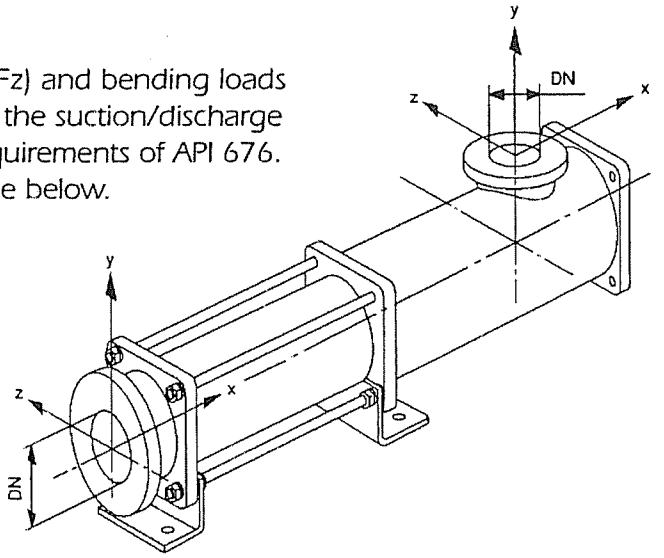
Disassembly length ABL in mm:

Pump size	Number of Stages							
	1*	2	3	4	6	8	10	12
015	160	160	230	310	460	610	770	920
021	230	230	340	450	670	880	1100	1310
031	310	310	450	590	880	1160	1440	1730
038	430	430	630	830	1230	1630	2030	2430
045	500	500	730	960	1430	1890	2350	2820
053	600	600	880	1170	1730	2290	2860	3420
063	690	690	1010	1330	1980	2620	3270	3910
076	800	800	1170	1540	2280	3030	3770	4520
090	950	950	1390	1840	2720	3610	4500	
105	1180	1180	1740	2300	3410	4520		
125	1400	1400	2060	2720	4040			
148	1680	1680	2470	3260				
180	1910	1910						

*This dimension applies to 1L geometry, 2 through12 refer to S geometry

4 INSTALLATION INSTRUCTIONS

The twisting loads (Fx, Fy, Fz) and bending loads (Mx, My, Mz) permitted for the suction/discharge flange comply with the requirements of API 676. They are shown in the talbe below.



Pump type NM	Standard nominal diameter DN	F_x, F_y, F_z lbs.	M_x, M_y, M_z in/lbs.
003 005 008 011	FNPT	38	NPT joints must not be assembled with loads which may result in over tightening or loosening these joints
015 021	FNPT	95	
31	2"	152	3080
38	2.5"	191	3828
45 53	3"	229	4576
63	4"	305	6116
76	6"	382	7612
90 105	6"	458	9152
125	8"	611	12,188
148	10"	764	15,224
180	10"	764	15,224

5 Start-up

NEMO® Progressing Cavity Pumps must be operated with the following precautions:

Never run the pump dry!
Even a few rotations in dry condition will damage the stator.

If the rotor was protected with grease for long-term storage:
Thoroughly clean the rotor to prevent damage caused by interaction of the grease, stator material and medium.

- Before initial start-up, regardless of rotation, make sure the pump housing and suction piping are filled with medium. If medium is high in viscosity, it may be necessary to prime the pump with a compatible liquid. Priming of the pump is necessary to lubricate the stator.

NEMO® Pumps are positive displacement progressing cavity pumps and have the potential to generate very high pressure capable of bursting vessels or pipes.

Excessive pressure can overload the drive train (shaft, connecting rod, joints, rotor) or exceed pressure limitations of the housings and their connections, resulting in damage or breakage. Refer to Section 4.4 of this manual for housing pressure limitations.

Never run the pump with an inlet or outlet valve closed.

- Open valves and vents before starting the pump!
- Turn pump motor on and off briefly to check direction of rotation.

6 Temporary Shutdown

- Following the temporary shutdown, the pump should be emptied and rinsed when:

  - the pump is installed in a location inside or outside where the medium has the potential to freeze.
  - the medium has a tendency to solidify or harden.
  - the medium tends to build up or become tacky on the shaft sealing area.

- **Stator:**

  When stored for an extended period, the elastomer along the contact line between the rotor and stator may become temporarily distorted (compression-set).

  This will increase the required starting torque. For this reason, the stator should be removed and stored in a cool, dry place in an air-tight package and protected from light.

- **Rotor:**

  Support with wooden blocks and cover to protect from mechanical damage, after the stator has been removed.

  Rotors made with Tool Steel (Material number 1.2436)
  Should be protected against corrosion with protective grease.

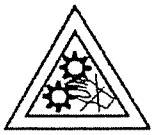
  Prior to installation, thoroughly clean rotor to prevent damage caused by interaction of the grease, stator material and medium.

- **Stand-by Pump:**

  A stand-by pump is sometimes installed to eliminate downtime.
  Stand-by pumps should be operated occasionally to keep properly conditioned for use.

7 Maintenance

7.1 Pumps in General



- The pumps should be regularly rinsed or cleaned if deposits of medium are likely to build up.

  If the pump needs to be disassembled, ensure that the pump and motor are switched off and cannot be turned on accidentally (eg. by removing the fuse).

7.2 Lubrication

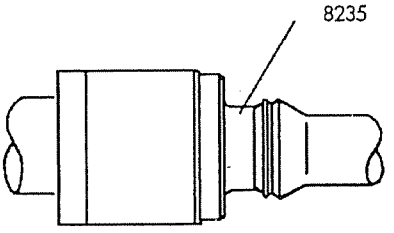
The NEMO® Pump does not require frequent lubrication.

- Maintenance and lubrication of the drive should be carried out according to the drive manufacturers instructions.

7.3 Lubricating the Pin Joints with SM-Pin Joint Seals

- It is advisable to change the oil and check the seals of the pin joints:
  - when replacing worn joint parts
  - when disassembling the pump for any reason

Joint basic size series NM	Quantity of oil per joint	
	cm^3	fl oz.
NM 003-011	1	0.0338
NM 015	1.5	0.05
NM 021	2	0.067
NM 031	5	0.17
NM 038	15	0.51
NM 045	22	0.75
NM 053	36	1.22
NM 063	78	2.64
NM 076	165	5.60
NM 090	205	6.93
NM 105	450	15.20



Continued on Page 7.2R

Lubricating Oil:

Industrial Application	Designation DIN 51502	Permitted Product
General Industry	CLP 460	"SHELL" Omala 460 (or equivalent)
	with SM-pin joint seal (8235) of EPDM CLP PG 320	prescribed: KLUBERSYNTH GH 6-320

8 Trouble-Shooting

8.1 Trouble-Shooting Guide

The following chart lists possible problems and corresponding solutions:

8.2 Determining the Kind of Problem and the Possible Cause

- The column describing a possible problem shows one or more boxes marked with an "**X**."

- On the corresponding lines, you will find the possible reasons/causes and some hints how to handle the problem. Thus, the actual cause of the problem can be narrowed down and eventually detected.

◆ The table helps to identify the problem and offers a possible solution. For more complicated problems, consult the manufacturer.

Continued on Page 8.0R

Possible Problem												TROUBLE-SHOOTING GUIDE	
Pump will not start	No suction capability	Discharge output low	Discharge pressure low	Discharge output fluctuates	Pump is noisy	Pump jammed	Drive overloaded	Stator service life too short	Rotor service life too short	Shaft seal leaks	A good service life can be expected if the pump is used in accordance with your specified application and maintained in accordance with this manual. If operating problems arise, use this chart as a guide in locating the problem.	See Next Page for Corrective Action.
											POSSIBLE CAUSE	
X							X				Pump or stator is new, to much static friction.	1
X		X	X				X				Power supply incorrect; drive not properly wired.	2
		X					X	X	X		Discharge pressure too high.	3
X						X	X				Foreign matter or debris in pump.	4
X						X	X	X	X		Temperature of pumped liquid too high; stator swells.	5
X						X	X	X			Stator swells due to chemical attack, unsuitable elastomer.	6
X						X	X	X			Liquid contains too many solids, causing blockages.	7
X						X	X	X	X	X	Liquid settles and hardens at pump shut-down.	8
		X	X	X							Air in suction piping.	9
	X	X	X	X							Suction pipe leaks.	10
	X	X	X	X							Shaft sealing leaks.	11
		X	X								Pump speed too low.	12
	X	X	X								Undersized rotor; operating temperature not reached.	13
		X	X	X	X			X	X		Discharge too high or suction head too low (cavitation).	14
		X	X		X	X	X	X	X		Pump running dry.	15
	X	X	X		X						Stator worn out.	16
	X	X	X		X			X	X		Stator material brittle.	17
	X	X	X		X			X			Rotor worn out.	18
					X						Joints worn.	19
					X						Pump and drive out of alignment.	20
					X						Elastomer in coupling worn out.	21
					X					X	Pump bearings worn.	22
							X				Pump speed too high.	23
							X				Viscosity too high.	24
							X				Specific gravity too high.	25
							X			X	Stuffing box not properly tightened.	26
										X	Incorrect packing.	27
										X	Wrong direction of rotation.	28
	X									X	Stationary or rotating face of mechanical seal worn.	29
										X	O-Rings in mechanical seal worn or damaged.	30

	CORRECTIVE ACTION
1	Fill pump and turn by hand. If necessary, use glycerine to lubricate stator.
2	Check motor nameplate data. Test voltage, phase and frequency.
3	Measure actual discharge pressure and compare to your specification.
4	Remove debris and correct any damage.
5	If liquid temperature cannot be reduced, use an undersized rotor.
6	Check specified application, If necessary, change stator material.
7	Increase liquid-to-solids ratio.
8	Clean pump and rinse out after each use.
9	Increase NPSHA; eliminate leaks (see No. 10).
10	Check seals; tighten piping connections.
11	Packing: tighten stuffing box or replace packing. Mech. seal: replace rings or seals; remove deposits.
12	If drive is variable speed, increase speed at pump.
13	Heat pump (stator) to operating temperature.
14	Reduce suction losses; lower liquid temperature; install pump at lower elevation.
15	Fill pump; provide dry run protection; relocate suction piping.
16	Replace stator.
17	Replace stator, check specified application; change stator material of construction if necessary.
18	Replace rotor; determine cause; change rotor material of construction if necessary.
19	Replace necessary parts; seal and refit carefully.
20	Re-align pump and drive.
21	Replace coupling elastomer; re-align.
22	Replace bearings, lubricate and seal. For high temperature, check bearing tolerances and lubrication.
23	If drive is variable, set at lower speed.
24	Measure viscosity and compare to specified viscosity.
25	Measure specific gravity and compare to specified specific gravity.
26	Service stuffing box; replace worn shafts.
27	Change packing material.
28	Reverse polarity of drive motor.
29	Rework or replace seal faces.
30	Replace o-rings; check specified application. Change o-ring material of construction if necessary.

9 DISASSEMBLY AND ASSEMBLY OF THE PUMP HOUSING

9 Removal and Assembly of End Flange, Stator and Pump Housing

The pump with attached pipework should be empty and must have cooled off!

- DIsconnect the pipework on the suction side and pressure side of the pump.
- Remove securing hardware, from support feet to baseplate.
- Remove the hex nuts (3020) with spring washers (3015).
- Remove the end flange (2035) from the stator (3005).
- Remove the stator (3005).
- Remove the pump housing (2010) from drive stool (0085) or bearing housing (0005).

Reassemble in reverse order.

- Installing the stator (3005) will be easier when using glycerine as a lubricant.
- Ensure during refitting that gasket (8110) is in perfect condition and will seat properly.

Torque values for hex nuts (2030):

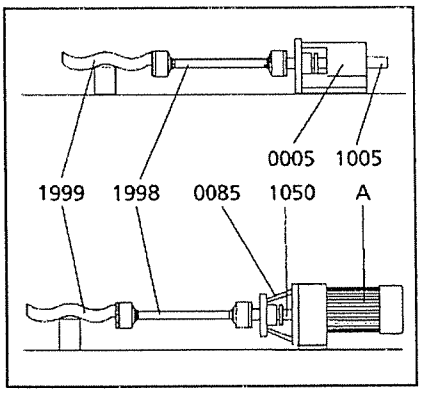
Size	M6	M8	M10	M12	M16	M20	M24	M30
Required torque in/lbs.	70	132	264	396	660	704	880	1056

10 Disassembly and Assembly of the Rotating Parts with Pin Joints with SM-Pin Joint Seal

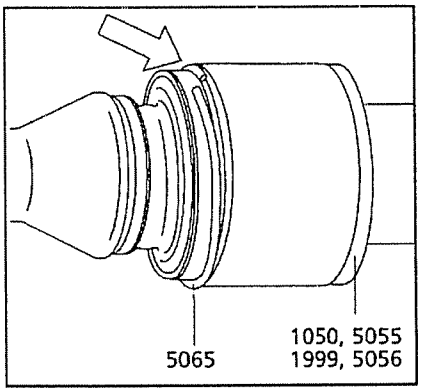
10.1 Removal of Rotor and Coupling Rod

Where a pump is fitted with a ceramic rotor (1999) the following operations should be carried out with great care.
Do not use any force or sharp tools! Special care must be taken to prevent vibrations or impact by a hammer.

For removal of the rotor (1999) and coupling rod (1998) the pin joints should be dismantled as follows:

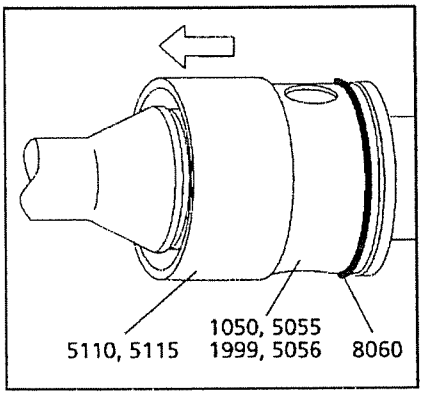


- Place the dismantled unit – consisting of bearing housing (0005) with drive shaft (1005) or drive stool (0085) with drive (A) and connecting shaft (1050), coupling rod (1998) and rotor (1999) – on the workbench with a wooden block supporting the rotor (1999).



- Push circlip (5065) out of its groove and slip off over the head of rotor (1999), connecting shaft (1050) or adapter (5055, 5056).

- **Pumps fitted with a ceramic rotor (1999):**
  Carefully turn safety sleeve (5110, 5115) with a squeeze belt wrench, and remove.
  The following method should **not** be employed for pumps fitted with a **ceramic** rotor.

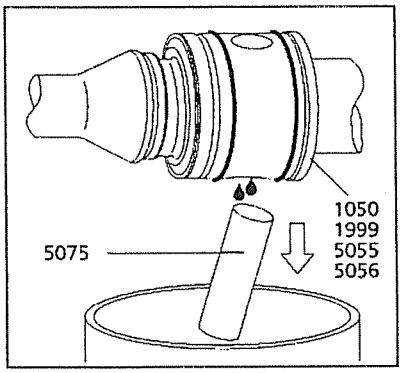


  Pumps fitted with a metallic rotor (1999):
  If necessary hit the edge of sleeve (5110, 5115) at an angle with the help of a wooden block and a plastic hammer. Taking care not to damage the O-rings (8060)!

Continued on Page 10.0R

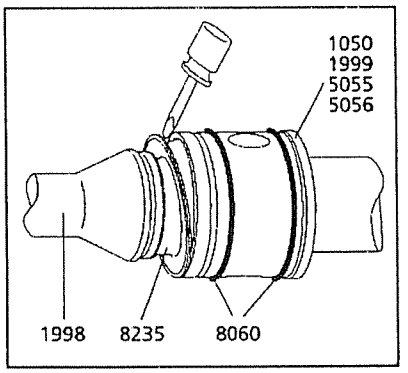
10 DISASSEMBLY AND ASSEMBLY OF THE ROTATING PARTS

- Press the pin (5075) out of the head of rotor (1999), connecting shaft (1050) or adapter (5055, 5056). If necessary use a hammer and a thin cylindrical pin (DIN 6450 C).
  Drain the oil into a receptacle.



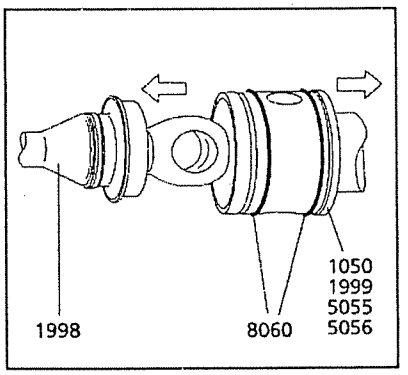
Use caution for pumps with ceramic rotors!

Where a pin (5075) may not come out easily, the metallic head of rotor (1999) should be supported on wooden blocks. Then the pin (5075) can be driven out with the help of a pin punch (DIN 6450 C).
This should be done **with care**, holding the ceramic rotor with your hands.
Please dispose of this oil in the proper manner.



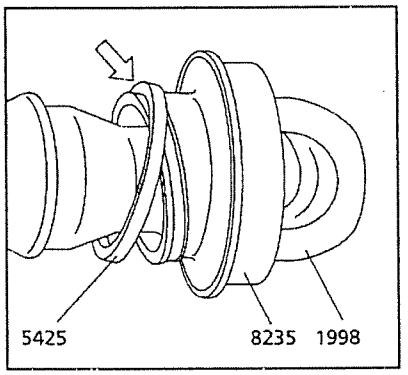
- Using a screwdriver, carefully remove the SM-pin joint seal (8235) from the head of rotor (1999), connecting shaft (1050) or adapter (5055, 5056).

  Taking care not to damage the SM-pin joint seal (8235)!



- Pull apart the rotor (1999)/coupling rod (1998)/drive shaft (1005) or connecting shaft (1050) with adapter (5055, 5056) assembly. Remove the O-rings (8060).

- Push the SM-pin joint seal (8235) towards the head of coupling rod (1998). In the narrow coupling rod section press the clamp ring (5425) out of the groove of the seal. Then slip the SM-pin joint seal (8235) and clamp ring (5425) off over the head of the coupling rod (1998).



- Where an adapter (5055, 5056) is fitted:
  See Page 10.3, Section 10.3:
  Removal and Fitting of Adapters.

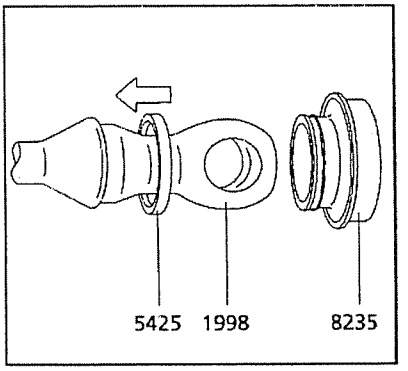
Continued on Page 10.1

10.2 Assembling the Rotor and Coupling Rod

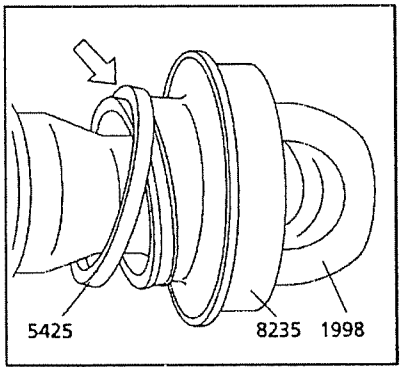
For fitting the rotor (1999) with coupling rod (1998), the two pin joints should be assembled as follows:

- If an adapter (5055, 5056) is installed:
  See Page 10.3, Section 10.3 – Fitting and Removal of Adapters.

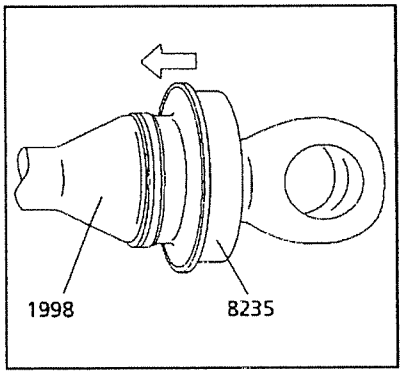
- Slip the clamp ring (5425) over the head of coupling rod (1998).



- Push the SM-pin joint seal (8235) over the head of coupling rod (1998) toward its narrow section, there squeezing the clamp ring (5425) into the groove of the SM-pin joint seal (8235).



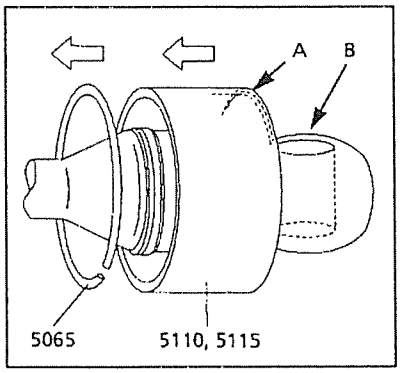
- Push the SM-pin joint seal (8235) with the correctly placed clamp ring (5425) up to the shoulder of coupling rod (1998).



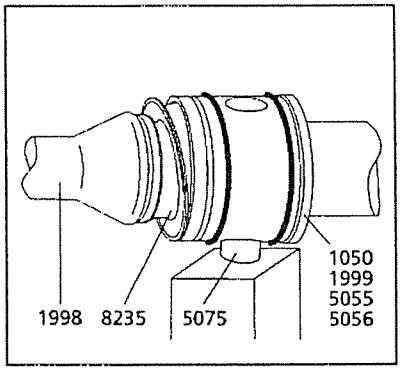
Continued on Page 10.1R

10 DISASSEMBLY AND ASSEMBLY OF THE ROTATING PARTS

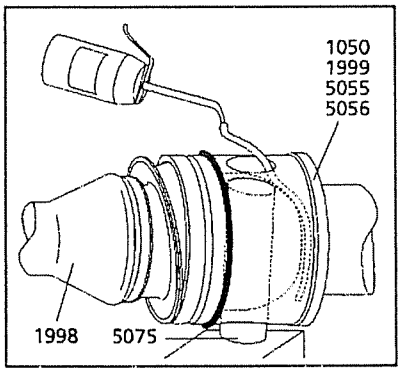
- Slip the circlip (5065) on to the coupling rod (1998). Slide the sleeve (5110) or (5115) on to coupling rod (1998) so the inside diameter of chamfering (A) is being placed towards the coupling rod (1998) extension. Chamfering (A) will later on ease the installation over the O-rings (8060).
  Orient the head of coupling rod (1998) until it is in vertical position for the bore (B) for the pin (5075).



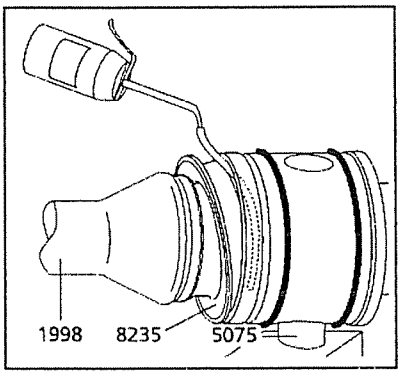
- Slide the coupling rod (1998) with SM-pin joint seal (8235) into the bore of rotor (1999), connecting shaft (1050) or adapter (5055, 5056) and insert the pin (5075) from below and push up to the upper edge of coupling rod (1998).
  Support the pin (5075) against dropping out.
  Slide the SM-pin joint seal (8235) into the rotor (1999), connecting shaft (1050)/ or adapter (5055, 5056) only from below, and in a slightly slanted position.



- For lubrication, use an oil can which should be fitted with a thin plastic hose having an outside diameter of not more than 4 mm.
  Insert this hose into the upper oil port opening in the rotor (1999), connecting shaft (1050) or adapter (5055, 5056). Then slide the hose end past the coupling rod (1998) all the way down to the bottom section of the rotor head (1999) or connecting shaft (1050) or adapter (5055, 5056).
  Slowly fill with lubricating oil up to the filling port.



- Pull the hose out.
  Then insert the hose end through the small gap on the topside of Sm-pin joint seal (8235) and guide it down to the bottom of the hollow space between coupling rod (1998) and SM-pin joint seal (8235). Slowly fill with lubricating oil up to the gap.

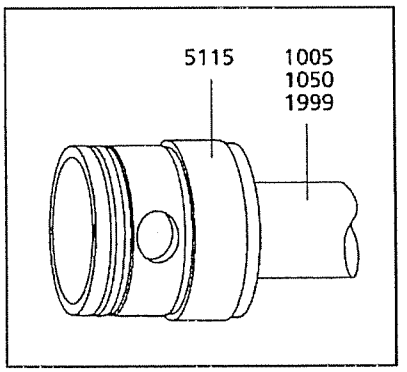


Continued on Page 10.2

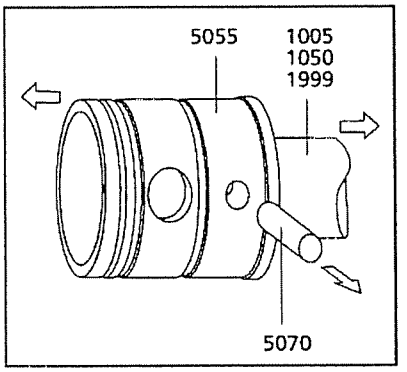
10.3 Disassembly and Reassembly of the Adapters

If a pump is fitted with adapters (5055) either on the drive shaft (1005) or connecting shaft (1050) and rotor (1999), these adapters should be removed as follows:

- Remove the second sleeve (5115) where this has not been taken off earlier when dismantling the joint.

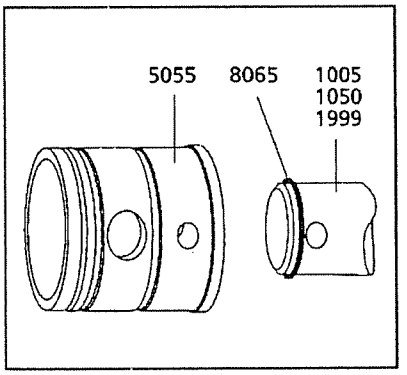


- Then drive the pin (5070) out of the adapter (5055).



- Now remove the adapter (5055) from drive shaft (1005) or connecting shaft (1050) and rotor (1999).

  Remove O-ring (8065).



11 Disassembly and Assembly of the Connecting Shaft with Shaft Seal

Disassembly

- Remove pin (1055).
- If the shaft seal housing (W) is connected tightly to the drive stool (0085), then pull off thye connecting shaft (1050) from the drive shaft.
  If the shaft seal housing (W) is a separate part, then take it out of the drive stool (0085) together with the connecting shaft (1050).
- If a mechanical seal is installed, see description "Removal and Fitting of the Mechanical Seal" after Page 12.0.

Assembly

- Apply grease into the bore of the connecting shaft (1050) to avoid rust.
- If the shaft seal housing (W) is connected tightly to the drive stool (0085), then insert connecting shaft (1050) into the shaft seal housing (W) and push connecting shaft (1050) on to the drive shaft.
  If the shaft seal housing (W) is a separate part, then place it into the drive stool (0085) together with the connecting shaft (1050) and push connecting shaft (1050) on to the drive shaft.
- If the mechanical seal is installed, see description "Removal and Fitting of the Mechanical Seal" after Page 12.0.
- Apply some grease into the pin (1055) also, or oil, and fit in.

12 Removal and Installation of the Mechanical Seal

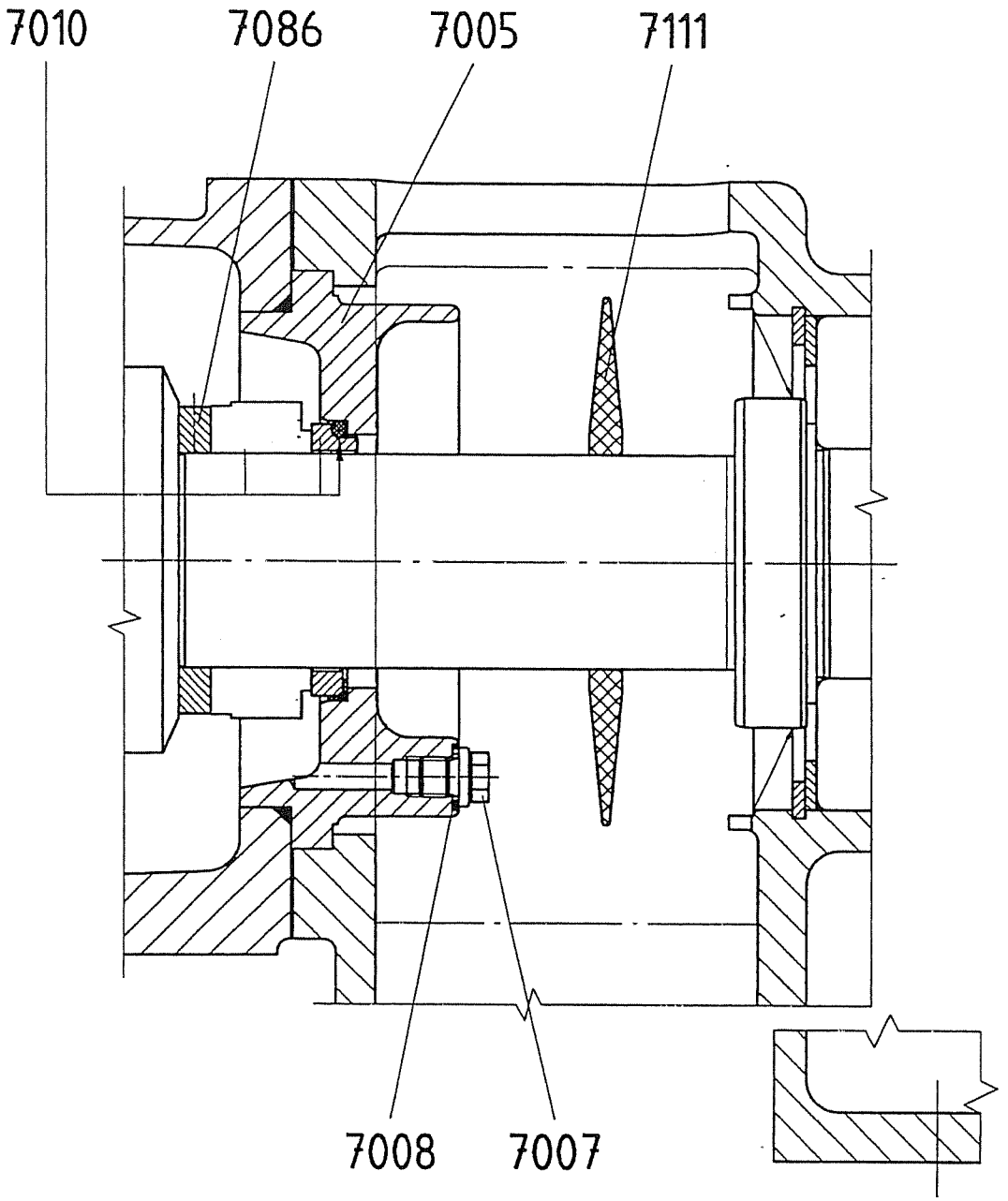
- **Carefully** slide out mechanical seal housing (7005) together with the parts of the mechanical seal contained in it from connecting shaft (1050) or drive shaft (1005).

- **Carefully** push mechanical seal (7010) stationary seat out of mechanical seal housing (7005).

  Refitting is a simple reversal of the above procedure.

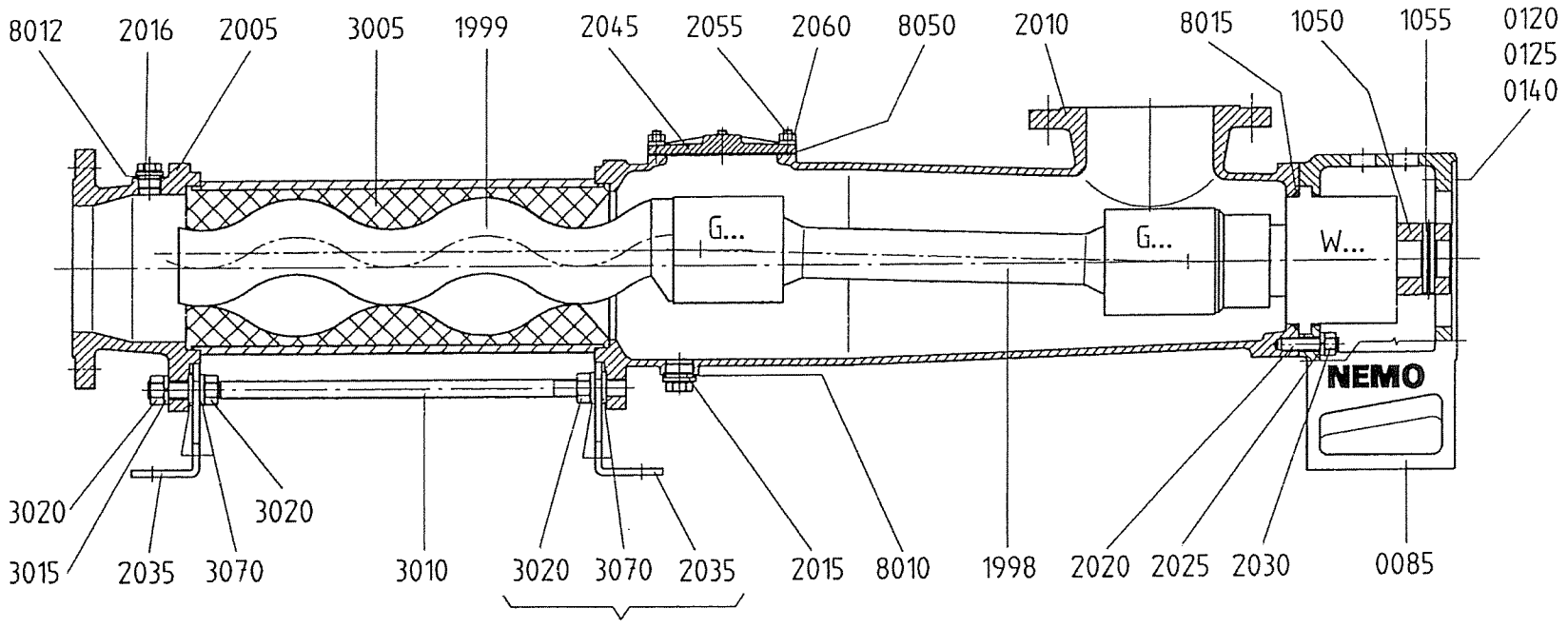
- To reduce frictional forces during seal assembly, apply some glycerine to the shaft and the seal housing in the area of the gaskets.

Ensure that the distribution of pressure is uniform when inserting the pressure sensitive counter rings. When inserting larger rings, use a suitable mandrel. Do not allow any foreign objects to get between the sliding surfaces.



1 : X	Drawing Number	Mechanical Seal	Type:
	W 1 2 4 0 0 0	Burgmann Type MG1	NM015S - NM105S

Type: NM045BY--S12- — NM148BY-- S04 D03 -
NM038BY--S24-
NM045BY--S18- — NM090BY--S18-

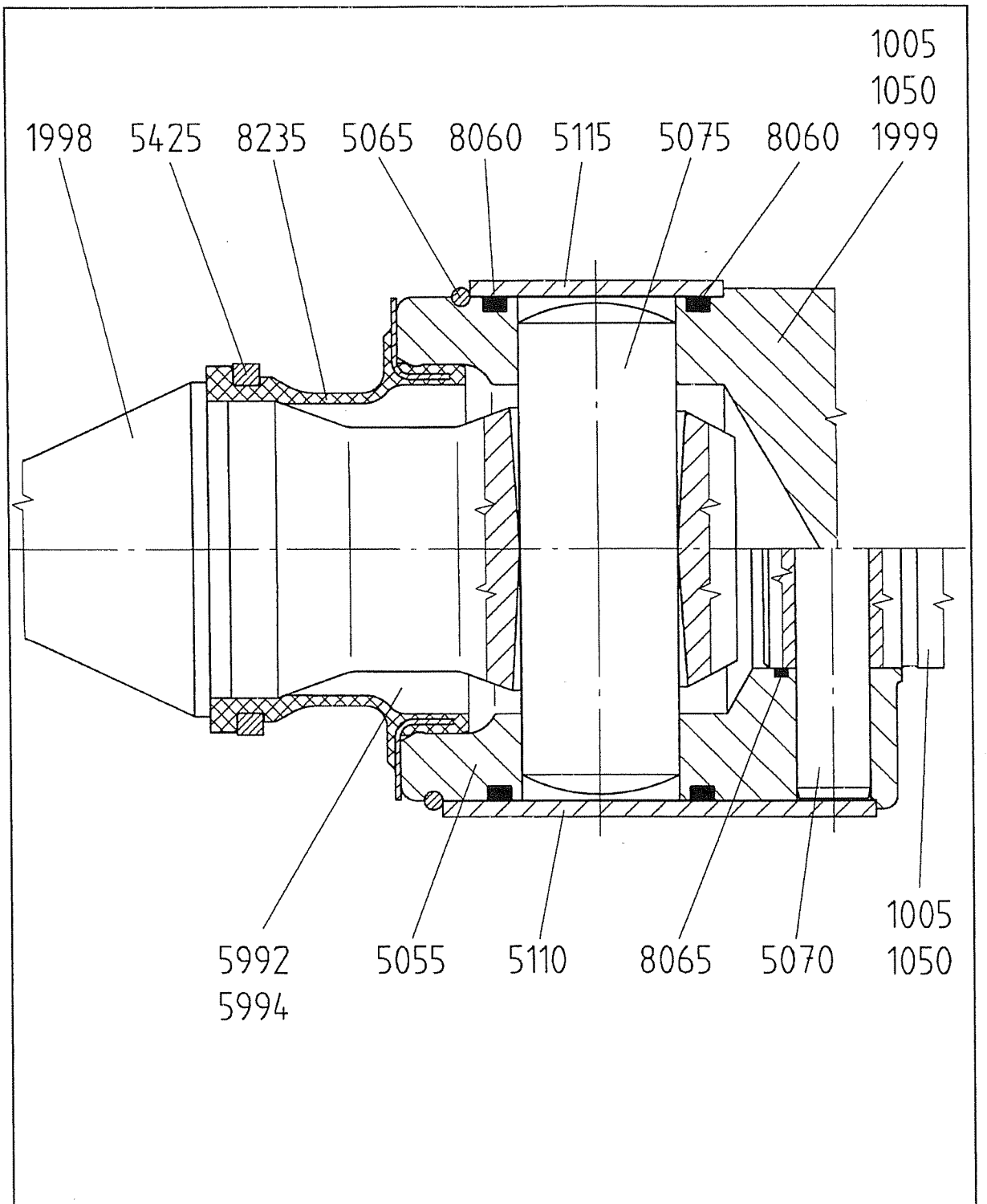


Type. NM105BY02S04- NM105BY02S08- NM105BY02S12-
NM125BY--S04- NM125BY--S08-
NM148BY--S04-

NM---BY--D03- NM105BY01L04-
NM---BY--D05- NM125BY01L04-
NM---BY--D09-

NM015BY--S24- — NM038BY--S24-
NM045BY--S18- — NM090BY--S18-

Drawing Number	Type:		
N M B Y 0 0 1 0		NM015BY--S12-	NM148BY-- S04 D03
		NM015BY--L06-	NM038BY--L06
		NM045BY--L04-	NM125BY--L04
		NM015BY--S24-	NM038BY--S24
		NM045BY--S18-	NM090BY--S18



1 : x	Drawing Number	Sealed Pin Joint	Type: NM021 - NM053 N...15 - N...100
	G 0 5 7 0 0 0		

14 Recommended Spare Parts

(Pump with pin joints with SM-seal)

In general, we have all spare parts subject to wear in stock. Our subsidiaries and exclusive representatives also hold a certain stock. We recommend to keep an amount of spare parts, corresponding to the pump, in stock on site as follows:

Pieces		Position Number	Designation
Large Set	Small Set		
1	1	3005	stator
2	2	8005*	gasket
1	1	8015	O-ring
1	–	1998	coupling rod
2	–	5075	pin
2	–	8235	SM-seal
4	–	8060	O-ring
1	–	8065	O-ring
2	–	5065	circlip
1	–	5110	sleeve
1	–	5115	sleeve
1	–	1999	rotor
2	–	5425	clamp ring

To ensure that you receive the part quickly, please provide the following information with your order. Also, please specify the model number of your pump.

Either: 1. a. Part number per the parts drawing
b. Job number (see pump nameplate)

or: 2. a. Part number per the parts drawing
b. Pump machine number. The machine number is stamped on both the pump nameplate and the bearing housing (0005) or drive stool (0085).

or: 3. Identification number of part (Note: The I.D. Number is a six digit number which describes the part, pump size, and materials of construction).

* This gasket is only used with rigid material stators (i.e. metal, PTFE, plastics)

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www.netzschusa.com

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NETZSCH

Intelligent Drivesystems

B1000

Operating & Instruction Manuals For Gear Units

B1000

NORD DRIVESYSTEMS

TABLE OF CONTENTS

TITLE	Document Number & Hyperlink
General Instructions	U10000
Safety Notes	U10020
Storage & Commissioning	U10040
Unit Installation	U10060
Solid Shaft Connections	U10250
Keyed Hollow Shaft	U10270
Fixing Kit	U10280
Hollow Shaft With Shrink Disc	U10290
GRIPMAXX™ Bushing System	U10310
Reducer Mounting Footed & Flange Mount Gear Units	U10500
Clincher Shaft Mount With Rubber Buffer	U10580
Right Angle Shaft Mount with Bottom Mount Torque Arm (K)	U10600
Helical Bevel Shaft Mount with Torque Arm (D)	U10620
Helical & Bevel Reducer Lubrication	U10750
Helical Worm Reducer Lubrication	U10770
Minicase Worm Reducer Lubrication	U10790
FLEXBLOC Worm Reducer Lubrication	U10810
Expansion Chambers	U10830
Helical & Bevel Reducer Lubrication Types	U11000
Helical Worm Reducer Lubrication Types	U11020
Minicase Worm Reducer Lubrication Types	U11040
FLEXBLOC Worm Reducer Lubrication Types	U11060
Standard In-Line Foot Oil Fill Quantities	U11500
Standard In-Line Flange Oil Fill Quantities	U11600
Helical In-Line Foot Mount Oil Fill Quantities	U11700
Helical In-Line Flange Mount Oil Fill Quantities	U11800
CLINCHER Oil Fill Quantities	U11900
Helical Bevel Foot Mount Oil Fill Quantities	U12000
Helical Bevel Flange Mount Oil Fill Quantities	U12100
92 Helical Bevel Foot Mount Oil Fill Quantities	U12200
92 Helical Bevel Flange Mount Oil Fill Quantities	U12300
Helical Worm Foot Mount Oil Fill Quantities	U12400
Helical Worm Solid Shaft/Flange Mount Oil Fill Quantities	U12500
Helical Worm Hollow Shaft Oil Fill Quantities	U12600
Nordbloc Foot Mount Oil Fill Quantities	U12700
Nordbloc Flange Mount Oil Fill Quantities	U12800
Nordbloc.1 Foot Mount Oil Fill Quantities	U12900
Nordbloc.1 Flange Mount Oil Fill Quantities	U13000
Minicase Foot Mount Oil Fill Quantities	U13100
Minicase Flange Mount Oil Fill Quantities	U13200
FLEXBLOC Oil Fill Quantities	U13300
Standard In-Line Oil & Drain Plug Locations	U14000
Helical In-Line Oil & Drain Plug Locations	U14100
CLINCHER Oil & Drain Plug Locations	U14200
92 Helical Bevel Oil & Drain Plug Locations	U14300
90.1 Helical Bevel Oil & Drain Plug Locations	U14400
Helical Worm Oil & Drain Plug Locations	U14500
Nordbloc Oil & Drain Plug Locations	U14600
Nordbloc.1 Oil & Drain Plug Locations	U14700
FLEXBLOC Oil & Drain Plug Locations	U14800
Standard In-Line Parts Lists	U15000
Helical In-Line Parts Lists	U15100
CLINCHER Parts Lists	U15200
90.1 Helical Bevel Parts Lists	U15300
92 Helical Bevel Parts Lists	U15400
Helical Worm Parts LIsts	U15500
Nordbloc Parts Lists	U15600
Troubleshooting	U19000
Terms & Conditions	Terms

1. Importance of the operating instructions

These operating instructions are intended to provide general information and safety guidelines. It is the responsibility of the buyer, machine builder, installer and user of the NORD product to make sure that all the proper safetynotes and operating instructions have been reviewed and understood. If the contents of this instruction or any applicable operating instructions are not understood, please consult NORD.

⚠ *WARNING* ⚠

Electric motors, gearmotors, electrical brakes, variable frequency drives, and gear reducers contain potentially dangerous high-voltage, rotating-components and surfaces that may become hot during operation. All work involved in the transport, connection, commissioning and maintenance of any NORD product must be carried out by qualified and responsible technicians.

2. Inspect incoming freight

Before accepting shipment from the freight company, thoroughly inspect the NORD equipment for any shipping and handling damage. If any goods called for in the bill of lading or express receipt are damaged, or if the quantity is short, do not accept until the freight express agent makes an appropriate notation on your freight bill or express receipt. If any concealed loss or damage is discovered later, notify your freight carrier or express agent at once, and request a formal review of your claim.

Claims for loss or damage in shipment must not be deducted from the NORD invoice, nor should payment of the NORD invoice be withheld awaiting adjustment of such claims, as the carrier guarantees safe delivery. NORD will try to assist in collecting claims for loss or damage during shipment; however, this willingness on our part does not remove the transportation company's responsibility in reimbursing you for collection of claims or replacement of material.

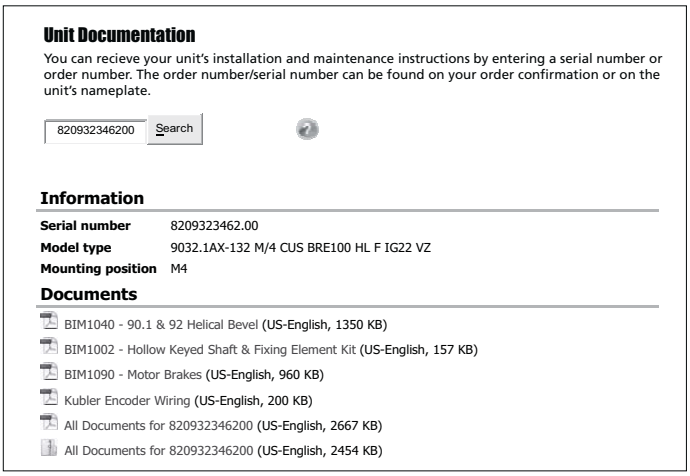
3. Obtaining detailed operating instructions

One can receive the detailed installation and maintenance instructions by entering a serial number (or NORD order number) at the appropriate location on the NORD web site.

i. Record the serial number from your gearmotor, gear reducer, or motor nameplate, or record the serial number found on your order confirmation.

ii. Go to **www.nord.com/docs** to download the appropriate operating instructions.

EXAMPLE: www.nord.com/docs



4. Intended use

NORD is a supplier of electric motors, gearmotors, reducers, electromechanical brakes, mechanical variators, and electrical variable frequency drives that are intended for commercial installations on larger systems and machines.

⚠ *WARNING* ⚠

NORD does not accept any liability for damage or injury caused by:

- Inappropriate use, operation or adaptation of the drive system.
- Unauthorized removal of housing covers, safety and inspection covers, guarding, etc.
- Unauthorized modifications to the drive system.
- Improper servicing or repair work on the drive system.
- Damage caused during shipment or transportation.
- Disregard of the important Safety Notes or Operating Instructions.

5. Notes concerning warranty and liability

All units are supplied according to the terms described in our standard "Conditions of Sale." The unit limited warranty is also defined in our "Conditions of Sale" and is located in the back of our product catalogs as well as the back of your order invoice.

All NORD Safety Notes and all related NORD Operating instructions shall be considered up-to-date at the time in which they were compiled by the buyer, machine builder, installer or user. NORD reserves the right to incorporate technical modifications and information updates to any safety/operating instructions that are within the scope of providing additional knowledge or clarification, communicating design changes, or product enhancements. Information updates may include any NORD product, or subsequent products purchased and supplied by NORD; No specific claims can be derived from the information or illustrations and descriptions contained in the safety notes or related operating instructions.

⚠ *WARNING* ⚠

NORD assumes no liability for personal injury, equipment damage or malfunctions resulting from failure to comply with any installation safety notes. The applicable national, regional, and local work regulations and safety requirements must also be complied with. Failure to comply with any safety notes or regulations may result in serious injury, damage to property, or even death.

6. Checklist for installation and operation

- ☑ Verify that the purchased NORD product has been supplied with the expected accessories & options. Check the received goods and packing slip to make sure items are properly received.
- ☑ Make sure that you have all of the required Operating Instructions for your NORD electric motor, gearmotor, reducer, electromechanical brake, mechanical variable speed drives, or electrical variable frequency drives.
- ☑ Consult NORD if you feel you are missing any documentation or if you have questions.

1. Safety & information symbols

All work including transportation, storage, installation, electrical connection, commissioning, servicing, maintenance and repair must be performed **only by qualified specialists or personnel**. It is recommended that repairs to NORD Products are carried out by the NORD Service Department. Instructions related to operational safety will be emphasized as shown.

Symbol	Meaning
⚠	**General Warning or Hazard -** Severe risk or danger of personal injury or death by working around dangerously high electrical voltage or moving machinery. Proper safety precautions must be taken.
STOP	**Possible Harmful Situation -** Care must be taken to avoid the possibility of damaging the drive unit, driven machine, or the environment.
ℹ	**Important Note -** Useful note or tip to help assure trouble-free operation.
♻	**Material Disposal Note -** Important note concerning suggested material disposal.

2. Safety warnings

⚠ GENERAL WARNINGS ⚠

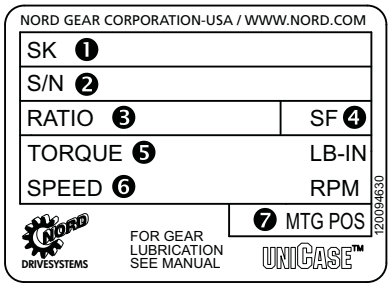
- All work involved in the transport, connection, commissioning and maintenance of any NORD product must be carried out by qualified and responsible technicians. All applicable national, regional, and local work regulations and safety requirements must also be complied with. **NORD assumes no liability for personal injury, accidental death, or equipment damage and malfunctions resulting from failure to comply with installation or operating instructions, safety notes, or any work regulations and laws!**
- Gear unit installation and maintenance work may only be performed when no power is available to the prime mover or motor. Electric motors, electrical brakes, and variable frequency drives, contain potentially dangerous high-voltage. Prior to installation or maintenance, shut down the power at the circuit breaker or power switch. **While working on the drive, make sure the power from the prime mover is isolated or secured on "lock-out" to prevent accidental start-up and to safeguard against injury!**
- Surfaces of motors and gear units may become hot during operation or shortly after start-up. In some instances additional protection against accidental contact may be necessary. **Use caution to avoid burns or serious injury!**

3. Observe published performance range & nameplate data

STOP HARMFUL SITUATION STOP

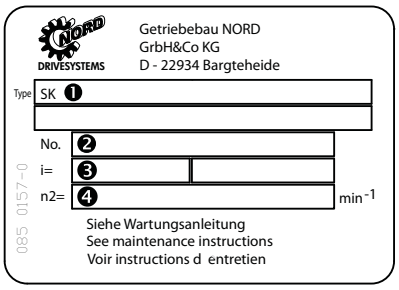
Observe the data on all reducer nameplates and verify published ratings for the NORD item/s in question. Do not operate any NORD equipment outside the published performance range. Failure to comply may result in damage to the drive unit, driven machine, or the environment.

U.S. Nameplate



❶ Model/Type
❷ Serial Number
❸ Gear Ratio
❹ Service Factor
❺ Torque Rating
❻ Output Speed RPM
❼ Mounting Position

European Nameplate



❶ Model/Type
❷ Serial Number
❸ Gear Ratio
❹ Speed

4. Transportation and handling

Make sure that all eyebolts and lifting lugs are tight and lift only at designed points. Protect the mounting surface from possible damage during transportation.

⚠ WARNING ⚠

Do not attach other machinery or loads to the NORD assembly, since the supplied lifting bolts are not designed for this purpose.

If the gearmotor or assembly is equipped with two suspension eye bolts, then both locations should be used for transportation and placement of the unit; in this case the tension force of the slings must not exceed a 45° angle.

In some instances it may be appropriate to use additional lifting straps or slings in order to assure safe transportation of the assembly. Always use sufficiently rated handling equipment and ensure that adequate safety measures are taken to protect personnel from injury during transportation. Once the NORD assembly is properly installed, remove the transportation fixtures.

7. DISPOSAL

MATERIAL DISPOSAL

Properly dispose of all used gear units and internal parts in accordance with all local regulations. In particular, all lubricants must be properly collected and disposed.

For confirmation of specific materials used in a specific reducer or gearmotor assembly, please consult NORD with the appropriate unit identification or serial number.

Components	Material
Gear wheels, shafts, rolling bearings, parallel keys, snap rings, spacers, shims, etc.	Steel
Gear housing and housing components	Cast iron or Aluminum (depending on type and size)
Worm gears	Bronze alloy
Radial seals, sealing caps, and rubber components	Elastomers with some steel
Coupling components	Plastic or Elastomer with Steel
Housing gaskets and flat oil seals	Asbestos-free sealing or gasket material (various types used)
Gear Oil	Mineral, SHC-Synthetic or PG-Synthetic (can vary)

1. Storage

IMPORTANT NOTE

For storage periods longer than 9 months, or for storage in less than desirable conditions, please consult NORD for recommendations.

Storage for up to 9 months is possible, so long as the following conditions are observed:

- Store the gear unit in its actual mounting position in accordance with the specified oil fill-level, in a clean and dry temperature controlled area. Avoid temperature fluctuations within the range of 0°C and 40°C (32°F to 104°F) and avoid relative humidity conditions in excess of 60%.
- Protect all exposed or unpainted shaft and flange surfaces with an anti-corrosion agent or grease.
- Store in a location free from shock and vibration, to avoid false brinelling of bearing elements and raceways.
- Whenever possible, rotate the shafts periodically, by hand if necessary, to help prevent brinelling (bearing damage) and to help keep the shaft seals pliable.
- Avoid direct exposure to the sun or UV light and aggressive or corrosive materials in the environment (ozone, gases, solvents, acids, caustic solutions, salts, radioactivity, etc.

2. Commissioning

Prior to gear unit start-up, complete the following:

- Check the lubricant and be sure the gear unit is filled with the proper oil type, to the proper level, as determined by the mounting position.

IMPORTANT NOTE

Some smaller gear units are supplied as maintenance free/lubricated for life gear units. Oil level may neot be checked on some of these units.

- Check the condition of all shaft seals and all assembled flange gasket areas. If any change is detected in the shape, color, hardness or permeability, or if any leaks are detected, the corresponding shaft seals and/or gaskets must be replaced.
- Remove all anti-corrosive metal protectant from otherwise bare metal surfaces. Follow product manufacturers directions and warnings during surface protection removal.
- Check the resistance of all motor and brake windings to verify the integrity of the winding insulation and inspect all terminal box openings and wire connection areas to verify that all components are dry and free of corrosion.

3. Additional Guidelines for Reducer Long-Term Storage

By taking special precautions, problems such as seal leakage and reducer failure due to the lack of lubrication, improper lubrication quantity, or contamination can be avoided. The following precautions will protect gear reducers during periods of extended storage:

- Fill the reducer with oil that is compatible with the product normally used or recommended during service and replace the air vent with a solid pipe plug.
- Apply grease to all unpainted or unprotected shafts, bores, keyways, flange surfaces, tapped holes, and to the exterior of all oil seals.
- Once every few months rotate the input shaft approximately 10-20 revolutions to redistribute the weight of gears and shafts and to prevent false brinnelling of the bearings and drying of the seal track.

4. Commissioning After Long-Term Storage

- Remove all protective coatings and protective grease from the gear unit.
- Drain the reducer and refill it with the proper type and amount of lubricant.
- Reinstall the vent plug in its proper position.
- Observe start-up and initial operation to make sure there are no seal or gasket leaks, or unusual sounds, vibration or heat rise during operation.

1. Installation site

Drives must be properly installed if they are to produce the rated torque. Improper installation may lead to oil leaks, reduced life, or even catastrophic failure. NORD gear drives and motors are intended to be installed at a suitable mounting site under the following conditions:

- Unimpeded airflow to and around the units.
- Accessibility to oil drain, level and breather plugs.
- On brakemotors, allow adequate space for removing the fan guard and replacing and adjusting the brake.
- Mounting surfaces must be flat, torsionally rigid, and dampened against vibration.
- Unless special measures are taken, the immediate vicinity around the gear drive or motor should not be exposed to any aggressive or corrosive substances, contaminated air, ozone, gases, solvents, acids, alkalis, salts, radioactivity, etc.

2. Mounting position

Reducer mounting position charts illustrate the standard mounting positions for horizontal and vertical mounting. All gear units are assembled with the oil fill-level, oil-drain and vent plugs installed in their proper locations, **according to the customer-specified mounting position**. For mounting orientations other than shown consult NORD Gear.

HARMFUL SITUATION

The gear reducer may not receive proper lubrication if the unit is not mounted in the position for which it is designed. Observe the mounting position designated on the reducer nameplate, or specified in the order acknowledgement. Consult NORD prior to changing mounting position in the field. While it is often possible to simply relocate the oil fill-level and vent locations, and adjust the oil fill amount, in some cases, different mounting positions may lend themselves to different internal construction features.

3. Reducer mounting

- The support foundation must be straight, level and flat. Whether the gear unit is foot-mounted or flange-mounted, NORD recommends that the straightness and flatness of the customer-supplied support foundation follow **Table 1**.
- The gear unit must be properly aligned with the driven shaft of the machine in order to prevent additional stress or load forces from being imposed upon the gear unit.
- To facilitate oil drainage it may be desirable to elevate the gear box foundation above the surrounding support structure.
- All bolting surfaces must be clean and free from contamination and corrosion.

Table 1: Recommended Straightness and Flatness of Customer-Supplied Support Foundation

Above (in)	To & Including (in)	General Tolerance on Straigtness & Flatness ISO 2768-2, Tolerance Class K
0.00	0.39	+/- 0.002 in
0.39	1.18	+/- 0.004 in
1.18	3.9	+/- 0.008 in
3.9	11.8	+/- 0.016 in
11.8	39	+/- 0.024 in
39	118	+/- 0.031 in

Above (mm)	To & Including (mm)	General Tolerance on Straigtness & Flatness ISO 2768-2, Tolerance Class K
0	10	+/- 0.05 mm
10	30	+/- 0.1 mm
30	100	+/- 0.2 mm
100	300	+/- 0.4 mm
300	1000	+/- 0.6 mm
1000	3000	+/- 0.8 mm

Straightness: Based upon the length of the corresponding line.

Flatness: Based upon the longer lateral surface or the diameter of the circular surface.

HARMFUL SITUATION

The responsibility for the design and construction of the support foundation is with the user. The foundation must be adequate to withstand normal operating loads and possible overloads while maintaining alignment to attached system components under such loads. ***Motors and drive components mounted on prefabricated base plates can become misaligned during shipment. Always check alignment after installation.***

4. Steel foundation

An engineered structural steel foundation should be designed to provide adequate rigidity and prevent loads from distorting the housing or causing misalignment of internal gears and shafts. When foot-mounting the gear reducer, a base plate or sole plate with suitable thickness (generally equal or greater than the thickness of the drive feet) should be securely bolted to steel supports and extend under the entire gear drive assembly. When flange-mounting the gear unit, the bulk head plate must be engineered to minimize buckling distortions and support the cantilevered weight of the gear unit or gear motor.

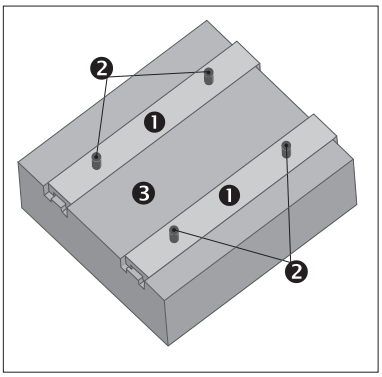
HARMFUL SITUATION

Do not weld on the gear unit or use the gear unit as an earth or ground connection for any welding procedure as this may cause permanent damage to the bearings and gears.

5. Concrete foundation

If a concrete foundation is used, allow the concrete to set firmly before bolting down the gear drive. Grout structural steel mounting pads and bolts of sufficient size into the concrete, to adequately distribute the load stress onto the concrete foundation.

Figure 1: Concrete Foundation



❶ Grouted Structural Steel Mounting Pads
❷ Mounting Bolts
❸ Concrete Foundation

6. Bolt connections for footed & flange mounted units

NORD footed reducers and flange-mount reducers (with B5 flange) have clearance designed into the mounting holes to allow for some minor adjustments in alignment. Bolt size, strength and quantity should be verified to insure proper torque reaction capacity whatever the mounting arrangement. Tightening torque for gear reducer mounting bolts, and recommended fastener grades, are provided in Table 2.

Table 2A: Tightening Torque for Inch Reducer Mounting Bolts

Thread Size	Tightening Torque					
	Grade SAE 5 / ASTM A449			Grade SAE 8		
(in)	(lb-in)	(lb-ft)	(Nm)	(lb-in)	(lb-ft)	(Nm)
1/4-20	85	7.1	9.6	120	10.0	13.6
5/16-18	190	16	21	267	22	30
3/8-16	330	28	37	470	39	53
1/2-13	825	69	93	1,170	98	132
5/8-11	1,660	138	188	2,340	195	264
3/4-10	2,960	247	334	4,180	348	472
7/8-9	4,750	396	537	6,700	558	757
1-8	7,100	592	802	10,000	833	1,130
1 1/8-7	-	-	-	14,800	1,233	1,672
1 1/4-7	-	-	-	20,600	1,717	2,327
1 3/8-6	-	-	-	27,200	2,267	3,073
1 1/2-6	-	-	-	35,800	2,983	4,045
1 3/4-5	-	-	-	53,500	4,458	6,045

- Calculated tightening torques are based a conventional 60°, clean and dry (un-lubricated) thread, with thread-friction and head-friction equal to 0.15.
- When using inch-fasteners, NORD recommends a minimum Grade SAE 5 (ASTM A-449) for sizes up to 1-8 UNC, and Grade SAE 8 for all larger sizes.

Table 2B: Tightening Torque for Metric Reducer Mounting Bolts

Above	Tightening Torque					
	ISO Grade 8.8			ISO Grade 10.9		
(mm)	(lb-in)	(lb-ft)	(Nm)	(lb-in)	(lb-ft)	(Nm)
M4	28	2.4	3.2	42	3.5	4.7
M5	57	4.7	6.4	82	6.9	9.3
M6	97	8	11	142	12	16
M8	239	20	27	345	29	39
M10	469	39	53	690	58	78
M12	814	68	92	1,195	100	135
M14	1,283	107	145	1,903	159	215
M16	2,036	170	230	2,965	247	335
M18	2,876	240	325	4,116	343	465
M20	4,071	339	460	5,841	487	660
M22	5,576	465	630	7,966	664	900
M24	6,992	583	790	10,178	848	1,150
M27	10,178	848	1,150	14,604	1,217	1,650
M30	14,161	1,180	1,600	19,914	1,660	2,250
M36	24,605	2,050	2,780	34,606	2,884	3,910
M42	39,563	3,297	4,470	55,671	4,639	6,290

- Calculated tightening torques are based on a conventional 60°, clean and dry (un-lubricated) thread, with thread-friction and head-friction equal to 0.15.
- When using metric-fasteners, NORD recommends a minimum ISO Grade 8.8 bolt.

7. Mounting the prime mover

When the motor is not flange mounted or integrally mounted to the gearbox, it is important to properly secure and align the gear drive with respect to the driven machine before attempting to align the prime mover or motor.

A. After the main gear drive is properly aligned and bolted in place, align the prime mover with respect to the reducer input shaft.

B. Use shims under the feet of the prime mover as needed, and secure in place with the proper mounting bolts. Dowel pins may be field-installed to help prevent misalignment and ensure proper realignment if removed for service.

IMPORTANT NOTE

When using a high speed coupling connection between the prime mover and the reducer, check alignment per the coupling manufacturers recommendations. If the coupling is misaligned, the reducer alignment or shimming is incorrect. Re-align the gear reducer and re-check the high-speed coupling alignment before re-aligning the motor.

SOLID SHAFT CONNECTIONS

1. Solid shaft diameter tolerance

Reducer input and output shaft extensions have a diameter tolerance as specified in **Table 1**.

Table 1: Solid Shaft Diameter Tolerance

Above ø (in)	To & Including ø (in)	Tolerance (in)
0.375	1.750	+0.0000 / -0.0005
1.750	7.500	+0.0000 / -0.0010

Above ø (mm)	To & Including ø (mm)	Tolerance (mm)	ISO 286-2 Fit Class
10	18	+0.012 / +0.001	k6
18	30	+0.015 / +0.002	k6
30	50	+0.018 / +0.002	k6
50	80	+0.030 / +0.011	m6
80	120	+0.035 / +0.013	m6
120	180	+0.040 / +0.015	m6
180	190	+0.046 / +0.017	m6

2. Fitting drive elements onto the reducer solid shaft

Solid input and output shaft extensions are provided with a drill and tap feature as indicated in Table 2. When installing drive elements such as coupling hubs, pulleys, sprockets, or gears, NORD recommends using the threaded hole in the end of the shaft, along with a suitable assembly device fitted into the threaded hole.

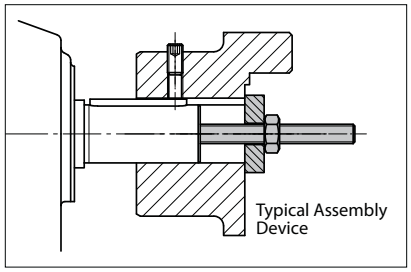


Table 2: Solid Shaft End - Threaded Holes

Above ø (in)	To & Including ø (in)	Tap size & Depth (in)
0.375	0.500	10-24 x 0.43 in
0.500	0.875	1/4-20 x 0.59 in
0.875	0.938	5/16-18 x 0.71 in
0.938	1.100	3/8-16 x 0.87 in
1.100	1.300	1/2-13 x 1.10 in
1.300	1.875	5/8-11 x 1.42 in
1.875	3.500	3/4-10 x 1.73 in
3.500	7.500	1-8 x 2.20 in

Above ø (mm)	To & Including ø (mm)	Tap Size & Depth (mm)
10	13	M4 x 10 mm
13	16	M5 x 12.5 mm
16	21	M6 x 16 mm
21	24	M8 x 19 mm
24	30	M10 x 22 mm
30	38	M12 x 28 mm
38	50	M16 x 36 mm
50	85	M20 x 42 mm
85	130	M24 x 50 mm
130	190	M30 x 60 mm

HARMFUL SITUATION

DO NOT DRIVE or **HAMMER** the coupling hub, pulley, sprocket, or gear into place. An endwise blow to the reducer shaft can generate damaging axial forces and cause damage to the reducer housing, bearings or internal components.

WARNING

To avoid serious injury the user must provide suitable safety guards for all rotating shafts and shaft components such as couplings, chain drives, belt drives, etc. All guarding must adhere to local regulations and safety standards.

3. Installing interference-fit hubs to the reducer shaft

Prior to installing any interference-fit hubs to the reducer shaft, consult with the manufacturer to determine proper assembly and fit. Interference-fits usually require heating the coupling, sprocket or gear hub, per the manufacturer's recommendations. Coupling hub installation typically follows ANSI/AGMA 9002-A86. Always make sure the reducer shaft seals are protected from the heat source. Apply uniform heat to the drive element hub to prevent distortion. NORD does not recommend heating the drive element hub beyond 212°F to 275°F (100°C to 135° C).

WARNING

When using heat to mount a drive element hub, do not use open flame in a combustible atmosphere or near flammable materials. Use suitable protection to avoid burns or serious injury.

HARMFUL SITUATION

When using external chain or belt drives, make sure the reducer is sized so that the shaft and bearings have adequate capacity. To avoid unnecessary bearing loads and additional shaft deflection, mount all power take-off devices (sprockets, pulleys, etc.) so that the applied load center is as close to the gear housing as possible and check component alignment and tension of any belts or chains per the manufacturer's recommendation. Do not over tighten the belts or chains.

4. Coupling installation

The performance and life of any coupling depends upon how well it is installed. Coupling hubs are typically mounted flush with the shaft ends, unless specifically ordered for overhung mounting. Shaft couplings should be installed according to the coupling manufacturer's recommendations for gap, angular and parallel alignment. To help obtain critical shaft alignment coupling hubs may be installed to the machine shafts prior to final shimming or tightening of the foundation bolts. Proper coupling alignment allows for thermal and mechanical shaft movement during operation and ensures that only torque (no radial load) is transmitted between the mating shafts.

Coupling gap and angular alignment

The shaft gap must be sufficient to accommodate any anticipated thermal or mechanical axial movement. When setting the coupling gap, insert a spacer or shim stock equal to the required spacing or gap between the coupling hub faces. Measure the clearance using feeler gauges at 90-degree intervals, to verify the angular alignment.

Parallel (or offset) alignment

Mount a dial indicator to one coupling hub, and rotate this hub, sweeping the outside diameter of the other hub. The parallel or offset misalignment is equal to one-half of the total indicator reading. Another method is to rest a straight edge squarely on the outside diameter of the hubs at 90° intervals and measure any gaps with feeler gauges. The maximum gap measurement is the parallel or offset misalignment.

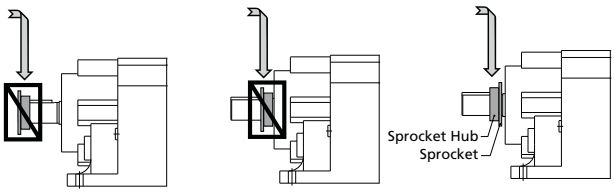
Check alignment

After both angular and parallel alignments are within specified limits, tighten all foundation bolts securely and re-check critical alignment. If any of the specified limits for alignment are exceeded, realign the coupling.

5. Installing sheaves (pulleys), sprockets and gears

To avoid unnecessary bearing loads and additional shaft deflection, mount all power take-off devices (sprockets, pulleys, gears, etc.) so that the applied load center is as close to the gear housing as possible, as shown in **Figure 2**.

Figure 2: Sprocket or Gear Mounting



Preferred Mounting of Sprocket or Gear

Align the driver sheave or sprocket with the driven sheave or sprocket by placing a straight-edge length-wise across the face of the sheaves or sprockets. Alignment of bushed sheaves and sprockets should be checked only after bushings have been tightened. Check horizontal shaft alignment by placing one leg of a square or a level vertically against the face of the sheave or sprocket.

Always check component alignment and tension any belts or chains per the manufacturer's recommendation. The ideal belt or chain tension allows proper wrap of the driver and driven wheels, while maintaining the lowest possible tension of the belts or chain, so that no slipping occurs under load conditions. Check belt or chain tension frequently over the first 24 to 48 hours of operation.

STOP ***HARMFUL SITUATION*** **STOP**

When using external chain or belt drives, make sure the reducer is sized so that the shaft and bearings have adequate capacity. To avoid unnecessary bearing loads and additional shaft deflection, mount all power take-off devices (sprockets, pulleys, etc.) so that the applied load center is as close the gear housing as possible and check component alignment and tension of any belts or chains per the manufacturer's recommendation. Do not over tension the belts or chains.

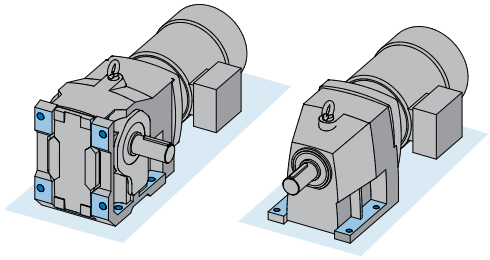
6. Outboard pinion gear alignment

Align outboard pinion gears and adjust the gear tooth clearance according to the manufacturer's recommendations, checking for acceptable outboard pinion tooth contact. The foundation bolts may have to be loosened and the gear unit moved slightly to obtain proper gear tooth contact. After the unit is moved to correct tooth contact, the prime mover may need to be realigned.

REDUCER MOUNTING
FOOTED & FLANGE MOUNT GEAR UNITS

1. Foot-mounted reducers

When installing the foot-mounted gear unit, observe the flatness specifications and bolt tightening torque guidelines provided in U10060 and make sure the mating mounting surface and reducer feet are clean and free of debris. Use of shims under the feet of the gear unit may be required in order to align the output shaft to the driven equipment. Make sure that all feet are supported so that the housing will not distort when it is bolted down. Improper shimming will cause mis-alignment and may reduce the life of the gear unit or cause component failure. Dowel pins may be field-installed to help prevent misalignment and ensure proper realignment if removed for service.



IMPORTANT NOTE

Gear units may be subjected to radial loads or side pull, caused by external chain drives or belt drives. In these instances it is recommended that the mounting base be designed with a slide-plate adjustment to accommodate extra slack in the chain or the belt after the feet are loosened. When using an external chain or belt drive, make sure the reducer is sized so that the shaft and bearings have adequate capacity.

2. Flange-mounted reducers (with B5 flange)

When using the B5 flange to mount the gear unit, the bulk head plate must be engineered to minimize buckling distortions and support the cantilevered weight of the gear reducer or gearmotor. On the B5 mounting flange NORD provides a pilot register or and the flange pilot tolerance as listed per Table 1. When the mating hole is designed with the proper fit, the flange pilot tenon provides a means of accurately positioning the reducer while the hold-down bolts are properly secured; once the reducer is secured, the tenon helps prevent movement of the reducer and it helps locate the center of the reducer output shaft.

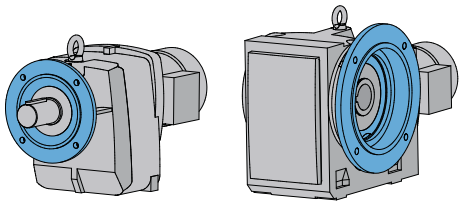


Table : Flange Pilot Tolerance

Above ø (in)	To & Including ø (in)	Tolerance (in)	ISO 286-2 Fit Class
1.969	3.150	+0.0005 / -0.0003	j6
3.150	4.724	+0.0005 / -0.0004	j6
4.724	7.087	+0.0006 / -0.0004	j6
7.087	9.055	+0.0000 / -0.0005	h6
9.055	9.843	+0.0000 / -0.0011	h6
9.843	12.402	+0.0000 / -0.0013	h6
12.402	15.748	+0.0000 / -0.0014	h6
15.748	19.685	+0.0000 / -0.0016	h6

Above ø (mm)	To & Including ø (mm)	Tolerance (mm)	ISO 286-2 Fit Class
50	80	+0.012 / -0.007	j6
80	120	+0.013 / -0.009	j6
120	180	+0.014 / -0.011	j6
180	230	+0.000 / -0.013	h6
230	250	+0.000 / -0.029	h6
250	315	+0.000 / -0.032	h6
315	400	+0.000 / -0.036	h6
400	500	+0.000 / -0.040	h6

When installing the flange mounted gear unit, observe the flatness specifications and bolt tightening torque guidelines provided in U10060. Make sure the mating mounting surface and reducer flange are clean and free of debris. Use a straight edge or parallel bar to check for high spots on the mating mounting surface and remove any raised material around the mounting holes.

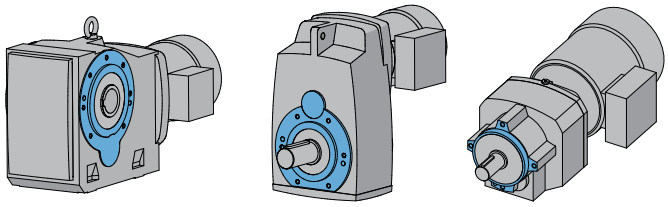
Set the gear unit into place and tighten the bolts until they are snug. Before final bolt-tightening check for any material gaps between the mating surfaces and if shimming is required, use "U" shaped shims at least 2 times the width of the bolt. Avoid over shimming a very irregular surface as this will make it very difficult to achieve proper alignment.

IMPORTANT NOTE

For heavy shock applications, it is advisable to field-install dowel pins through the mounting flange connection (in addition to the mounting bolts). This will help control flange movement or flange rotation and relieve the mounting bolts from this additional stress.

3. Flange-mounted reducers (with B14 flange)

When using the B14 flange to mount the gear unit, the bulk head plate must be engineered to minimize buckling distortions and support the cantilevered weight of the gear reducer or gearmotor. When properly installed, the output flange of the reducer housing is designed to enable the permissible torques and radial forces to be reliably transmitted by the bolt connections.



IMPORTANT NOTE

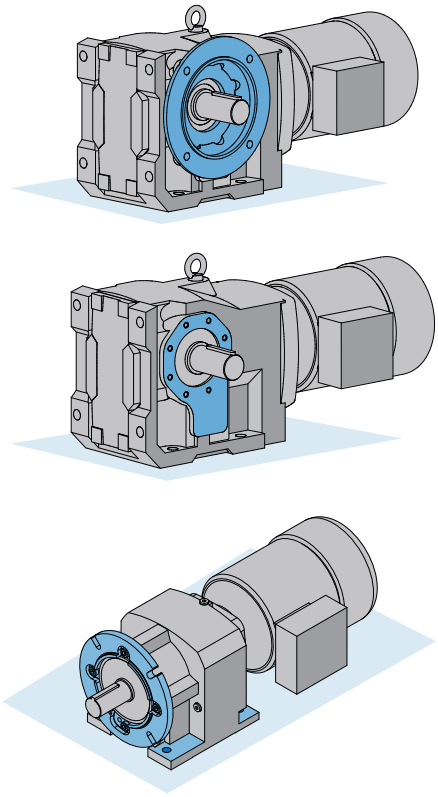
When using the B14 flange-face for mounting, if dowel pin holes are provided in addition to the threaded holes, then it is advisable to also use the proper dowel pins, to help control flange movement or flange rotation and relieve the mounting bolts from this additional stress This is especially important for heavy shock applications.

4. Foot & flange reducer housings

Some gear reducer housings are available with a foot and an output flange. Units with a foot and a B5 Flange are designated with the suffix XF after the primary model number and units with a B14 face-flange are designated with the suffix XZ after the primary model number. When a gear unit is provided with both a foot and a flange, the foot is consider the primary mounting surface. The flange is generally considered to be the secondary mounting option and it is intended that this surface be used for auxiliary add on elements that place minimal load stress on the reducer housing.

HARMFUL SITUATION

To prevent overstress on the main gear unit housing, never tighten the reducer mounting feet and the mounting flange against one-another. Auxiliary add-on elements that are mounted to the reducer flange, must not transmit excessive force, torque or vibration to the main gear housing.



HELICAL & BEVEL REDUCER LUBRICATION TYPES

Lubrication Tables – Helical and Bevel Gear Units

Standard Oil Lubricants

ISO Viscosity	Oil Type	Ambient Temperature Range	Manufacturer Brand / Type
VG220	MIN-EP	0 to 40 °C (32 to 104 °F)	Mobil / Spartan EP220 ♦ ❶
	PAO	-35 to 60 °C (-31 to 140 °F)	Mobil / SHC630 ♦ ❷
	FG	-5 to 40 °C (23 to 104 °F)	Shell / FM220 ♦

Optional Oil Lubricants

ISO Viscosity	Oil Type	Ambient Temperature Range	Manufacturer Brand / Type
VG460	PAO	-35 to 80 °C (-31 to 176 °F)	Mobil / SHC634
	FG-PAO	-35 to 80 °C (-31 to 176 °F)	Mobil / Cibus SHC460
VG220	FG-PAO	-34 to 60 °C (-29 to 140 °F)	Mobil / Cibus SHC220
VG150	PAO	-35 to 25 °C (-30 to 77 °F)	Mobil / SHC629

Grease Options (applied to greased bearings and seal cavities)

NLGI Grade	Grease Type / Thickener	Ambient Temperature Range	Manufacturer Brand / Type
NLGI 2	Standard / Li-Complex	-30 to 60 °C (-22 to 140 °F)	Mobil Grease XHP222 ♦ ❶
	High-Temperature / Polyurea	-25 to 80 °C (-13 to 176 °F)	Mobil Polyrex EP 2 ♦ ❷
	Food-Grade / Al-Complex	-25 to 40 °C (-13 to 104 °F)	Mobil Grease FM222 ♦

♦ Stocked Lubricants

❶ Standard product on serviceable gear units

❷ Standard product on maintenance free gear units

IMPORTANT NOTES

- The "Ambient Temperature" is intended to be an operation guideline based upon the typical properties of all the lubricant. The viscosity and other properties of the lubricant change based upon load, speed, ambient conditions, and reducer operating temperatures. The user should consult with their lubrication supplier & NORD gear before considering changes in oil type or viscosity.
- To prevent reducer overheating, observe the maximum operating oil temperature limits:
  Mineral Oil: 80-85 °C (176 – 180 °F).
  Synthetic Oil: 105 °C (225 °F).
- In the following instances, please consult NORD for specific recommendations:
  - √ Gear units will operate in high ambient temperature conditions exceeding 40 °C (104 °F).
  - √ Gear units will operate in cold ambient temperature conditions approaching 0 °C (32 °F) or lower.
  - √ Lower than an ISO VG100 viscosity oil is being considered for a cold-temperature service.
  - √ Fluid grease is required for lubricating the gear unit.
- Observe the general lubrication guidelines outlined in user manual U10750.

Oil Formulation Codes

MIN-EP - Mineral Oil with EP Additive
PAO-EP - Synthetic Polyalphaolefin Oil with EP Additive
PAO - Synthetic Polyalphaolefin Oil
PG - Synthetic Polyglycol Oil
FG - Food-Grade Oil
FG-PAO - Food-Grade, Synthetic Poyalphaolefin Oil
FG-PG - Food-Grade, Synthetic Polyglycol Oil

Lubrication Notes

- Avoid using (EP) gear oils in worm gears that contain sulfur-phosphorous chemistries, as these additives can react adversely with bronze worm gears and accelerate wear.
- Food grade lubricants must be in compliance with FDA 212 CFR 178.3570 and qualify as a NSF-H1 lubricant. Please consult with lubrication manufacturer for more information.
- When making a lubrication change, check with the lubrication supplier to assure compatibility and to obtain recommended cleaning or flushing procedures.
- Do not to mix different oils with different additive packages or different base oil formulation types. Polyglycol (PG) oils are not miscible with other oil types and should never be mixed with mineral oil or polyalphaolefin (PAO) synthetic oil.

HELICAL & BEVEL REDUCER LUBRICATION TYPES

Oil Cross-reference Chart

ISO Viscosity	Oil Type	Ambient Temperature Range	Mobil	Shell	Castrol	FUCHS	KLÜBER LUBRICATION
VG460	MIN-EP	0 to 40 °C (32 to 104 °F)	Spartan EP460	Omala 460	Alpha SP460	Renolin EP460	Klüberoil GEM 1-460N
	PAO-EP	-20 to 80 °C (-4 to 176 °F)	Mobilgear SHC460	Omala HD460	Alphasyn EP460	Gearmaster SYN460/NA	Klübersynth EG 4-460
	PAO	-20 to 80 °C (-4 to 176 °F)	Mobil SHC634	Omala RL460	Alphasyn T460	Geralyn SF460	Klübersynth GEM 4-460N
	PG	-20 to 80 °C (-15 to 176 °F)	Mobil Glygoyle 460	Tivela S460	Alphasyn PG460	Renolin PG460	Klübersynth GH 6-460
	FG	0 to 40 °C (32 to 104 °F)	Mobil DTE FM460	Shell FM460	N/A	Geralyn AW 460	N/A
	FG-PAO	-20 to 80 °C (-4 to 176 °F)	Mobil Cibus SHC460	Cassida GL460	N/A	Geralyn SF460	Klüberoil 4 UH 1-460N
	FG-PG	-20 to 80 °C (-4 to 176 °F)	Mobil Glygoyle 460	Cassida WG460	N/A	N/A	Klübersynth UH1 6-460
VG220	MIN-EP	0 to 40 °C (32 to 104 °F)	Spartan EP220	Omala 220	Alpha SP220	Renolin EP220	Klüberoil GEM 1-220N
	PAO-EP	-30 to 60 °C (-22 to 140 °F)	Mobilgear SHC220	Omala HD220	Alphasyn EP220	Gearmaster SYN220/NA	Klübersynth EG 4-220
	PAO	-30 to 60 °C (-22 to 140 °F)	Mobil SHC630	Omala RL220	Alphasyn T220	Geralyn SF220	Klübersynth GEM 4-220N
	PG	-25 to 60 °C (-13 to 140 °F)	Mobil Glygoyle 220	Tivela S220	Alphasyn PG220	Renolin PG220	Klübersynth GH 6-220
	FG	0 to 40 °C (32 to 104 °F)	Mobil DTE FM 220	Shell FM220	N/A	Geralyn AW220	N/A
	FG-PAO	-25 to 60 °C (-13 to 140 °F)	Mobil Cibus SHC220	Cassida GL220	N/A	Geralyn SF220	Klüberoil 4 UH 1-220N
	FG-PG	-25 to 60 °C (-13 to 140 °F)	Mobil Glygoyle 220	Cassida WG220	N/A	N/A	Klübersynth UH1 6-220
VG150	MIN-EP	0 to 25 °C (32 to 77 °F)	Spartan EP150	Omala 150	Alpha SP150	Renolin EP150	Klüberoil GEM 1-150N
	PAO-EP	-30 to 25 °C (-22 to 77 °F)	Mobilgear SHC150	Omala HD150	Alphasyn EP150	Gearmaster SYN150/NA	Klübersynth EG 4-150
	PAO	-30 to 25 °C (-22 to 77 °F)	Mobil SHC629	Omala RL150	Alphasyn T150	Geralyn SF150	Klübersynth GEM 4-150N
	PG	-25 to 25 °C (-13 to 77 °F)	Mobil Glygoyle 150	Tivela S150	Alphasyn PG150	Renolin PG150	Klübersynth GH 6-150
	FG	0 to 25 °C (32 to 77 °F)	Mobil DTE FM 150	N/A	N/A	N/A	N/A
	FG-PAO	-25 to 25 °C (-13 to 77 °F)	N/A	Cassida GL150	N/A	Geralyn SF150	Klüberoil 4 UH 1-150N
	FG-PG	-25 to 25 °C (-13 to 77 °F)	Mobil Glygoyle 150	N/A	N/A	N/A	Klübersynth UH1 6-150

Low-end service temperature limit may vary for a specific lubricant; Please also see the important notes on Page 1.

NORDBLOC®.1 FLANGE MOUNTED OIL FILL QUANTITIES

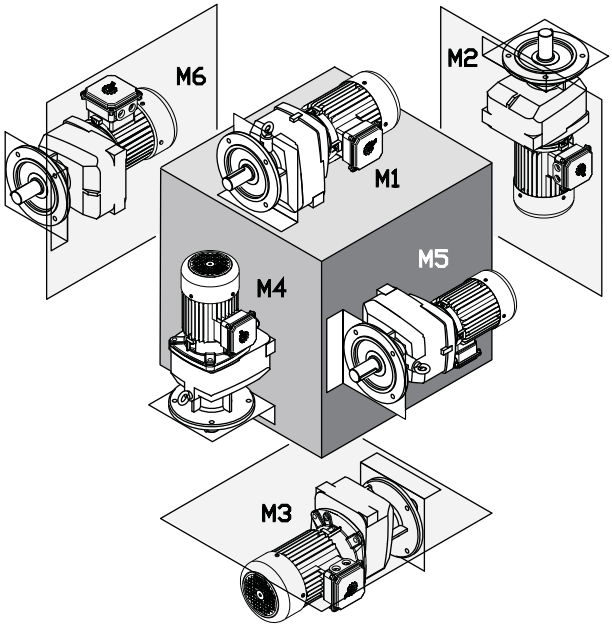
NORDBLOC®.1 flange mounted lubrication

The following NORD Gear reducers are shipped from the factory with a pre-determined oil fill level in accordance to the specified reducer size and mounting position. For additional information, please refer to the "Oil Plug & Vent Locations" documentation for your gear unit.

HARMFUL SITUATION

Actual oil volume can vary slightly depending upon the gear case size, mounting and ratio. Prior to commissioning the reducer, check the oil-fill level using the reducer's oil level plug and drain or add addition oil as needed.

For mounting orientations other than shown please consult NORD Gear. Reducer modifications may be required.

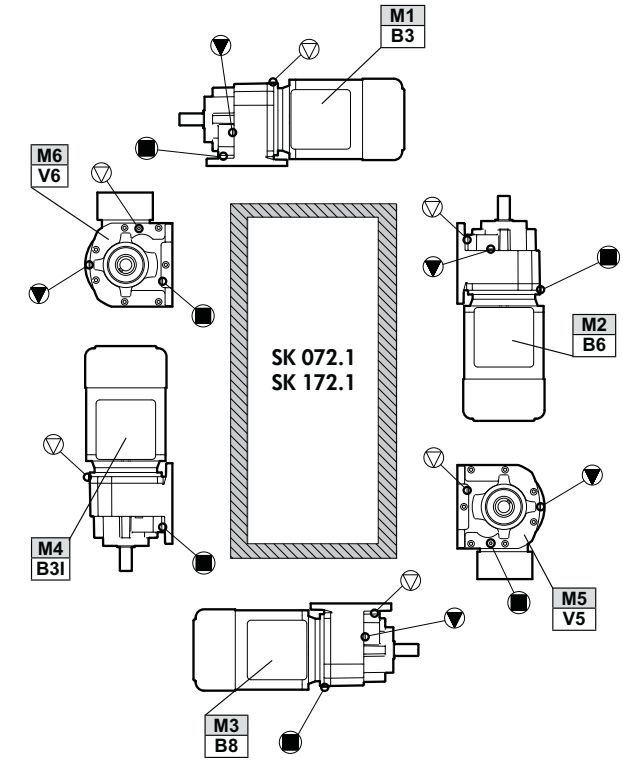


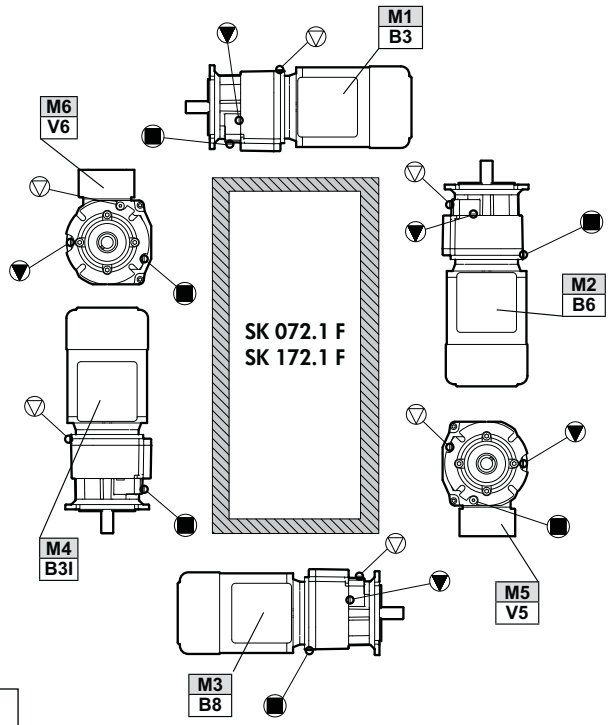
Type	M1		M2		M3		M4		M5		M6	
	Quarts	Liters	Quarts	Liters	Quarts	Liters	Quarts	Liters	Quarts	Liters	Quarts	Liters
SK 072.1 F	0.169	0.160	0.338	0.320	0.222	0.210	0.243	0.230	0.190	0.180	0.210	0.200
SK 172.1 F	0.285	0.270	0.624	0.590	0.444	0.420	0.529	0.450	0.338	0.320	0.412	0.390
SK 372.1 F	0.480	0.450	1.11	1.05	0.790	0.750	1.06	1.000	0.630	0.600	0.690	0.650
SK 373.1 F	0.480	0.450	1.11	1.05	0.791	0.750	1.06	1.000	0.630	0.600	0.690	0.650
SK 572.1 F	0.790	0.750	2.01	1.90	1.59	1.50	2.11	2.00	1.16	1.10	1.22	1.15
SK 573.1 F	0.790	0.750	2.00	1.90	1.59	1.50	2.11	2.00	1.16	1.10	1.22	1.15
SK 672.1 F	1.16	1.10	2.75	2.60	2.27	2.15	2.85	2.70	1.64	1.55	1.74	1.65
SK 673.1 F	1.16	1.10	2.75	2.60	2.27	2.15	2.85	2.70	1.64	1.55	1.74	1.65
SK 772.1 F	1.22	1.15	3.86	3.65	2.38	2.25	3.33	3.15	1.43	1.35	2.27	2.15
SK 773.1 F	2.06	1.95	3.70	3.50	3.38	3.20	3.06	2.90	2.38	2.25	3.12	2.95
SK 872.1 F	2.75	2.60	8.45	8.00	5.60	5.30	7.40	7.00	2.96	2.80	4.86	4.60
SK 873.1 F	4.28	4.05	8.03	7.60	7.24	6.85	6.92	6.55	5.28	5.00	6.92	6.55
SK 972.1 F	4.76	4.50	13.63	12.90	8.56	8.10	13.42	12.70	4.86	4.60	8.24	7.80
SK 973.1 F	7.82	7.40	12.89	12.20	11.73	11.10	12.26	11.60	8.45	8.00	11.52	10.90

NORDBLOC®.1
OIL PLUG & VENT LOCATIONS

Oil plug connections

Prior to commissioning the reducer, check the oil-fill level using the reducer's oil-level plug and drain or add additional oil as needed. ***For mounting orientations other than shown please consult NORD Gear. New plug locations may be required.***

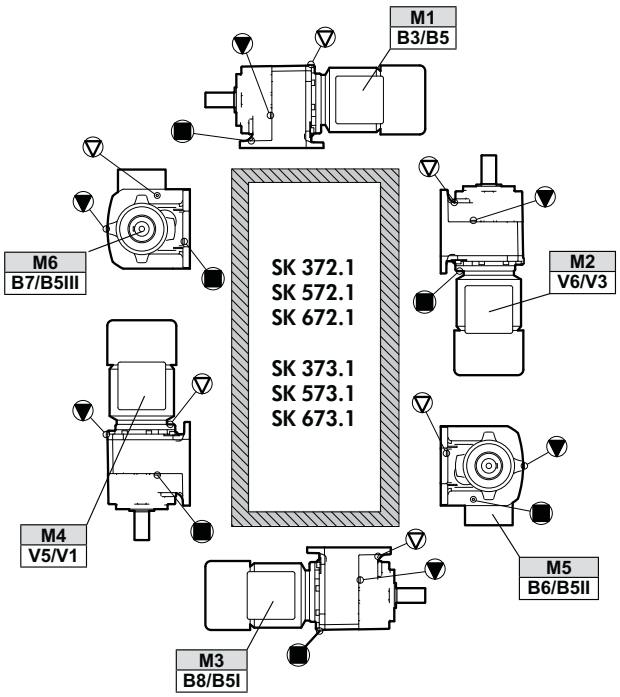


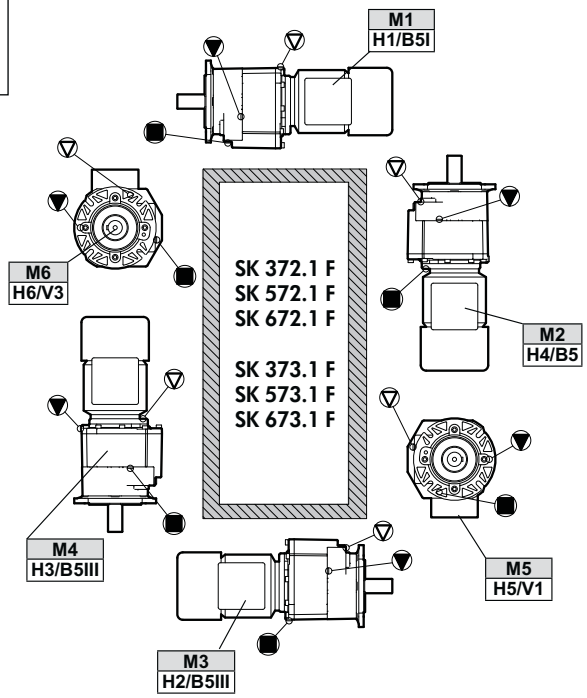


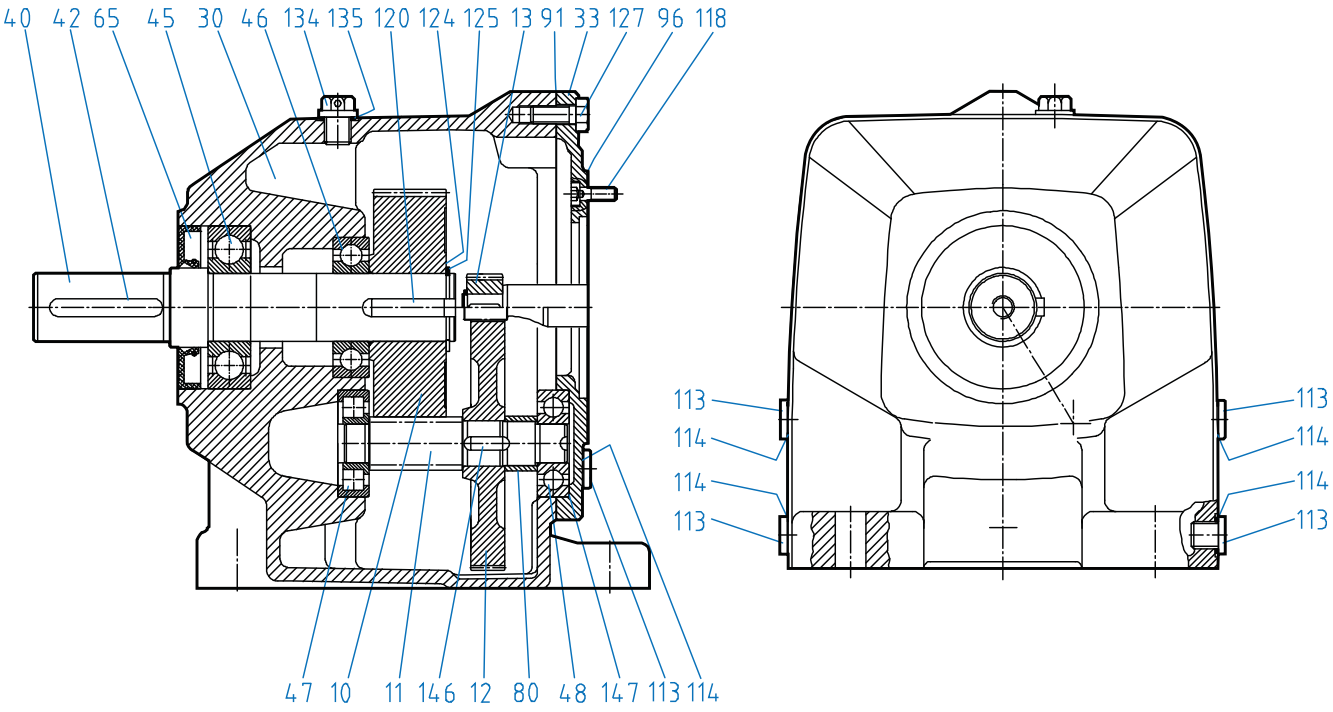
▽ = Vent

▼ = Oil Level

■ = Oil Drain

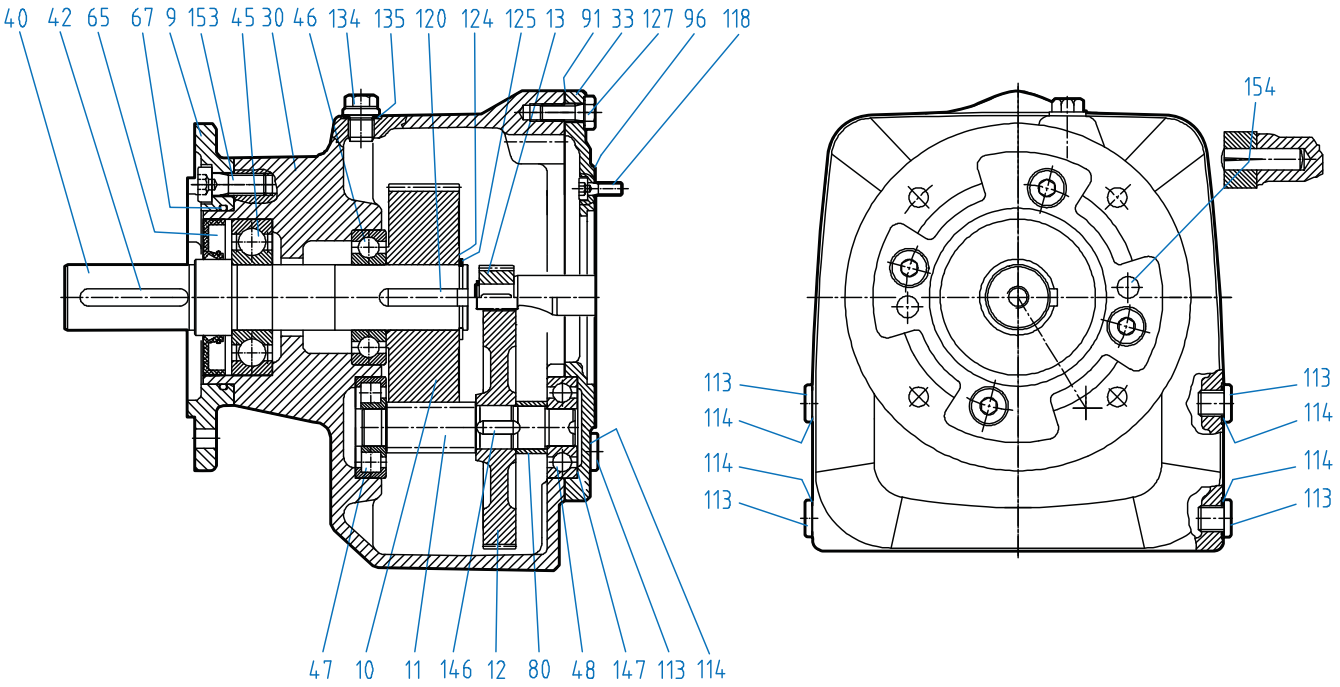






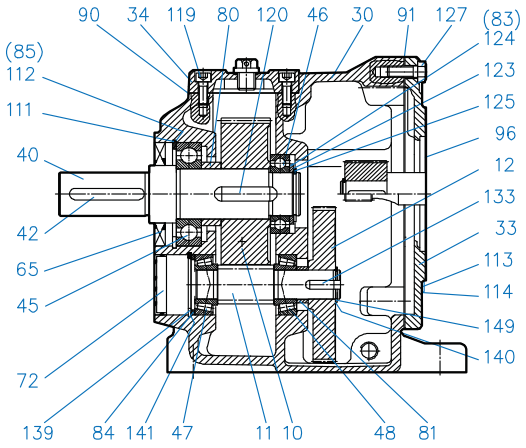
SK 172 - SK 972 Foot Mounted

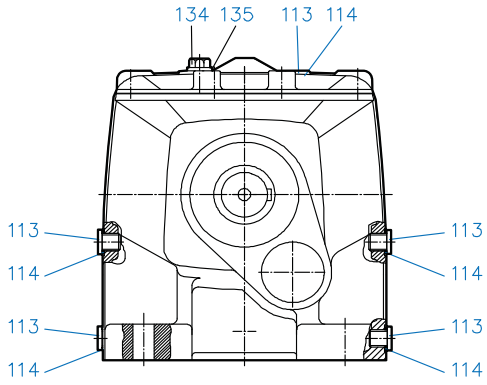
10	Driven gear	46	Output shaft bearing	118	Bolt
11	Pinion shaft	47	Pinion shaft bearing	120	Key
12	Driving gear	48	Pinion shaft bearing	124	Shim
13	Driving pinion	65	Shaft seal	125	Snap ring
30	Gearcase	80	Spacer	127	Bolt
33	Input cover	91	Gasket	134	Vent plug
40	Output shaft	96	Gasket	135	Gasket
42	Key	113	Oil plug	146	Key
45	Output shaft bearing	114	Gasket	147	Shim

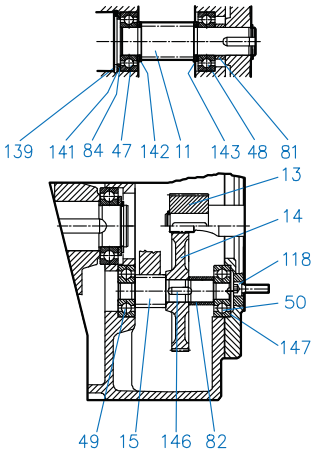


SK 172 - SK 972 Flange Mounted

9	Flange	47	Pinion shaft bearing	124	Shim
10	Driven gear	48	Pinion shaft bearing	125	Snap ring
11	Pinion shaft	65	Shaft seal	127	Bolt
12	Driving gear	67	O-Ring	134	Vent plug
13	Driving pinion	80	Spacer	135	Gasket
30	Gearcase	91	Gasket	146	Key
33	Input cover	96	Gasket	147	Shim
40	Output shaft	113	Oil plug	153	Bolt
42	Key	114	Gasket	154	Grooved dowel pin
45	Output shaft bearing	118	Bolt		
46	Output shaft bearing	120	Key		

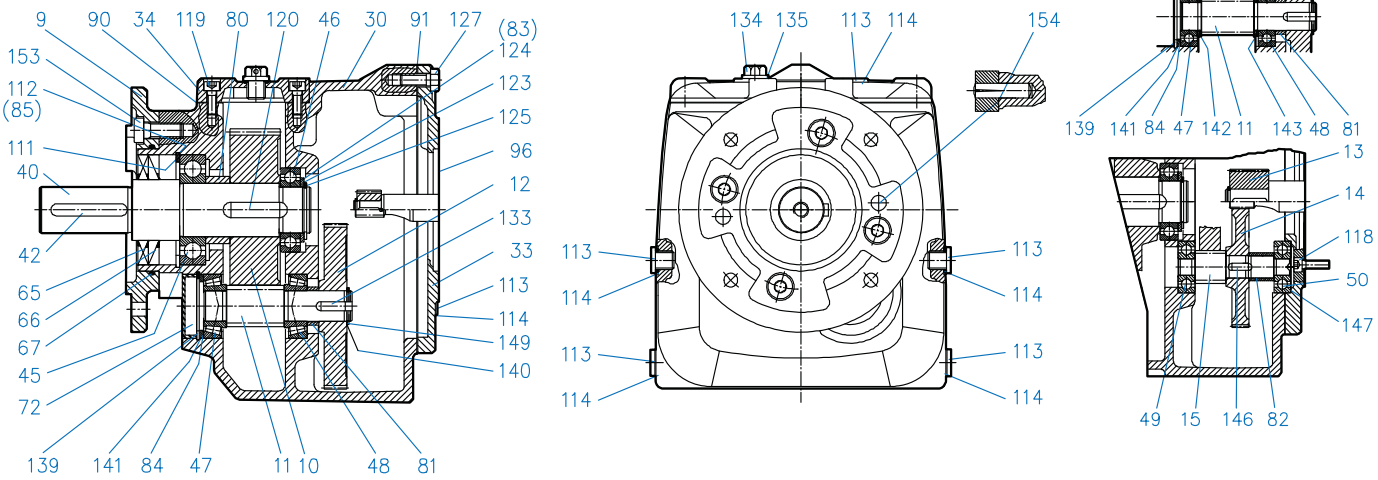






SK 273 - SK 973 Foot Mounted

10	Driven gear	65	Shaft seal	120	Key
11	Pinion shaft	72	Bore plug	123	Thrust washer
12	Driving gear	80	Spacer	124	Shim
13	Driving pinion	81	Spacer	125	Snap ring
14	Driving gear	82	Spacer	127	Bolt
15	Pinion shaft	83	Thrust washer	133	Key
30	Gearcase	84	Thrust washer	134	Vent plug
33	Input cover	85	Thrust washer	135	Gasket
34	Gear case cover	90	Gasket	139	Snap ring
40	Output shaft	91	Gasket	140	Shim
42	Key	96	Gasket	141	Shim
45	Output shaft bearing	111	Snap ring	142	Thrust washer
46	Output shaft bearing	112	Shim	143	Thrust washer
47	Pinion shaft bearing	113	Oil plug	146	Key
48	Pinion shaft bearing	114	Gasket	147	Shim
49	Pinion shaft bearing	118	Bolt	149	Snap ring
50	Pinion shaft bearing	119	Bolt		



SK 273 - SK 973 Flange Mounted

9	Flange	66	Shaft seal	123	Thrust washer
10	Driven gear	67	O-Ring	124	Shim
11	Pinion shaft	72	Bore plug	125	Snap ring
12	Driving gear	80	Spacer	127	Bolt
13	Driving pinion	81	Spacer	133	Key
14	Driving gear	82	Spacer	134	Vent plug
15	Pinion shaft	83	Thrust washer	135	Gasket
30	Gearcase	84	Thrust washer	139	Snap ring
33	Input cover	85	Thrust washer	140	Shim
34	Gearcase cover	90	Gasket	141	Shim
40	Output shaft	91	Gasket	142	Thrust washer
42	Key	96	Gasket	143	Thrust washer
45	Output shaft bearing	111	Snap ring	146	Key
46	Output shaft bearing	112	Shim	147	Shim
47	Pinion shaft bearing	113	Oil plug	149	Snap ring
48	Pinion shaft bearing	114	Gasket	153	Bolt
49	Pinion shaft bearing	118	Bolt	154	Grooved dowel pin
50	Pinion shaft bearing	119	Bolt		
65	Shaft seal	120	Key		

Troubleshooting

This section identifies some of the most common issues involved with NORD Gear speed reducers , and provides recommendations to assist you in defining and answering your questions as you work with our products. You may also contact our Engineering/Application departments if your questions are not answered in the table below.

Problem With the Reducer		Possible Causes	Suggested Remedy
Runs Hot	Overloading	Load exceeds the capacity of the reducer	Check rated capacity of reducer, replace with unit of sufficient capacity or reduce the load.
	Improper lubrication	Insufficient lubrication	Check lubricant level and adjust up to recommended levels
		Excessive lubrication	Check lubricant level and adjust down to recommended levels.
		Wrong lubrication	Flush out and refill with correct lubricant as recommended
Runs Noisy	Loose foundation bolts	Weak mounting structure	Inspect mounting of reducer. Tighten loose bolts and/or reinforce mounting and structure.
		Loose hold down bolts	Tighten bolts
	Failure of bearings	May be due to lack of lubricant	Replace bearing. Clean and flush reducer and fill with recommended lubricant.
		Overload	Check rated capacity of reducer.
	Insufficient lubricant	Level of lubricant in reducer not properly maintained.	Check lubricant level and adjust to factory recommended level.
Output shaft does not turn	Internal parts are broken or missing	Overloading of reducer can cause damage	Replace broken parts. Check rated capacity of reducer.
		Key missing or sheared off on input shaft.	Replace key.
		Coupling loose or disconnected	Properly allign reducer and coupling. Tighten coupling.
Oil Leakage	Worn seals	Caused by dirt or grit entering seal.	Replace seals. Autovent may be clogged. Replace or clean.
	Unit runs hot or leaks	Overfilled reducer	Check lubricant level and adjust to recommended level.
		Vent clogged.	Clean or replace, being sure to prevent any dirt from falling into the reducer.
	Incorrect fill level	Improper mounting position, such as wall or ceiling mount of horizontal reducer.	Check mounting position on the name tag & verify with mounting chart in manual.

CONDITIONS OF SALE

1. CONTRACT

Any contract between Nord Gear Corporation, hereinafter designated as Seller, and the Buyer is subject to the terms and conditions of sale hereinafter set forth. Any deviation from such terms and conditions must be specifically set forth in writing and consented to by Seller. Accordingly, the Buyer and Seller acknowledge and agree that the terms and conditions set forth below and on the face hereof shall govern Buyer's purchase of the goods described on the face hereof and shall take precedence over and represents the final agreement between Buyer and Seller, notwithstanding any inconsistent, contradictory or other prior or further conditions contained in any oral or written request or purchase order issued by Buyer or any other document furnished by Buyer in connection with its purchase of the Goods, regardless of whether such document or documents are exchanged simultaneously with this Invoice or prior or subsequent thereto. Any additional or different terms or conditions which may appear in any communicaiton, oral or written, from Seller, its officers, employees, agents or representatives, are hereby expressly rejected and shall not be effective or binding upon the Seller, unless specifically hereafter agreed to in writing by Seller and no such additional or different terms or conditions in any document submitted to Seller by Buyer shall become part of the contract between Buyer and Seller, unless such written acceptance by Seller specifically recognizes and assents to their inclusion. Any objection by Buyer to the terms and conditions hereof shall be ineffective unless Seller is advised in writing thereof within two (2) days of the date of this Invoice.

2. CONFIRMATION

An order shall be deemed accepted only when duly confirmed by Seller, at Nord Gear Corporation's home office in Waunakee, Wisconsin, and upon such confirmation the order shall become a contract binding upon the parties hereto, their successors and assigns.

3. PRICES

Prices shown are list prices and may be subject to applicable discounts. Unless otherwise agreed upon in writing, prices are FOB factory Waunakee, Wisconsin. Prices and discounts are subject to change without notice until order is accepted. Seller's prices do not include cost of any inspection permits required.

4. LIMITED WARRANTY

Seller warrants the goods sold hereunder to be free from defects in material and workmanship under normal use and service not arising from misuse, negligence, or accident, including but not limited to the use, installation, and transportation of the goods by the Buyer, its agents, servants, employees, or by carriers. Such obligations under this warranty are limited to remedying any deficiencies in the goods at Waunakee, Wisconsin, or at such place or places in the United States of America as may be designated by Seller. THIS WARRANTY SHALL PERTAIN TO ANY PART OR PARTS OF ANY GOODS TO WHICH BUYER OR ITS ASSIGNS HAS GIVEN WRITTEN NOTICE OF CLAIMED DEFECTS TO SELLER. NORD GEAR CORP. WARRANTS ITS PRODUCTS AGAINST DEFECTS IN MATERIAL AND WORKMANSHIP FOR A PERIOD OF 12 MONTHS FROM DATE OF INSTALLATION OR 18 MONTHS FROM DATE OF SHIPMENT WHICHEVER COMES FIRST ON ALL COMPONENTS. 36 MONTHS FROM DATE OF INVOICE OR 24 MONTHS FROM DATE OF INSTALLATION WHICHEVER COMES FIRST ON GEARS AND HOUSINGS ONLY. PARTS WHICH ARE SUBJECT TO OPERATIONAL WEAR AND TEAR, SUCH AS BELTS & TRACTION DISCS, ARE NOT COVERED BY THE LIMITED WARRANTY. Buyer shall be required to furnish Seller with details of such defects and this warranty shall be effective as to such goods which Seller's examination shall disclose to its satisfaction to have been defective and which at Seller's option shall promptly thereafter be returned to Seller or its nominees. THE LIMITED WARRANTY SET FORTH HEREIN IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED. EXCEPT FOR THE EXPRESS WARRANTIES SET FORTH HEREIN, SELLER HAS MADE AND MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, AS TO THE GOODS SOLD HEREUNDER, INCLUDING, BUT NOT LIMITED TO, THEIR MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. ANY DESCRIPTION OR MODEL OF THE GOODS IS FOR IDENTIFICATION OR ILLUSTRATIVE PURPOSES ONLY AND SHALL NOT BE DEEMED TO CREATE ANY WARRANTY, EXPRESS OR IMPLIED. SELLER MAKES NO REPRESENTATIONS AS TO THE CAPACITY OR PERFORMANCE OF THE GOODS SOLD HEREUNDER, EXCEPT AS SET FORTH IN THE INVOICE'S SPECIFICATIONS OR OTHER VALID AGREEMENT OR CONDITION AGREED TO BETWEEN THE PARTIES, AND ANY SUCH REPRESENTATIONS ARE EXPRESSLY CONDITIONED UPON THE CORRECTNESS OF THE DATA AND INFORMATION FURNISHED BY THE BUYER AND UPON THE GOODS BEING PROPERLY INSTALLED AND MAINTAINED. THE REMEDIES OF THE BUYER PROVIDED HEREUNDER ARE EXCLUSIVE. In no event shall the Seller be liable to the Buyer or to any other person for any loss or damage, direct or indirect, arising out of or caused by the use or operation of the goods, or for the loss of profits, business, or good will, or for any incidental, special or consequential damages. Seller shall in no event be liable to any person or firm (including any assignee or Buyer) except Buyer and its successors. Unless specifically authorized by Seller in writing, Seller shall not become responsible for any repair work done by Buyer or any other party on any goods sold. Any and all costs of the return to the Seller of such goods and all related costs to remove and re-install such goods, shall be borne by Buyer. Goods sold but not manufactured by the Seller are being warranted as to defects in material and workmanship consistent with the limited warranty policy of the original manufacturer of the goods and if there is not such a limited warranty policy, the warranty shall be limited to the provision of the preceding paragraph of Article 4 herein. Standards for the operating characteristics of the gearboxes and the gearmotors are in conformity with Seller's tests.

5. SHORTAGE AND NONCONFORMITY

Any claim of shortage or that the goods do not conform with the specifications of the order or model must be made in writing within ten (10) days after delivery of the goods (as to which such claim is made) to Buyer or its nominees, but in no event shall the claim be later than within the time limit provided by the carrier or insurance company, otherwise such claim shall be deemed waived. Buyer may not return any goods claimed to be in non-conformity without Seller's prior written authorization. Goods returned without permission will not be accepted, including for credit, and will be returned to Buyer, F.O.B. Sellter's plant. Any claim based on the receipt of damaged Goods must be filed with the carrier which delivered the goods. The samples, measurements, dimensions and weights contained in the Seller's catalogs, sales manuals, photographs and drawings constitute only an approximate guide. The Seller reserves the right to make any change which the Seller, in its absolute discretion, considers necessary. While the goods will be delivered principally according to specifications or standards or quantities agreed upon, insignificant deviations or insignificant changes in construction are permissible. The same applies to partial deliveries, In the event that Buyer has a verified claim of shortage or nonconformity of the goods to the specifications of the order or the model, and if such claim has been submitted within the required time limit as set forth above, the Seller shall, at its own expense, make up for the shortage of the goods, or replace or repair the goods, as the case may be, but in no event shall Seller be or become liable to Buyer or to any other person or persons for any loss in damage, direct or indirect, arising out of or caused by such incidents or for the loss of profits, business or good will. The liability of the Seller to Buyer, if any hereunder, for breach of warranty, contract, negligence or otherwise, shall in no event exceed the amount of the purchase price of the goods sold with respect to which any damages are claimed. Shipping dates are estimates unless parties expressly agree on time of the essence.

6. FORCE MAJEURE

The obligation of the Seller shall be modified or excused, as the case may be, for reasons of Acts of God, war, governmental law regulations, strikes or lock-outs, fire, breakdown of machinery, whether in its own business enterprise, or if for any other cause beyond Seller's control, the goods cannot be delivered or their delivery becomes delayed in whole or in part. In the above instances time for delivery shall be extended for the period of the delay caused, with the proviso, however, that either party may cancel in writing the undelivered portion of the order or contract if the delay exceeds six (6) months from the delivery date originally confirmed by Seller. In no event shall Seller become liable in the aforesaid instances to Buyer or any third party for consequential damages or business loss.

7. SHIPMENT AS UNIT

Each shipment by Seller shall be treated as a separate and distinct unit with respect, but only with respect to forwarding, terms of payment, and the making of claims by the Buyer: provided, however, that if the Buyer defaults in the payment of any obligation to Seller or any installments thereof, under any agreement between Buyer and Seller, or if Buyer refuses to accept any goods when tendered for delivery, the Seller may, on fifteen (15) days written notice to the Buyer, without prejudice to Seller's other lawful remedies, either defer further performance until the defaulted payments are made in full, or make future deliveries for cash in advance only, or treat the entire contract or contracts with Buyer as breached by the Buyer and pursue its remedies for breach.

8. BUYER'S REFUSAL OF DELIVERY

If Buyer refuses to accept delivery of any goods tendered for delivery, then Seller, without prejudice to Seller's other lawful remedies, may either store or cause such goods to be stored in a warehouse, for buyer's account and at Buyer's cost, risk and expense, or sell such goods (without notice) to any purchases at public or private sale, and hold the Buyer liable for any difference between (a) the contract price of the goods, and (b) the price at which goods are resold less the costs and expense of such resale including brokerage commissions, or restocking charges.

9. GOODS IN TRANSIT

If prior to delivery or while the goods are in transit, Buyer or Seller becomes bankrupt or insolvent, or any petition in bankruptcy or for the reorganization or for a state court receivership is filed against Buyer or Seller, as the case may be, then the other party hereto may forthwith terminate this contract by giving written notice of such termination. Such termination shall not affect any claim for damages available to the Buyer, provided that if Buyer is then indebted to Seller, the amount of any such damage claim shall be abated to the extent that the indebtedness of Buyer to Seller, as actually paid in money, is abated by any order of judgement entered or any plan adopted in any bankruptcy, reorganization, receivership, or similar proceeding. Such termination shall not prejudice the Seller's rights to any amounts then due under the contract. If Buyer becomes bankrupt or insolvent or any petition in bankruptcy or for reorganizing or if a state court receivership is filed against Buyer, then, at its option Seller may take possession of any goods theretofore sold to Buyer, in connection with which the full purchase price has not been paid, analogous to the terns and provisions set forth in Paragraphs 11 and 12 hereinafter.

10. DELIVERY

(a) Any indicated dates of delivery are approximate only, but NORD Gear will attempt to meet them whenever possible. (b) NORD Gear will not be liable for any penalty clausess contained in any specifications or order submitted unless agreed to in writing by an authorized officer of NORD Gear Corporation. (c) Unless otherwise agreed, delivery of the goods to any carrier shall constitute delivery to the Buyer, and thereafter the risk of loss or damage to the goods shall be upon the Buyer. (d) If the Buyer does not give delivery instructions to the Seller at least (10) days prior to the delivery date ex factory confirmed by the Seller, the Seller may deliver the goods to a carrier of its own choosing, at Buyer's cost and risk, or, at Seller's option, may store the goods on the pier or any warehouse, at Buyer's cost and risk. Any purchase price in such event becomes due and payable within ten (10) days of such storage.

11. PAYMENT OF PURCHASE PRICE

Time of payment is of the essence under the contract. Unless otherwise provided, terms of payment are 30 days net from the date of invoice with a 1% discount if paid within 10 days of date of invoice. Upon default in any of the terms of the contract, or failure to comply with any of the conditions thereof, or upon seizure of the property under execution or other legal process, or if the Buyer becomes bankrupt or insolvent, or any petition for reorganization or for a state court receivership is filed against Buyer, or if the Buyer makes any assignment for the benefit of it's creditors or otherwise sells, encumbers or disposes of the goods, or if for any other reason the Seller should deem itself insecure, the full amount of the purchase price then remaining unpaid shall at once become due and payable at the option of the Seller.

12. BUYER'S DEFAULT

Upon the Buyer's default, the Seller may dispose of the merchandise in any manner that it deems fit and, if it desires to resell same, may do so at private or public sale, with or without notice, and with or without the property being at the place of sale, subject, however, to applicable laws. The Seller or its assigns shall have the right to bid at such sale and may become the purchaser of the property. The proceeds of the sale shall first be applied to the expenses incurred in retaking, repairing, storing and selling the goods, reasonable attorney's fees included, and then shall be applied to the payment of the balance due under the contract. Any surplus amount shall be paid to the Buyer. If a deficiency results after the resale, the Buyer agrees to pay such forthwith, together with reasonable attorney's fees, for the recovery of the goods incurred by the Seller. If upon the Buyer's default, the Seller elects not to resell any goods which it may repossess, then the cost of repossession, including reasonable attorney's fees, shall forthwith be due and payable from Buyer to Seller. Buyer agrees to pay all reasonable costs and reasonable attorneys' fees incurred by Seller in enforcing Seller's rights against Buyer, including Seller's right to payment of the purchase price of the goods and Buyer's payment of all other amounts owing to Seller required under this Invoice and Conditions of Sale.

13. SECURITY INTEREST AND TITLE

In states and localities which are governed by the Uniform Commercial Code, this contract shall serve as security agreement, reserving in Seller a security interest until full payment of purchase price. The provisions of the Uniform Commercial Code regarding security interest shall have preference and apply if inconsistent with other terms of the conditions of sale. In states and localities where the Uniform Commercial Code does not apply, title to the goods shall remain in the Seller or its assigns until full payment of the purchase price. Buyer agrees to execute forthwith any and all documents in such a way and form as Seller may need for filing or recording the security interest under the Uniform Commercial Code with the proper registers or offices, or for filing or recording the conditional sales contract.

14. SALES AND USE TAX

Buyer agrees to bear and pay any sales or use tax in connection with the purchase herein, and to hold the Seller harmless from payment. At the option the Seller, Buyer shall give evidence of payment or of exemption certificate.

15. INSURANCE

The Buyer shall keep the goods insured against damage by fire, water or other casualty as required by Seller, with a company acceptable to Seller, with loss payable to Seller for the total purchase price until the Seller is fully paid. Seller, if it so elects, may place said insurance at Buyer's expense; Seller may cancel such insurance at any time and without notice and may receive the return premium, if any.

16. MODIFICATION BY SELLER

Any contract may be assigned or transferred by the Seller, or the time for the making of any payment due by Buyer may be extended by Seller without derogation of any of the rights of the Seller or its assigns. Waiver by any party of any default shall not be deemed a waiver of any subsequent default.

17. RETURNED GOODS

No goods will be accepted for return unless authorized in writing by Seller. In all cases, transportation and restocking charges will be borne by Buyer.

18. PACKING

The Buyer will be charged for export packaging or other special packing desired. Cost for cartage to ship or transfer express will be added to the invoice. No credit will be allowed if no packing is required.

19. CHANGES/CANCELLATION

NORD Gear will not accept changes in specifications to a confirmed order unless such changes are requested in writing and confirmed back in writing. In addition, the purchaser must to agree to any additional charges that may arise from the change. Placing orders on hold or cancellation of orders require Seller's written approval, and are subject to cancellation and/or restocking charges.

20. BUYER'S RESPONSIBILITY AS TO MAINTENANCE

Buyer shall use and shall require its employees and agents to use all safety devices and guards and shall maintain the same in proper working order. Buyer shall use and require its employees and agents to use safe operation procedures in operating the equipment and shall further obey and have its employees and agents obey safety instructions given by Seller. If Buyer fails to meet the obligations herein, Buyer agrees to defend, indemnify and save Seller harmless from any liability or obligation with regard to any personal injuries or property damages directly or indirectly connected with the operation of the equipment. Buyer further agrees to notify Seller promptly and in any event not later than ten (10) days after notice or knowledge of any accident or malfunction involving Seller's equipment which has caused personal injury or property damages and to cooperate fully with Seller in investigating and determining the causes of such accident and malfunction. In the event that Buyer fails to give such notice to Seller or to cooperate with Seller, Buyer shall be obligated to defend, indemnify and save Seller harmless from any such claims arising from such accident.

21. MISCELLANEOUS PROVISIONS

(a) If for any reason a provision of a contract is legally invalid, then in such event the rest of the contract shall remain in full force and affect, except that the parties shall try to replace such invalid provision closest to their original mutual intentions. (b) This Invoice and these Conditions of Sale constitute the entire agreement between the parties regarding the subject matter hereof and supercedes all prior agreements, understandings and statements, whether oral or written, regarding such subject matter. No modification to, change in or departure from, the provisions of this Invoice and Conditions of Sale shall be valid or binding on Seller, unless approved in writing by Seller. No course of dealing or usage of trade shall be applicable unless expressly incorporated into this Invoice and Conditions of Sale. Any amendments to any contract or contracts between the parties shall be valid only upon the written consent of both parties.

22. NON ASSIGNMENT BY BUYER

Contract or contracts may not be assigned by the Buyer without prior written consent of the Seller.

23. APPLICABLE LAW AND VENUE

All contracts and their interpretation are governed by the applicable, substantive laws of the State of Wisconsin. Any litigation brought by the Buyer regarding this Invoice or goods purchased hereunder may only be brought in the Circuit Court for Dane County, Wisconsin.

1. CONTRACT

Any contract between Nord Gear Limited, hereinafter designated as Seller, and the Buyer is subject to the terms and conditions of sale hereinafter set forth. Any deviation from such terms and conditions must be specifically set forth in writing and consented to by Seller.

2. CONFIRMATION

An order shall be deemed accepted only when duly confirmed by Seller, at Nord Gear Limited's home office in Brampton, Ontario, and upon such confirmation the order shall become a contract binding upon the parties hereto, their successors and assigns.

3. PRICES

Prices shown are list prices and may be subject to applicable discounts. Unless otherwise agreed upon in writing, prices are FOB factory Bramton, Ontario. Prices and discounts are subject to change without notice until order is accepted. Seller's prices do not include cost of any inspection permits required.

4. LIMITED WARRANTY

Seller warrants the goods sold hereunder to be free from defects in material and workmanship under normal use and service not arising from misuse, negligence, or accident, including but not limited to the use, installation, and transportation of the goods by the Buyer, its agents, servants, employees, or by carriers. Such obligations under this warranty are limited to remedying any deficiencies in the goods at Brampton, Ontario, or at such place or places in Canada as may be designated by Seller. This warranty shall pertain to any part or parts of any goods to which Buyer or its assigns has, within one year from date of original factory invoice, given written notice of claimed defects to Seller. Buyer shall be required to furnish Seller with details of such defects and this warranty shall be effective as to such goods which Seller's examination shall disclose to its satisfaction to have been defective and which at Seller's option shall promptly thereafter be returned to Seller or its nominees. EXCEPT FOR THE EXPRESS WARRANTIES SET FORTH ABOVE, SELLER HAS MADE NO WARRANTIES, EXPRESS, IMPLIED OR STATUTORY, AS TO THE GOODS SOLD HEREUNDER, INCLUDING, BUT NOT LIMITED TO THEIR MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. ANY DESCRIPTION OR MODEL OF THE GOODS IS FOR IDENTIFICATION OR ILLUSTRATIVE PURPOSES ONLY AND SHALL NOT BE DEEMED TO CREATE AN EXPRESS WARRANTY. THE REMEDIES OF THE BUYER SET FORTH IN THIS SECTION ARE EXCLUSIVE. In no event shall the Seller be liable to the Buyer or to any other person for any loss or damage, direct or indirect, arising out of or caused by the use or operation of the goods, or for the loss of profits, business, or good will, or for any incidental, special or consequential damages. Seller shall in no event be liable to any person or firm (including any assignee or Buyer) except Buyer and its successors. Unless specifically authorized by Seller in writing, Seller shall not become responsible for any repair work done by Buyer or any other party on any goods sold. Any costs of the return of such goods to Seller shall be borne by Buyer. Goods sold but not manufactured by the Seller are being warranted as to defects in material and workmanship consistent with the limited warranty policy of the original manufacturer of the goods and if there is not such a limited warranty policy, the warranty shall be limited to the provisions of the preceding paragraph of Article 4 herein. Standards for the operating characteristics of the gearboxes and the gearmotors are in conformity with Seller's test. THIS WARRANTY IS IN LIEU OF ALL OTHER EXPRESS OR IMPLIED WARRANTIES, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE THE SELLER DOES NOT ASSUME, NOR DOES IT AUTHORIZE ANY PERSON TO ASSUME, ON ITS BEHALF, ANY OTHER OBLIGATION OR LIABILITY.

5. SHORTAGE AND NONCONFORMITY

Any claim of shortage or that the goods do not conform with the specifications of the order or model must be made in writing within ten (10) days after delivery of the goods (as to which such claim is made) to Buyer or its nominees, but in no event shall the claim be later than within the time limit provided by the carrier or insurance company, otherwise such claim shall be deemed waived. The samples, measurements, dimensions and weights contained in the Seller's catalogs, sales manuals, photographs and drawings constitute only an approximate guide. The Seller reserves the right to make any changes which the Seller, in its absolute discretion, considers necessary. While the goods will be delivered principally according to specifications or standards or quantities agreed upon, insignificant deviations or insignificant changes in construction are permissible. The same applies to partial deliveries. In the event that Buyer has a verified claim of shortage or noncomformity of the goods to the specifications of the order or the model, and if such claim has been submitted within the required time limit as set forth above, the Seller shall, at its own expense, make up for the shortage of the goods, or replace or repair the goods, as the case may be, but in no event shall Seller be or become liable to Buyer or to any other person or persons for any loss in damage, direct or indirect, arising out of or caused by such incidents or for the loss of profits, business or good will. Shipping dates are estimates unless parties expressly agree on time of the essence.

6. FORCE MAJEURE

The obligation of the Seller shall be modified or excused, as the case may be, for reasons of Acts of God, war, governmental law regulations, strikes or lock-outs, fire, breakdown of machinery, whether in its own business enterprise, or if for any other cause beyond Seller's control, the goods cannot be delivered or their delivery becomes delayed in whole or in part. In the above instances time for delivery shall be extended for the period of the delay caused, with the proviso, however, that either party may cancel in writing the undelivered portion of the order or contract if the delay exceeds six (6) months from the delivery date originally confirmed by Seller. In no event shall Seller become liable in the aforesaid instances to Buyer or any third party for consequential damages or business loss.

7. SHIPMENT AS UNIT

Each shipment by Seller shall be treated as a separate and distinct unit with respect, but only with respect to forwarding, terms of payment, and the making of claims by the Buyer; provided, however, that if the Buyer defaults in the payment of any obligation to Seller or any installments thereof, under any agreement between Buyer and Seller, or if Buyer refuses to accept any goods when tendered for delivery, the Seller may, on fifteen (15) days' written notice to the Buyer, without prejudice to Seller's other lawful remedies, either defer further performance until the defaulted payments are made in full, or make future deliveries for cash in advance only, or treat the entire contract or contracts with Buyer as breached by the Buyer and pursue its remedies for breach.

8. BUYER'S REFUSAL OF DELIVERY

If Buyer refuses to accept delivery of any goods tendered for delivery, then Seller, without prejudice to Seller's other lawful remedies, may either store or cause such goods to be stored in a warehouse, for Buyer's account and at Buyer's cost, risk and expense, or sell such goods (without notice) to any purchaser at public or private sale, and hold Buyer liable for any difference between (a) the contract price of the goods, and (b) the price at which goods are resold less the costs and expense of such resale including brokerage commissions, or restocking charges.

9. GOODS IN TRANSIT

If prior to delivery or while the goods are in transit, Buyer or Seller becomes bankrupt or insolvent, or any petition in bankruptcy or for the reorganization or for appointment of a receiver is filed against Buyer or Seller, as the case may be, then the other party hereto may forthwith terminate this contract by giving written notice of such termination. Such termination shall not affect any claim for damages available to the Buyer, provided that if Buyer is then indebted to Seller, the amount of any such damage claim shall be abated to the extent that the indebtedness of Buyer to Seller, as actually paid in money, is abated by any order or judgment entered or any plan adopted in any bankruptcy, reorganization, receivership, or similar proceeding. Such termination shall not prejudice the Seller's rights to any amounts then due under the contract. If Buyer becomes bankrupt or insolvent or any petition in bankruptcy or for reorganization or if a state court receivership is filed against Buyer, then, at its option, Seller may take possession of any goods theretofore sold to Buyer, in connection with which the full purchase price has not been paid, analogous to the terms and provisions set forth in Paragraphs 11 and 12 hereinafter.

10. DELIVERY

(a) Unless otherwise agreed, delivery of the goods to any carrier shall constitute delivery to the Buyer, and thereafter the risk of loss or damage to the goods shall be upon the Buyer. (b) If the Buyer does not give delivery instructions to the Seller at least (10) days prior to the delivery date *ex factory confirmed* by the Seller, the Seller may deliver the goods to a carrier of its own choosing, at Buyer's cost and risk, or, at Seller's option, may store the goods on the pier or on any warehouse, at Buyer's cost and risk. Any purchase price in such event becomes due and payable within ten (10) days of such storage.

11. PAYMENT OF PURCHASE PRICE

Time of payment is of the essence under the contract. Upon default in any of the terms of the contract, or failure to comply with any of the conditions thereof, or upon seizure of the property under execution or other legal process, or if the Buyer becomes bankrupt or insolvent, or any petition for reorganization or for appointment of a receiver is filed against Buyer, or if the Buyer makes any assignment for the benefit of its creditors or otherwise sells, encumbers or disposes of the goods, or if for any other reason the Seller should deem itself insecure, the full amount of the purchase price then remaining unpaid shall at once become due and payable at the option of the Seller.

12. BUYER'S DEFAULT

Upon the Buyer's default, the Seller may dispose of the merchandise in any manner that it deems fit and, if it desires to resell same, may do so at private or public sale, with or without notice, and with or without the property being at the place of sale, subject, however, to applicable laws. The Seller or its assigns shall have the right to bid at such sale and may become the purchaser of the property. The proceeds of the sale shall first be applied to the expenses incurred in retaking, repairing, storing and selling the goods, reasonable solicitor's fees included, and then shall be applied to the payment of the balance due under the contract. Any surplus amount shall be paid to the Buyer. If a deficiency results after the resale, the Buyer agrees to pay such forthwith, together with reasonable solicitor's fees, for the recovery of the goods incurred by the Seller. If upon the Buyer's default, the Seller elects not to resell any goods which it may repossess, then the cost of repossession, including reasonable solicitor's fees, shall forthwith be due and payable from Buyer to Seller.

13. SECURITY INTEREST AND TITLE

In provinces which are governed by a Personal Property Security Act, this contract shall serve as Security Agreement, reserving in Seller a security interest until full payment of purchase price. The provisions of the Personal Property Security Act regarding security interest shall have preference and apply if inconsistent with other terms of the conditions of sale herein. In provinces where a Personal Property Security Act does not apply, title to the goods shall remain in the Seller or its assigns until full payment of the purchase price. Buyer agrees to execute forthwith any and all documents in such a way and form as Seller may need for filing or recording the security interest under a Personal Property Security Act with the proper registers or offices, or for filing or recording the Conditional Sales Contract herein.

14. SALES AND USE TAX

The Seller's prices do not include sales, use, excise or other taxes payable to any governmental authority in respect of the sale of Seller's goods. The Buyer shall pay, in addition to the Seller's price the amount of any such taxes or shall reimburse the Seller for the amount thereof that the Seller may be required to pay. At the option of the Seller, Buyer shall give evidence of payment or of exemption certificate.

15. INSURANCE

The Buyer shall keep the goods insured against damage by fire, water or other casualty as required by Seller, with a company acceptable to Seller, with loss payable to Seller for the total purchase price until the Seller is fully paid. Seller, if it so elects, may place said insurance at Buyer's expense; Seller may cancel such insurance at any time and without notice and may receive the return premium, if any.

16. MODIFICATION BY SELLER

Any contract may be assigned or transferred by the Seller, or the time for the making of any payment due by Buyer may be extended by Seller without derogation of any of the rights of the Seller or its assigns. Waiver by any party of any default shall not be deemed a waiver of any subsequent default.

17. RETURNED GOODS

No goods will be accepted for return unless authorized in writing by Seller. In all cases, transportation and restocking charges will be borne by Buyer.

18. PACKING

The Seller does not charge for standard packaging for domestic shipment. The Buyer will be charged, however, for export packaging or other special packing desired. Cost for cartage to ship or transfer express will be added to the invoice. No credit will be allowed if no packing is required.

19. EXPORT ORDER

Export orders are to be accompanied by a confirmed irrevocable Letter of Credit in Seller's favor, in Canadian currency, with an accredited Canadian bank, subject to Seller's draft, with shipping documents attached.

20. CANCELLATION

Placing orders on hold or cancellation of orders require Seller's written approval, and are subject to cancellation and/or restocking charges.

21. BUYER'S RESPONSIBILITY AS TO MAINTENANCE

Buyer shall use and shall require its employees and agents to use all safety devices and guards and shall maintain the same in proper working order. Buyer shall use and require its employees and agents to use safe operating procedures in operating the equipment and shall further obey and have its employees and agents obey safety instructions given by Seller. If Buyer fails to meet the obligations herein, Buyer agrees to indemnify and save Seller harmless from any liability or obligation with regard to any personal injuries or property damages directly or indirectly connected with the operation of the equipment. Buyer further agrees to notify Seller promptly and in any event not later than ten (10) days after notice or knowledge of any accident or malfunction involving Seller's equipment which has caused personal injury or property damages and to cooperate fully with Seller in investigating and determining the causes of such accident and malfunction. In the event that Buyer fails to give such notice to Seller or to cooperate with Seller, Buyer shall be obligated to indemnify and save Seller harmless from any such claims arising from such accident.

22. MISCELLANEOUS PROVISIONS

(a) If for any reason a provision of a contract is legally invalid, then in such event the rest of the contract shall remain in full force and affect, except that the parties shall try to replace such invalid provision with a provision closest to their original mutual intentions. (b) Any amendments to any contract or contracts require the consent in writing by both parties.

23. NON ASSIGNMENT BY BUYER

Contract or contracts may not be assigned by the Buyer without prior written consent of the Seller.

24. APPLICABLE LAW

All contracts are governed by the applicable laws of Ontario.

25. This instrument sets forth the entire understanding and agreement of the parties hereto in respect of the subject matter hereof, and all prior undertakings between the parties hereto, together with all representations and obligations of such parties in respect of such subject matter, shall be superceded by and merged into this instrument.

26. The provisions of this agreement shall bind and enure to the benefit of the parties hereto and their respective heirs, executors, administrators, successors and (subject to any restrictions or assignment herein above set forth) assigns, as the case may be.

27. The parties acknowledge that they have requested this Contract and all notices or other documents relating thereto be drafted in the English language.

Les parties reconnaisent qu'ils ont requis que ce contrat et tous les avis ou autres documents qui s y rapportent soient rediges en langue anglaise.

"Terms and Conditions in French available upon request."

Product Overview

We can match our NORDAC AC vector drives with our Inverter/Vector Duty Motors and UNICASE™ Speed Reducers to provide a total AC Motor Drive solution from one trusted source.

UNICASE™ SPEED REDUCERS

HELICAL IN-LINE
- Foot or Flange Mount
- Torque up to 205,000 lb-in
- Gear ratios – 1.82:1 to over 300,000:1

NORDBLOC® HELICAL IN-LINE
- Foot or Flange Mount
- Torque up to 26,550 lb-in
- Gear ratios – 1.88:1 to over 370:1

PARALLEL HELICAL CLINCHER™
- Shaft, Flange or Foot Mount
- Torque up to 797,000 lb-in
- Gear ratios – 4.26:1 to over 300,000:1

RIGHT ANGLE HELICAL-BEVEL 2-STAGE
- Foot, Flange or Shaft Mount
- Torque up to 5,840 lb-in
- Gear ratios – 4.1:1 to 72:1

RIGHT ANGLE HELICAL-BEVEL
- Foot, Flange or Shaft Mount
- Torque up to 283,000 lb-in
- Gear ratios – 8.04:1 to over 300,000:1

RIGHT ANGLE HELICAL-WORM
- Foot, Flange or Shaft Mount
- Torque up to 27,585 lb-in
- Gear ratios – 4.40:1 to over 300,000:1

MINICASE™ RIGHT ANGLE WORM
- Foot, Flange or Shaft Mount
- Torque up to 3,540 lb-in
- Gear ratios – 5:1 to 500:1

FLEXBLOC™ WORM
- Modular bolt-on options
- Torque up to 4,683 lb-in
- Gear ratios – 5:1 to 3,000:1

HIGH PERFORMANCE MOTORS & BRAKEMOTORS

INVERTER/VECTOR DUTY
- Standard or Energy Efficient
- Integral, NEMA or Metric IEC
- 1/6 to 250 hp

NORDAC AC VECTOR DRIVES

TRIO SK300E
- Motor or remote mounted
- IP55 – washdown
- 380-460V, 3-phase, to 5hp
- 200-240V, 3-phase, to 3hp

SK500/520/530E
- Compact, high performance
- 380-480V, 3-phase, to 10hp
- 200-240V, 3-phase, to 5hp
- 200-240V, 1-phase, to 3hp
- 110-120V, 1-phase, to 1.5hp

SK700E
- Flexible high performance
- 380-460V, 3-phase, to 200hp

DRIVESYSTEMS

www.nord.com

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National Customer Service Toll-Free: 888.314.6673
info.us@nord.com

NORD Gear Limited
Toll-Free in Canada: 800.668.4378
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EAST
Charlotte, NC
Phone: 608.849.0140

CANADA
Brampton, ON (Toronto)
Phone: 905.796.3606

10020010 4/0909

"The Right Control for Your Application."
KB Electronics, Inc.
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www.kbelectronics.com

KBPC-240D (Part Nos. 9338 and 9342) Installation and Operation Manual Supplement

This supplement is for Model KBPC-240D Installation and Operation Manual (Part No. A40400) until the new manual is available. The manual must be read and understood before operating this drive. For further assistance, contact our Sales Department at 954-346-4900 or Toll Free at 800-221-6570 (outside Florida).

PRODUCT UPDATES

- **Run Relay Added**
- **SMT Construction**

This drive has been converted to Surface Mount Technology (SMT). All trimpots have been moved and aligned at the top of the PC board. A Run Relay has been added, which can be used to turn equipment "on" or "off" as a function of drive status (Off, Stop, Run). The General Performance Specifications, Electrical Ratings, Mechanical Specifications, and Connection Diagrams have not changed. The Parts List (Table 11, on pages 17 and 18) and Schematic (Figure 16, on page 19) in the manual no longer apply to this drive and should not be used. See Figure 1 for the location of the Run Relay Output Contacts, Trimpots, and Jumpers (replaces Figure 1, on page 3, in the manual). See Figure 1 for the Run Relay Output Contacts ratings. See Table 1 for the drive operating conditions and Run Relay Output Contacts status.

FIGURE 1 – DRIVE LAYOUT

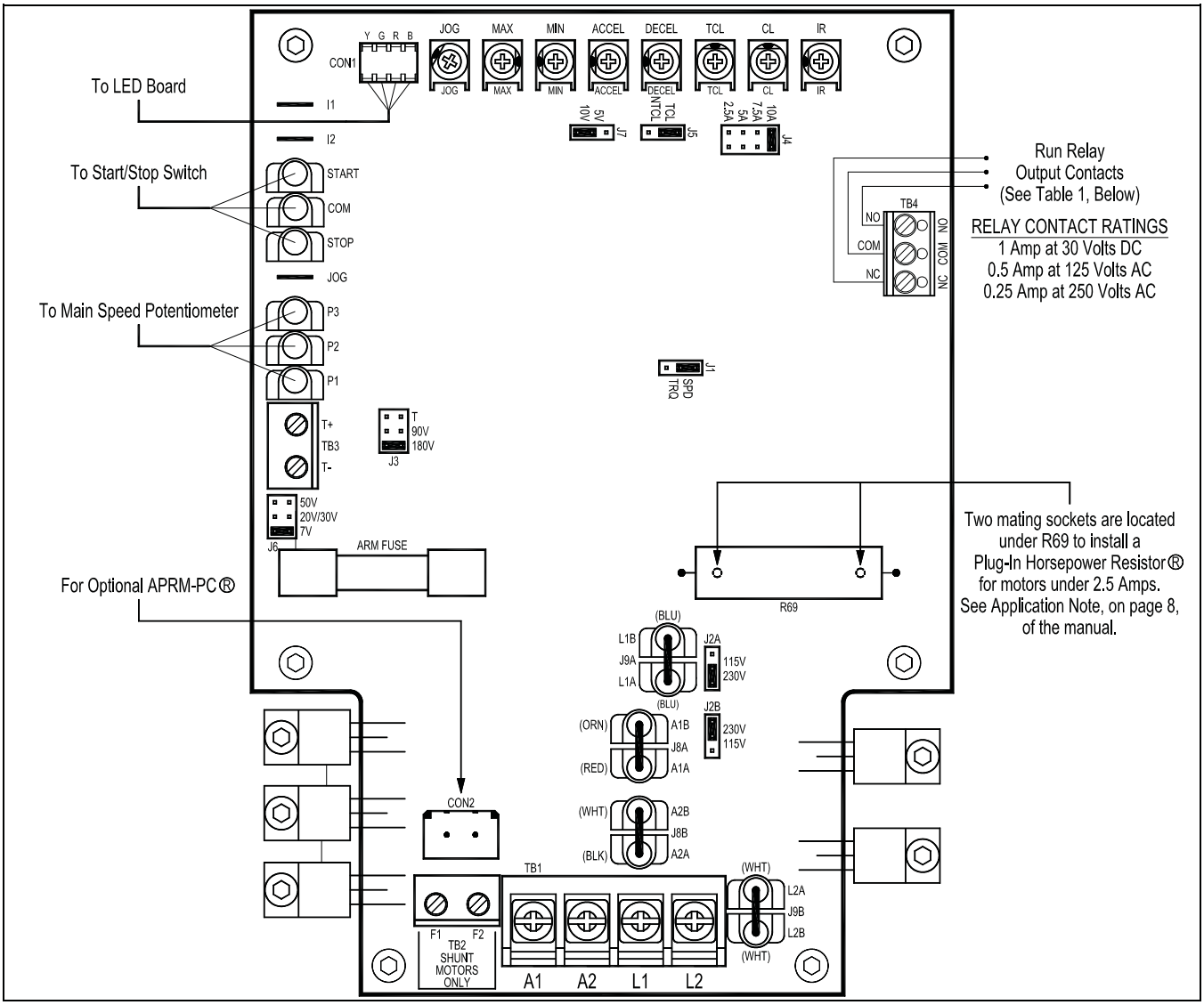


TABLE 1 – DRIVE OPERATING CONDITION AND RUN RELAY OUTPUT CONTACTS STATUS

Drive Operating Condition	Description	Normally Open Contact	Normally Closed Contact
Power Off	Main Power Disconnected	Open	Closed
Run Mode	Normal Drive Operation	Closed	Open
Stop Mode	Selected by Operator	Open	Closed
Trip	Drive Tripped	Open	Closed

INSTALLATION AND OPERATING INSTRUCTIONS

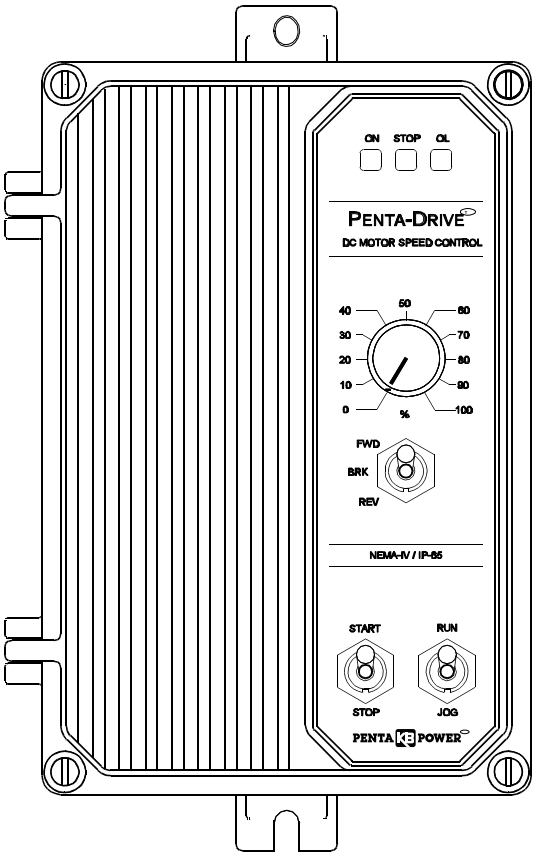
MODEL KBPC-240D

KB Part No. 9338 (Black Case) • Part No. 9342 (White Case)

NEMA 4X, IP-65

SCR Speed and Torque Control Designed
For DC Motors Rated
1/50 – 1 HP @ 90VDC, 1/25 – 2 HP @ 180VDC

This control will not operate without installing the correct armature fuse – supplied separately.



Note: Product illustration is shown with optional Forward-Brake-Reverse and Run-Jog options.

CE

See Page 2

c UL us

See Safety Warning on Page 2

The information contained in this manual is intended to be accurate. However, the manufacturer retains the right to make changes in design which may not be included herein.

PENTA KB POWER™

A COMPLETE LINE OF MOTOR DRIVES

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TABLE OF CONTENTS

Section		Page
i.	KBPC-240D Simplified Operating Instructions	1
ii.	Safety Warning	2
I.	General Information	2
II.	Setting Selectable Jumpers	5
III.	Mounting	9
IV.	Wiring	10
V.	Fusing	13
VI.	Operation	13
VII.	Trimpot Adjustments	14
VIII.	Function Indicator Lamps	15
IX.	Optional Accessories	15
X.	Limited Warranty	22

TABLES

1.	Electrical Ratings	5
2.	General Performance Specifications	5
3.	Setting AC Line Voltage with Jumper J2A and J2B	7
4.	Setting Armature Voltage with Jumper J3	8
5.	Jumper J4 vs Motor Horsepower	8
6.	Current Limit Settings with .05 Ohm Plug-In-Horsepower Resistor Installed	8
7.	Terminal Block Wiring Information	10
8.	Relationship of AC Line Input and Motor Voltage with J2 and J3 Jumper Position	10
9.	Field Connections (Shunt Wound Motors Only)	11
10.	Armature Fuse Chart	13
11.	Parts List	17, 18

FIGURES

1.	Control Layout	3
2.	Mechanical Specifications	4
3.	Motor Speed vs Potentiometer Rotation	6
4.	Preset Motor Speed vs Motor Load	6
5.	Motor Output Torque vs Potentiometer Rotation	7
6.	Motor Speed vs Applied Motor Load	7
7A.	Captive Screw Tightened in Case	10
7B.	Captive Screw Engaged in Front Cover	10
8.	Connection Diagram	10
9A.	Full Voltage Field	11
9B.	Half Voltage Field	11
10.	Tach-generator Connection Diagram	11
11.	Remote Potentiometer	12
12.	Analog Voltage	12
13.	Remote Start/Stop Switch	12
14.	Inhibit Circuit	12
15.	Enable Circuit	13
16.	Schematic	19
17.	Connection Diagram for KBPC-240D with KBSI-240D Signal Isolator	20
18.	Internal Connection Diagram	21
19.	Connection Diagrams for Available Options	21

i. KBPC-240D SIMPLIFIED OPERATING INSTRUCTIONS

IMPORTANT – You must read these simplified operating instructions before you proceed. These instructions are to be used as a reference only and are not intended to replace the detailed instructions provided herein. You must read the Safety Warning on page 2 before proceeding.

1. CONNECTIONS.

A. AC Line – Wire AC line voltage to terminals L1 and L2. Be sure jumpers J2A and J2B are both set to the correct input line voltage 115 or 230 VAC. Connect ground wire (earth) to green ground screw on case.

B. Motor.

1. Permanent Magnet (PM) Type. Connect motor armature leads to A1(+) and A2(–). Be sure jumper J3 is set to the proper position “90V" for 90 volt DC motors and “180V" for 180 volt DC motors. Note: 180 volt DC motors must be used with 230 VAC line, 90 volt motors can be used with a 230 VAC or 115 VAC line. See sec. II, C, on page 7.
2. Shunt Wound Motors. Connect motor armature as above. Connect full voltage shunt field wires (90 volt motors with 100 volt fields and 180 volt motors with 200 volt fields) to F1 and F2. Connect half voltage field wires (90 volt motors with 50 volt fields and 180 volt motors with 100 volt fields) to F1 and L1. See sec. IV, C, on page 11.

2. SPEED OR TORQUE MODE.
Jumper J1 is factory set for speed control operation (SPD). For torque control, set J1 to TRQ position. See sec. II, A, on page 5.

3. MOTOR CURRENT.
Jumper J4 is factory set for 10 amp motors (10A). For lower amperage motors, place J4 in the proper position. See section II, D, on page 8 for details. Note: The factory setting for Current Limit is 150% of the nominal current setting, e.g., if J4 is selected for 10 amps, the actual CL setting will be 15 amps.

4. TRIMPOT SETTINGS.
All trimpots have been factory set in accordance with figure 1, page 3 and table 1, page 5.

5. DIAGNOSTIC LED’s.
After power is turned on, observe LED’s to verify proper control function. See sec. VIII on page 15.

6. ARMATURE FUSE.
The correct size armature fuse **must be installed**, depending on the rating of the motor. Control will not operate if fuse is not installed. See section V, B on page 13 and table 6 on page 12.

7. START/STOP SWITCH.
The KBPC contains a built-in manual start/stop switch. This switch must be used to start the control each time AC power is lost. To override this function see sec IV, G, p. 12.

ii. SAFETY WARNING! — PLEASE READ CAREFULLY

This product should be installed and serviced by a qualified technician, electrician or electrical maintenance person familiar with its operation and the hazards involved. Proper installation, which includes wiring, mounting in proper enclosure, fusing or other overcurrent protection and grounding, can reduce the chance of electric shocks, fires or explosion in this product or products used with this product, such as electric motors, switches, coils, solenoids and/or relays. Eye protection must be worn and insulated adjustment tools must be used when working with control under power. This product is constructed of materials (plastics, metals, carbon, silicon, etc.) which may be a potential hazard. Proper shielding, grounding and filtering of this product can reduce the emission of radio frequency interference (RFI) which may adversely affect sensitive electronic equipment. If information is required on this product, contact our factory. It is the responsibility of the equipment manufacturer and individual installer to supply this safety warning to the ultimate user of this product. (SW effective 11/92)

This control contains electronic Start/Stop and inhibit circuits that can be used to start and stop the control. However, these circuits are never to be used as safety disconnects since they are not fail-safe. Use only the AC line for this purpose.

The input circuits of this control (potentiometer, start/stop, Inhibit) are not isolated from AC line. **Be sure to follow all instructions carefully. Fire and/or electrocution can result due to improper use of this product.**

CE This product complies with all CE directives pertinent at the time of manufacture. Contact factory for detailed installation instructions and Declaration of Conformity. Installation of a CE approved RFI filter (KBRF-200A, KB P/N 9945A or equivalent) is required. Additional shielded motor cable and/or AC line cables may be required along with a signal isolator (KBSI-240D, KB P/N 9431 or equivalent).

I. GENERAL INFORMATION.

The KBPC Series Nema 4 X (IP-65) is a unidirectional SCR DC Motor Speed and Torque Control designed for applications requiring watertight integrity, including washdown. Its housing is ruggedly constructed of die cast aluminum, protected with an acrylic coating that provides excellent corrosion resistance. All switches are sealed with rubber boots and the main speed potentiometer contains a shaft seal.

The electronics for the KBPC is state-of-the-art and includes short circuit and transient protection which provides the ultimate in reliability. Electronic overload protection prevents motor burnout and demagnetization of PM motors. The control can be operated in either the Speed or Torque mode via jumper selection. The current range, which is also jumper selectable, eliminates the necessity for calibration of IR Compensation and Current Limit for most applications. The KBPC also contains jumper selections for AC line voltage (230/115), DC armature voltage (180/90) and feedback type (armature/Tach-generator).

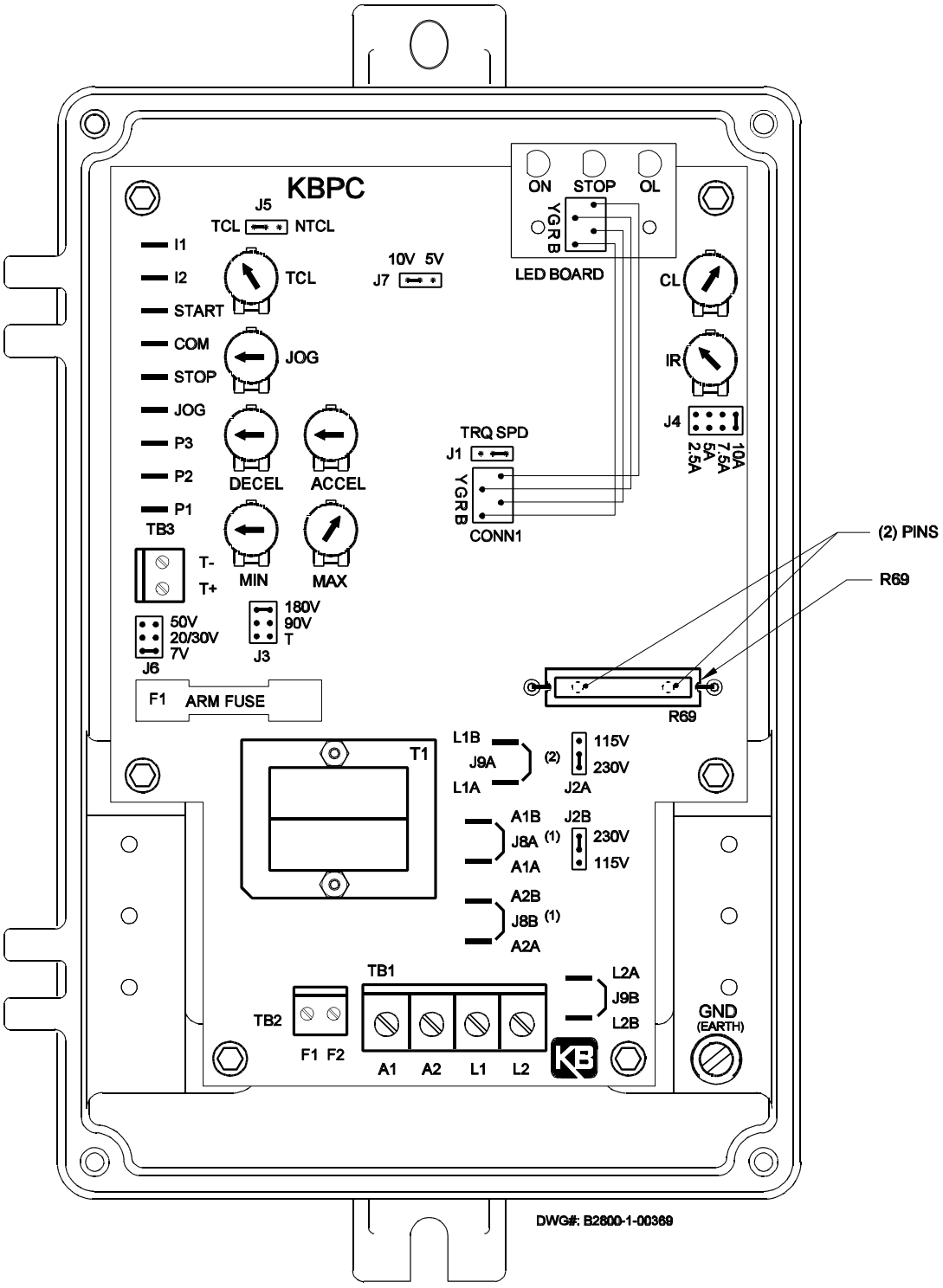
Standard features include armature fusing*, electronic start/stop and an LED indicator array for Power On, Stop and Overload (*fuse supplied separately).

Although the KBPC is factory set for most applications, a variety of trimpots allow adjustment of the following parameters: Minimum and Maximum Speed, Acceleration, Deceleration, Current Limit, IR Comp, and Timed Current Limit. Optional features offered are: On/Off AC Line Switch, Forward-Brake-Reverse, Run-Stop-Jog, Input Signal Isolation, RFI Filtering, and Electronic Run-Brake Module.

WARNING! Be sure to follow all instructions carefully. Fire or electrocution can result due to improper use of this product. Read Safety Warning.

FIG. 1 – CONTROL LAYOUT

(Illustrates Factory Setting of Jumpers and Approximate Trimpot Settings)



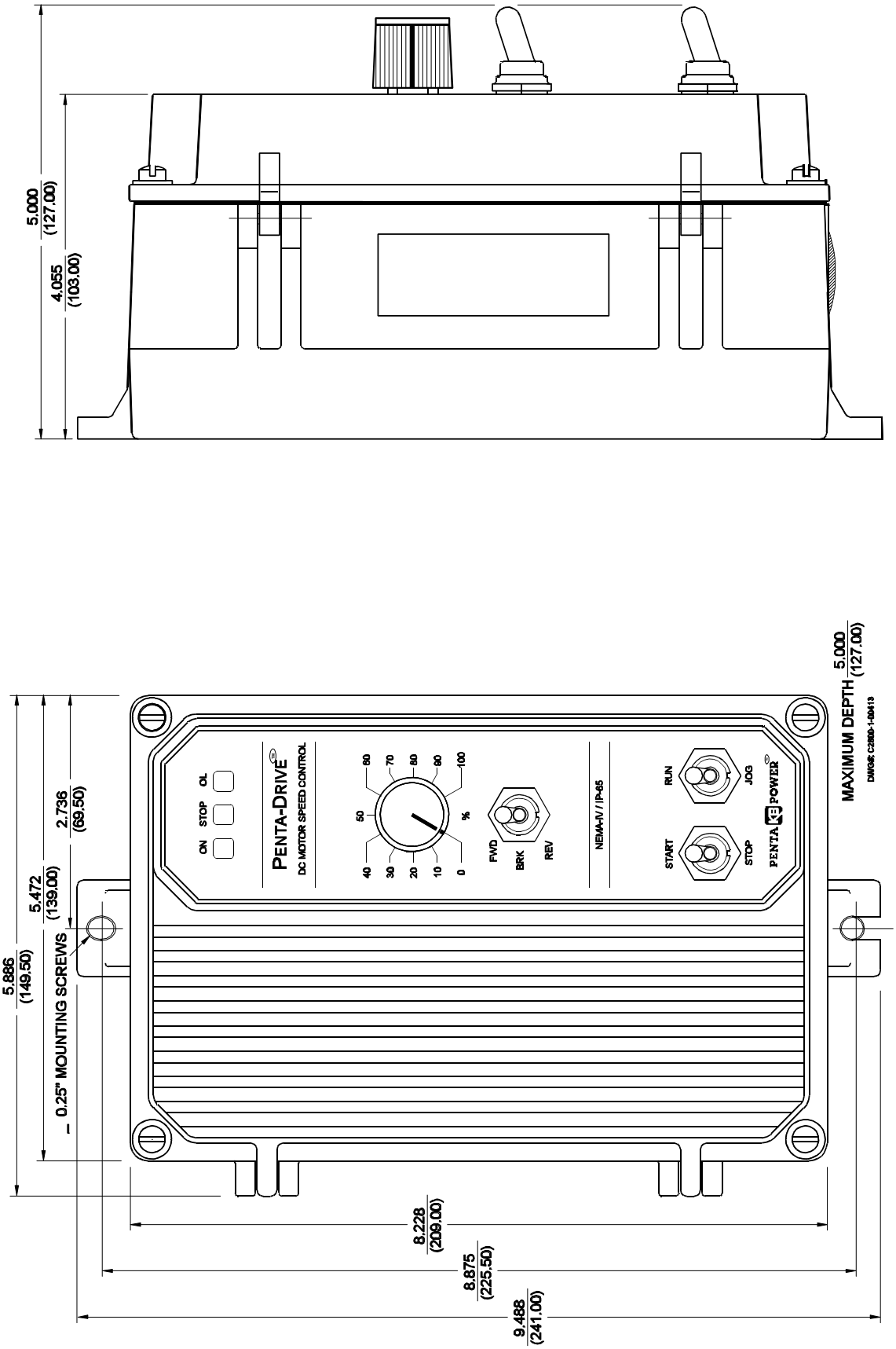


FIG. 2 – MECHANICAL SPECIFICATIONS

TABLE 1 – ELECTRICAL RATINGS

Model	Input Voltage (VAC)	Max. AC Current (ARMS)	Output Voltage (VDC)	Max. DC Output Current (ADC)	Max. HP, (KW)
KBPC-240D	115	15.0	0 – 90	10.2	1, (.75)
	230	15.0	0 – 180	10.2	2, (1.5)
	230	15.0	0 – 90	10.2	1, (.75)

TABLE 2 – GENERAL PERFORMANCE SPECIFICATIONS

Parameter	Specification	Factory Setting
AC Line Input Voltage (VAC ±10%,50/60 Hz)	115 or 230	230
AC Line Frequency (Hz), # of Phases	50/60, 1	—
Arm Voltage Range at 115VAC Line (VDC)	0 – 90	—
Arm Voltage Range at 230VAC Line (VDC)	0 – 180, 0 – 90	0 – 180
Field Voltage at 115VAC Line (VDC)	100/50	—
Field Voltage at 230VAC Line (VDC)	200/100	—
Horsepower Range at 115 VAC HP, (KW)	1/50 – 1, (.015 – .75)	—
Horsepower Range at 230 VAC HP, (KW)	1/25 – 2, (.03 – 1.5)	—
Ambient Temperature Range (ºC)	0 – 50	—
Speed Range (Ratio)	50:1	—
Arm Feedback Load Regulation (% Base Speed)	±1	—
Tach Feedback Load Regulation (% Set Speed)	±1	—
Line Regulation (% Base Speed)	±0.5	—
Current Ranges (ADC)	2.5, 5.0, 7.5, 10	10
ACCEL and DECEL Ranges (Sec.)	0.1 – 15	1
MIN Speed Range (% Base Speed)	0 – 30	0
MAX Speed Range (% Base Speed)	60 – 140	100
IR Comp Range at 115VAC Line (VDC)	0 – 15	4
IR Comp Range at 230VAC Line (VDC)	0 – 30	8
CL Range (% Range Setting)	0 – 200	150
Timed CL Range (Sec.)	0.5 – 15	7
Voltage Following Linearity (% Base Speed)	±0.5	—

II. SETTING SELECTABLE JUMPERS.

The KBPC-240D has customer selectable jumpers which must be set before the control can be used. Bold indicates factory setting. See fig. 1, page 3 for location of jumpers.

A. Control Mode – Speed **(SPD)** or Torque (TRQ). Note: Factory setting for J1 is Speed mode. When Jumper J1 is placed in the "SPD" position the drive will control motor speed as a linear function of the main potentiometer rotation, or analog voltage input. The range of output speed can be adjusted with the MIN and MAX trimpots. The motor will maintain the preset speed as long as the maximum load does not exceed the current limit set point. If the motor load exceeds the current limit setting, the Overload LED will turn on and the motor will stall.

FIG. 3 – MOTOR SPEED vs POTENTIOMETER ROTATION – [SPEED MODE]

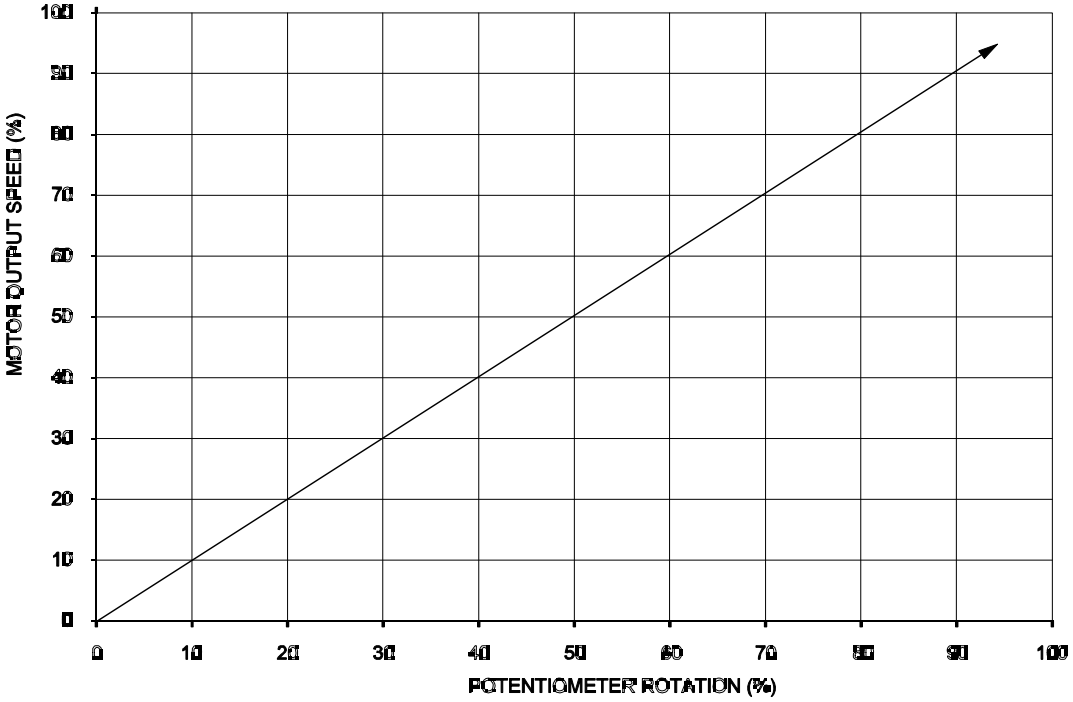
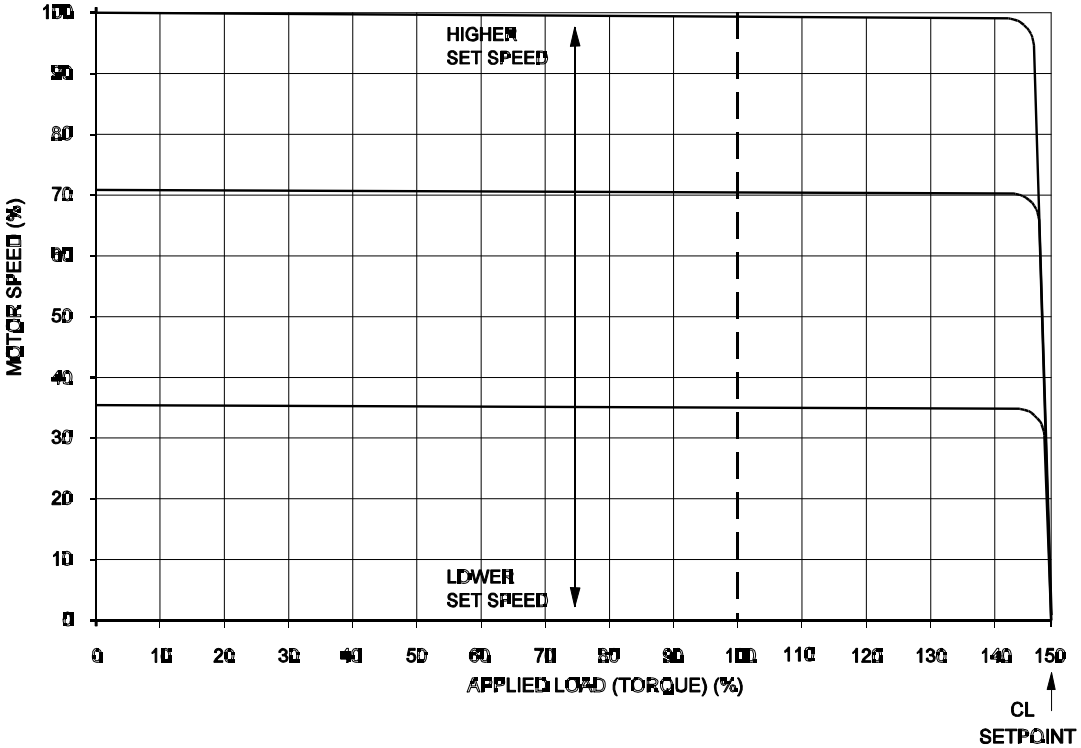


FIG. 4 – PRESET MOTOR SPEED vs MOTOR LOAD – [SPEED MODE]



When Jumper J1 is placed in the "TRQ" position, the drive will control motor torque as a linear function of main potentiometer rotation. If the motor load exceeds the torque setting, the motor will stall, the Overload LED will light, and the drive will apply a constant preset torque based on the potentiometer setting. The Overload LED will light when the load torque approaches the current limit set point. The torque limits are set via jumper J4 and the CL trimpot. (Note: When operating in the Torque Mode, Jumper J5 **must** be in the "NTCL" position or drive will shut down when CL Timer times out.)

FIG. 5 – MOTOR OUTPUT TORQUE vs POTENTIOMETER ROTATION – [TORQUE MODE]

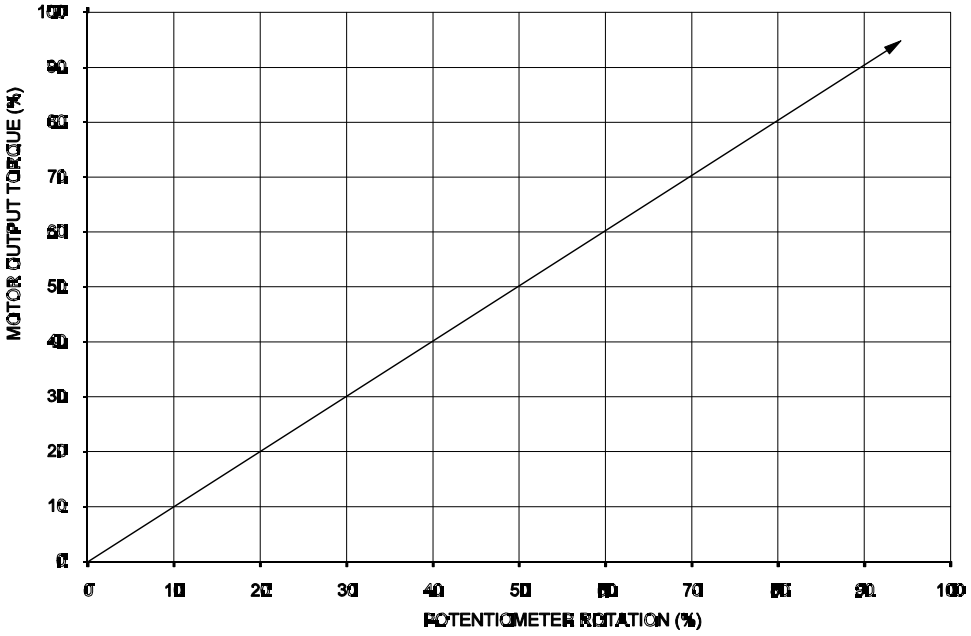
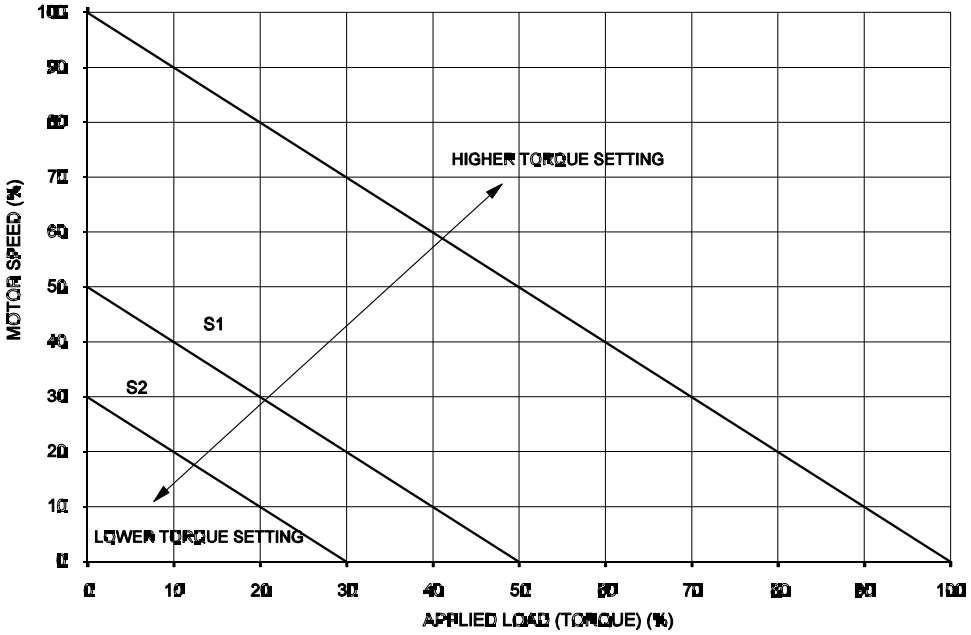


FIG. 6 – MOTOR SPEED vs APPLIED MOTOR LOAD – [TORQUE MODE]



B. **J2A, J2B – Input AC Line Voltage –** Select proper input line voltage 115VAC or 230VAC by placing **both** J2A and J2B in the correct corresponding positions, "115V" or **"230V."**

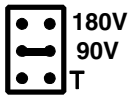
TABLE 3 – SETTING AC LINE VOLTAGE WITH JUMPER J2A and J2B

Control Set for 230 VAC (Factory Setting)	Control Set for 115 VAC
115V 230V J2A J2B 230V 115V	115V 230V J2A J2B 230V 115V

C. **J3 – Armature Voltage Output and Tach-generator Feedback –** Select the desired armature voltage by placing J3 in the proper position "90V" for 90 – 130VDC motors and **"180V"** for 180 – 220 VDC motors. For 115VAC line input the armature voltage must be set to "90V."

For 230VAC line input, the armature voltage is normally set to"180V". However, it is also possible to operate in a Step-Down Mode (90 – 130VDC motor with a 230VAC line) by setting J3 to "90". However, reduced performance may result.

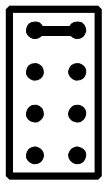
TABLE 4 – SETTING ARMATURE VOLTAGE WITH JUMPER J3

Control Set for 180 VDC (Factory Setting)	Control Set for 90 VDC
J3	 J3

If tach-generator feedback is to be used, J3 must be placed in the "T" position and an external DC tach-generator must be connected. See section II, F, p. 9, and section IV, E on page 11 for additional information.

D. J4 – Armature Current – Select the J4 position (2.5A, 5A, 7.5A, **10A**) closest to the rated motor current. Note that the output is factory set to 150% of the J4 position (e.g. 15 amps in the 10A position and 11 amps in the 7.5 position, etc.). This setting can be readjusted using the CL trimpot (see section VII, E on page 14).

TABLE 5 – JUMPER J4 SETTING vs MOTOR HORSEPOWER

JUMPER J4*		Motor Horsepower Range	
		90 VDC	180 VDC
10.0 Amps		1	2
7.5 Amps		3/4	1
5.0 Amps		1/3 – 1/2	3/4 – 1
2.5 Amps		1/6 – 1/4	1/3 – 1/2

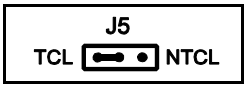
Note: Jumper J4 is shown in the factory setting.

Application Note – Subfractional Horsepower Motors. For subfractional motors with current ratings below 2.5 amps, the KBPC can be modified as follows. Note: Before making this modification you must have a .05 ohm Plug-in Horsepower Resistor® (KB P/N 9839). Carefully clip out the large power resistor R69 on the printed circuit board. The resistor location is indicated in fig. 1, p. 3.) Insert the .05 ohm Plug-in Horsepower Resistor® into the two (2) pins located under the resistor R69. Each of the current selection values are now divided by 10. See table 6 below.

TABLE 6 – CURRENT LIMIT SETTINGS with .05 OHM PLUG-IN HORSEPOWER RESISTOR INSTALLED

Original J4 Current Jumper Selection	New J4 Current Jumper Selection	New Current Limit Trimpot Range	New Current Limit Trimpot Factory Setting
10.0 Amps	1.0 Amps	0 – 2.0 Amps	1.50 Amps
7.5 Amps	0.75 Amps	0 – 1.5 Amps	1.13 Amps
5.0 Amps	0.5 Amps	0 – 1.0 Amps	0.75 Amps
2.5 Amps	0.25 Amps	0 – 0.5 Amps	0.38 Amps

E. J5 – Current Limit Mode – (Factory set for **"TCL"**) This control contains electronic current limiting which limits the maximum DC current to the motor (the current limit set point is established with the selection of the J4 position and the setting of the CL trimpot). Two modes of current limit operation are provided:

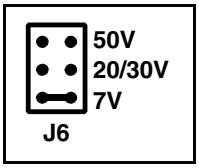


1. Timed current limit "TCL": In this mode the drive will turn off after being in current limit for a preset time. The time period is adjustable with the TCL trimpot from 0.5-15 seconds and is factory set for approximately seven (7) seconds. **TCL provides electronic motor overload protection.**

   Application Note: *After the control times out in TCL, it can be reset using the Start Switch by setting the switch to the "STOP" position and then to "START," or by disconnecting and reconnecting the AC line. If the Start Switch is jumpered out, the control can be restarted after timing out in TCL, by disconnecting and reconnecting the AC line. Note, the Overload lamp will remain lighted until the control is reset.*

2. Non-Timed Current Limit "NTCL": In this mode the drive will reach the preset current limit during overload and stay at that level until a fuse blows or the drive is manually turned off. If non-timed CL operation is desired, move jumper J5 from the factory set "TCL" position to the "NTCL" position. The NTCL position must be used when operating in the Torque Mode. See section II, A on page 5.

F. J6 – Tach-generator voltage – (Note: Selection of this jumper position is not required if tach-generator feedback is not used.) If tach-generator feedback is used, select the J6 position (**7V**, 20/30V, 50V) which corresponds to the tach-generator voltage in **Volts/1000 RPM**. The selection of J6 position is based on a maximum motor speed of 1800 RPM. If other than standard tach-generator voltages and motor speeds are used, an external resistor (RT) may be used (1/2 watt rating).

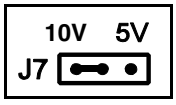


1. Install resistor (RT) in series with either tach-generator lead.
2. Place J6 in "7V" position.
3. Calculate the value of (RT) as follows:

RT = [(1.64 x VT x S) - 20,000] ohms { VT = Tach Voltage in Volts/1000 RPM; S = Base speed of motor in RPM

Note: For tach-generator feedback, Jumper J3 must be in the "T" position.

G. J7 – Signal Input Voltage – The output of this control is normally controlled with the main potentiometer. However, an **Isolated** analog voltage may also be used in place of a potentiometer. The control can be scaled for either a 0-5VDC or 0-10VDC by placing J7 in the appropriate position "5V" or **"10V"**. The scaling can be further adjusted with the "Max" trimpot. See section IV, F 2, on page 12 for wiring information.



Note: If an **Isolated** input signal is not available an accessory Signal Isolator Model KBSI-240D (KB P/N-9431) can be installed. The KBSI-240D accepts a wide range of signal voltage and current. An Installation Kit containing Auto/Man Switch and required wiring is also available (P/N 9377).

III. MOUNTING

Mount the control in a vertical position on a flat surface. Be sure to leave enough room below the bottom of the control to allow for the AC line and motor connections. Although the control is designed for outdoor and washdown use, care should be taken to avoid extremely hazardous locations where physical damage can occur. **Note: Do not use this control in an explosion proof application.** If the control is mounted in a closed, unventilated cabinet, remember to allow for proper heat dissipation. If full rating is required, a minimum enclosure size of 12" W x 24" H x 12" D should be used.

Front Cover - The KBPC case is designed with a hinge so that when the front cover is open, all wiring stays intact. To open the cover, the four cover screws must be loosened, so they no longer are engaged in the case bottom. Note that these screws are captive and the front cover holes are threaded. After mounting and wiring, close the front cover, making sure all wires are contained within the enclosure and the gasket is in place around the cover lip. Tighten all four cover screws so that the gasket is slightly compressed. **Do not overtighten.**

FIG. 7A – CAPTIVE SCREW TIGHTENED IN CASE

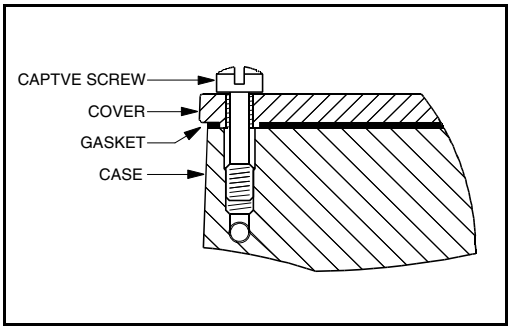
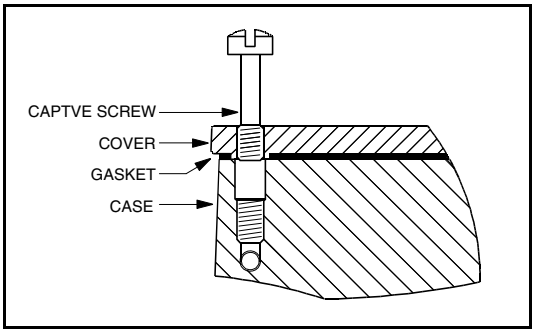


FIG. 7B – CAPTIVE SCREW ENGAGED IN FRONT COVER



IV. WIRING. ⚠ Warning! Read Safety Warning before attempting to use this control.

Warning! To avoid erratic operation do not bundle AC Line and motor wires with potentiometer, voltage following, enable, inhibit or other signal wiring. Use shielded cables on all signal wiring over 12" (30 cm) – Do not ground shield.

Wire control in accordance with the National Electric Code requirements, and other codes that apply. Be sure to fuse each conductor which is not at ground potential. **Do not fuse neutral or grounded conductors**. Note: See section V, Fusing, on page 13. A separate AC line switch, or contactor, must be wired as a disconnect switch, so that the contacts open each ungrounded conductor. An accessory ON/OFF AC Line Switch (KB P/N 9341) may be installed in this control in lieu of, or in addition to, the Start/Stop Switch normally provided. The switch can be wired for double pole or single pole operation. (See fig. 8, for AC Line and Armature connection.)

To maintain the watertight integrity of the control, be sure to use suitable watertight connectors and wiring, which are appropriate for the application. Two .875" (22.2 mm) knockout holes are provided for a standard 1/2" knockout connector (not supplied) for wiring. A watertight plug is provided if only one knockout is required.

A. AC Line – Connect AC Line to terminals L1 and L2. (Be sure jumpers J2A and J2B are set to the correct position to match the AC line input voltage. See table 8 on page 11.

TABLE 7 – TERMINAL BLOCK WIRING INFORMATION

Terminal Block Designation	Connection Designation	Supply Wire Gauge*		Maximum Tightening Torque (lbs inch)
		Minimum	Maximum	
TB1	A1, A2, L1, L2	22	12	12
TB2	F1, F2	22	14	3.5
TB3	T+, T–	22	14	3.5

*Use Cu wire only (AWG)

B. Motor Armature – Connect motor armature to terminals A1 (+) and A2 (–). (Be sure jumper J3 is set to closely match motor voltage. See table 8, p. 11.) **WARNING!** Do not wire switches or relays in series with the armature. **Armature switching can cause catastrophic failure of motor and/or control. Do not bundle AC and motor wires with other wires (e.g., potentiometer, analog input, Forward-Brake-Reverse, etc.).**

FIG. 8 – CONNECTION DIAGRAM

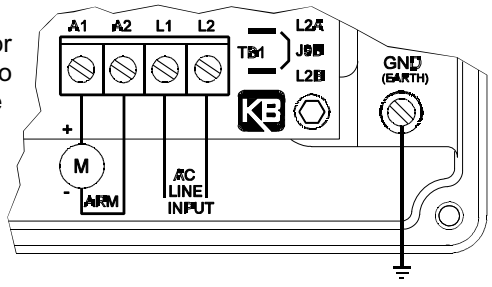


TABLE 8 – RELATIONSHIP of AC LINE INPUT AND MOTOR VOLTAGE with J2 and J3 JUMPER POSITION

AC INPUT VOLTAGE	J2A, J2B POSITION	J4 POSITION	MOTOR VOLTAGE
115	115	90	90
230	230	180	180
230	230	90*	90*

*A 90VDC motor can be used with a 230VAC line. However, speed range may be reduced and motor derating may be required.

C. Field – For Shunt Wound Motors **Only**. Do not use terminals F1 and F2 for any other purpose than to power the field on a shunt wound motor. Connect motor shunt field to terminals F1 and F2 for 90VDC motors with 100VDC fields and 180VDC motors with 200VDC fields. For motors with half voltage fields, 90VDC motors with 50VDC fields and 180VDC motors with 100VDC fields, connect field to terminals F1 and L1. See table 9 for summary of Field Connections. See figures 9A and 9B for field wiring diagrams.

CAUTION – Shunt-Wound motors may be damaged if field remains powered without motor rotating for an extended period of time.

TABLE 9 – FIELD CONNECTIONS (Shunt Wound Motors Only)

AC Line Voltage (VAC)	Motor Voltage	Field Voltage (VDC)	Field Connection
115	90	100	F+, F–
115	90	50	F+, L1
230	180	200	F+, F–
230	180	100	F+, L1
230	90*	100	F+, L1

*Step Down operation (see section II C, p. 7).

FIG. 9A – FULL VOLTAGE FIELD

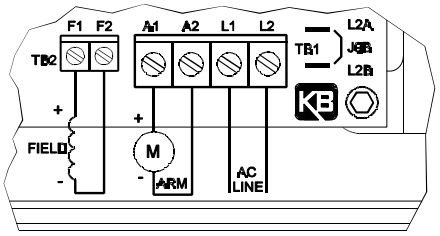
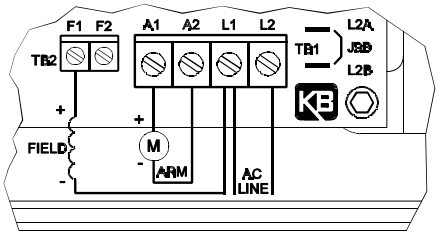
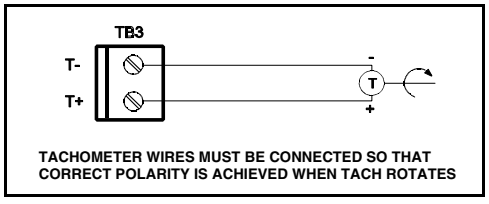


FIG. 9B – HALF VOLTAGE FIELD



D. Ground – Be sure to ground (earth) the control by connecting a ground wire to the Green Ground Screw located to the right of the terminal block. (See fig. 1, p. 3)

FIG. 10 – TACH-GENERATOR CONNECTION DIAGRAM



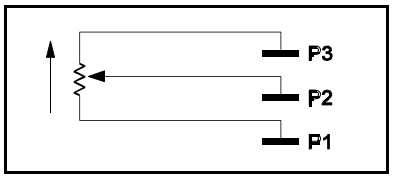
E. DC Tach-generator Input – If tach-generator feedback is required, an analog tach signal must be connected to the terminal block TB3. (Note: For tach-generator feedback Jumper J3 must be set to the "T" position, jumper J6 must be set for the proper tach voltage, and the IR COMP **must be set to minimum (ccw) position.**) (See section II F, p. 9.) Connect the tach-generator so that when the motor rotates the positive tach voltage lead is connected to T+ and the negative tach lead is connected to T– (See figure 10).

Note: If the tach voltage is connected backwards, the control will drive the motor at full speed only. Note: If the Forward-Brake-Reverse switch is used, provision must be made to reverse the polarity of the tach-generator leads when the control is switched to "Reverse."

Warning! To avoid erratic operation do not bundle AC Line and motor wires with potentiometer, voltage following, enable, inhibit or other signal wiring. Use shielded cables on all signal wiring over 12" (30 cm) – Do not ground shield.

F. Main Potentiometer – The control is supplied with the main potentiometer prewired. However, the control can also be operated from a remote potentiometer, or from an ***Isolated*** analog voltage for voltage following. To operate from an external source remove **white, orange and violet** potentiometer leads from terminals P1, P2 and P3. The leads may be taped and left in the control. The potentiometer itself may be removed, if a watertight seal is used to cover the hole in the front cover.

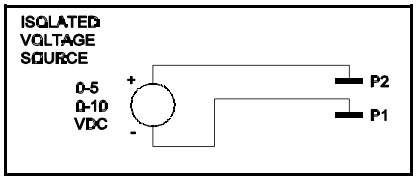
FIG. 11 – REMOTE POTENTIOMETER



1. Remote Potentiometer – Connect remote potentiometer wires to terminals P1, P2 and P3, so that the "high" side of the potentiometer connects to P3, the "wiper" to P2 and the "low" side to P1. (See figure 11.)

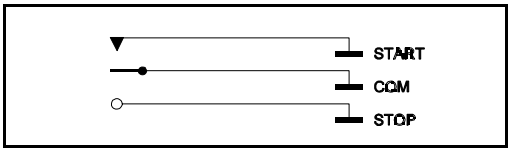
2. Analog Input – An isolated 0-5 or 0-10VDC analog voltage can also be used to drive the control. Note: If an isolated signal voltage is not available, an optional signal isolator can be installed (Model KBSI-240D, P/N 9431, see figure 17, p. 20 for signal isolator wiring diagrams). Connect the isolated input voltage to terminal P2 (+) and P1 (–). (See fig. 12) Note: Be sure jumper J7 corresponds to proper range of input voltage 0-10 or 0-5VDC. When the potentiometer is disconnected from P1, P2 and P3 to connect an analog input signal, the MIN trimpot will have to be adjusted clockwise to achieve a 0^{+} output voltage.

FIG. 12 – ANALOG VOLTAGE



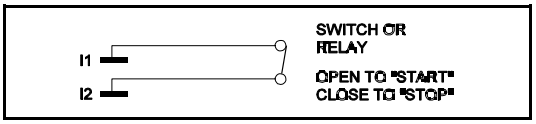
G. Remote Start/Stop Switch – A remote Start/Stop Switch can be installed by removing the wires from the "Start," "Com" and "Stop" terminals, and reconnecting them to a remote switch. (See fig. 13.) Note: To eliminate Start/Stop function, join the "Start" & "Com" Quick Connect terminals with a jumper.

FIG. 13 – REMOTE START/STOP SWITCH



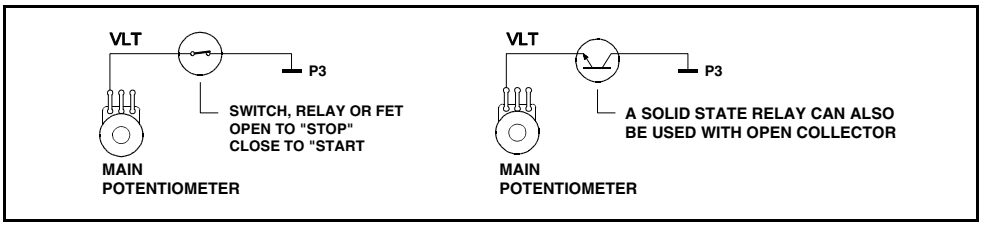
H. Inhibit – The control can be electronically stopped and started with the Inhibit circuit. To "Stop" the control, Terminals I1 & I2 must be joined via a contact. The control can be restarted by opening the contact. **Note: The Inhibit should not be used as a safety disconnect.** Use only the AC Line for that purpose. (See fig. 14.) Note: The Inhibit Circuit is not isolated. Do not common or ground inhibit leads.

FIG. 14 – INHIBIT CIRCUIT



I. Enable – The control can also be started and stopped with an Enable circuit (the Enable circuit functions opposite to that of the inhibit circuit; INHIBIT: open to start-close to stop, ENABLE: open to stop-close to start). The Enable function is established by wiring a contact in series with the violet potentiometer lead connected to terminal P3. (See fig. 15 on page 13.) The Enable circuit is not isolated. Do not common or ground wiring. **Note:** The MIN speed trimpot must not be set higher then 70% CW rotation (approx. 2:00 o'clock position) or Enable will not function.

FIG. 15 – ENABLE CIRCUIT



V. FUSING.

A. AC Line Fusing – Most electrical codes require that each ungrounded conductor contain fusing. Separate branch circuit fusing, or circuit breaker may be required. Check all electrical codes that may apply to the installation. This control does not contain AC line fuses. A 20 amp rated fuse or circuit breaker can be used.

B. Armature Fusing – The correct size armature fuse **must be installed**, depending on the rating of the motor. **Control will not operate if fuse is not installed.** Fuse type should be Littelfuse 326 ceramic, Buss ABC, or equivalent. A fuse chart is presented below which suggests appropriate armature fuse ratings. However, the specific application may require larger fuse ratings based on ambient temperature, CL set point and duty cycle of operation. (See table 10 below.) (Fuse rating is based upon 1.7 times the motor current rating.)

TABLE 10 – ARMATURE FUSE CHART

Motor Horsepower		Approx. DC Motor Current Amps	Fuse Rating (AC Amps)
90VDC	180VDC		
1/8	1/4	1.3	2
1/6	1/3	1.7	2
1/4	1/2	2.5	4
1/3	3/4	3.3	5
1/2	1	5.0	8
3/4	1	7.5	12
1	2	10.0	20

Note: Armature fuse is not supplied and must be installed for control to operate.

VI. OPERATION

WARNING! Read Safety Warning on page 2 before attempting to operate the control or severe injury or death can result. Failure to follow the Safety Warning Instructions may result in electric shock, fire or explosion.

After the control has been set up properly (the jumpers set to the desired positions, and the wiring completed), the start-up procedure can begin. If AC power has been properly brought to the control, the "ON" LED and the "STOP" LED indicators will be lighted. Before initially starting, be sure the main potentiometer is in the minimum position. To start the control move the Start/Stop toggle to the "Start" position and release. The "Stop" LED should extinguish and the motor should rotate as the potentiometer knob is rotated clockwise. Note: If the motor rotates in the incorrect direction, it will be necessary to disconnect the main AC power and reverse the armature wires. To stop the motor, move the Start/Stop toggle to the Stop position. If power is lost, the control will not restart, unless the Start/Stop toggle is moved to the Start position.

VII. TRIMPOT ADJUSTMENTS.

The control contains trimpots, which have been factory adjusted for most applications. Figure 1 page 3 illustrates the location of the trimpots and their approximate adjustment positions. Some applications may require readjustment of the trimpots in order to tailor the control to exact requirements. (See table 2, p. 5 for range and factory setting of all trimpots.) Readjust trimpots as follows: **WARNING**. Do **not** adjust trimpots with main power on if possible. **If adjustments are made with power on, insulated adjustment tools must be used and safety glasses must be worn. High voltage exists in this control. Electrocution and/or fire can result if caution is not exercised. Safety warning must be read and understood before proceeding**.

A. Minimum Speed (MIN) – The MIN trimpot is used to set the minimum voltage of the drive. This sets the minimum speed of the motor. Adjust the MIN trimpot as follows:

1. Rotate Main Potentiometer to minimum speed position (full counterclockwise).
2. Increase setting of MIN trimpot so that motor runs at desired minimum speed.

B. Maximum Speed (MAX) – The MAX trimpot is used to set the maximum voltage of the drive. Adjust the MAX trimpot as follows:

1. Rotate Main Potentiometer to maximum speed position (full clockwise).
2. Adjust MAX trimpot setting to desired setting of motor speed.

C. Acceleration (ACCEL) – The ACCEL trimpot sets the amount of time it takes the control to reach full output. The trimpot is factory set to one (1) second. If more rapid acceleration is desired, rotate the trimpot counterclockwise. Note: Rapid ACCEL setting may cause the current limit circuit to activate which will extend the acceleration time. For a longer acceleration time, rotate ACCEL trimpot clockwise. 50% rotation represents approximately seven (7) seconds and full rotation is approximately fifteen (15) seconds.

D. Deceleration (DECEL) – The DECEL trimpot sets the amount of time it takes the control to go from full speed to minimum speed when rotating the main potentiometer CCW. The trimpot is factory set to one (1) second, and can be readjusted to full counterclockwise position for more rapid DECEL. Note: On high inertial loads, a rapid DECEL setting may cause the motor to coast to a stop slower than the DECEL setting. To increase deceleration time, rotate DECEL trimpot clockwise. 50% rotation represents approximately seven (7) seconds and full rotation is approximately fifteen (15) seconds. Note: The Decel circuit works when rotating the main speed pot in the CCW direction or when opening the P3 lead of the main pot or when placing the Start/Stop Switch Toggle to the Stop position. It does not operate when power is removed.

E. Current Limit (CL) – This trimpot is used to set the maximum amount of DC current that the motor can draw. The amount of DC current determines the amount of maximum motor torque in both the Speed Control Mode and Torque Mode. The CL trimpot is factory set at 150% of the current established by the jumper J4 selection. Also see section VIII C, on page 15). Readjust the CL trimpot as follows:

1. Turn CL trimpot to minimum (CCW) position. Be sure jumper J4 is in proper position approximately equal to the motor DC ampere rating.
2. When jumper J1 is set to the Speed Control Mode the main potentiometer should be set at 50% rotation. When jumper J1 is set to the Torque Mode the main potentiometer should be set at 100% of full rotation.
3. Wire in a DC ammeter in series with armature lead. Lock shaft of motor.
4. Apply power. Rotate CL trimpot CW until desired CL setting is reached (factory setting is 1.5 times rated motor current).

CAUTION:

1. Adjusting the CL above 150% of motor rating can cause overheating and demagnetization of some PM motors. Consult motor manufacturer.

2. Do not leave the motor in a locked condition for more than a few seconds since armature damage may occur.

F. IR Compensation (IR) – The IR comp circuit is used to stabilize motor speed under varying loads. **(Note: If control is in Tach Feedback mode, the IR trimpot should be set to minimum - ccw.)** Readjust the IR trimpot as follows:

1. Run the motor at approximately 30-50% of rated speed under no load and measure actual speed;

2. Load the motor to rated current. Rotate IR trimpot so that the loaded speed is the same as the unloaded speed measured in 1.

Control is now compensated so that minimal speed change will occur over a wide range of motor load. (Note: Too much IR Comp will cause unstable [oscillatory] operation.)

G. Timed Current Limit (TCL) – Jumper J5 must be in the "TCL" position, in order for Timed Current Limit to be operational. This trimpot determines the approximate amount of time the drive will stay in Current Limit before trip out. The trimpot has an adjustment range of .5-15 seconds and is factory set for seven (7) seconds. The trimpot can be reset according to the desired trip time. Rotating the trimpot clockwise increases the trip time. This function provides motor overload protection. (See page 9, section II, E 1, "Application Note," for TCL operation.)

H. Jog Speed (JOG) – This trimpot is operational only when the optional RUN-STOP-JOG Switch is installed (KB P/N 9340). In the JOG position the JOG trimpot can be used to set the JOG speed.

VIII. FUNCTION INDICATOR LAMPS.

The control contains three function LED Indicator Lamps that reflect its operational status.

A. Power On Indicator (ON) – This lamp will glow GREEN when the AC line is connected to the control.

B. Stop Indicator (STOP) – This lamp will glow YELLOW when the control is placed in the STOP mode with the Start/Stop Switch.

C. Overload Indicator (CL) – When the motor is loaded to the current limit setpoint (CL setpoint is established by the setting of jumper J4 and the CL trimpot), this lamp will glow RED. If the control is allowed to stay in CL and then trips out in Timed Current Limit, the OL LED will remain lighted, until the control is restarted with the Start/Stop Switch. If the OL LED remains lighted during control operation, a fault condition may exist. Possible causes for this condition are as follows:

1. Motor is overloaded – Check motor amps with DC ammeter in series with armature. (If motor is shunt type, field may be open or not receiving proper voltage.)

2. Motor may be defective – Check motor for shorts or grounds.

3. The CL may be set too low – Check position of jumper J4 and CL trimpot.

NOTE: In some applications, especially those requiring the motor to cycle on and off or from one speed to another, the OL indicator may blink indicating a transient overload. This may be a normal condition for the application.

IX. OPTIONAL ACCESSORIES.

A. RUN-STOP-JOG Switch (P/N 9340) – This switch provides a momentary jog speed that can be used to "inch" a machine into position. It assembles easily to the control via quick connect terminals. A rubber switch seal is included in order to maintain watertight integrity.

B. Forward-Brake-Reverse Switch (P/N 9339) – This module provides a reversing function along with dynamic braking. A special hesitation switch is used along with an Inhibit function which minimizes arcing and plug-reversing. The installation is made simple with the use of quick-connect terminals. **Note: Signal Isolator (P/N 9431) cannot be installed with Foward-Brake-Reverse Switch.**

C. Signal Isolator (Model KBSI-240D, P/N 9431) – Signal isolation is required when a remote nonisolated analog signal is to be used. Provision is made to install Model KBSI-240D on 4 bosses inside the front cover. The unit accepts a variety of voltage and current signals.

Note: Foward-Brake-Reverse Switch (P/N 9339) cannot be installed with Signal Isolator.

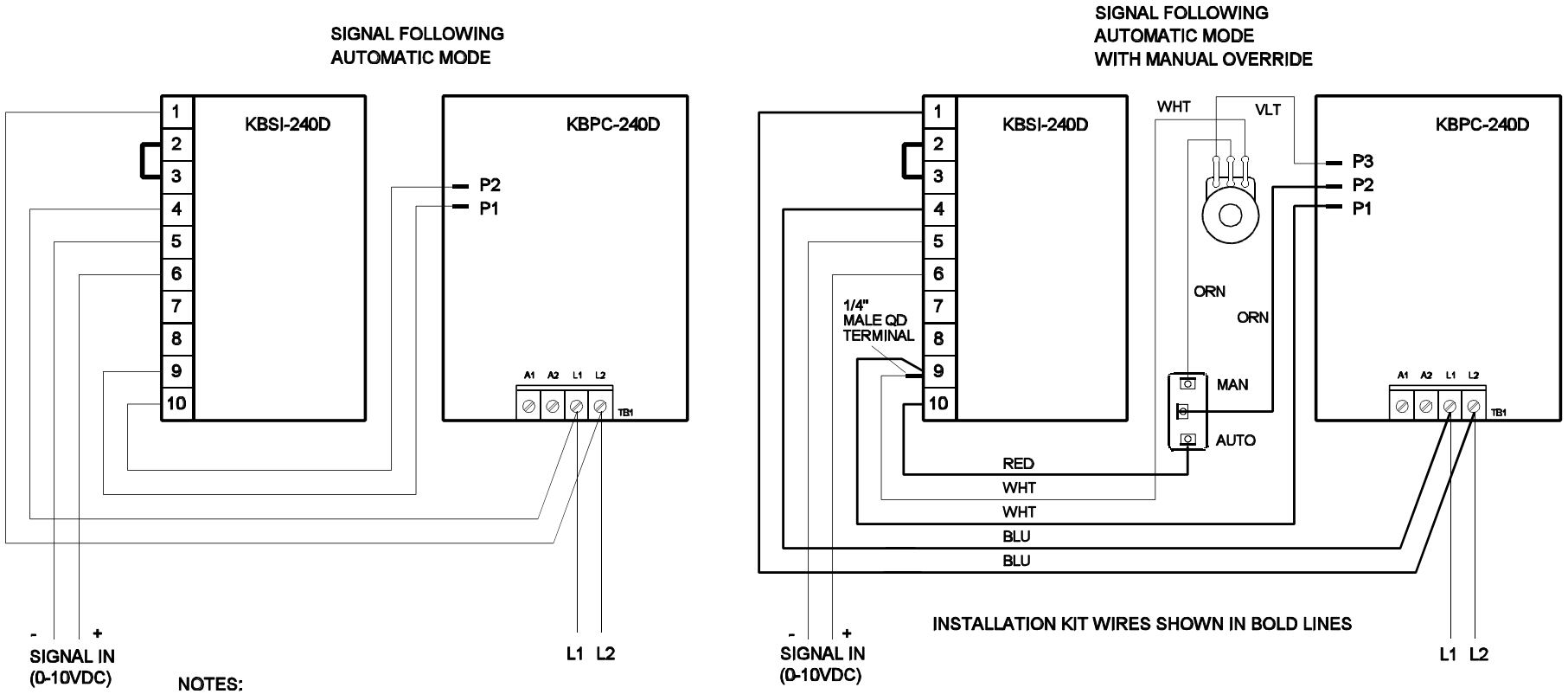
D. Auto/Manual Installation Kit (P/N 9377) – This kit facilitates mounting of KBSI-240D Signal Isolator into KBPC-240D. Contains Auto/Man Switch and necessary wiring and hardware. (KBSI-240D, P/N 9431 purchased seperately).

E. ON/OFF AC Line Switch (P/N 9341) – This option is desirable if a positive AC Line disconnect is required. The switch can be installed in lieu of the Start/Stop Switch (which can be easily removed) or in place of the Run-Stop-Jog or the Forward-Brake Reverse Switch. Installation is made via quick-connect terminals.

F. RFI Filter (Model KBRF-200A, P/N 9945A) – The KBRF-200A meets the requirements of CE directives pertaining to RFI filtering.

G. Electronic Forward-Brake-Reverse (APRM-PC P/N 9378) – The APRM-PC provides electronic reversing with solid state dynamic braking. Plug reversing is eliminated with KB's patented APRM®. The Unit is supplied with a FWD-BRK-REV toggle switch; however, it can also be switched with an external switch or relay.

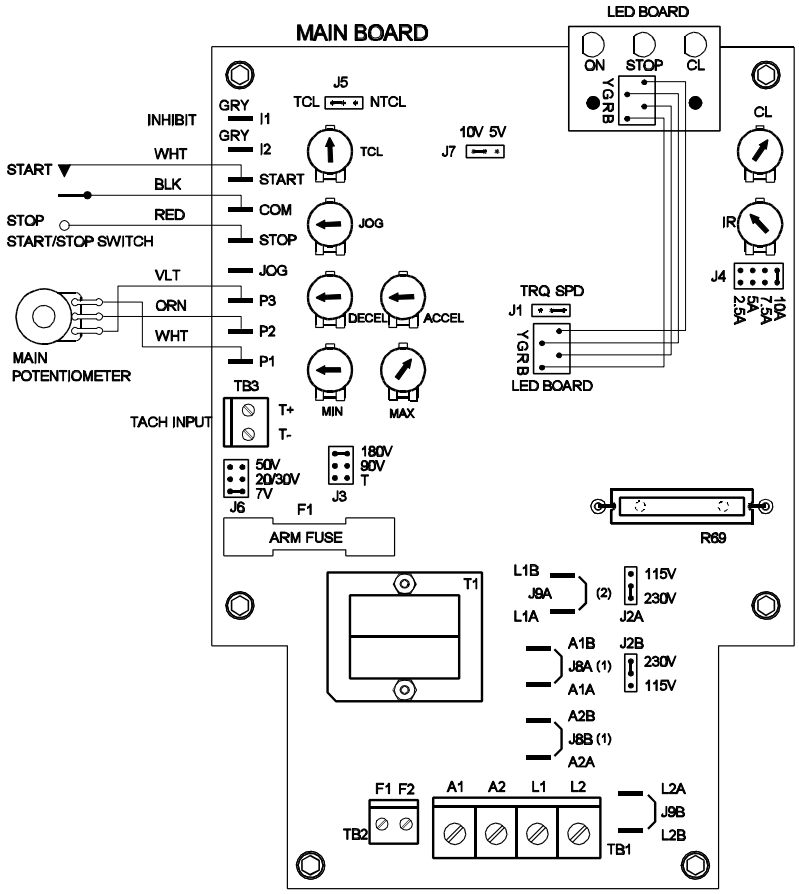
FIG. 17 – CONNECTION DIAGRAMS FOR KBPC-240D WITH KBSI-240D SIGNAL ISOLATOR



NOTES:

1. KBSI-240D IS SHOWN WIRED FOR 230VAC LINE
2. OTHER SIGNAL RANGES AVAILABLE. (SEE KBSI-240D INSTRUCTION MANUAL)

FIG. 18 – INTERNAL CONNECTION DIAGRAM

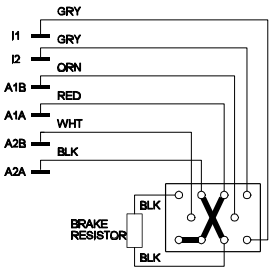


NOTES:

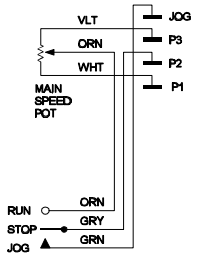
1. J8A AND J8B ARE REMOVED WHEN INSTALLING OPTIONAL FWD-BRK-REV SWITCH.
2. J9A AND J9B ARE REMOVED WHEN INSTALLING OPTIONAL ON/OFF AC LINE SWITCH START/STOP SWITCH IS REPLACED BY ON/OFF AC LINE SWITCH.
3. ALL JUMPERS ARE SHOWN IN FACTORY SET POSITIONS.

FIG. 19 – CONNECTION DIAGRAMS FOR AVAILABLE OPTIONS

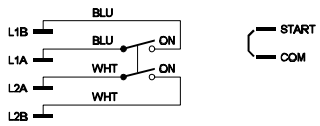
FWD-BRK-REV SWITCH [1]



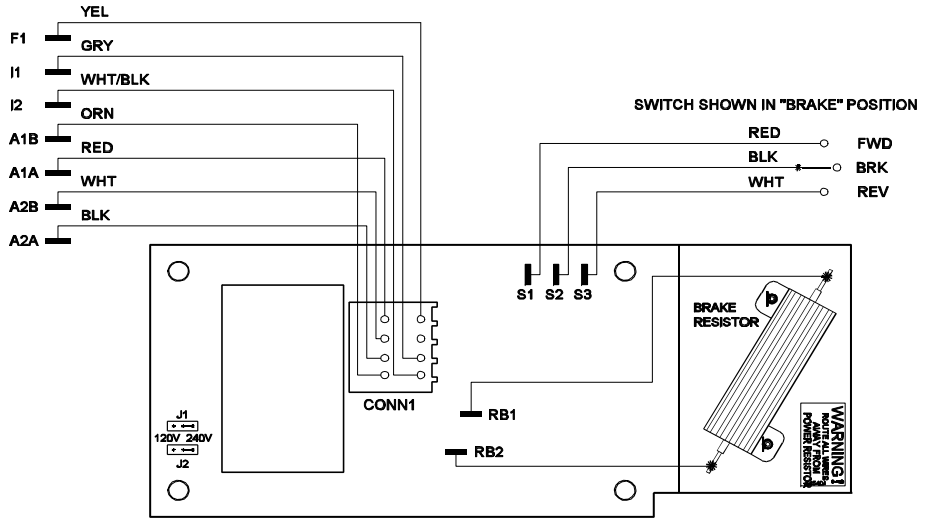
RUN-STOP-JOG SWITCH
(SHOWN IN "STOP" POSITION)



ON/OFF AC LINE SWITCH [2]
(SHOWN IN "OFF" POSITION)



APRM®-PC (Electronic FWD-BRK-REV)

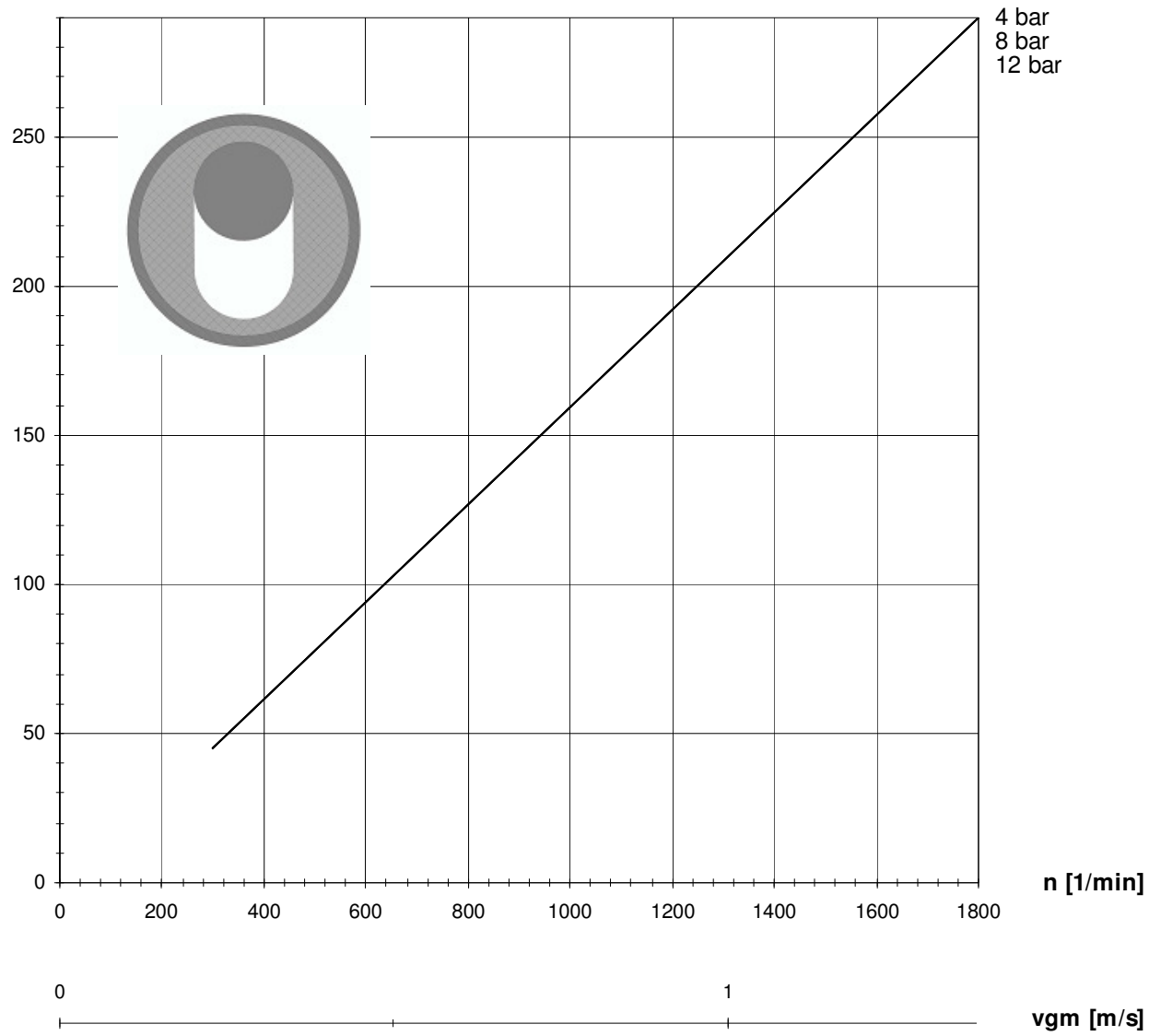


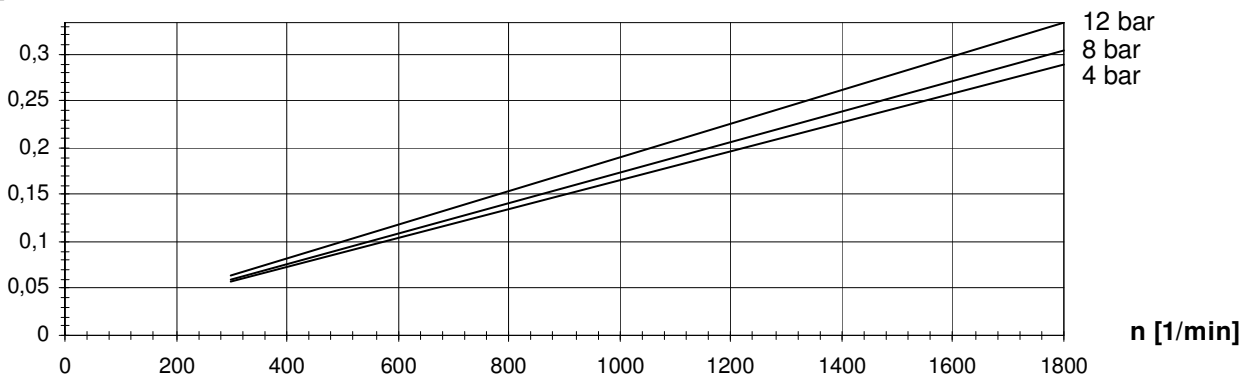
X – LIMITED WARRANTY

For a period of 18 months from date of original purchase, KB will repair or replace without charge devices which our examination proves to be defective in material or workmanship. This warranty is valid if the unit has not been tampered with by unauthorized persons, misused, abused, or improperly installed and has been used in accordance with the instructions and/or ratings supplied. The foregoing is in lieu of any other warranty or guarantee, expressed or implied, and we are not responsible for any expense, including installation and removal, inconvenience, or consequential damage, including injury to any person, caused by items of our manufacture or sale. Some states do not allow certain exclusions or limitations found in this warranty so that they may not apply to you. In any event, KB's total liability, under all circumstances, shall not exceed the full purchase price of this unit. (rev 4/88)

KB ELECTRONICS, INC.
12095 NW 39th Street, Coral Springs, FL 33065 • (954) 346-4900 • Fax (954) 346-3377
Outside Florida Call **TOLL FREE** (800) 221-6570 • **E-mail** – info@kbelectronics.com
www.kbelectronics.com

(A40400) – Rev. B – 3/98



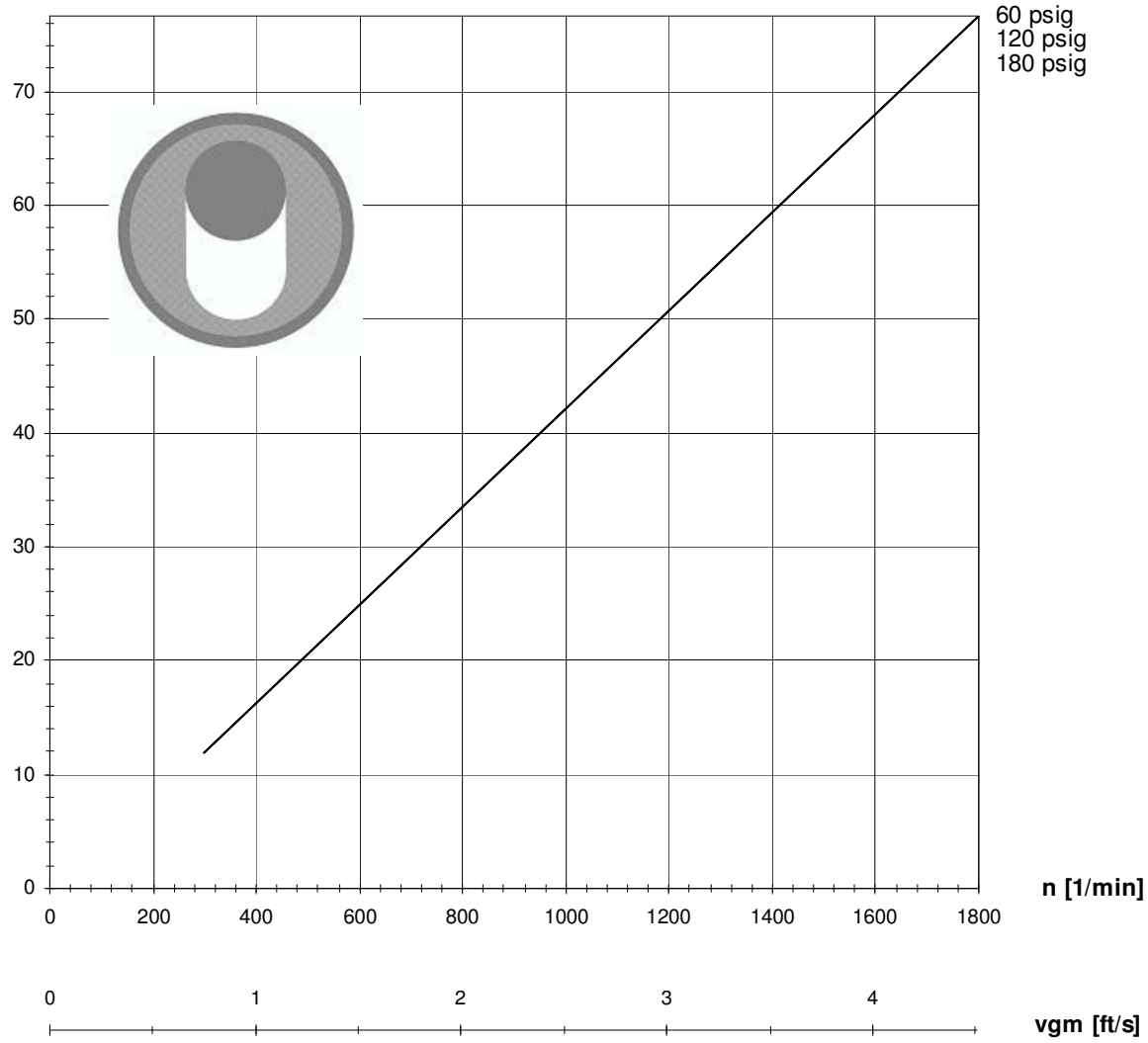


Losbrechmoment / starting torque T(L) = 1,5 Nm

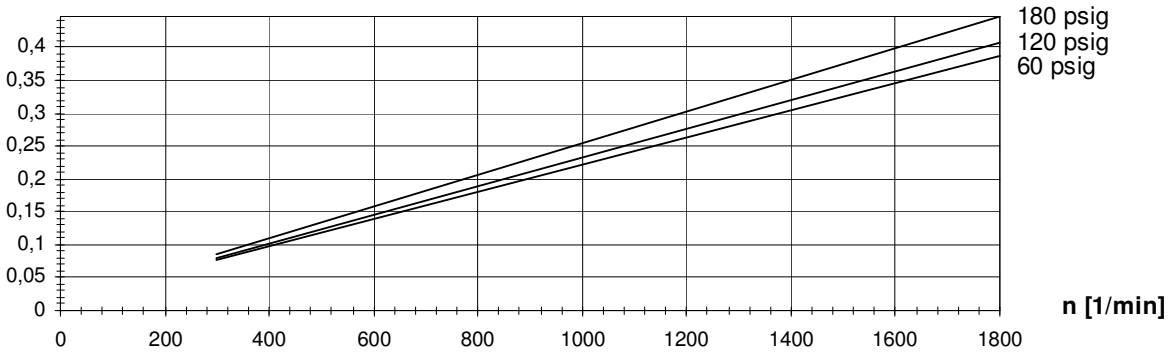
Druck / pressure	T
4 bar	1,4 Nm
8 bar	1,5 Nm
12 bar	1,7 Nm

Gültigkeit für Wasser (1 cP) bei 20 °C. Toleranzen nach VDMA 24284 (+10%/-5%).
Valid for water (1 cP) at 20 °C (70 °F). Tolerances are in accordance with VDMA 24284 (+10%/-5%).

GPH



HP



starting torque T(L) = 1,11 lbft

pressure	T
60 psig	1,036 lbft
120 psig	1,11 lbft
180 psig	1,258 lbft

Valid for water (1 cP) at 20 °C (70 °F). Tolerances are in accordance with VDMA 24284 (+10%/-5%).

PolyFloc* AE1138

High Molecular Weight Flocculant

- Dewaters sludges
- Cost-effective liquid
- Effectively clarifies wastewater in a variety of applications

Description and Use

PolyFloc* AE1138 is a highly anionic charged, high molecular weight, polymeric flocculant. It is designed to function in industrial water and wastewater treatment programs as a coagulant aid or flocculant in clarification and sludge dewatering processes.

PolyFloc AE1138 is a liquid emulsion, providing a cost-effective solution to many solids separation processes, particularly in effluent water treatment applications.

PolyFloc AE1138 produces a fast-settling floc, which reduces carryover when used as a flocculant in raw water or wastewater treatment clarifiers, thus mitigating bulking problems.

PolyFloc AE1138 provides cost-effective sludge conditioning for those sludges having a high anionic charge demand. It produces a clean filtrate, high solids capture, and a drier cake, resulting in lower sludge transportation and disposal costs.

Treatment and Feeding Requirements

PolyFloc AE1138 must be dissolved in water before use. The solution may be prepared in batch fashion by slowly adding the pre-mixed polymer to the vortex of an agitated tank. **Do not add water to the neat polymer.** Recommended initial make down solution concentration is 0.5 percent. Low speed (350 rpm) mechanical agitation should continue until complete dissolution is accomplished. Avoid high shear or excessive agitation once the product has been dissolved. Dilute solutions should be used within 24 hours for maximum activity.

Continuous make down systems are also available and can produce more reliable results than manual batch make down. Further dilution of the stock solution to approximately 0.1 percent enhances polymer performance in most applications. For dewatering applications, dilution to approximately 0.25 percent may be more practical. Your GE Water & Process Technologies representative can assist you in this and other polymer feeding requirements.

Diluted product may be fed by a pump, eductor, or gravity flow to a point where good mixing, but no violent agitation, of the treated water occurs. High speed mixing decreases the activity of the polymer. Pumps used to transfer the solution to the point of application should be positive displacement, such as gear or piston pumps.

Liquid-side components of tanks, pumps, and piping can be constructed of stainless steel, copper, brass, or plastics, with the exception of polyethylene and polypropylene. Mild steel construction of tanks, pumps, and piping is not recommended. Viton and Tygon rubbers are acceptable for pump components and hose linings.

General Properties

Physical properties of PolyFloc AE1138 are shown on the Material Safety Data Sheet (MSDS), a copy of which is available on request.

Find a contact near you by visiting www.ge.com/water and clicking on "Contact Us".

* Trademark of General Electric Company; may be registered in one or more countries.

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Packaging Information

PolyFloc AE1138 is a liquid emulsion product available in a variety of containers. Consult your GE representative for delivery and packaging alternatives.

Storage and Handling

Store PolyFloc AE1138 at moderate temperatures of 45 to 95°F (7 to 35°C), and protect from freezing. Bulk containers should be insulated and heat traced (where necessary) if outdoors. Neat polymer should be recirculated or mixed periodically to avoid product separation. Recirculate one container volume per day. The recommended shelf life of the product is six months. Spilled polymer is very slippery. Small amounts of spilled polymer can be washed down with copious amounts of water. Large spills should be contained and absorbed on inert material and disposed as solid waste, prior to flushing with water.

Safety Precautions

An MSDS containing detailed information about this product is available on request.

VISSERS SALES CORP.
220 INDUSTRIAL PARKWAY S, UNIT 19
AURORA, **ONTARIO**, L4G 3V6
TEL: (905) 841-4073
FAX: (905) 841-4018

#102-1628 Fosters Way
Delta **BRITISH COLUMBIA** V3M 6S6
TEL: (604) 523-1798
FAX: (604) 523-1788

QUOTATION

Date	**July 23, 2009**
Reference	**BM072209rev1**
No. of Pages	

Customer: AMEC GEOMATRIX LIMITIED	**Contact JERED MUNRO**
Address:	**Title:**
	Phone: 519-886-7500 EXT 248
	Fax: 519-886-7419

AS DISCUSSED I AM PLEASED TO QUOTE THE FOLLOWING

1) Pulsatron LPH8SAPTCBXXX rated at 94.6 litres per hour @ 30 psi.
Net price $ 1778.00

1) 1000ml cal column CC1000S
Net price $ 127.00

1) Pulsatron LPH6SAPTC3XXX rated at 18.9 liters per hour @ 100 psi
Net price $ 1066.00

1) 500 ml cal column CC0500S
Net price $ 105.00

1) CG3 mixer ½ hp 350 rpm c-clamp style mixer ¾ x 36” shaft single 10” prop
Net price $ 2278.00 (polymer makedown)with 10 foot power cord.

Regards
Barrie.

PRICING / TERMS / DELIVERY		
Terms:	**Net 30 Days O.A.C**	
F.O.B.:	**Aurora, Ontario**	
Taxes:	**Extra**	
Quotation Valid 60 Days		**Quoted By: BARRIE MILES**
Delivery:	**2-3 days**	

Quantity:	**Unit Price:**	**Total Price:**

8.0 POLICIES AND PROCEDURES

8.1 Manufacturers Product Warranty

The manufacturer warrants its equipment of its manufacture to be free of defects in material or workmanship Liability under this policy extends for twenty-four (24) months from the date of purchase or one (1) year from date of installation or whichever comes first. The manufacturer's liability is limited to repair or replacement of any device or part, which is returned, prepaid, to the factory and which is proven defective upon examination. This warranty does not include installation or repair cost and in no event shall the manufacturer's liability exceed its selling price of such part.

The manufacturer disclaims all liability for damage to its products through improper installation, maintenance, use, or attempts to operate such products beyond their functional capacity, intentionally or otherwise, or any unauthorized repair. Replaceable elastomeric parts are expendable and are not covered by any warranty either expressed or implied. The manufacturer is not responsible for consequential or other damages, injuries, or expense incurred through use of its products.

The above warranty is in lieu of any other warranty, either expressed or implied. The manufacturer makes no warranty of fitness or merchantability. No agent of ours is authorized to make any warranty other than the above.

For warranty and service matters within the European Union, contact the seller first or:

Pulsafeeder, Inc. Europe
Units 12 and 13, Edison Road
Eastbourne, East Sussex BN23 6PT

8.2 Returns

The Customer Service Department will issue a Return Authorization (RA) number for all returns. The following information will be required:

1. Billing and a ship-to address.
2. Model and serial number.
3. Contact name and phone number.
4. Reason for return.
5. Purchase order (where applicable).
6. RA number on outside of the carton.

All material must be returned freight prepaid. All merchandise must be properly packaged and free of any corrosive, toxic or otherwise hazardous chemical. All items returned must reference Return Authorization.

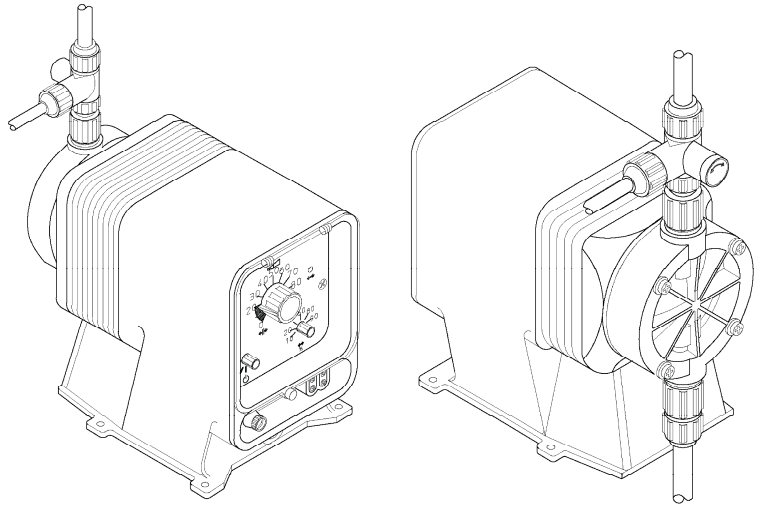
8.3 Credits

No equipment will be accepted beyond six months after date of shipment from the factory. Only unused and undamaged equipment will be accepted for return to stock. All credits are based on acceptance of materials as new and unused by our inspection personnel. A restocking fee will apply. All equipment returned for credit must have a RA number and be returned freight prepaid.

Electronic Metering Pumps

Series C, C+, A+, E, E-DC and E+

Installation
Operation
Maintenance
Instruction

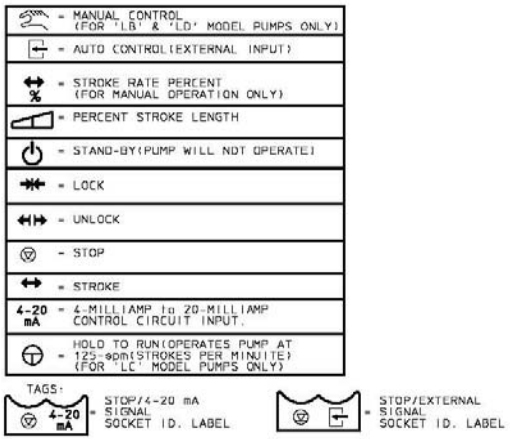


READ ALL WARNINGS CAREFULLY
BEFORE INSTALLING

TABLE OF CONTENTS

1.0 SAFETY INSTRUCTIONS 3
1.1 General Safety Considerations 3
1.2 Safety Operating Procedures 3
2.0 UNPACKING THE PUMP 4
3.0 INTRODUCTION 5
3.1 Principle of Operation 5
3.2 Materials of Construction 5
4.0 INSTALLATION 5
4.1 Mounting 5
4.2 Piping 6
4.3 Wiring 7
4.4 Well Pump System Installation 7
5.0 START UP AND OPERATION 8
5.1 Power 8
5.2 Priming 8
5.3 Capacity Control 8
5.3.1 Stroke Frequency Adjustment 8
5.3.2 Stroke Length Adjustment 9
5.3.3 Controlling Procedure 9
5.4 Control Panel Symbols 9
5.5 Operation By External Input Signals 9
5.5.1 Stop Functions 9
5.5.2 External Pacing Function 10
5.5.3 4-20mA DC Input Function 10
6.0 MAINTENANCE 11
6.1 Routine Maintenance 11
6.2 Disassembly and Assembly Diaphragm Removal 11
6.3 Diaphragm Replacement 11
6.4 Valve Replacement 12
7.0 TROUBLESHOOTING 13
Appendix A 15
8.0 POLICIES AND PROCEDURES 16
8.1 Manufacturer's Product Warranty 16
8.2 Returns 16
8.3 Credits 16

Appendix A



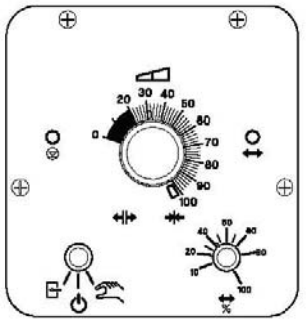


Figure 11

Leakage at Fitting	**1. Loose fittings**	**1. Tighten hand tight. Replace gasket if hand tightening does not stop leakage**
	2. Broken or twisted gasket	**2. Check gaskets and replace if broken or damaged**
	3. Chemical attack	**3. Consult your pump supplier for alternate material**
Pump Loses Prime	**1. Dirty check valve**	**1. Remove and replace or clean off any scale or sediment**
	2. Ball checks not seating or not sealing properly	**2. Check seat and ball checks for chips, clean gently. If deformity or deterioration is noted, replace part with proper material. Resulting crystals can hold check valves open, therefore, the valves must be disassembled and cleaned**
	3. Solution container allowed to run dry	**3. Refill the tank with solution and prime. See 5.0 Start-up and Operation Section**
	4. Chemical out gassing	**4. Bleed gas, use flooded suction and maintain chemical at room temperature (approximately 20˚F) to minimize out gassing**
Pump will not Prime	**1. Too much pressure at discharge**	**1. Turn off all pressure valves, relieve system pressure then loosen outlet tubing connection at discharge point. Remove discharge valve cartridge. Dampen ball check and valve seats with a few drops of solution. Set pump dial to maximum rate. When pump is primed, reconnect all tubing connections**
	2. Check valves not sealing	**2. Disassemble, clean and check for deterioration, damage or swelling. Reassemble and wet the valve assembly, then prime. See 5.0 Start-Up and Operation Section.**
	3. Output dials not set at maximum	**3. Always prime pump with output dial set at maximum rated capacity.**
	4. Suction lift height too much. Maximum 5ft (1.5m)	**4. Decrease suction lift or pull vacuum on pump discharge until pump is primed**
	5. Pump equipped with spring loaded high viscosity valves	**5. Loosen discharge valve to aid in priming, take necessary safety precautions for spills or apply vacuum to pump discharge**

1.0 SAFETY INSTRUCTIONS

WARNING

When using chemical feed pumps, basic safety precautions should always be followed to reduce risk of fire, electric shock, and personal injury. Failure to follow these instructions could result in death or serious injury.

READ ALL INSTRUCTIONS

1.1 General Safety Considerations

Always wear protective clothing including gloves and safety goggles when working on or near chemical metering pumps.

Inspect tubing regularly when replenishing chemical solution for cracking or deterioration and replace as necessary. **(Always wear protective clothing and safety glasses when inspecting tubing.)**

When pump is exposed to direct sunlight use U.V. resistant tubing.

Follow directions and warnings provided with the chemicals from the chemical manufacturer. User is responsible for determining chemical compatibility with chemical feed pump.

Secure chemicals and metering pumps, making them inaccessible to children and pets.

Make sure the voltage on the chemical metering pump matches the voltage at the installation site.

Do not cut plug or the ground lug off of the electrical cord – consult a licensed electrician for proper installation.

Pump is **NOT** to be used to handle flammable liquids.

1.2 Safety Operating Procedures

Each Electronic Metering Pump has been tested to meet prescribed specifications and safety standards.

Proper care in handling, installation and operation will help in ensuring a trouble free installation.

Please read all these cautionary notes prior to installation and start-up of your metering pump.

Important: Pump must be installed and used with supplied back pressure/injection valve. Failure to do so could result in excessive pump output.

Handle the pump with care. Dropping or heavy impact causes not only external damage to the pump, but also to electrical parts inside.

Install the pump in a place where the ambient temperature does not exceed 104ºF (40ºC). The pump is water resistant and dust proof by construction and can be use outdoors, however **do not operate the pump submerged**. To avoid high internal pump temperatures, do not operate in direct sunlight.

CAUTION Solenoid housing, head and pump housing may be hot to touch 160ºF (70ºC).

Install the pump in a place convenient for its future maintenance and inspection, and then secure it to prevent vibration.

Protective caps must be removed prior to installing tubing onto valve assemblies. Use tubing of specified size. Connect the tubing to the suction side securely to prevent the entrance of outside air. Make sure that there is no liquid leakage on the discharge side.

Be careful to check that the voltage of the installation matches voltage indicated on the pump data label. Most pump models are equipped with a three-prong plug. Always be sure the pump is grounded. To disconnect, do not pull wire but grip the plug with fingers and pull out. Do not use the receptacle in common with heavy electrical equipment, which generates surge voltage. It can cause failure of the electronic circuit inside the pump.

Tampering with electrical devices can be potentially hazardous. Always place chemicals and pump installation well out of the reach of children.

Never repair or move the metering pump while operating. Always disconnect electrical power. **For safety, always wear protective clothing (protective gloves and safety glasses) when working on or near chemical metering pumps.**

An air bleed valve is available for most models with tubing connections. Air purges should be performed when the pump-chamber contains no fluid at the time of start-up. As a safety measure, connect the return tubing to the air bleed valve and bypass fluid back to storage tank or a suitable drain.

For accurate volume output, the pump must be calibrated under typical operating conditions.

Chemicals used may be dangerous and should be used carefully and according to warnings on the label. Follow the directions given with each type of chemical. Do not assume chemicals are the same because they look alike. Always store chemicals in a safe location away from children and others. We cannot be responsible for the misuse of chemicals being fed by the pump. Always have the material safety data sheet (MSDS) available for any fluid being pumped.

All pumps are pretested with water before shipment. Remove head and dry thoroughly if you are pumping a material that will react with water, (i.e. sulfuric acid, polymers). Valve seats, ball checks, gaskets, and diaphragm should also be dried. Before placing pump into service, extreme care should be taken to follow this procedure.

Valve cartridges are stamped to indicate fluid flow direction. Always install so that markings read from top to bottom, with the arrow pointing in the direction of flow.

When metering hazardous material **DO NOT** use plastic tubing, strictly use proper rigid pipe. Consult supplier for special adapters or valve assemblies.

Pump is NOT to be used to handle or meter flammable liquids or materials.

Standard white discharge tubing is not recommended for installations exposed to direct sunlight. Consult supplier for special black tubing.

Factory will not be held responsible for improper installation of pump, or plumbing. All cautions are to be read thoroughly prior to hookup and plumbing. For all installations a professional plumber should be consulted. Always adhere to local plumbing codes and requirements.

When using pump with pressurized systems, make sure the pressure of the system does not exceed the maximum pressure rating on the pump data label. Be sure to depressurize system prior to hook up or disconnecting a metering pump.

Electronic power modules are equipped with automatic reset thermal overload devices and may reset unexpectedly.

2.0 UNPACKING THE PUMP

Check all equipment for completeness against the order and for any evidence of shipping damage. Shortages or damages should be reported immediately to the carrier and to the seller of the equipment.

The carton should Contain:

- ✓ Metering Pump
- ✓ Clear Flexible Suction Tubing*
- ✓ Stiff White Discharge Tubing*
- ✓ Foot valve/Strainer Assembly
- ✓ Backpressure Injection Valve Assembly
- ✓ Manual
- ✓ Bleed Valve Assembly*
- ✓ Strainer Weight*

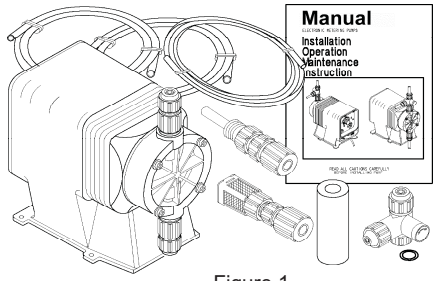


Figure 1

*Items may or may not be included depending on model.

Make sure that all items have been removed from the shipping carton before it is discarded.

7.0 TROUBLESHOOTING

Problem	Probable Cause	Remedy
Failure to Pump	1. Leak in suction side of pump	1. Examine suction tubing. If worn at the end, cut approximately one inch (2.5cm) off and reconnect
	2. Valve seats not sealing	2. Clean valve seats if dirty or replace with alternate material if deterioration is noted
	3. Low setting on pump	3. When pumping against pressure, the dial should be set above 20% capacity for a reliable feed rate
	4. Low suction level	4. Solution must be above foot valve strainer
	5. Diaphragm ruptured	5. Replace diaphragm as shown in 6.0 Maintenance Section. Check for pressure above rated maximum at the injection point. NOTE" Chemical incompatibility with diaphragm material can cause diaphragm rupture and leakage around the pump head
	6. Pump head cracked or broken	6. Replace pump head as shown in 6.0 Maintenance Section. Make sure fitting are hand tight only. Using pliers and wrench can crack pump head. Also, chemical incompatibility can cause cracking and subsequent leakage.
	7. Pump head contains air or chlorine gas	7. Bleed pump head, see 5.0 Start-up and Operation section
	8. Breakdown or disconnection of wiring	8. Connect wiring properly. Check fuse or circuit breaker
	9. Voltage drop	9. Take measures after investigation of cause
	10. Malfunction of electronic control board	10. Contact supplier
Loss of Chemical Residual	1. Pump setting to low	1. Adjust to higher setting (pump must be operating to adjust stroke length knob)
	2. Scale at injection point	2. Clean injection parts with 8% muriatic acid or undiluted vinegar (also, see Maintenance Section)
	3. Solution container allowed to run dry	3. Refill the tank with solution and prime (see Start-up and Operation Section)
Too Much Chemical	1. Pump setting too high	1. Lower pump setting (pump must be operating to adjust stroke length knob)
	2. Chemical in solution tank too rich	2. Dilute chemical solution. NOTE: For chemical that reacts with water, it may be necessary to purchase a more dilute grade of chemical direct from chemical supplier
	3. Siphoning of chemical into well or main line	3. Test for suction or vacuum at the injection point. If suction exists, install an anti-siphon valve
Leakage at Tubing Connections	1. Worn tube ends	1. Cut off end of tubing approximately one inch (2.5cm) and reconnect
	2. Chemical attack	2. Consult your seller for alternate material

Apply grease to areas of the diaphragm that contact the deflection plate.

Slide the diaphragm deflection plate onto the back of the diaphragm stud, radius side towards the diaphragm. Next slide two shims onto the diaphragm threaded stud and screw the diaphragm into the EPM unit. Refer to Figure 14. Turn diaphragm clockwise until deflection plate and shims are tight against solenoid shaft and the diaphragm stops turning. If there is a gap between the adaptor and diaphragm, repeat the procedure removing one shim each time until the diaphragm just touches the adaptor or is slightly recessed.

If not already done, adjust stroke length to 50%. Place the pump head onto the adaptor with valve flow arrows pointing up and install and tighten pump head screws. Tighten screws until pump head pulls up against adaptor.

NOTE: Adjust stroke length only when pump is running!

Adjust stroke length back to 100% for easier priming and place pump back into service.

6.4 Valve Replacement

Flush pump to clean any chemical from pump head.

Unplug pump, release system pressure, and disconnect tubing or piping.

Unscrew valve cartridges and discard. Also remove o-rings down inside the pump head.

Install new valve cartridges with stamped letters reading from top to bottom, and the arrow pointing in the direction of flow. Hand-tighten only, do not use wrenches or pliers.

Reconnect tubing or piping and reinstall the pump.

Check for leaks around newly installed fittings.

3.0 INTRODUCTION

These installation, operation and maintenance instructions cover your electronic metering pump. Refer to the pump data label to determine the actual model.

3.1 Principle of Operation

Diaphragm metering pumps are used to dispense chemicals or fluids. This is achieved by an electromagnetic drive mechanism (solenoid), which is connected to a diaphragm. When the solenoid is pulsed by the control circuit it displaces the diaphragm, which, through the use of check valves, moves the fluid out the discharge under pressure. When the solenoid is de-energized it returns the diaphragm and pulls more fluid into the pump head and the cycle repeats.

The pump stroke rate is controlled by an internal circuit and is changed by turning the rate knob. The mechanical stroke length is controlled by the stroke length knob. Some models do not allow stroke rate control and do not have the stroke rate knob.

3.2 Materials of Construction

The wetted materials (those parts that contact the solution being pumped) available for construction are FPP (glass filled polypropylene), PVC, CSPE, Viton, PTFE or FTF, 316 Stainless Steel, PVDF, Ceramic and Alloy C. These materials are very resistant to most chemicals. However, there are some chemicals, such as strong acids or organic solvents, which cause deterioration of some elastomer and plastic parts, such as the diaphragm, valve seats, or head.

Consult a Chemical Resistance Guide or Supplier for information on chemical compatibility.

Various manufacturers of plastics, elastomers and pumping equipment publish guidelines that aid in the selection of wetted materials for pumping commercially available chemicals and chemical compounds. Two factors must always be considered when using an elastomer or plastic part to pump chemicals. They are:

The temperature of service: Higher temperatures increase the effect of chemicals on wetted materials. The increase varies with the material and the chemical being used. A material quite stable at room temperature might be affected at higher temperatures.

Material choice: Materials with similar properties may differ greatly from one another in performance when exposed to certain chemicals.

4.0 INSTALLATION

The metering pump should be located in an area that allows convenient connections to both the chemical storage tank and the point of injection. The pump is water resistant and dust proof by construction and can be used outdoors, however, **do not operate submerged.** Avoid continuous temperatures in excess of 104˚F (40˚C). To do otherwise could result in damage to the pump.

4.1 Mounting

Typical mounting arrangements are shown in Figures 3, 4, and 5.

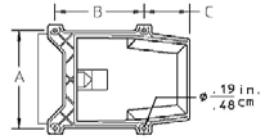
Important: Injection point must be higher than the top of the solution supply tank to prohibit gravity feeding, unless suitable backpressure is always present at the injection point. Installation of an anti-siphon valve will prohibit gravity feeding.

For wall or shelf mounting refer to Figure 3. Connect suction tubing to suction valve of chemical pump. Suction valve is the lower valve. Tubing should be long enough so that the foot valve/strainer assembly hangs about 1-2 inches (2-5 cm) above the bottom of chemical tank. To keep chemical from being contaminated, the tank should have a cover.

Flooded suction mounting (installing the pump at the base of the chemical storage tank, Figure 4) is the most trouble free type of installation and is recommended for very low output requirements. Since the suction tubing is filled with chemical, priming is accomplished quickly and the chance of losing prime is reduced.

To mount pump, drill four holes of .25” (6 mm) diameter in the shelf as shown in the dimension drawing (figure 2). Attach pump securely using four #10 (M5) bolts and nuts.

The pump can be mounted on top of a solution tank as shown in Figure 5. Install chemical pump on the cover. Insert suction tubing through the center hole and cut tubing so foot valve/strainer hangs about 1 or 2 inches (2-5 cm) above the bottom of the tank. Mount the chemical pump rigidly by drilling four .25” (6 mm) holes and using four (4) #10 (M5) screws and nuts.



MOUNTING HOLE DIMENSIONS

HOUSING SIZE	DIMENSIONS (in./cm.) A	B	C
HSG.#1	4.50/11.4	3.00/ 7.6	1.75/4.4
HSG.#2	4.81/12.2	4.38/11.1	2.19/5.6
HSG.#3	5.56/14.1	4.38/11.1	2.19/5.6

FIGURE 2

USE AN ANTI-SIPHON VALVE IN THE DISCHARGE LINE whenever the fluid pressure in the discharge line is below atmospheric pressure. This can occur if the injection point is on the suction side of a water pump or against a "negative" head such as when feeding down into a well.

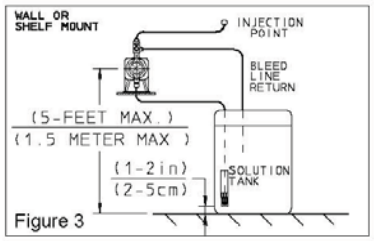


Figure 3

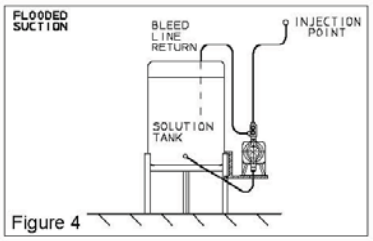


Figure 4

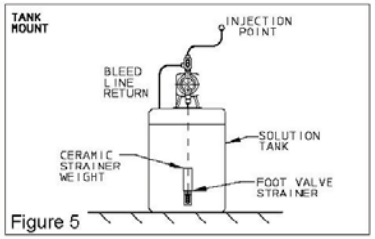


Figure 5

4.2 Piping

Use provided tubing of specified size for connection. Connect tubing securely to prevent leakage of chemical and the entrance of air. Since plastic nuts are used for fittings, they should not be tightened excessively (i.e. hand tighten only). NPT suction and discharge valves must **NOT** be over tightened. Hold fitting in place while adding piping and fittings. NPT suction and discharge valves should only be tightened 25 to 35 in. lbs. (4.5-6.3 kg/cm).

If the air bleed valve assembly is being used, a return line (tubing) should be securely connected and routed back to the storage tank. **To avoid possible injury from chemicals do not attempt to prime using a bleed valve without installing a return line.**

When pump is shelf mounted or top mounted on tank, suction tubing should be kept as short as possible.

To maintain metering performance, a backpressure/injection valve is provided. The spring in the standard injection valve typically adds 17 - 20 PSI (1.17 - 1.38 BAR) to the line pressure, with the exception of the H8 pump, which adds 8 - 10 PSI (.55 - .69 BAR). The injection valve must be installed in the discharge line. Best practice is to install the injection valve at the point of chemical injection.

If the discharge tubing is going to be exposed to direct sunlight, black tubing should be used instead of the standard white translucent tubing supplied with each pump. To obtain, contact supplier.

To prevent clogging or check valve malfunction always install a strainer assembly to the end of the suction tubing (Figure 5). This foot valve/strainer assembly should always be installed 1 to 2 inches (2-5 cm) above the bottom of the chemical tank. This will help prevent clogging the strainer with any solids that may settle on the tank bottom. The chemical tank and foot valve/strainer should be cleaned regularly, to ensure continuous trouble free operation. If the chemical being pumped regularly precipitates out of solution or does not dissolve easily or completely (e.g. calcium hydroxide), a mixer should be used in the chemical tank. These are readily available in many motor configurations and mounting. To obtain, contact supplier.

The signal cord polarity is:

Black = Common
White = Positive
Wrong polarity can result in excess flow.

Signal input impedance is 124 ohms.

Remove cap from pump socket labeled 4-20 mA, use polarized cord supplied with pump to connect control circuit to pump. Plug cord into pump socket labeled 4-20 mA.

6.0 MAINTENANCE

⚠ CAUTION Before performing any maintenance or repairs on chemical metering pumps, be sure to disconnect all electrical connections, insure that all pressure valves are shut off and pressure in the pump and lines has been bled off.

Always wear protective clothing, gloves and safety glasses when performing any maintenance or repairs on chemical metering pumps.

6.1 Routine Maintenance

Routinely check the physical operating condition of the pump. Look for the presence of any abnormal noise, excessive vibration, low flow and pressure output or high temperatures [when running constantly at maximum stroke rate, the pump housing temperature can be up to 160˚F (70˚C)].

For optimum performance, cartridge valves should be changed every 6-12 months. Depending on the application, more frequent changes may be required. Actual operating experience is the best guide in this situation.

Repeated short-term deterioration of valve seats and balls usually indicates a need to review the suitability of wetted materials selected for the application. Contact the supplier for guidance.

Check for leaks around fitting or as a result of deteriorating tubing e.g. when standard white translucent discharge tubing is exposed to direct sunlight. Take appropriate action to correct leak by tightening fittings or replacing components.

Keep the pump free of dirt and debris as this provides insulation and can lead to excessive pump temperatures.

If the pump has been out of service for a month or longer, clear the pump head valve assemblies by pumping fresh water for approximately 30 minutes. If the pump does not operate normally after this “purging run”, replace cartridge valve assemblies.

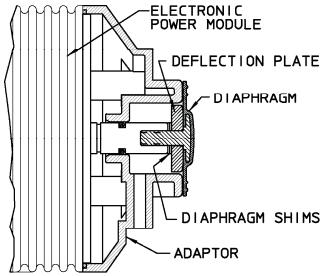
6.2 Disassembly and Assembly

Diaphragm Removal

Flush pump head and valve assemblies out by running pump with water or other suitable neutralizing solution. Wash outside of pump if chemical has dripped on pump. Set stroke length knob of pump to 0% and unplug pump.

Depressurize the system and disconnect tubing or piping from the pump. Remove the four pump head screws and then remove the pump head assembly.

Remove the diaphragm by grasping it at the outer edge and turning it counter clockwise until it unscrews from the electronic power module (EPM). Don’t lose the deflector plate or diaphragm shims which are behind the diaphragm, they are needed for re-assembly. Note shim quantity may be from 0 to 2.



Inspect diaphragm, if it is intended to be used again look for indications of the PTFE face being overstretched, (localized white areas) or the elastomer on the back of the diaphragm being worn. Excessive amounts of either condition require diaphragm replacement.

6.3 Diaphragm Replacement

When replacing the diaphragm, it is always a good idea to replace the valve cartridges and other worn parts. A kit is available from your supplier with all parts necessary to completely rebuild your pump’s wet end. All your supplier needs to know is the “KOPkit No.” on your pump’s data label to supply this kit.

Set pump stroke length at 50% and unplug the pump.

If you kept the shims from the original diaphragm or know the original quantity you can avoid the next step for shimming the diaphragm.

5.5.2 External Pacing Function (E+, A+, C+ and C only)

The pump's stroke rate can be controlled by an external signal input. When the input signal line is connected and the EXTERNAL /OFF /MANUAL switch is in the external position and a contact signal is input to the terminal marked ⇆, the pump makes one discharge stroke.

⚠ CAUTION **Operation of more than one pump from the same contact closure will damage the pump circuits. When such operation is required, the pump circuits must be electrically isolated from one another by means of a multi-contact control relay or similar means**.

When the "ON" signal pulse is input, the pump operates one stroke and the fluid is discharged. In addition, the pump can be operated continuously to its maximum strokes/min. by repeated input of "ON" and "OFF" signals.

After receiving an input signal, the pump generates the necessary power pulse to actuate the solenoid. The external signal input is debounced by the pump circuit. The pump will not stroke in response to a spurious or erratic input signal that follows at a rate greater than its maximum strokes/minute. If the external signal rate exceeds its maximum stokes/minute, the pump will stroke at half the external signal rate to prevent overdosing and to protect the pump from overheating.

The input signal must be in the form of closure of a mechanical relay, other mechanical switching device, or of a solid-state switching device. Voltage signals are prohibited. The switching resistance of either mechanical or solid-state devices must be 100 ohms or below when ON and 1 megohm or above when OFF. If any type of solid-state device is employed, it must be installed with proper polarity, if required for the device; and leakage current must not exceed 200 microamperes to prevent false triggering in the OFF state.

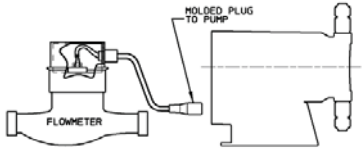


Figure 12

Cycle rate of the input signal should not exceed the maximum stroke/minute speed of the pump.

Typical wiring is shown at right for use with switch closure flow-meters. (Figure 12)

10 millisecond contact time required for each "ON" input signal.

5.5.3 4-20mA DC Input Function (E+ only)

The pump's stroke rate can also be controlled by a 4-20 mA DC signal to the terminal marked [4-20 mA].

For the 4-20 mA input to have any effect on the pump output rate, the AUTO/OFF/MANUAL switch must be in the AUTO position.

The 4-20 mA input signal affects the pump's outputs as per the graph below:

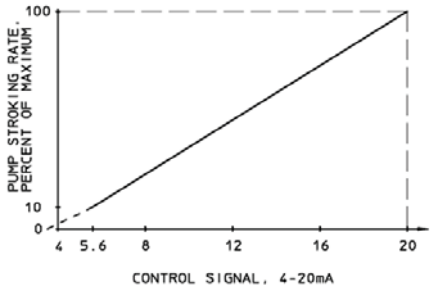


Figure 13

A flooded suction (tank liquid level always at a higher elevation than the pump) is recommended when pumping solutions such as sodium hypochlorite (NaOCl), hydrogen peroxide (H_2O_2), etc., which are likely to produce air bubbles. Maintaining a low liquid temperature will also help eliminate this problem.

Pipe corrosion can result if dilution at the injection point does not occur rapidly. This problem is easily prevented by observing this simple rule: install injection fitting so that the end is in the center of the flow stream of the line being treated. Trim injector tip as required. See Figure 6. Note: Extended injection assemblies are available for large water lines. Consult your supplier for more information.

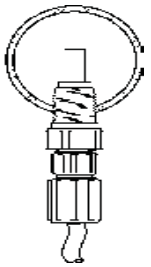


Figure 6

4.3 Wiring

⚠ WARNING **Risk of electrical shock. This pump is supplied with a three-prong grounding type power plug. To reduce risk of electric shock, connect only to a properly grounded, grounding type receptacle.**

The metering pump should be wired to an electrical source, which conforms to those on the pump data label. Applying higher voltage than the pump is rated for will damage the internal circuit.

In the electronic circuit of the control unit, measures for surge voltage are made by means of surge absorbing elements and high voltage semiconductors. Nevertheless, excessive surge voltage may cause failure in some areas. Therefore, the receptacle should not be used in common with heavy electrical equipment, which generates high voltage. If this is unavoidable however, measures should be taken by (a) the installation of a surge-absorbing element (varistor of min. surge resistance 2000A) to the power supply connection of the pump, or (b) the installation of a noise suppression transformer.

Signal input to the external pulse signal input terminals ([EXTERNAL], [STOP]) must be a no-voltage signal from relay-contacts etc. and the input of other signals is prohibited. In the case of relay contacts, 100 ohms or below when ON and 1-meg ohms or above when OFF. The pulse duration of the input signal must be 10 milliseconds or over and the frequency of the input signal must not exceed 125 times per minute. Signal cord is provided with the pump.

4.4 Well Pump System Installation

Ensure that the metering pump voltage matches the voltage of the well pump. Typical well pump electrical circuits are shown in Figure 8. All electric wiring should be installed in accordance to local codes by a licensed electrician.

Install the backpressure/injection (Figure 7) on the discharge side of the metering pump into a tee which is installed into the water line going to the pressure tank.

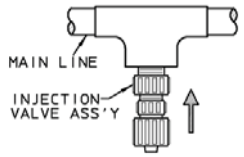


Figure 7

Pumps carrying the or "ETL Sanitation" (tested to NSF Standard-50) marks are listed for swimming pools, spas and hot tubs, and when proper materials are selected, are capable of handling but not limited to the following chemical solutions:

12% ALUMINUM SULPHATE,	5% SODIUM CARBONATE,
2% CALCIUM HYPOCHLORITE,	10% SODIUM HYDROXIDE,
12.5% SODIUM HYPOCHLORITE,	10% HYDROCHLORIC ACID

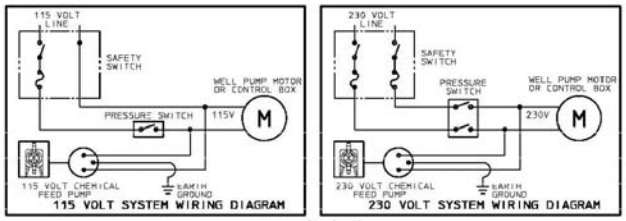


Figure 8

5.0 START UP AND OPERATION

5.1 Power

All metering pumps are available in 115 and 230 volts at 50/60 Hertz, single phase. In addition, certain models are available in 12 volt DC. Prior to start-up always check to insure that the pump voltage/frequency/phase matches that of the power supply.

⚠ CAUTION If pump is fitted with a PVC pump head (7th position of model number is “V” or "W". Note: PVC is gray, not black), uniformly hand tighten the four head screws before use, 18-22 in. lbs. (3.2 -3.9 kg/cm). Periodically tighten after installation.

5.2 Priming

⚠ CAUTION **When working on or around a chemical metering pump installation, protective clothing and gloves and safety glasses should be worn at all times.**

All pumps are tested with water. If the chemical to be pumped reacts when mixed with water (e.g. sulfuric acid, polymer) the pump head should be removed and dried thoroughly along with the diaphragm and valve seats.

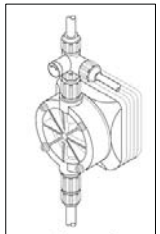


Figure 9

Turn on the power to the pump. The green LED (not available on all models) will light up and flash off each time the pump strokes.

Adjust the stroke rate knob to the 100% setting mark (for more information see Section 5.3, Capacity Control).

Adjust the stroke length knob to the 100% setting mark if applicable (for more information see Section 5.3, Capacity Controls).

If the discharge line is connected directly to a pressurized system it should be temporarily bypassed during priming of the pump. A bleed valve will simplify this operation by allowing easy bypass of the discharge fluid. Air must be purged from the pump-head before the pump will operate against pressure. (See Figure 9)

Air Bleed Operation:

While pump is running, turn adjustment knob counterclockwise.

Run with valve open until a solid stream of fluid comes out of the bypass tubing with no air bubbles.

Close air bleed valve by turning adjustment screw clockwise.

Chemical should reach the pump head after a few minutes of operation. If not, remove the discharge fitting and moisten the discharge valve area (ball check and valve seats) with a few drops of ***chemical being fed to the metering pump.*** For safety, always use protective clothing and gloves, wear safety glasses and use a proper container to hold the chemical.

If the pump continues not to prime, refer to Section 7.0, Troubleshooting, of these instructions.

Once the pump has been primed and is pumping the chemical through the head, turn off the power, reconnect the discharge tubing (if it had been removed) and immediately clean any spilled chemical that is on the pump housing or head.

Turn the power on once more and adjust the pump flow to the desired rate (see Section 5.3.3, Controlling Procedure).

Always check the calibration of the pump after start-up. It’s best to calibrate the pump under your typical use conditions.

5.3 Capacity Control

Capacity can be controlled by means of the stroke length adjusting knob and/or stroke rate adjusting knob (except model C pumps). Control knobs provide coarse adjustment; use a calibration column for accurate calibration. Contact your pump supplier for proper calibration equipment.

5.3.1 Stroke Frequency Adjustment (E, E-DC, E+, A+ and C+ only)

Stroke frequency can be controlled from 10 to 100% (12 to 125 strokes per minute on 125SPM models or 25 to 250 strokes per minute on 250SPM models) by means of the electronic circuit.

Stroke frequency can be set by means of the stroke rate adjusting knob even while the pump is in operation (See Figure 10).

5.3.2 Stroke Length Adjustment

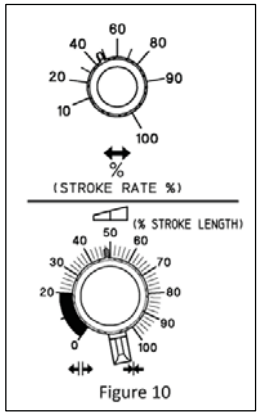


Figure 10

Stroke length can be controlled within 0 to 100% of the diaphragm displacement. It should be controlled within 20 to 100% for practical use.

Stroke length can be set by means of the stroke length adjusting knob while the pump is in operation. Do not turn the knob while the pump is stopped.

5.3.3 Controlling Procedure

Proper set points for stoke length and stroke frequency should be determined after consideration of the pump and characteristics of the fluid. The following procedure is recommended from the viewpoint of pump performance. **Note: The closer the stroke length is to 100%, the better the pump performance will be.**

Set the stroke length to 100% then adjust the stroke frequency for coarse capacity control.

Measure the capacity.

When the measured capacity is less than the required value, increase the stroke frequency and measure the capacity again.

Then, adjust the stroke length for fine capacity control.

Finally, measure the capacity and make sure that the required value is obtained.

Example

Selected Model	=	LPD4
Set Stroke Length	=	100%
Set Stroke Rate	=	100%
Output Capacity (Rated Pressure)	=	21 gallons per day (GPD)*
Desired Flow	=	15 GPD
Adjust Stroke Rate to 80%		
Output Capacity	=	0.80 x 21 = 16.8 GPD*
Stroke Length Setting	=	$\frac{15}{16.8}$ x 100 = 90% approximate

Thus to obtain the desired flow, stroke length is set at 90% and stroke rate is set at 80% i.e. output capacity = 0.90 x 0.80 x 21 = 15.12 GPD*

***IMPORTANT!**

Check these values by measurement. Output capacity is higher when feeding against less than rated pressure

5.4 Control Panel Symbols

The pumps come with universally accepted symbols which is provided in appendix A, page 14.

5.5 Operation By External Input Signals (Options):

The pump can be controlled by three types of input signals. All are fully isolated from AC input and from earth ground. The input socket connections are located at the bottom of the control panel face and the signal cords are provided with the pump. Remove rubber plugs to access plug sockets.

5.5.1 Stop Function (E+, A+, C+ and C only)

Operation of the pump can be stopped by an external signal input. When the external signal is input to the terminal marked Ⓥ which is provided at the bottom of the control panel, the Ⓥ lamp (red) lights up and operation of the pump is stopped. The stop function overrides both manual settings and external input.

⚠ CAUTION **Operation of more than one pump from the same contact closure will damage the pump circuits. When such operation is required, the pump circuits must be electrically isolated from one another by means of a multi-contact control relay or similar means.**

The input signal must be in the form of closure of a mechanical relay or other mechanical switching device, or solid-state relay or other solid-state switching device. Voltage signals are prohibited. The switching resistance of either mechanical or solid-state devices must be 100 ohms or below when ON and 1 megohm or above when OFF. If any type of solid-state device is employed, it must be installed with the proper polarity, if required for the device; and leakage current must not exceed 200 microamperes to prevent false triggering in the OFF state.

The stop function is commonly used in conjunction with a tank float switch. The float switch contacts are normally open but when the tank level falls past a certain point the contacts close and the pump stops.

PULSAFEEDER®
An IDEX Water & Wastewater Business

pulsafeeder.com

The Pulsatron Series E Plus offers manual control over stroke length and stroke rate as standard with the option to choose between 4-20mA and external pace inputs for automatic control.

Twenty distinct models are available, having pressure capabilities to 300 PSIG (21 BAR) @ 3 GPD (0.5 lph), and flow capacities to 600 GPD (94.6 lph) @ 30 PSIG (2 BAR), with a turndown ratio of 100:1. Metering performance is reproducible to within ± 2% of maximum capacity.
Please refer to the reverse side for Series E PLUS specifications.

Features

- Automatic Control, available with 4-20mADC direct or external pacing, with stop function.
- Manual Control by on-line adjustable stroke rate and stroke length.
- Auto-Off-Manual switch.
- Highly Reliable timing circuit.
- Circuit Protection against voltage and current upsets.
- Panel Mounted Fuse.
- Solenoid Protection by thermal overload with auto-reset.
- Water Resistant, for outdoor and indoor applications.
- Indicator Lights, panel mounted.
- Guided Ball Check Valve Systems, to reduce back flow and enhance outstanding priming characteristics.
- Safe & Easy Priming with durable leak-free bleed valve assembly (standard).

Controls

Manual Stroke Rate
- Turn-Down Ratio 10:1

Manual Stroke Length
- Turn-Down Ratio 10:1

4-20mADC Direct or External Pacing with Stop
- Automatic Control

Operating Benefits

- Reliable metering performance.
- Rated “hot” for continuous duty.
- High viscosity capability.
- Leak-free, sealless, liquid end.

Aftermarket

- KOPkits
- Gauges
- Dampeners
- Pressure Relief Valves
- Tanks
- Pre-Engineered Systems
- Process Controllers (PULSAblue, MicroVision)

PULSAtron® Series E Plus Electronic Metering Pumps

PULSAtron® Series E Plus

Specifications and Model Selection

MODEL		LPK2	LPB2	LPA2	LPD3	LPB3	LPA3	LPK3	LPF4	LPD4	LPB4	LPH4	LPG4	LPE4	LPK5	LPH5	LPH6	LPK7	LPH7	LPJ7	LPH8
Capacity	GPH	0.13	0.21	0.25	0.5	0.50	0.50	0.60	0.85	0.90	1.00	1.70	1.75	1.85	2.50	3.15	5.00	8.00	10.00	10.00	25.00
nominal	GPD	3	5	6	12	12	12	14	20	22	24	41	42	44	60	76	120	192	240	240	600
(max.)	LPH	0.5	0.8	0.9	1.9	1.9	1.9	2.3	3.2	3.4	3.8	6.4	6.6	7	9.5	11.9	18.9	30.3	37.9	37.9	94.6
Pressure	PSIG	300	250	150	250	150	100	100	250	150	100	250	150	100	150	150	100	50	35	80	30
(max.)	BAR	21	17	10	17	10	7	7	17	10	7	17	10	7	10	10	7	3.3	2.4	5.5	2
Connections	Tubing	1/4" ID X 3/8" OD 3/8" ID X 1/2" OD													3/8" ID X 1/2" OD 1/2" ID X 3/4" OD (LPH8 ONLY)						
	Piping	1/4" FNPT													1/4" FNPT 1/2" FNPT						

Engineering Data

Pump Head Materials Available: GFPPL, PVC, PVDF, 316 SS

Diaphragm: PTFE-faced CSPE-backed

Check Valves Materials Available:

Seats/O-Rings: PTFE, CSPE, Viton

Balls: Ceramic, PTFE, 316 SS, Alloy C

Fittings Materials Available: GFPPL, PVC, PVDF

Bleed Valve: Same as fitting and check valve selected, except 316SS

Injection Valve & Foot Valve Assy: Same as fitting and check valve selected

Tubing: Clear PVC, White PE

Important: Material Code - GFPPL=Glass-filled Polypropylene, PVC=Polyvinyl Chloride, PE=Polyethylene, PVDF=Polyvinylidene Fluoride, CSPE=Generic formulation of Hypalon, a registered trademark of E.I. DuPont Company. Viton is a registered trademark of E.I. DuPont Company. PVC wetted end recommended for sodium hypochlorite.

Engineering Data

Reproducibility: +/- 2% at maximum capacity

Viscosity Max CPS :

For viscosity up to 3000 CPS, select connection size 3, 4, B or C with 316SS ball material. Flow rate will determine connection/ball size. Greater than 3000 CPS require spring loaded ball checks. See Selection Guide for proper connection.

Stroke Frequency Max SPM: 125

Stroke Frequency Turn-Down Ratio: 10:1

Stroke Length Turn-Down Ratio: 10:1

Power Input: 115 VAC/50-60 HZ/1 ph, 230 VAC/50-60 HZ/1 ph

Average Current Draw:

@ 115 VAC; Amps: 1.0 Amps

@ 230 VAC; Amps: 0.5 Amps

Peak Input Power: 300 Watts

Average Input Power @ Max SPM: 130 Watts

Custom Engineered Designs – Pre-Engineered Systems

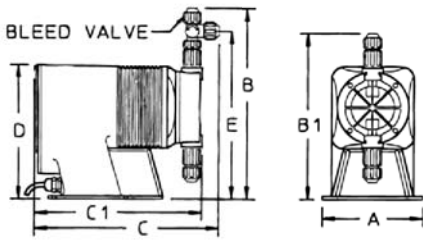
Pre-Engineered Systems

Pulsafeeder's Pre-Engineered Systems are designed to provide complete chemical feed solutions for all electronic metering applications. From stand alone simplex pH control applications to full-featured, redundant sodium hypochlorite disinfection metering, these rugged fabricated assemblies offer turn-key simplicity and industrial-grade durability. The UV-stabilized, high-grade HDPE frame offers maximum chemical compatibility and structural rigidity. Each system is factory assembled and hydrostatically tested prior to shipment.

Dimensions

Series E Plus Dimensions (inches)																	
Model No.	A	B	B1	C	C1	D	E	Shpg Wt	Model No.	A	B	B1	C	C1	D	E	Shpg Wt
LPA2	5.4	10.3	-	10.8	-	7.5	8.9	13	LPH4	6.2	10.9	-	11.2	-	8.2	9.5	21
LPA3	5.4	10.6	-	10.7	-	7.5	9.2	13	LPH5	6.2	11.3	-	11.2	-	8.2	9.9	21
LPB2	5.4	10.3	-	10.8	-	7.5	8.9	13	LPH6	6.2	11.3	-	11.9	-	8.2	9.9	21
LPB3	5.4	10.6	-	10.7	-	7.5	9.2	13	LPH7	6.1	11.7	-	11.9	-	8.2	10.3	21
LPB4	5.4	10.6	-	10.7	-	7.5	9.2	13	LPH8*	6.1	-	10.9	-	11.3	8.2	-	26
LPD3	5.4	10.6	-	11.2	-	7.5	9.2	15	LPK2	5.4	10.3	-	10.8	-	7.5	8.9	13
LPD4	5.4	10.6	-	11.2	-	7.5	9.2	15	LPK3	5.4	10.6	-	10.7	-	7.5	9.2	13
LPE4	5.4	10.6	-	11.2	-	7.5	9.2	15	LPK5	5.4	10.9	-	11.7	-	7.5	9.5	18
LPF4	5.4	10.6	-	11.7	-	7.5	9.2	18	LPK7	6.1	11.7	-	11.2	-	8.2	10.3	21
LPG4	5.4	10.6	-	11.7	-	7.5	9.2	18	LPJ7	6.1	10	-	10.7	-	-	-	21

NOTE: Inches X 2.54 = cm /* the LPH8 is designed without a bleed valve available



WT40XK2C

- Honda GX340 OHV engine
- 102 mm (4") suction and discharge ports
- Pumps 1,640 litres per minute (361 Imp. Gal. per minute)
- Oil Alert™ is standard
- Full frame
- Commercial drainage

SPECIFICATIONS

WATER PUMP TYPE	TRASH	**Honda ENGINE**	GX340K1 4-STROKE
PUMP	CENTRIFUGAL	**TYPE**	OHV; AIR-COOLED; SINGLE CYL.
TYPE	SELF-PRIMING	**DISPLACEMENT**	337 CC
SUCTION PORT DIAMETER	102 MM /4 IN.	**LUBRICATION SYSTEM**	SPLASH TYPE
DISCHARGE PORT DIAMETER	102 MM /4 IN.	**GOVERNOR**	MECHANICAL
LITRES PER MINUTE	1640	**STARTING SYSTEM**	RECOIL
IMP. GAL. PER MINUTE	361	**FUEL TANK CAPACITY**	6.5 L /1.43 IMP. GAL.
LITRES PER HOUR	98400	**OIL ALERT**	STANDARD
IMP. GAL. PER HOUR	21660	**DRIVE UNIT TYPE**	DIRECT COUPLE / MECH. SEAL
TOTAL HEAD	26 M /85 FT.	**FRAME TYPE**	FULL FRAME
SUCTION HEAD (TOTAL LIFT)	8 M /26 FT.	**LENGTH**	735 MM /28.9 IN.
PRIMING TIME @ 5M(16.4 FT.)	160 SECONDS	**WIDTH**	535 MM /21.1 IN.
PUMP BODY	ALUMINUM	**HEIGHT**	565 MM /22.2 IN.
IMPELLER	CONICAL CAST IRON	**DRY WEIGHT**	78 KG. /172 LB.

Models and/or colours may not be exactly as shown. Errors and omissions excepted. Specifications are subject to change without notice.
See your Honda Power Equipment dealer for details.

For optimum performance and safety, please read your owner's manual before operating your Honda product. Always wear the appropriate safety gear when operating your Honda.

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WT30XK3C

- Honda GX240 OHV engine
- 76 mm (3") suction and discharge ports
- Pumps 1,208 litres per minute (266 Imp. Gal. per minute)
- Commercial drainage

SPECIFICATIONS

WATER PUMP TYPE	TRASH	**Honda ENGINE**	GX240K1 4-STROKE
PUMP	CENTRIFUGAL	**TYPE**	OHV; AIR-COOLED; SINGLE CYL.
TYPE	SELF-PRIMING	**DISPLACEMENT**	242 CC
SUCTION PORT DIAMETER	76 MM /3.0 IN.	**LUBRICATION SYSTEM**	SPLASH TYPE
DISCHARGE PORT DIAMETER	76 MM /3.0 IN.	**GOVERNOR**	MECHANICAL
LITRES PER MINUTE	1208	**STARTING SYSTEM**	RECOIL
IMP. GAL. PER MINUTE	266	**FUEL TANK CAPACITY**	6 L /1.32 IMP. GAL.
LITRES PER HOUR	72480	**OIL ALERT**	STANDARD
IMP. GAL. PER HOUR	15960	**DRIVE UNIT TYPE**	DIRECT COUPLE / MECH. SEAL
TOTAL HEAD	27 M /89 FT.	**FRAME TYPE**	FULL FRAME
SUCTION HEAD (TOTAL LIFT)	8 M /26 FT.	**LENGTH**	660 MM /26 IN.
PRIMING TIME @ 5M(16.4 FT.)	100 SECONDS	**WIDTH**	495 MM /19.5 IN.
PUMP BODY	ALUMINUM	**HEIGHT**	515 MM /20.3 IN.
IMPELLER	CONICAL CAST IRON	**DRY WEIGHT**	60 KG. /132 LB.

Models and/or colours may not be exactly as shown. Errors and omissions excepted. Specifications are subject to change without notice.
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APPENDIX D
POSSIBLE IMPROVEMENTS

Duplex Basket Strainers

1/2″ to 4″ - PVC, Corzan® CPVC and Eastar® Clear Polyester

Features

- Uninterrupted Flow
- External Cover Threads
- Low Pressure Drop
- Wide Choice of Baskets
- In-Line or Loop Piping
- True Union Connections
- Ergonomic Hand Removable Cover
- FPM Seals
- Integral Flat Mounting Bases
- Hand Removable Vents On Covers
- Hand Removable Drains On Bodies
- Liquid Displacing Covers

Options

- Stainless Steel Mesh Strainer Baskets
- EPDM Seals

Corzan® is a registered trademark of Noveon, Inc.
Eastar ® is a registered trademark of Eastman

Protect System Components

When pipeline system components require protection from dirt and debris and the line cannot be shut down for basket cleaning, a Hayward All Plastic Duplex Basket Strainer is the ideal choice. Unwanted particles are removed as the process media passes through a perforated strainer basket contained inside the strainer body. The basket traps the unwanted material while allowing the process media to flow freely.

Easy Basket Cleaning

Cleaning or changing the strainer basket is quick and easy. Turning the operating handle on the diverter valve assembly switches the flow from one strainer housing to the other. Then, the out of service housing can be serviced by opening the hand removable, spin-off cover for access to the basket. The cover features two angled handles for easy opening and closing. The housing has external cover threads that do not contact the process media eliminating the need for cleaning. Venting and draining are easily accomplished by using the hand removable, threaded plugs on the cover and the side of the housing.

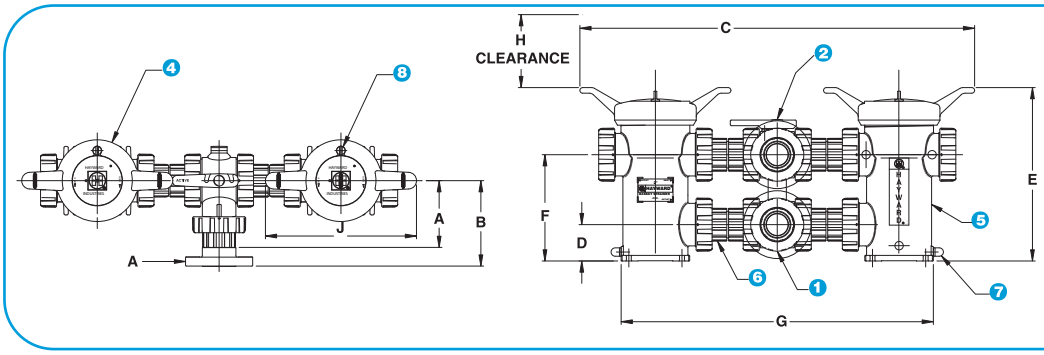
Choice of Piping Connections

The strainer can be installed either in-line or with a loop piping configuration. This is made possible by changing the orientation of the bottom outlet connection. Just loosen the connection assembly nuts on the bottom diverter valve and rotate it 180 degrees to convert from one type of connection to the other. Maintenance is simplified by the strainers true union piping connections which make it possible to remove the strainer from the pipeline without breaking down piping connections.

Wide Range of Strainer Baskets

Plastic baskets in perforation sizes from 1/32″ to 3/16″ and stainless steel baskets from 1/2″ perforation down to 325 mesh are available.

Technical Information



Parts List
Duplex Basket Strainer

1. Single Stem Lateral
2. Double Stem Lateral
3. Inlet Flange
4. Cover
5. Strainer Body
6. Spool
7. Drain Plug
8. Vent Plug

Dimensions - Inches / Millimeters

Size	A	B	C	D	E	F	G	H	J	Weight (lb / kg) Skt / Thd	Weight (lb / kg) Flg
1/2″	4.14 / 105	5.21 / 132	27.2 / 693	2.25 / 57	11.7 / 297	6.75 / 171	20.5 / 521	5.0 / 127	11.0 / 279	20.0 / 9	21.0 / 9.5
3/4″	4.14 / 105	5.33 / 135	27.2 / 693	2.25 / 57	11.7 / 297	6.75 / 171	20.5 / 521	5.0 / 127	11.0 / 279	20.0 / 9	21.0 / 9.5
1″	4.14 / 105	5.64 / 143	27.2 / 693	2.25 / 57	11.7 / 297	6.75 / 171	20.5 / 521	5.0 / 127	11.0 / 279	20.0 / 9	21.0 / 9.5
1 1/4″	6.0 / 152	7.44 / 189	35.3 / 897	3.25 / 83	15.5 / 394	9.5 / 241	28.0 / 711	10.8 / 274	13.5 / 343	39.5 / 18	42.0 / 20
1 1/2″	6.0 / 152	7.6 / 193	35.3 / 897	3.25 / 83	15.5 / 394	9.5 / 241	28.0 / 711	10.8 / 274	13.5 / 343	39.5 / 18	42.0 / 20
2″	6.0 / 152	7.77 / 197	35.3 / 897	3.25 / 83	15.5 / 394	9.5 / 241	28.0 / 711	10.8 / 274	13.5 / 343	39.5 / 18	42.0 / 20
2 1/2″	7.6 / 178	9.85 / 250	44.4 / 1128	4.83 / 123	22.3 / 566	14.83 / 377	35.6 / 904	14.8 / 376	16.0 / 406	83.0 / 38	88.0 / 40
3″	7.6 / 178	9.85 / 243	44.4 / 1128	4.83 / 123	22.3 / 566	14.83 / 377	35.6 / 904	14.8 / 376	16.0 / 406	83.0 / 38	88.5 / 40
4″	9.33 / 237	11.76/ 299	47.5 / 1207	4.83 / 123	22.3 / 566	14.83 / 377	38.7 / 983	14.8 / 376	16.0 / 406	100 / 45	105 / 48

Cv Factors

Size	Factor	Size	Factor
1/2″	12.5	1 1/2″	45
3/4″	13	2″	48
1″	14	3″	200
1 1/4″	40	4″	230

The above Cv Factors were determined using a 1/16″ perforated plastic basket.

Pressure Drop Calculations

Basket Perforation Correction Factors

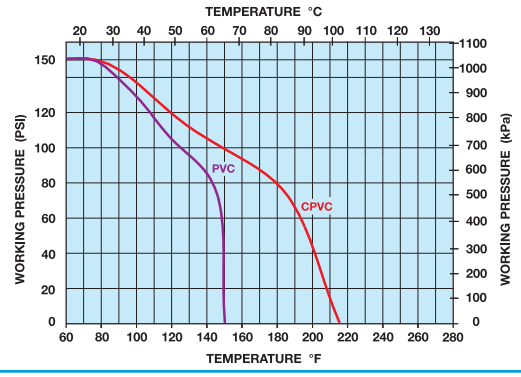
Plastic Baskets		Stainless Steel Baskets			
1/32″	1.05	1/32″	.82	3/8″	.45
1/16″	1.00	3/64″	.63	1/2″	.48
1/8″	.58	1/16″	.74	20 Mesh	.79
3/16″	.46	5/64″	.50	40 Mesh	1.01
		7/64″	.51	60 Mesh	1.20
		1/8″	.58	80 Mesh	1.16
		5/32″	.37	100 Mesh	1.20
		3/16″	.46	200 Mesh	1.09
		1/4″	.58	325 Mesh	1.22

The pressure drop across the strainer, for water or fluids with a similar viscosity, can be calculated using the formula below:

$$\Delta P = \left[\frac{Q}{Cv}\right]^2$$

Where ΔP = Pressure Drop
Q = Flow in GPM
Cv = Flow Coefficient

Operating Temperature/Pressure



Selection Chart

Size	Material	End Connection	Seal*	Rating
1/2″ to 4″	PVC, CPVC	Thd, Skt, Flg	FPM	150 PSI @ 70°F
1/2″ to 2″	EASTAR®*	Thd, Skt, Flg	FPM	100 PSI @ 70°F

*EPDM seals POA.

Basket Selection

- The 1/2″ to 1″ strainers can be ordered with either a 1/32″ or 1/16″ perf plastic basket.
- The 1 1/2″ and 2″ with a 1/32″, 1/16″, 1/8″, or 3/16″ perf plastic basket.
- The 3″ and 4″ with a 1/16″, 1/8″ or 3/16″ perf plastic basket.
- The 6″ and 8″ with a 1/8″ or 3/16″ perf plastic basket.
- Stainless steel baskets for all size strainers are available in these perfs: 1/32″, 3/64″, 1/16″, 5/64″, 7/64″, 1/8″, 5/32″, 3/16″, 1/4″, 3/8″, 1/2″; and in mesh sizes: 20, 40, 60, 80, 100, 200, 325

Basket Strainer Technical Information

Selection Criteria

The first consideration when selecting a Hayward basket strainer is the amount of free open area. This is the ratio of the open area through the strainer basket to the cross sectional area of the pipe. A well-designed basket strainer should have an open area ratio of at least 4 to 1. Anything less may cause excessive pressure drop. The area is calculated with a clean basket – and as the basket begins to clog, the ratio will drop. Unless there is a wide safety margin, the area through the basket may quickly become smaller than the pipe area. This will reduce flow through the strainer and necessitate very frequent cleaning. A small open area ratio also means the holding capacity of the basket is small (an important consideration if there is a lot of solid material to be removed.)

Second, is ease of basket removal. Since a basket strainer is used where cleaning may occur often, it stands to reason that the basket should be able to be removed and replaced as simply as possible. Hayward simplex and duplex strainers feature hand removable, precision machined, threaded covers which can be quickly loosened or tightened by hand without the use of tools.

Another item to look for in selecting a strainer is compactness of design. Is the strainer unnecessarily bulky or tall? In many industrial areas, space is at a premium and the less room a strainer takes the better.

Lastly, a wide variety of basket perforation sizes should be available. This is necessary to cope with the great range of particle sizes which the strainer may be called upon to remove.

Selection and Sizing

Selecting the proper size basket strainer for a particular application is extremely important for optimum performance of the strainer. Factors such as viscosity, specific gravity, and mesh lining size all influence pressure drop of flow through the strainer. As a general rule of thumb, a pressure of greater than 2 PSI through a clean strainer usually indicates the strainer selected is too small for the intended application.

In some cases, the strainer size may not always be the same size as the pipe diameter. For example, the pressure drop of highly viscous liquids passing through a mesh basket can cut flow considerably making it necessary to use a strainer several times larger than pipeline to ensure adequate flow.

Likewise, if an unusually large amount of material needs to be taken out of the process flows, a larger strainer or multiple strainer should be specified. By using two strainers in a series, the first with large openings designed to catch larger particles and the second with a fine mesh lining to trap smaller material, the load is spread over two strainers and time between maintenance for cleaning is also extended.

While the initial investment is slightly more for a larger strainer or multiple strainers, there are no added long term operating costs since basket strainers have no parts to wear out and last indefinitely.

Proper Basket Selection

The question of which perforation or mesh lining size to use comes up regularly. Here again, the basic rule is to use the coarsest size which will strain out the product to be removed. Using a finer mesh than needed will only result in premature clogging. When in doubt about which of two basket screens to use, it is best to choose the larger. As a rule of thumb, size the baskets for one half the particle size to be removed.

Basket Sizes Offered for Hayward Simplex and Duplex Plastic Basket Strainers

Pressure Drop Correction Factors for Various Size Basket Screens

PLASTIC		STAINLESS STEEL		STAINLESS STEEL	
Perforation	Correction Factor	Perforation	Correction Factor	Mesh	Correction Factor
1/32″	1.05	1/32″	0.82	20	0.79
1/16″	1.00	3/64″	0.63	40	1.01
1/8″	0.58	1/16″	0.74	60	1.20
3/16″	0.46	5/64″	0.50	80	1.16
		7/64″	0.51	100	1.20
		1/8″	0.58	200	1.09
		5/32″	0.37	325	1.22
		3/16″	0.46		
		1/4″	0.58		
		3/8″	0.45		
		1/2″	0.48		

Note: Pressure Drop Correction Factors for various size basket screens may be applied to data for 1/16″ perforation plastic baskets. Simply multiply the pressure drop shown in the 1/16″ basket chart by the appropriate correction factor.

Comparative Particle Size

Mesh	Inches	Microns	Mesh	Inches	Microns	Mesh	Inches	Microns
3250	0.0002	6	130	0.0043	110	24	0.028	718
1600	0.0005	14	120	0.0046	118	20	0.034	872
750	0.0010	25	110	0.0051	131	18	0.039	1000
325	0.0016	40	100	0.0055	149	16	0.045	1154
250	0.0024	62	90	0.0061	156	14	0.051	1308
200	0.0029	74	80	0.0070	179	12	0.060	1538
180	0.0033	85	70	0.0078	200	10	0.075	1923
170	0.0035	90	60	0.0092	238	8	0.097	2488
160	0.0038	97	50	0.0117	300	6	0.132	3385
150	0.0041	100	40	0.015	385	5	0.159	4077
140	0.0042	108	30	0.020	513	4	0.203	5205

CLEMMER STEELCRAFT TECHNOLOGIES

CUSTOMER: ***AMEC EARTH & ENVIRONMENTAL LTD***
ATTENTION: ***JOEL WESTBURG***
E-MAIL: ***Joel.Westberg@amec.com***

1 - carbon steel vertical expansion tank, ***227***L capacity, ***24***" dia x ***36***" overall. Vessel is constructed to the latest ASME/CSA codes for installation in Ontario and a MAWP of ***100*** PSIG.
PRICE EACH $2,200.00

1 - carbon steel vertical expansion tank, ***482***L capacity, ***30***" dia x ***48***" overall. Vessel is constructed to the latest ASME/CSA codes for installation in Ontario and a MAWP of ***100*** PSIG.
PRICE EACH $2,680.00

***INTERIOR FINISH*:** as welded
***EXTERIOR FINISH*:** one coat primer
***EACH VESSEL COMPLETE WITH*:**
3 - legs
2 - 3" NPT fittings
1 - 6" 150# RFSO
1 - ½" NPT fittings
1 - 1" NPT fitting

***NOTE*:** Pressure gauges, relief valves, thermometers, structural supports, control valves and all other related accessories not included in this quotation unless specifically stated.

F.O.B. Waterloo, freight collect, not unloaded.....EXTRA
PST & GST.....EXTRA
ESTIMATED DELIVERY*: *4-6 weeks from receipt of approved drawings.

Terms and Conditions

The following terms and conditions apply to proposals made by Clemmer Steelcraft Technologies Inc, where the goods and/or services offered are to be invoiced by Clemmer Steelcraft Technologies Inc. Proposals made by Clemmer Steelcraft Technologies Inc on behalf of a principal representative by Clemmer Steelcraft Technologies Inc will be subject to the terms and conditions of that principal, at the time any subsequent order is accepted.

1) ***This quotation is valid for 30 days, with no changes in specifications or drawings that were used for quoting and based on normal delivery scheduling.***
2) ***It is the responsibility of the contractor (customer) to verify that the product supplied by Clemmer Steelcraft Technologies Inc meets all required project specifications and site conditions.***
3) ***Specified delivery date will be subject to timely receipt of approved drawings, availability of material, with no changes to specifications or drawings used at the time of quoting. Orders will not be processed without a purchase order or written confirmation.***
4) ***Payment terms:***
Subject to customer credit approval, is as specified on our quotation, or net 30 days. All applicable taxes will be charged unless purchaser supplies the proper tax exemption paperwork. For quotes over 100k the terms are 30/30/30/10 based on credit approval.
5) ***Prices shown are in Canadian dollars for quantities and commodities offered unless otherwise stated.***
6) ***Orders cannot be cancelled by the purchaser under any circumstances without the seller's consent and upon terms which will indemnify against all loss.***
7) ***Title to materials in this contract shall remain with the seller until the goods supplied are paid for. All materials are FOB Clemmer Steelcraft Technologies Inc plant. The purchaser is responsible for loss or damage from the time of shipment from Clemmer Steelcraft Technologies Inc plant.***
8) ***Any product returned to Clemmer Steelcraft Technologies Inc will require a return authorization number and the required paperwork.***
9) ***Your order will be invoiced at requested time of completion unless other arrangements have been made. Storage costs will be charged if not shipped two weeks after requested completion date.***

Clemmer Steelcraft Technologies Inc. and its' agents and representatives are not responsible for any additional fees incurred over and above those expressly quoted regarding freight and related activities including but not limited to:

- ***Vessels that exceed standard quoted dimensions***
- ***Traffic delays due to uncontrollable circumstances (construction, accidents, detours, etc.)***
- ***Escorts, permits and utilities for oversize items (may include customs clearance charges)***
- ***Warehousing during transit***
- ***Accessories shipped separately and/or not encompassed within the initial freight quote***

Cliff Arcand
1-800-265-8840 ext 211

APPENDIX E
MSDS

Material Safety Data Sheet - MSDS

Dry Alum

Section 1. Chemical Product and Company Identification

Trade name : Dry Alum

Material uses : Alum is used as a coagulating agent in municipal and industrial water and wastewater treatment and as an additive in papermaking.

Headquarters : Marsulex Inc.
111 Gordon Baker Road
Suite 300
North York, ON
M2H 3R1
(416) 496-9655
www.marsulex.com

Validation date : **11/15/2007**

In case of emergency : Canada : CANUTEC 1-613-996-6666
US : CHEMTREC: 1-800-424-9300

Section 2. Hazards identification

Physical state and Appearance : Solid. (Granules or powder.)

This material is classified hazardous under OSHA regulations in the United States and the WHMIS Controlled Product Regulation in Canada.

Emergency overview : WARNING!
CAUSES EYE AND SKIN IRRITATION.
MAY CAUSE ALLERGIC SKIN REACTION.
Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

Routes of entry : Dermal contact. Eye contact. Inhalation. Ingestion.

Potential acute health effects

Eyes : The dust becomes acidic following contact with moisture in the eye and may result in moderate to severe irritation to eyes.

Skin : The dust becomes acidic following contact with moisture on the skin and mild to moderate irritation can occur. Aluminum is very poorly absorbed through the skin and toxic effects would not be expected following short-term skin contact. Prolonged and repeated exposure to dilute solutions may cause irritation, redness, pain and drying and cracking of the skin.

Inhalation : Dusts of aluminum sulfate hydrate probably cause irritation of the nose, throat and respiratory tract based on pH. The dust becomes acidic following contact with moisture in the air or tissues of the respiratory tract.

Ingestion : May cause irritation of the lining of the stomach. Ingestion is not a typical route of occupational exposure.

Potential chronic health effects : CARCINOGENIC EFFECTS: Not classified or listed by IARC, NTP, OSHA, EU and ACGIH.
MUTAGENIC EFFECTS: Not available.
TERATOGENIC EFFECTS: Not available.

Medical conditions aggravated by over-exposure : Skin irritation may be aggravated in individuals with existing skin lesions. Breathing of dust may aggravate acute or chronic asthma and chronic pulmonary disease such as emphysema and bronchitis.

Over-exposure signs/symptoms : Prolonged or repeated contact with dust may cause redness, dryness and itching of the skin (dermatitis).

See Section 11 for Toxicological Data.

Continued on next page

Section 3. Composition/information on ingredients

Name	CAS #	% by weight
Aluminum Sulfate Hydrate	16828-12-9	99

See Section 8 for Exposure Limits.
See Section 11 for Toxicological Data.

Section 4. First Aid Measures

Eye contact : Immediately flush eyes with lukewarm, gently running water for a minimum of 5 minutes or until the chemical is removed. Hold eyelids open during flushing. If irritation persists, repeat flushing. Obtain medical attention IMMEDIATELY. Do not transport victim until the recommended flushing period is completed unless flushing can be continued during transport.

Skin contact : Flush skin with lukewarm running water for a minimum of 5 minutes or until the chemical is removed. Start flushing while removing contaminated clothing. If irritation persists, repeat flushing and obtain medical attention. Do not transport victim unless the recommended flushing period is completed or flushing can be continued during transport.
Discard heavily contaminated clothing and shoes in a manner, which limits further exposure. Otherwise, wash clothing separately before reuse.

Inhalation : Move victim to fresh air. If irritation persists, obtain medical attention immediately. Give artificial respiration ONLY if breathing has stopped. Give Cardiopulmonary Resuscitation (CPR) if there is no breathing AND no pulse. Obtain medical attention IMMEDIATELY.

Ingestion : If irritation or discomfort occur, obtain medical advice immediately.

Notes to physician : Not available.

Section 5. Fire Fighting Measures

Flammability of the product : Non-flammable.

Auto-ignition temperature : Not applicable.

Flash points : Not applicable.

Flammable limits : Not applicable.

Products of combustion : Forms aluminum oxide, sulfur dioxide and/or sulfur trioxide at temperatures reported above 650 ˚C (1200˚F).

Fire hazards in the presence of various substances : Not applicable.

Explosion hazards in the presence of various substances : Dry alum will dissolve in water to form sulfuric acid which reacts with some metals, especially when dilute, to give flammable, potentially explosive hydrogen gas. Hydrogen gas can accumulate to explosive concentrations inside confined spaces. Follow appropriate NFPA codes.

Fire-fighting media and instructions : Use appropriate extinguisher for surrounding material.

Protective clothing (fire) : The decomposition products are corrosive and hazardous to health. Wear a NIOSH/MSHA approved self-contained breathing apparatus and full protective clothing if vapors or mists are present. For fighting fires in close proximity to spill or vapors, use acid-resistant personal protective equipment. Evacuate residents who are downwind of fire. Prevent unauthorized entry to fire area. Dike area to contain runoff and prevent contamination of water sources. Neutralize runoff with lime, soda ash or other suitable neutralizing agents (see Deactivating Chemicals, Section 6). Cool containers that are exposed to flame with streams of water until fire is out. Take care not to get water inside container.

Section 6. Accidental Release Measures

Small spill and leak : Shovel into clean, dry, labelled containers and cover. Flush area with water. Do not get water inside containers or on spilled material.

Large spill and leak : Prevent solids from mixing with water or entering sewers or waterways. Shovel into clean, dry, labelled containers and cover. If liquid is present, dike with inert material (sand, earth, etc.). Consider in situ neutralization and disposal. Ensure adequate decontamination of tools and equipment following clean up. Comply with Federal, Provincial/State and local regulations on reporting releases.
Deactivating Chemicals: Lime, limestone, soda ash, sodium bicarbonate, dilute sodium hydroxide, dilute aqua ammonia.

Continued on next page

Section 7. Handling and Storage

Handling : Dry Alum is an irritating solid. Avoid generating dusts. Do not breathe dusts. Do not ingest. Do not get in eyes, on skin or on clothing. Use proper tools when opening containers. Keep containers closed when not in use. Empty containers may contain hazardous residues. When there is a large-scale use, do not use in areas equipped with sprinkler systems. Post "DO NOT USE WATER" signs. Good housekeeping is important to prevent accumulations of dust. Dry sweeping is not recommended.

Storage : Keep container tightly closed. Keep container in a cool, dry, well-ventilated area. Store away from incompatible materials such as strong bases. Post warning signs.

Section 8. Exposure Controls, Personal Protection

Engineering controls : Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits. If user operations generate dust, fumes or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.The most effective measures are the total enclosure of processes and the mechanization of handling procedures to prevent all personal contact. Use a corrosion resistant ventilation system separate from other exhaust ventilation systems.

Personal protection

Eyes : Splash goggles.

Body : Lab coat or coveralls.

Respiratory : NIOSH/MSHA approved dust mask, for dust concentrations of up to 10 mg/m^3. Air-purifying respirator equipped with acid gas/fume, dust, mist cartridges for concentrations up to 20 mg/m^3. An air-supplied respirator if concentrations are higher or unknown.

Hands : Gloves: Neoprene, PVC, vinyl or rubber.

Feet : Appropriate industrial footware.

Protective clothing (pictograms) :

Personal protection in case of a large spill : Splash goggles. Full suit. Dust respirator. Boots. Gloves. Self-contained breathing apparatus (SCBA) should be used to avoid inhalation of the product. Suggested protective clothing might not be adequate. Consult a specialist before handling this product.

Exposure limits

Product name	Exposure limits
Aluminum Sulfate Hydrate	**ACGIH TLV (United States).** TWA: 2 mg/m³ 8 hour(s). Form: as Aluminium (soluble salts) **OSHA PEL (United States).** TWA: 2 mg/m³ 8 hour(s). Form: as Aluminium (soluble salts)

Consult local authorities for acceptable exposure limits.

Section 9. Physical and Chemical Properties

Physical state and Appearance : Solid. (Granules or powder.)

Color : White.

Odor : Odorless.

Molecular weight : 594.4 g/mole

Molecular formula : $Al_2(SO_4)_3.14\ H_2O$

pH : > 2.9 @ 5%.

Boiling/condensation point : Not available.

Melting/freezing point : 86°C (186.8°F)

Specific gravity : Not available.

Vapor pressure : Not available.

Vapor density : Not available.

Odor threshold : Not available.

Evaporation rate : Not available.

Continued on next page

$LogK_{ow}$: Not available.
Solubility : Solubility in water at 20˚C equivalent to approximately 8 wt-% Al_2O_3.

Section 10. Stability and Reactivity

Stability and reactivity : The product is stable.
Incompatibility with various substances : Strong bases such as sodium hydroxide. Reaction may be violent.
Hazardous decomposition products : Sulfuric acid vapors may be released upon heating and sulfur dioxide and sulfur trioxide may be released upon decomposition.
Hazardous polymerization : Will not occur.

Section 11. Toxicological Information

Toxicity data

Ingredient name	Test	Result	Route	Species
Aluminum Sulfate Hydrate	LD50	>9000 mg/kg	Oral	Rat
	LD50	>9000 mg/kg	Oral	Mouse

Chronic effects on humans : See Section 2.
Other toxic effects on humans : Very hazardous by the following route of exposure: of eye contact (irritant).
Hazardous by the following route of exposure: of skin contact (irritant).
Slightly hazardous by the following route of exposure: of inhalation (lung irritant).

Section 12. Ecological Information

Ecotoxicity data

Ingredient name	Species	Period	Result
Aluminum Sulfate Hydrate	Goldfish (LC50)	72 hour(s)	100 mg/l

Products of degradation : Decomposition products may include the following materials: carbon and sulfur oxides (CO_2, CO, SO_3 & SO_4). Toxicity is primarily associated with acidic pH. Acidic soil conditions can develop with the material present leading to release of some trace metals.
Toxicity of the products of biodegradation : The products of biodegradation are more toxic than the original product.

Section 13. Disposal Considerations

Waste information : Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Consult your local or regional authorities.

Section 14. Transport Information

Canada (TDG) : Not regulated.
United States (DOT) : RQ, UN3077, ENVIRONMENTALLY HAZARDOUS SUBSTANCES, SOLID, N.O.S. (Aluminum sulfate), 9, PG III.
ERG : 171

Section 15. Regulatory Information

WHMIS (Canada) : Class D-2B: Material causing other toxic effects (Toxic).
Canada inventory: All components are listed or exempted.
CEPA Toxic substances: This material is not listed.
Canadian ARET: This material is not listed.
Canadian NPRI: This material is not listed.
Alberta Designated Substances: This material is not listed.
Ontario Designated Substances: This material is not listed.
Quebec Designated Substances: This material is not listed.

Continued on next page

This product has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all the information required by the CPR.

HCS Classification : Irritating material

U.S. Federal Regulations : **United States inventory (TSCA 8b):** All components are listed or exempted.

SARA 302/304/311/312 extremely hazardous substances: No products were found.
SARA 302/304 emergency planning and notification: No products were found.
SARA 302/304/311/312 hazardous chemicals: No products were found.
SARA 311/312 MSDS distribution - chemical inventory - hazard identification: No products were found.

State Regulations :

Connecticut Carcinogen Reporting: This material is not listed.
Connecticut Hazardous Material Survey: This material is not listed.
Florida substances: This material is not listed.
Illinois Chemical Safety Act: This material is not listed.
Illinois Toxic Substances Disclosure to Employee Act: This material is not listed.
Louisiana Reporting: This material is not listed.
Louisiana Spill: This material is not listed.
Massachusetts Spill: This material is not listed.
Massachusetts Substances: This material is not listed.
Michigan Critical Material: This material is not listed.
Minnesota Hazardous Substances: This material is not listed.
New Jersey Hazardous Substances: This material is not listed.
New Jersey Spill: This material is not listed.
New Jersey Toxic Catastrophe Prevention Act: This material is not listed.
New York Acutely Hazardous Substances: This material is not listed.
New York Toxic Chemical Release Reporting: This material is not listed.
Pennsylvania RTK Hazardous Substances: This material is not listed.
Rhode Island Hazardous Substances: This material is not listed.

California Prop. 65

No products were found.

Section 16. Other Information

Hazardous Material Information System (U.S.A.)

Health	2
Fire hazard	0
Physical Hazard	0
Personal protection	E

National Fire Protection Association (U.S.A.)

References : - 29CFR Part1910.1200 OSHA MSDS Requirements. - 49CFR Table List of Hazardous Materials, UN#, Proper Shipping Names, PG. ANSI Z400.1, MSDS Standard, 2004. - Canada Gazette Part II, Vol. 122, No. 2. Registration SOR/88-64, 31 December 1987. Hazardous Products Act "Ingredient Disclosure List" - Canadian Transport of Dangerous Goods, Regulations and Schedules, Clear Language version 2005. - Manufacturer's Material Safety Data Sheet.

Responsible name : **Atrion Regulatory Services, Inc.**
Date of issue : **11/15/2007**
Date of previous issue : **09/30/2006**
Version : **3**

Notice to reader

To the best of our knowledge, the information contained herein is accurate. However, neither the above named supplier nor any of its subsidiaries assumes any liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

GE
Water & Process Technologies

Material Safety Data Sheet

Issue Date: 17-APR-2008
Supercedes: 17-APR-2008

POLYFLOC AP1138

1 Identification

Identification of substance or preparation
POLYFLOC AP1138

Product Application Area
Flocculant

Company/Undertaking Identification
GE Water & Process Technologies Canada
3239 Dundas Street West
Oakville, Ontario, L6M 4B2
T 905-465-3030

Emergency Telephone
(800) 877-1940

Prepared by Product Stewardship Group: T 215-355-3300 Prepared on: 17-APR-2008

2 Hazard(s) identification

****
EMERGENCY OVERVIEW

May cause slight irritation to the skin. May cause moderate irritation to the eyes. Dusts may cause irritation to the upper respiratory tract.

Odor: None; Appearance: White, Powder

Fire fighters should wear positive pressure self-contained breathing apparatus(full face-piece type). Proper fire-extinguishing media: dry chemical, carbon dioxide, foam or water
****

POTENTIAL HEALTH EFFECTS

ACUTE SKIN EFFECTS:
Primary route of exposure; May cause slight irritation to the skin.

ACUTE EYE EFFECTS:
May cause moderate irritation to the eyes.

ACUTE RESPIRATORY EFFECTS:
Dusts may cause irritation to the upper respiratory tract.

INGESTION EFFECTS:

May cause gastrointestinal irritation.

TARGET ORGANS:
No evidence of potential chronic effects.

MEDICAL CONDITIONS AGGRAVATED:
Not known.

SYMPTOMS OF EXPOSURE:
May cause redness or itching of skin.

3 Composition / information on ingredients

Information for specific product ingredients as required by the WHMIS Regulations is listed. Refer to additional sections of this MSDS for our assessment of the potential hazards of this formulation.

HAZARDOUS INGREDIENTS:

Product contains no hazardous ingredients reportable under WHMIS regulation

No component is considered to be a carcinogen by the U.S. National Toxicology Program (NTP), the International Agency for Research on Cancer (IARC), the American Conference of Governmental Industrial Hygienists (ACGIH), or under WHMIS.

4 First-aid measures

SKIN CONTACT:
Wash thoroughly with soap and water. Remove contaminated clothing. Get medical attention if irritation develops or persists.

EYE CONTACT:
Remove contact lenses. Hold eyelids apart. Immediately flush eyes with plenty of low-pressure water for at least 15 minutes. Get immediate medical attention.

INHALATION:
If nasal, throat or lung irritation develops - remove to fresh air and get medical attention.

INGESTION:
Do not feed anything by mouth to an unconscious or convulsive victim. Do not induce vomiting. Immediately contact physician. Dilute contents of stomach using 2-8 fluid ounces (60-240 mL) of milk or water.

NOTES TO PHYSICIANS:
No special instructions

5 Fire-fighting measures

FIRE FIGHTING INSTRUCTIONS:
Fire fighters should wear positive pressure self-contained breathing apparatus (full face-piece type).
EXTINGUISHING MEDIA:
dry chemical, carbon dioxide, foam or water
HAZARDOUS DECOMPOSITION PRODUCTS:
oxides of carbon
FLASH POINT:
> 200F > 93C P-M(CC)

6 Accidental release measures

PROTECTION AND SPILL CONTAINMENT:
Ventilate area. Use specified protective equipment. Sweep up and remove. Minimize dust generation.
DISPOSAL INSTRUCTIONS:
The waste characteristics of the absorbed material, or any contaminated soil, should be determined in accordance with provincial regulations. Water contaminated with this product may be sent to a sanitary sewer treatment facility, in accordance with any local agreement or discharged under provincial regulations.
Incinerate or land dispose in an approved landfill.

7 Handling and storage

HANDLING:
This material may be combustible. As with all dry powders it is advisable to ground mechanical equipment in contact with dry material to dissipate the potential buildup of static electricity.
STORAGE:
Keep containers closed when not in use. Do not expose to moisture.

8 Exposure controls / personal protection

EXPOSURE LIMITS
Consult local authorities for acceptable provincial values.

Product contains no hazardous ingredients reportable under WHMIS regulation

ENGINEERING CONTROLS:
Adequate ventilation to maintain air contaminants below exposure limits.
RESPIRATORY PROTECTION:
If air-purifying respirator use is appropriate, use any of the following particulate respirators: N95, N99, N100, R95, R99, R100, P95, P99 or P100.
SKIN PROTECTION:
rubber, butyl, viton or neoprene gloves -- Wash off after each use. Replace as necessary.
EYE PROTECTION:
airtight chemical goggles

9 Physical and chemical properties

Density	43.120 lb/cu.	Vapor Pressure (mmHG)	< 0.1
Freeze Point (F)	NA	Vapor Density (air=1)	< 1.00
Freeze Point (C)	NA		
Viscosity(cps 70F,21C)	NA	% Solubility (water)	1.0

Odor		None
Appearance		White
Physical State		Powder
Flash Point	P-M(CC)	> 200F > 93C
pH 0.5% Sol. (approx.)		8.0
Evaporation Rate (Ether=1)		< 1.00
Percent VOC:		0.0

NA = not applicable ND = not determined

10 Stability and reactivity

STABILITY:
Stable under normal storage conditions.
HAZARDOUS POLYMERIZATION:
Will not occur.
INCOMPATIBILITIES:
May react with strong oxidizers.
DECOMPOSITION PRODUCTS:
oxides of carbon
INTERNAL PUMPOUT/CLEANOUT CATEGORIES:
"B"

11 Toxicological information

Oral LD50 MOUSE:	>2,000 mg/kg
NOTE - Supplier estimate; Rat oral LD50: >5,000 mg/kg per alternate supplier	
Carcinogenicity RAT/DOG:	NEGATIVE
Dermal LD50 RABBIT:	>2,000 mg/kg
NOTE - Estimated value	
Skin Irritation Score RABBIT:	NONIRRITANT
Eye Irritation Score RABBIT:	SLIGHT
Skin Sensitization G.PIG:	NEGATIVE

12 Ecological information

AQUATIC TOXICOLOGY
Bluegill Sunfish 48 Hour Static Screen
0% Mortality= 100 mg/L
Daphnia magna 48 Hour Static Renewal Bioassay
LC50= 470; No Effect Level= 178 mg/L
Fathead Minnow 96 Hour Static Renewal Bioassay
LC50= 239; No Effect Level= 45 mg/L

BIODEGRADATION
BOD-28 (mg/g): 0
BOD-5 (mg/g): 0
COD (mg/g): 775
TOC (mg/g): 349

13 Disposal considerations

Incinerate or bury in approved landfill. Please be advised that there may be additional local or provincial requirements relating to the disposal of waste. Consult provincial and local regulations regarding the proper disposal of this material.

14 Transport information

Transportation of Dangerous Goods:

DOT EMERGENCY RESPONSE GUIDE #: Not applicable

15 Regulatory information

This product has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all the information required by the CPR.

CEPA:

All components of this product comply with substance notification requirements under CEPA.

WHMIS CLASSIFICATION:

NOT REGULATED

FOOD AND DRUG ADMINISTRATION:

The ingredients in this product are approved by FDA under 21 CFR 173.5 and 21 CFR 573.120

16 Other information

NFPA/HMIS		CODE TRANSLATION
Health	1	Slight Hazard
Fire	1	Slight Hazard
Reactivity	0	Minimal Hazard
Special	NONE	No special Hazard
(1) Protective Equipment	B	Goggles,Gloves

(1) refer to section 8 of MSDS for additional protective equipment recommendations.

CHANGE LOG

	EFFECTIVE DATE	REVISIONS TO SECTION:	SUPERCEDES
MSDS status:	07-MAY-1997		** NEW **
	01-MAY-1998	8;EDIT:9	07-MAY-1997
	01-JUN-1999	15	01-MAY-1998
	13-SEP-2000	4	01-JUN-1999
	11-DEC-2000	15	13-SEP-2000
	02-DEC-2003	16	11-DEC-2000
	03-NOV-2006	16	02-DEC-2003
	17-APR-2008	4,5,6,7,8,10	03-NOV-2006

APPENDIX F
LOG SHEETS

Baffinland Iron Mines - Mary River Pond Water Summer Treatment Period
Daily Field Log Sheet

Pond being treated:

		Feed Pump					Alum Pump					Poly Pump		Bicarb		DAF Pump				Discharge Pump							
Date	Time	Pressure	Flow	T1	T2	pH	Pump	Stroke	Speed	Flow	pH	Speed	Flow	Stroke	Speed	Gate Valve P	Discharge P	Airflow	Totalizer	Flow	Filter 1 Inlet	Filter 1 Out	Filter 2 Inlet	Filter 2 Out	pH	Turbidity	Temp.
dd/mmm/yy	(24hr)	(psi)	Lpm	m3	m3		#	%	%	ml/min		%	mL/min	%	%	psi	psi	SCFH	m3	Lpm	psi	psi	psi	psi		NTU	deg C

Baffinland Iron Mines - Mary River Pond Water Spring Treatment Period
Daily Field Log Sheet

Pond being treated:

		Field Parameters					Lab Parameters				Observations/Notes
Date	Time	pH	Turbidity	Temperature	Cartridge Filter ΔP	Flowrate	Ammonia as N	TP as P	COD	Turbidity	
dd/mmm/yy	(24hr)	-	NTU	deg C	psig	US GPM	mg/L	mg/L	mg/L	NTU	