

Instruction Handbook

For

Installation, Operation and Maintenance

Centrifugal Pump (No Seals)

Pump Model: TC34

Pump Serial No: 14189301 - 14189305



ACD LLC
2321 S. Pullman Street
Santa Ana, CA 92705
Tel: +1.949.261.7533
Fax: +1.949.261.6285
Email: acd@acdcom.com
Website: www.acdcom.com

English – Original Version

Read these instructions before installing or operating this pump!



INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance





INSTRUCTION HANDBOOK For Installation, Operation & Maintenance

ACD LLC

Based in Southern California, ACD LLC has long been recognized as the leading manufacturer of cryogenic equipment for the industrial gas and air separation industries, enhanced oil recovery operations, and “alternative fuels” projects worldwide.

ACD offers a wide variety of cryogenic pumps for high flow and high pressure off-loading, bulk transfer, injection, onboard vehicle fueling, and storage tank filling. Centrifugal transfer and high pressure reciprocating pumps are specifically designed to meet application requirements while providing both efficient operation and extended product life.

ACD is ISO 9001-2008 certified, ensuring that every component produced meets the highest standards of quality in the industry. Worldwide sales and service locations offer knowledgeable advice on product selection, technical support and trouble-shooting, repair and overhaul capabilities, and extensive spare parts inventories. With nearly 50 years of experience, ACD continues to provide highly engineered solutions to the most challenging problems in cryogenic equipment design and operation.





INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance





INSTRUCTION HANDBOOK

For

Installation, Operation & Maintenance

HOW TO USE THIS MANUAL

This manual consists of three parts: 1) The main body of the manual, comprised of Modules 1 through 11, provides basic information common to all similar ACD pumps; 2) Appendix A provides operation, installation, and maintenance information for the pump model for which this manual was supplied, and is intended to be removed or copied from the manual for use onsite; and 3) Appendix B provides technical information for the specific pump for which this manual was supplied. Modules 1 through 11 are intended to *educate* the user in the basics of pump design and operation to establish a foundation for safe, efficient, and trouble-free ownership. Appendix A is intended to support the *action* of using the particular pump model; and Appendix B provides *reference* data including pump performance sheets, drawings, data for vendor-supplied components, certificates, and any other data pertinent to the specific pump for which this manual was supplied.



INSTRUCTION HANDBOOK

For Installation, Operation & Maintenance

Table of Contents

ACD LLC	1
1 General	7
1.1 About these instructions	7
1.2 Explanation of symbols	7
1.3 Limitation of liability	8
1.4 Copyright	9
1.5 Warranty provisions.....	9
2 Safety	11
2.1 Intended use.....	11
2.2 Operator responsibility	12
2.3 Personnel requirements	13
2.3.1 Qualifications	13
2.3.2 Unauthorized persons.....	14
2.4 Personal protective equipment.....	15
2.5 General hazards.....	17
2.5.1 General hazards in the workplace	17
2.5.2 Hazards posed by electrical power.....	17
2.5.3 Hazards posed by mechanical devices	19
2.5.4 Hazards posed by liquefied gases.....	19
2.5.5 Hazards posed by gases and liquids under pressure	21
2.5.6 Hazards posed by cryogenic and high temperatures.....	22
2.5.7 Hazards posed by fire.....	22
2.6 Safety equipment.....	23
2.7 Conduct during fire outbreak and accidents.....	24
2.8 Signs, signals and warnings.....	25
3 Technical data and suction conditions	27
3.1 Physical Properties.....	27
3.2 Cavitation and NPSH/NPSP.....	31
3.3 Cryogenic vapor pressure charts	33
4 Design and function	43
4.1 Overview.....	43
4.2 Safety equipment components.....	44
4.3 Assembly description.....	45
4.3.1 Electric motor	46
4.3.2 Pump.....	46



INSTRUCTION HANDBOOK

For Installation, Operation & Maintenance

4.4	Hazard area.....	47
4.5	Interfaces.....	48
5	Packaging, Off-loading and Storage	49
5.1	Safety instructions	49
5.2	Delivery inspection	50
5.3	Packaging.....	50
5.4	Off-loading (from delivery truck).....	51
5.5	Storage	51
6	Installation Instruction	53
6.1	Safety instructions for installation and initial startup	53
6.2	Site requirements	54
6.3	Installation	55
6.4	Final assembly checks	57
7	Operation.....	59
7.1	Safety during operation	59
7.2	Preparation for startup.....	60
7.3	Normal start up.....	61
7.4	Switching ON/OFF	61
7.5	Check for leaks.....	61
7.6	Emergency shutdown.....	62
7.7	Normal shutdown	63
8	Maintenance.....	65
8.1	Safety instructions	65
8.2	Spare parts.....	66
8.3	Post-maintenance activities.....	66
9	Troubleshooting	67
9.1	Safety instructions	67
9.2	Troubleshooting table.....	69
9.3	Malfunction elimination.....	70
9.4	Recommissioning	71
10	Disassembly and Disposal	73
10.1	Safety instructions for disassembly and disposal.....	73
10.2	Disassembly	74
10.3	Disposal.....	74
11	GLOSSARY OF TERMS.....	75



INSTRUCTION HANDBOOK For Installation, Operation & Maintenance

12	Appendices	79
	Appendix A	
	A1. Description, Installation, Operation, and Troubleshooting	
	A2. Maintenance (Cryogenic Industries locations)	
	A3. Removal and re-installation	
	A4. Maintenance Plan	
	A5. Field Trouble Report	
	A6. Repair Record	
	Appendix B	
	B1. Intended use	
	B2. Pump Technical Data	
	B2.1 Pump Data Sheet/performance curve	
	B2.2 Other data	
	B3. Drawings	
	B4. Spare parts	
	B5. Ancillary equipment (Vendor data)	
	B6. Certificates	
	B7. Declaration of Incorporation	

1 General

1.1 About these instructions

Following these instructions will ensure the safe and efficient handling of the pump assembly. The instruction manual is an integral part of the pump assembly and must be kept in the immediate vicinity of the pump assembly so that it is accessible to personnel at all times.

Personnel must carefully read and understand these instructions before beginning work. Compliance with all the safety guidelines and handling instructions provided in this instruction manual is a prerequisite for safe operation.

In addition, local accident prevention regulations and general safety provisions for the operational area of the pump assembly also apply.

Illustrations in this instruction manual are intended to provide a basic understanding but may deviate from the actual installation procedure; the exact installation procedure for a specific pump assembly is provided in the detailed drawings, parts list, and instructions in Module 12.

The instructions for the installed components in Module 12 also apply in addition to these instructions. If there is any conflict between the information provided in Module 12 and the information provided in Modules 1 through 11, the Module 12 information has precedence due to its being specific to the pump assembly for which it has been prepared.

1.2 Explanation of symbols

Safety guidelines

Safety guidelines in this instruction manual are identified by symbols. The safety instructions are introduced by signal words that indicate the extent of the hazard.

In order to avoid accidents, personal injury and property damage, it is imperative to comply with the safety instructions.



DANGER!

This combination of symbol and signal word indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.



WARNING!

This combination of symbol and signal word indicates a potentially hazardous situation which, if not avoided, can result in death or serious injury.



CAUTION!

This combination of symbol and signal word indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.



INSTRUCTION HANDBOOK For Installation, Operation & Maintenance

M-1
Rev. 1



NOTE!

This combination of symbol and signal word indicates a potentially hazardous situation which, if not avoided, can result in property and environmental damage.

Tips and recommendations



This symbol emphasizes useful tips and recommendations as well as information for an efficient and disruption-free operation.

Special safety instructions

The following symbols are used in the safety instructions to call attention to special hazards:



DANGER!

This combination of symbol and signal word indicates hazards posed by electrical current. The failure to observe the safety instructions can result in serious or fatal injury.

1.3 Limitation of liability

The information and guidelines provided in this document have been prepared in accordance with the applicable standards and regulations, state-of-the-art engineering and the manufacturer's knowledge and experience with this type of equipment.

The manufacturer assumes no liability whatsoever for injuries resulting from:

- Failure to fully observe and comply with these instructions
- Unintended use of the equipment
- Installation or operation by untrained personnel
- Unauthorized modifications or changes made to the equipment
- Inappropriate, defective or incomplete equipment controls installed by others
- Changes, modification or removal of factory installed components and parts
- Operation outside the "Name Plate Ratings" furnished with the equipment
- Use of "Non-Original-Equipment-Manufacturer" (ACD) spare parts

The manufacturer's Standard Terms and Conditions of Sales shall govern and constitute the sole basis for determination of liability in connection with the equipment and the contents of this document.

The contents of this document, descriptions, graphic illustration and other representations made, were developed with the manufacturer's standard line of products in mind. Custom made equipment and specially designed systems may deviate from the illustration and representations described herein.



INSTRUCTION HANDBOOK

For

Installation, Operation & Maintenance

M-1
Rev. 1

1.4 Copyright

The contents of this document are protected by copyright laws and form part of the manufacturer's Intellectual Property with all the rights and protection afforded by the law. This document is intended for the exclusive use of the purchaser of ACD's equipment and is to be used solely and exclusively for the purpose of installing, operating and maintain the equipment purchased by the buyer.

Furnishing this instruction manual to third parties, reproduction in any form whatsoever, including excerpts or any portion of it, is strictly prohibited, unless prior written authorization from the manufacturer has been obtained in writing. The exploitation and/or communication of any of the contents of this document except for internal use of the purchaser are prohibited.

Infringements of the legal rights of the manufacturer under copyright laws entitle the manufacturer to indemnification and all rights to additional claims and shall remain reserved.

1.5 Warranty provisions

The manufacturer's Standard Terms and Conditions of sale (see next page) shall govern all the warranty and guarantee provisions afforded to purchasers and users of ACD's equipment as well as the contents of this document.



INSTRUCTION HANDBOOK

For

Installation, Operation & Maintenance

M-1
Rev. 1

Standard Terms & Conditions of Sale

- 1. Exclusive Warranty - Goods manufactured by Seller** - Seller warrants to the original Buyer that its new goods are free from defects in materials and workmanship. Seller warrants rated performance of its new goods provided that such goods are used and maintained in accordance with the conditions set forth in the contract documents, including, but not limited to, the operating and maintenance manuals, and installation and use criteria set forth in specifications which are a part of this Agreement, or if there are none, under good operating, maintenance and use conditions. Seller's obligation under this warranty is limited to the repair, or, at Seller's option, the replacement of new equipment within twelve (12) months of delivery to the original Buyer, or the replacement of spare parts within ninety (90) days of delivery to the original Buyer, returned FOB to Seller's plant of manufacture, and which, after examination, appear to Seller's satisfaction to be defective under this warranty. All costs of shipping, insurance, and risk of loss arising in connection with performance of this warranty shall be borne by Buyer. **Components purchased by Seller** - Seller shall attempt to obtain, in its subcontracts with each supplier of components not made by Seller, a provision that the subcontractor's standard warranty, if any, shall survive Seller's inspection, acceptance, and payment, and shall run to Seller, its successors, assigns, and customers. **Designs** - Seller warrants to the original Buyer of its designs that such designs satisfy criteria and specifications set forth in the contract documents. Seller's obligation under this warranty is limited to redesign if, within twelve (12) months after delivery of new equipment, or ninety (90) days for spare parts, to the original Buyer, Buyer demonstrates to Seller's satisfaction that said design criteria and specification were not satisfied by Seller's design. If Seller manufactures the goods in accordance with Buyer's specifications, Seller shall have no liability whatsoever for defects in design or failure of performance of the goods. **Technical Assistance** - Seller warrants that services shall be provided in a professional manner. Seller's obligation hereunder is limited to the providing of services by its employees or agents at the time and place, and to the extent specified in this Agreement. THERE SHALL BE NO EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY BEYOND THE EXPRESS TERMS OF THIS AGREEMENT UNLESS EXPRESSLY AGREED TO IN A WRITING SIGNED BY AN OFFICER OF SELLER. SELLER DOES NOT WARRANT ITS GOODS AS TO THEIR FITNESS FOR ANY SPECIAL USE OR FUNCTION OR AS TO THEIR LIFE AFTER SALE TO BUYER AND/OR TO SUBSEQUENT BUYERS OR USERS OF THE GOODS. There are no warranties, express or implied, arising from course of dealing, course of performance, or usage of trade which extend beyond the face of this Agreement. Seller neither assumes nor authorizes any person to assume for it any other liability in connection with the sale of its goods. Seller has no responsibility whatsoever for reimbursing Buyer, its customers or users of the goods, nor shall Seller be liable in damages for repair or replacement costs incurred by Buyer, its customers or users of the goods in connection with the goods or parts thereof, without Seller first having given its written authorization for such charges and without Seller having an opportunity to perform its warranty obligations as hereinabove set forth. Seller's warranties as hereinabove set forth shall not be enlarged or affected by, and no obligation or liability shall arise or grow out of Seller's rendering of technical assistance or service in connection with the goods furnished hereunder. The limitations set forth herein shall not be affected by the failure of the repair and replacement remedy provided hereinabove. In no event shall Buyer, its successors, assigns, customers or users of the goods commence any action against Seller arising out of the sale, delivery or use of the goods and regardless of the form of the action (whether in contract or tort) later than one (1) year after the cause of action has accrued. Buyer's assertion of any rights under this warranty provision shall be in writing and shall specify with particularity the alleged defects in the goods.
- 2. Damages** - Seller shall not be liable for any exemplary, indirect or consequential damages (including loss of goodwill, revenues or profits) suffered by Buyer, any customer of Buyer or any user of the goods resulting from the nondelivery, use or inability to use the goods, integration of the goods with equipment not provided by Seller and/or from any other cause whatsoever, even if Buyer has been advised of the possibility of such damage. Seller's maximum total liability under this Agreement for actual, exemplary, incidental, proximate and/or consequential damages or expenses arising from any breach or breaches of warranty or failure to deliver the goods in conformance with this Agreement (regardless of the form of action, whether in contract or in tort) shall not exceed the lesser of: (i) the amount Buyer has paid to Seller for the goods, or (ii) the amount of Buyer's actual damages, or (iii) in the case of property damage or personal injury, the amount of such damages covered by Seller's liability insurance, and the period of such liability shall not extend beyond the warranty period under this Agreement. Buyer's remedies and measure of damages as set forth in this Agreement shall be exclusive.
- 3. Price** - Unless otherwise specified, price includes domestic packaging and crating charges, and transportation to the specified FOB point. Buyer will pay any additional transportation charges. Prices do not include any federal, state, or local taxes, assessments, or import duties applicable to the sales, ownership, production, transportation or use of goods sold. Any such tax or duties shall be separately itemized on Seller's invoice and paid by Buyer, or, in lieu thereof, Buyer shall furnish Seller with a valid tax exemption certification in the event Seller is required to pay such tax or assessments. Buyer shall reimburse Seller upon demand, plus interest on such amount at the rate of ten percent (10%) per annum from the date paid by Seller. Seller shall be under no obligation to contest the validity of any such tax or assessments or to prosecute any claims for refunds or returns. Any personal property taxes or similar taxes or assessments against the goods or on account of materials segregated for the Buyer and being held by the Seller at Buyer's request shall be paid by Buyer.
- 4. Shipments and Packaging** - Unless otherwise agreed in writing, all shipments shall be EX WORKS Seller's plant or plants, and title passed to Buyer upon delivery to carrier at such point, and packaging will be accomplished in accordance with Seller's standard commercial practice for domestic shipments. Seller may ship goods to the Buyer's place of business by such means as Seller shall select if adequate shipping instructions are not received from Buyer at least thirty (30) days before the shipment date. Buyer accepts all risk of loss or damage thereto, upon delivery of goods by Seller to a carrier, shipper, forwarding agent, transporter, or Government mailbox or post office, whether selected by Buyer or Seller. In no event shall Seller be responsible for any goods after delivery to such shipping means.
- 5. Payments** - Terms of payment, on open accounts only, are not thirty (30) days from receipt of invoice, unless otherwise agreed to in writing. Buyer agrees to pay Seller's finance charges (10% per annum) for late payments, and any expenses incurred in collecting such unpaid balance and finance charges, or in recovering possession of the goods.
- 6. Cancellation** - This Agreement is subject to cancellation only upon Seller's accepting such cancellation in writing, and the effective date of such cancellation shall be the date of such acceptance. Upon acceptance of cancellation, Seller shall commence efforts to terminate the purchase, rental, service, and employment commitments relating to the order, and Buyer shall be liable for the costs of terminating such commitments, as well for the payment for completed work, work in process at the time of cancellation, and lost profits. Buyer shall make payment of cancellation charges upon receipt of statement of same. Cancellation charges shall not exceed the purchase price of the cancelled portion of the Agreement.
- 7. Acceptance** - Buyer shall inspect all goods immediately upon their delivery to the destination stated in the Agreement and shall within ten (10) days provide written notice to Seller at its principal place of business of any claim that the goods do not conform to the terms of the Agreement. Any such notice shall specify with particularity each alleged defect or nonconformity. If Buyer shall fail to give such timely notice, the goods shall be conclusively deemed to conform to the terms and specifications of this Agreement and shall constitute an irrevocable acceptance of the goods. Any use by Buyer of the goods other than solely for test purposes, or any alteration of the goods by Buyer without Seller's prior written consent, shall be conclusive and binding evidence that the goods conform to the terms and specifications of this Agreement. If Buyer accepts or is deemed to have accepted the goods as hereinabove provided, Buyer shall not be entitled to revoke acceptance thereof at a subsequent time. In the event Buyer timely rejects the goods in accordance with the terms of this Agreement, Buyer shall hold the goods without charge to Seller for a reasonable time until Seller shall give instructions to Buyer with respect to the goods. Should Buyer sell or dispose of the goods, such sale or disposition shall constitute an unequivocal acceptance of the goods, notwithstanding any prior rejection of the goods.
- 8. Excusable Delays** - Seller shall not be in default for failure to deliver or delay in delivery arising out of causes beyond its control and without its negligence, including, but not limited to: Acts of God or the public enemy, Acts of the Government in either its sovereign or contractual capacity, fires, floods, epidemics, quarantine restrictions, strikes, shortages of materials or suppliers, labor disputes, freight embargoes, delays in transit, and unusually severe weather. If the delay or failure to deliver is caused by a delay or failure of a subcontractor supplier of Seller, and if such delay or failure arises out of causes beyond the control of Seller, Seller shall not be liable in damages nor shall Seller be in default hereunder, unless the material or services to be furnished by the subcontractor or supplier were obtainable from other sources in sufficient time to permit Seller to meet the required delivery schedule using reasonable effort. Any of the above excusable delays shall not terminate this Agreement, and Seller shall deliver the goods as promptly as practical thereafter. The time of the delivery set forth in the Agreement shall be extended, in the event of any change order or request for modification required by Buyer, for such period as is reasonably necessary for Seller to comply with any such change order or request for modification. In the event of a failure to deliver the goods in a timely manner, Buyer shall not have any right to procure goods from any other source except at Buyer's sole expense, provided, however, that after payment to Seller of the contract price for any completed goods and work in process, according to the terms of this Agreement, Buyer may procure such goods or portions thereof with Seller's written approval, and at Buyer's expense, the price of which shall not exceed the amount still owing under this Agreement after required payments for such completed goods and work in process that have been subtracted therefrom. Buyer's acceptance of late delivery goods shall constitute complete and satisfactory performance by Seller.
- 9. Patent indemnity** - If the goods furnished hereunder are specified in the Agreement as being "standard commercial supplies" of Seller, Seller agrees to indemnify Buyer, its successors, assigns, agents, and users of its products against loss, damage, or liability, including cost and expenses, such as may be incurred on account of any suit, claim, judgment or demand involving infringement or alleged infringement of any patent rights in the manufacture, use or disposition of any goods supplied hereunder, provided Buyer shall promptly notify Seller of any suit instituted against it and, to the full extent of its ability to do so, shall permit Seller to defend the same or make settlement in respect thereto. In the event the goods furnished hereunder are produced under special specifications of Buyer, no liability under this paragraph shall arise against Seller. In like manner, Buyer agrees to save Seller harmless from patent infringements resulting from Seller's compliance with designs and/or specifications not originating with Seller now or hereafter forming a part of this Agreement or with specific written instructions given by Buyer for the purpose of directing the manner in which Seller shall perform this Agreement.
- 10. Use of Products** - Seller grants no license or right, expressly or by implication, estoppel, or otherwise, beyond the right of Buyer to use the specified goods in the form delivered by Seller. Further, Seller's products are offered for sale and are sold subject in every case to the condition that such sale does not convey any license, expressly or by implication, estoppel, or otherwise, under any patent claim with respect to which Seller could grant licenses covering any other product, or any completed equipment, or any assembly, piping, pool, circuit, combination, method or process in which, or in the manufacturing or testing of which, any such Seller products are used (notwithstanding that such Seller products may have been designed only for use in, or may only be useful in, such other patented products or such patented equipment, assembly, piping pool, circuit, combination, method or process, or in the manufacturing or testing thereof, and that Seller products may have been purchased and sold for such use). Seller expressly reserves all its rights under such patent claims.
- 11. Proprietary Rights** - The prints, drawings or specifications of Seller attached hereto or hereafter furnished by Seller to Buyer in connection with the obtaining of the performance of this Agreement are the property of Seller and represent a proprietary article with respect to which Seller retains all United States or foreign letters patent, trademarks or copyrights, including exclusive rights of use, manufacture and sale. Possession by Buyer of such prints, drawings or specifications does not convey any permission to manufacture, use or sell any goods shown thereon, and such information is disclosed to Buyer on a confidential basis. Buyer shall not, directly or indirectly, disclose, copy or otherwise transfer such information to any third party at any time without the prior written consent of Seller. Buyer, Buyer's customers and users of the goods shall not modify or reverse engineer any of the goods or parts thereof.
- 12. Termination** - If Buyer fails to comply with any of the provisions hereof, or becomes the subject of a proceeding under state or federal law for relief of debtors, or makes an assignment for the benefit of creditors, Seller shall have the right to hold Buyer in default and, in addition to any other rights it may have, may cancel this Agreement in whole or in part.
- 13. Effect of Invalidity** - The invalidity in whole or in part of any provision hereof shall not affect the validity of any other provision.
- 14. Credit** - Seller reserves the right any time to alter or suspend credit, or to change credit terms provided herein, when in its sole opinion the financial condition of the Buyer so warrants. In such case, in addition to any other remedies herein or by law provided, cash payment or satisfactorily security from Buyer may be required by Seller before shipment, or Seller may, at its option, defer further shipments to Buyer until Buyer reestablishes satisfactory credit, cancel the unshipped portions of the order without any liability for failure to ship, or make shipments to Buyer on a prepayment or COD basis. Payments made by trade acceptances, notes, securities, postdated checks, etc., are unacceptable unless first approved in writing by Seller.
- 15. Remedies** - The rights and remedies provided Seller herein shall be cumulative, and in addition to any other rights and remedies provided by law or equity. Seller's failure to insist upon strict performance of any provision of this Agreement shall not be deemed to be a waiver of Seller's rights or remedies, nor a waiver by Seller of any subsequent default by the Buyer in performance of compliance with any of the terms of this Agreement.
- 16. Disputes** - Any controversy or claim arising out of or relating to this Agreement or a breach thereof shall be settled by arbitration in Los Angeles, California, in accordance with the Rules of the Judicial Arbitration Mediation Service ("JAMS"). Any award or decision obtained from any such arbitration proceeding shall be final and binding on the parties, and judgment on any award thus obtained may be entered in any court having jurisdiction thereof. The arbitrator(s) shall have the right to award any form of relief, provided, however, that the arbitrator(s) shall not have authority to award punitive damages. The cost of the arbitration shall be borne equally by the parties and each party shall be responsible for payment of its own attorneys' fees, expert witness fees and other expenses incurred in connection with the arbitration. In the event JAMS is not available to conduct the arbitration, the arbitration shall be conducted by the American Arbitration Association in accordance with its Rules for Commercial Arbitration then in effect.
- 17. Assignment** - Buyer may not assign this Agreement, or any portion thereof without the express prior written consent of Seller. Subject always to the foregoing, this Agreement insures to the benefit of, and is binding upon, the heirs, legatees, personal representatives, successors and assigns of the parties hereto. In no event shall assignment relieve Buyer of liability for performance of the obligations imposed by this Agreement.
- 18. Conformance with Law** - Buyer assumes all responsibility for conformance of the goods with laws, rules, regulations and ordinances of any governmental or quasi-governmental agency applicable to the use or operation of the goods.
- 19. Entire Agreement** - This Agreement shall constitute the entire understanding of the parties with reference to the subject matter hereof, and it is agreed that there are no understandings, promises, representations or agreements, whether oral or written, heretofore entered into between Seller and Buyer which have any force or effect. Only a writing signed by the parties may amend this Agreement. No agent, employee, or representative of Seller has any authority to bind Seller to any affirmation, promise, representation or warranty concerning the goods, and any such affirmation, promise, representation or warranty shall be of no force or effect unless set forth in this Agreement. The laws of the State of California shall govern the formation, performance, and construction of this Agreement.

2 Safety

This section provides an overview of the important safety aspects to be considered in order to ensure the maximum protection of personnel.

Failure to comply with the handling instructions and safety guidelines listed in this instruction manual can result in injury.

2.1 Intended use

The pump assembly is designed and constructed only for the intended use described in this document.



NOTE!

The pump assembly is intended only for the pumping of liquefied gases at high pressures and at low temperatures in accordance with the technical data provided in Module 3. The pump must be installed outdoors. Sealless centrifugal pumps are not to be used for pumping liquid oxygen .

The intended use includes compliance with all the instructions set forth in this instruction manual. Any use that goes beyond or is different from the intended use shall be deemed **misuse**.



WARNING!

Hazards posed by misuse!

Misuse of the pump can lead to hazardous situations.

- Redesign, retrofitting and modification of the pump assembly or the individual components is prohibited.
- Do not use the pump in liquid oxygen service.
- Do not use the pump in buildings.
- The pump is to be installed and operated only in accordance with the specifications described in the technical data provided in this manual including Module 12.

Claims of any type for damages resulting from misuse are excluded.



INSTRUCTION HANDBOOK

For

Installation, Operation & Maintenance

M-2
Rev. 1

2.2 Operator responsibility

Operator

The operator is the person or entity who operates the pump assembly, either directly or indirectly, for any purpose. Indirect operation includes entrusting a third party with the use/utilization of the pump assembly. The operator bears legal responsibility for the control and use of the pump assembly for the protection of the user, personnel or third parties during the operation of the pump assembly.

Operator obligations

The pump assembly is used in industrial areas. The operator of the pump assembly is therefore subject to the legal obligations arising under the occupational safety regulations.

In addition to the safety instructions set forth in this instruction manual, the operator must also comply with the safety, accident prevention, and environmental protection regulations applicable to the pump assembly operational area.

In particular:

- The operator must keep up-to-date with the applicable occupational safety provisions and conduct a hazard assessment in order to identify additional hazards that arise from the special operating conditions. He must implement these in the form of operating instructions for the operation of the pump assembly.
- The operator must check during the entire operating time of the pump assembly whether the operating instructions prepared by him are consistent with the current status of the regulations and adjust them if necessary.
- The operator must clearly supervise and define the responsibilities for installation, operation, troubleshooting, maintenance and cleaning.
- The operator must ensure that all employees who handle the pump assembly have read and understood this instruction manual. In addition, he must train personnel on a regular basis and inform them about the hazards.
- The operator must furnish personnel with the required protective equipment and make the wearing of the required protective equipment mandatory.

The operator is also responsible for ensuring that the pump assembly is always in a technically perfect condition. Thus, he is obligated to carry out the following tasks:

- The operator must adhere to the maintenance intervals described in this instruction manual.
- Perform the indicated maintenance in accordance with the procedures provided in this instruction manual.
- The operator must regularly have all safety devices checked for functional capability.

Overall system

- The pump assembly is part of an overall system. The operator must ensure that the necessary structural and organizational protective measures that apply at the site of system operation [for example, by setting up safeguards so as to protect the system against unauthorized access] are instituted and that personnel comply with these measures. He must ensure the safety of the overall system.
- The operator must inform the personnel working with the pump assembly about the hazards stemming from the overall system and train them in principles of conduct on a regular basis.

- The person or entity responsible for the overall installation must issue operating instructions on safety requirements, the operation and user interfaces of the overall installation. The required principles of conduct must also be included in these operating instructions. The operating instructions must be visibly displayed in the installation area.
- The operator may not make any technical changes to the system.

2.3 Personnel requirements

2.3.1 Qualifications



WARNING!

Risk of injury in case of unqualified personnel!

The risks associated with unqualified personnel performing work on the pump assembly or being within the hazard area of the pump assembly can result in serious injuries and significant property damage.

- All activities may be conducted only by qualified personnel.
- Unqualified personnel must not have access to hazard areas.

Only personnel qualified in the various areas of activity listed below should be allowed to work on this equipment:

Qualified electrical technicians

Electrical technicians must have the technical training, knowledge, experience and understanding of the applicable standards and regulations to be able to perform work on electrical installations and to independently recognize and avoid potential hazards.

Electrical technicians must be trained specifically for the work environment in which they operate and be familiar with the relevant standards and regulations.

Electrical technicians must comply with the provisions of the applicable legal regulations on accident prevention.

In addition, the technicians must be trained in the area of liquefied gases and must be able to independently recognize and avoid potential hazards posed by liquefied gases.

Qualified mechanical technicians

Mechanical technicians must have the ability to perform work on mechanical installations and to independently recognize and avoid potential hazards.

Mechanical technicians must be trained specifically for the work environment in which they operate and must be familiar with the relevant standards and regulations.

Mechanical technicians must comply with the provisions of the applicable legal regulations on accident prevention.

In addition, the technicians must be trained in the area of liquefied gases and must be able to independently recognize and avoid potential hazards posed by liquefied gases.



INSTRUCTION HANDBOOK

For

Installation, Operation & Maintenance

M-2
Rev. 1

Qualified technical personnel

Technical personnel must have the ability to perform the work assigned to them and to independently recognize and avoid potential hazards.

Manufacturer

Certain types of work may be performed only by the pump assembly manufacturer's technical personnel or at an authorized Cryogenic Industries Service Center. Other personnel are not authorized to carry out this work. Please contact the manufacturer's service department; refer to Module 12, Appendix A2, for contact information.

Qualified welding technicians

Welding technicians must have the ability to perform the work assigned to them and to independently recognize and avoid potential hazards.

Welding technicians must be certified in accordance with all applicable welding performance standards.

Welding technicians must be trained specifically for the work environment in which they operate and must be familiar with the relevant standards and regulations.

Welding technicians must comply with the provisions of the applicable legal regulations on accident prevention.

General

Only individuals who are expected to carry out their tasks reliably may be hired. Individuals whose ability to react is impaired, for example, by drugs, alcohol or medications may not be hired.

Age- and occupation-specific regulations applicable at site of operation must be considered in personnel selection.

2.3.2 Unauthorized persons



WARNING!

Unauthorized persons in the hazard and work area may cause serious injury or death!

- Keep unauthorized persons away from the hazard and work area.
- In case of doubt, approach persons who may be at risk and guide them outside the hazard and work area.
- Interrupt work as long as unauthorized persons are in the hazard and work area.

2.4 Personal protective equipment

Personal protective equipment serves to protect personnel against hazards that could adversely affect their safety or health during work.

Personnel must wear personal protective equipment while carrying out various tasks on and with the pump assembly. This is separately emphasized in the individual sections of this instruction manual. This personal protective equipment is explained below:

- It is imperative that the personnel put on the personal protective equipment required in this instruction manual prior to beginning work.
- Personnel must comply with the personal protective equipment instructions displayed in the work area.

Description of personal protection equipment



Protective work clothing

Protective work clothing is tight-fitting work clothing with narrow sleeves and without protruding parts. It is used primarily to protect persons from being caught in moving pump assembly parts.

Protective work clothing is of low flammability and completely covers the legs and arms. It serves to protect from burns and from cryogenic liquids and surfaces. It must be rapidly removable in the event of a hazard.

No chains, rings, watches or other jewelry may be worn. Highly flammable objects, such as matches or lighters, may not be carried.



Ear protection

Ear protection serves to protect against hearing damage.



Helmet

Helmets serve to protect against head injuries.



Safety goggles

Safety goggles or goggles closed all the way around serve to protect the eyes from foreign particles, (cryogenic) liquids and materials.



Protective gloves

Protective gloves serve to protect the hands from friction, abrasions, cuts or wounds and from contact with hot and cryogenic surfaces.



Safety vest

Reflective safety vests/warning vests serve to protect the safety of each individual person, making a person is visible from a distance in the light and also in the dark.



Protective welding gloves

Protective welding gloves serve to protect the hands from spatter, flying sparks and other hot particles as well as from contact with hot surfaces.



Protective welding shield

Protective welding shields serve to protect the eyes from flash burn and spatter, flying sparks and other hot particles that could injure the face.



Safety shoes

Safety shoes serve to protect against heavy falling parts, against sliding on slippery floors, to protect against cryogenic liquids and cryogenic surfaces as well as from contact with chemicals. Requirements:

- Resistance to oil and chemicals
- High skid resistance
- Toe protection (steel cap)
- Protection from electrostatic discharge (by conductive soles)

Special requirements for electrical technicians:

- Insulating

Special requirements for welding:

- Safety shoes with high shaft or gaiters

2.5 General hazards

Residual risks that can originate from the pump assembly and have been identified by means of a risk assessment are described in the following section.

In order to reduce health hazards and avoid hazardous situations, the safety instructions listed here and the safety instructions in the subsequent sections of this instruction manual must to be observed.

2.5.1 General hazards in the workplace

Noise



WARNING!
Risk of injury caused by noise!

The noise level in the work area can cause serious hearing damage.

- Always wear ear protection during work.
- Remain in the hazard area only for as long as necessary.

Liquid accumulations (non-cryogenic)



CAUTION!
Risk of injury due to slipping in liquid accumulations!

Slipping in liquid accumulations on the floor can lead to injuries.

- Liquid accumulations must be absorbed immediately with appropriate means.
- Skid resistant safety shoes must be worn at all times.
- Warnings and mandatory signs must be posted in or in the vicinity of an area in which liquid can accumulate on the floor.

2.5.2 Hazards posed by electrical power

Electrical current



DANGER!
Danger due to electrical current!

Contact with voltage-carrying parts may cause serious injury or death resulting from electric shock. Insulation damage on individual components can be life-threatening.

- Work on electrical installations may only be performed by qualified electrical technicians.
- In case of insulation damage, cut off power supply immediately and arrange for repairs to be made.

- Before beginning work on any circuit of an electrical installation or equipment, make sure there is no voltage in the circuit and ensure that this remains so for the duration of work. Observe the five safety rules:
 - Disconnect
 - Take protective measures against re-engagement
 - Ensure the absence of voltage
 - Ground and short-circuit
 - Cover or shield adjacent current-carrying parts
- Never bridge or remove fuses from operation. When replacing fuses, always replace with the correct current and voltage rating.
- Keep moisture away from voltage-carrying parts, as it can lead to a short circuit.

Stored charges



DANGER!
Danger due to stored charges!

Electrical charges can be stored in electronic components and can be retained even after the power is switched off and the electronic components are separated from the power supply. Contact with these components can result in severe or fatal injuries.

Before working on the above-mentioned components, separate them completely from the power supply. Allow 10 minutes to elapse in order to ensure that the internal capacitors are completely discharged.

Residual electrostatic potentials



WARNING!
Danger to life due to residual electrostatic potentials!

Significant electrostatic potentials can build up from friction if a belt drive is part of the pump assembly. Contact with parts immediately after a conveying operation can result in severe or fatal injuries.

Make sure that there is potential equalization before contact if this is not provided for on-site (through suitable earth grounding).

2.5.3 Hazards posed by mechanical devices

Moving components



WARNING!

Risk of injury due to moving components!

Rotating and/or linearly moving components can cause serious injury.

- Do not touch or handle moving components during operation.
- Do not open covers during operation.
- Observe rundown time: Before opening covers ensure that components are no longer moving.
- In the hazard area wear closely-fitting protective work clothing with low tear strength.

Sharp edges and pointed corners



CAUTION!

Risk of injury due to sharp edges and pointed corners!

Sharp edges and pointed corners can cause abrasions and cuts on the skin.

- Proceed with caution while working in the vicinity of sharp edges and pointed corners.
- In case of doubt, wear safety gloves.

2.5.4 Hazards posed by liquefied gases

Liquid jet



DANGER!

Danger due to liquid jet emerging under high pressure!

In defective lines or components, cryogenic liquid can emerge under high pressure. The liquid jet can amputate body parts and lead to very serious injuries or even death.

- Never hold body parts or objects in the liquid jet. Keep persons out of the hazard area. In case of inadvertent contact with the liquid jet, take first aid measures and immediately seek medical assistance.
- Immediately initiate emergency shutdown. If necessary, take additional measures in order to reduce the pressure and stop the liquid jet.
- Have defective components repaired immediately.

Liquefied gases



DANGER!

Danger due to liquefied gases!

When inhaled, emerging liquefied gases in high concentration can cause loss of consciousness with inability to move and can lead to asphyxiation and increased risk of fire and explosion hazard.

Skin or eye contact with cryogenic liquids can result in a risk of cold burns, severe frostbite and permanent eye damage.

- Observe the safety data sheet of the cryogenic liquid supplier.
- When handling liquefied gases always wear acid-resistant protective work clothing, chemical-resistant gloves and protective goggles in accordance with the instructions on the personal protection equipment in the safety data sheet of the cryogenic liquid supplier.
- Keep respiratory device handy for emergencies.
- Always ensure fresh air supply while working with liquid cryogenics. In case of inadvertent inhalation and loss of consciousness, immediately bring the affected person to fresh air in a stable side position and keep the person warm. In case of respiratory failure, immediately take first aid measures with artificial respiration. Immediately seek medical assistance.
- Quickly remove wetted clothing articles, shoes and socks.
- Avoid skin contact with liquefied gases. In case of inadvertent skin contact, wash the affected skin area with abundant water for at least 15 minutes. Then cover the affected skin area in a sterile fashion. Immediately seek medical assistance.
- Avoid eye contact with liquefied gases. In case of inadvertent eye contact immediately rinse out with clear water for at least 15 minutes including under the eyelid. Immediately seek medical assistance.

Nitrogen/Argon



WARNING!

Danger due to nitrogen or argon!

When inhaled, emerging nitrogen or argon in high concentration can cause loss of consciousness with inability to move and can lead to asphyxiation.

- Observe the safety data sheet of the liquid nitrogen or argon supplier.
- When handling liquid nitrogen or argon, always wear protective work clothing, chemical-resistant gloves and protective goggles in accordance with the instructions on personal protection equipment in the safety data sheet of the liquid nitrogen or argon supplier.
- Do not inhale nitrogen or argon. Always ensure fresh air supply while working with either liquid or gas. In case of inadvertent inhalation, immediately bring the affected person to fresh air in a stable side position and keep the person warm. In case of respiratory failure, immediately take first aid measures with artificial respiration. Immediately seek medical assistance.

Oxygen deficient atmosphere



WARNING!

Danger due to oxygen deficient atmosphere!

When present in areas with oxygen deficient atmosphere, serious injuries or even death can occur as a result of restricted performance capability.

- Areas with oxygen deficient air must be marked, indicating the current oxygen concentration and the associated risks.
- Limit access to areas with oxygen deficient atmospheres to authorized individuals with authorized access.
- Ensure that no permanent workstations are located in oxygen deficient areas.
- Limit the length of stay in the areas to brief and light activities.
- Only permit re-entry after 30 minutes have been spent outside of these areas.
- Immediately leave areas with oxygen deficient atmosphere if any symptoms appear.
- Carry along a communication device in order to be able to be in contact with persons outside the areas.
- Always use the “buddy system” if work is necessary in an oxygen deficient atmosphere. The “buddy system” requires that a second person outside in fresh air be present and continuously observing the personnel at work in the oxygen deficient atmosphere to render aid immediately as required.
- Keep respiratory device handy for emergencies.

If unaccompanied persons must enter the oxygen deficient area, the following applies:

- The oxygen concentration must be raised to at least 19.5 vol. % for the duration of work.

2.5.5 Hazards posed by gases and liquids under pressure

Components exposed to pressure



WARNING!

Danger due to components exposed to pressure!

Components exposed to pressure can move in an uncontrolled fashion and can cause serious injuries when improperly handled. Liquid can emerge under high pressure from components exposed to pressure and can cause serious injuries or even death when improperly handled or in case of a defect.

Before starting work on these components:

- Reduce pressure to atmospheric.
- Always ensure that unintentional emergence of liquids cannot occur.
- Defective components that are exposed to pressure during operation are to be immediately replaced by appropriate technical personnel.

2.5.6 Hazards posed by cryogenic and high temperatures

Cryogenic surfaces



DANGER!

Risk of injury due to cryogenic surfaces!

Surfaces can cool down during operation. Skin contact with cryogenic surfaces causes severe frostbite.

- While working in the vicinity of cryogenic surfaces, always wear temperature-resistant protective work clothing and safety gloves.
- Before performing maintenance, troubleshooting and disassembly work, ensure that all surfaces are brought to ambient temperature.

Hot surfaces



WARNING!

Risk of injury due to hot surfaces!

Surfaces of components can heat up intensely during operation. Skin contact with hot surfaces causes serious burns.

- While working in the vicinity of hot surfaces, always wear heat-resistant protective work clothing and safety gloves.
- Before starting work, ensure that all surfaces are cooled to ambient temperature.

2.5.7 Hazards posed by fire

Fire protection



WARNING!

Risk of injury due to restricted or improper firefighting!

If a fire extinguisher is not ready for use or is unsuited for a specific fire class, serious injuries or even death as well as significant property damage can occur in the event of a fire.

- Make sure that only fire extinguishers appropriate for the fire class are ready.
- Check fire extinguishers every 2 years for operational readiness or as required by local codes.
- Refill fire extinguishers after each operation (if refillable).
- Only use extinguishing propellants and spare parts that match the approved sample stated on the fire extinguisher.
- Observe the safety and operating instructions on the fire extinguisher during use.
- Observe functional temperature range during use.

Highly flammable substances



WARNING!

Danger to life in case of fire due to highly flammable substances!

Highly flammable substances, liquids or gases can catch fire and cause severe or fatal injuries.

- Do not smoke within the hazard area or in the immediate vicinity. Handling of open fire and ignition sources of all types is prohibited.
- Keep appropriate extinguishing agents (extinguishing blanket, fire extinguishers) handy.
- Immediately report suspicious substances, liquids or gases to the responsible person.
- In the event of fire, stop work immediately. Leave hazard area and notify the fire department.

2.6 Safety equipment



WARNING!

Danger to life due to nonfunctioning safety equipment!

Safety equipment that is nonfunctioning or is out of operation poses a risk of severe or fatal injuries.

- Before beginning work, check whether all safety equipment is functional and correctly installed.
- Never disconnect or bridge safety equipment.
- Make sure that all safety equipment is always accessible.

Integration in the emergency shutdown concept is essential



The pump assembly is intended for use within a system. It does not have its own control system or an autonomous emergency shutdown function.

Before the pump assembly is brought into operation, install emergency shutdown devices on the pump assembly and connect in the safety chain of the control system.

The emergency shutdown device(s) must be connected so that during interruption of power supply or activation of power supply after interruption, hazardous situations for persons and property do not occur.

The emergency shutdown equipment must always be freely accessible to personnel in the work area.

Emergency shutdown switch



HAZARD!

Danger from unconnected emergency shutdown switch!

The emergency shutdown devices must be installed on the pump and incorporated in the safety chain of the installation control.

Integration in a protective fence system required

The pump assembly is intended for use within a system. Before the pump assembly is brought into operation, install protective fences around the pump assembly and incorporate them in the safety chain of the control system.

Protective fences must separate hazard areas. The hazard areas within the protective fences may not be entered when the power supply is switched on.

Only enter using the doors prescribed for this purpose. Do not engage as long as persons are within the protective fences.

Safety valves

Safety valves are relieving devices for pressure containing components such as pressure vessels or pipelines. Safety valves divert gases, vapors or liquids into the atmosphere if pressure rises above the safety valve's setpoint.

A safety valve is situated in the high pressure system of the pump, which relieves the overpressure without hazard if pressure rises too high as a result of incorrect operation, component failure or other irregular events.

2.7 Conduct during fire outbreak and accidents

Protective measures

- Always be prepared for fire and accidents!
- Keep first aid equipment (first aid kits, blankets, etc.) and fire extinguishing equipment functional and handy.
- Familiarize personnel with accident reporting requirements, first aid and rescue equipment.
- Keep access routes open for rescue vehicles.

Measures during fire outbreak and accidents

- Immediately activate the emergency shutdown by means of the emergency shutdown device.
- If there is no risk to health, keep persons out of the hazard zone.

- If necessary, take first aid measures.
- Notify the fire department and/or rescue service.
- During fire outbreak: If there is no hazard to health, combat fire with fire extinguishing equipment and continue firefighting until the fire department arrives.
- Inform responsible persons at the site of operation.
- Keep access routes open for rescue vehicles.
- Direct rescue vehicles.

2.8 Signs, signals and warnings

The following symbols and instruction signs are found in the work area. They pertain to the immediate surroundings in which they are placed.



WARNING! **Risk of injury due to illegible symbols!**

Over the course of time, stickers and tags can be soiled or become unrecognizable in other ways so that hazards are not recognized and necessary operating instructions cannot be followed. As a result, this poses a risk of injury.

- Keep all safety, warning and operating instructions in a legible condition.
- Immediately replace damaged tags or stickers.

Personal protective equipment



Wear the appropriate personal protective equipment while working in order to protect against injury.

Electrical voltage



Only authorized electrical technicians may work in a marked area. Unauthorized personnel may not enter the marked workplaces or open a marked cabinet.

Cold



Warning from hazardous cold in the work area.
There is a special risk of frostbite of hands, feet and eyes. Wear cold-protective clothing.

Pull-in hazard



Conduct work at pull-in locations only during shutdown. As long as the pump assembly is moving there is a risk of injury.

Overpressure



Hazard from overpressure exists at the marked location.



INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-3
Rev. 1

3 Technical data and suction conditions

3.1 Physical Properties

For reference, the physical properties of the most commonly pumped cryogenic fluids are provided in the following tables:

Table 3-1	Argon (Ar)
Table 3-2	Carbon Dioxide (CO ₂)
Table 3-3	Ethylene (C ₂ H ₄)
Table 3-4	Hydrogen (H ₂)
Table 3-5	Methane (CH ₄) (LNG)
Table 3-6	Nitrogen (N ₂)
Table 3-7	Nitrous Oxide (N ₂ O)
Table 3-8	Oxygen (O ₂)

Table 3-1. Argon properties

<u>Property</u>	<u>Value</u>
Chemical symbol	Ar
Molecular weight	39.95
Color	None
Odor	None
Taste	None
Normal Boiling Point (NBP), °F (°C)	-302.6 (-185.9)
Latent heat of vaporization at NBP, BTU/lb (kJ/kg)	69.8 (162.3)
Critical pressure, psia (kPa)	711.5 (4905.6)
Critical temperature, °F (°C)	-188.1 (-122.3)
Triple point pressure, psia (kPa)	9.99 (68.88)
Triple point temperature, °F (°C)	-308.8 (-189.3)
Density at NBP, lb/ft ³ (kg/m ³)	87.0 (1393.6)
Weight. lb/gal (kg/l)	11.63 (1.39)
Expansion ratio, liquid at NBP to SCF (Nm ³)	841.5 (781.2)



INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-3
Rev. 1

Table 3-2. Carbon Dioxide properties

<u>Property</u>	<u>Value</u>
Chemical symbol	CO ₂
Molecular weight	44.01
Color*	None (gas)*
Odor	Slightly pungent
Taste	Biting
Normal sublimation temperature, °F (°C)	-109.3 (-78.5)
Latent heat of sublimation, BTU/lb (kJ/kg)	245.5 (571.3)
Critical pressure, psia (kPa)	1070.6 (7381.5)
Critical temperature, °F (°C)	87.8 (31)
Triple point pressure, psia (kPa)	75.13 (518)
Triple point temperature, °F (°C)	-69.83 (-56.6)
Density at 1.7 °F (-16.8°C), lb/ft ³ (kg/m ³) (liquid)**	63.4 (1014.9)**
Weight, lb/gal (kg/l) (liquid)	8.47 (1.02)

* Solid is translucent white

** at 300 psia (2068 kPa)

Table 3-3. Ethylene properties

<u>Property</u>	<u>Value</u>
Chemical symbol	C ₂ H ₄
Molecular weight	28.05
Color	None
Odor	Sweet
Taste	Sweet
Normal Boiling Point (NBP), °F (°C)	-154.8 (-103.8)
Latent heat of vaporization at NBP, BTU/lb (kJ/kg)	208 (484)
Critical pressure, psia (kPa)	742.1 (5116.6)
Critical temperature, °F (°C)	49.82 (9.9)
Triple point pressure, psia (kPa)	1.10 (7.58)
Triple point temperature, °F (°C)	-272.5 (-169.2)
Density at NBP, lb/ft ³ (kg/m ³) (liquid)	35.4 (567.1)
Weight, lb/gal (kg/l) (liquid)	4.73 (0.57)
Expansion ratio, liquid at NBP to SCF (Nm ³)	449.3 (417.2)



INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-3
Rev. 1

Table 3-4. Hydrogen properties

<u>Property</u>	<u>Value</u>
Chemical symbol	H ₂
Molecular weight	2.01
Color	None
Odor	None
Taste	None
Normal Boiling Point (NBP), °F (°C)	-423.0 (-252.8)
Latent heat of vaporization at NBP, BTU/lb (kJ/kg)	191.7 (446.0)
Critical pressure, psia (kPa)	188 (1296.2)
Critical temperature, °F (°C)	-399.9 (-240.0)
Triple point pressure, psia (kPa)	1.05 (7.24)
Triple point temperature, °F (°C)	-434.55 (-259.2)
Density at NBP, lb/ft ³ (kg/m ³) (liquid)	4.42 (70.8)
Weight, lb/gal (kg/l) (liquid)	0.59 (0.071)
Expansion ratio, liquid at NBP to SCF (Nm ³)	848.3 (788.1)

Table 3-5. Methane (LNG) properties

Natural gas is typically about 90% methane. When liquefied, natural gas becomes almost 100% methane as other constituents are removed in the process.

<u>Property</u>	<u>Value</u>
Chemical symbol	CH ₄
Molecular weight	16.04
Color	None
Odor	None
Taste	None
Normal Boiling Point (NBP), °F (°C)	-258.6 (-161.4)
Latent heat of vaporization at NBP, BTU/lb (kJ/kg)	219.2 (509.9)
Critical pressure, psia (kPa)	673.1 (4640.9)
Critical temperature, °F (°C)	-115.7 (-82.1)
Triple point pressure, psia (kPa)	1.69 (11.65)
Triple point temperature, °F (°C)	-296.5 (-182.5)
Density at NBP, lb/ft ³ (kg/m ³) (liquid)	26.4 (422.9)
Weight, lb/gal (kg/l) (liquid)	3.53 (0.423)
Expansion ratio, liquid at NBP to SCF (Nm ³)	634.8 (589.1)



INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-3
Rev. 1

Table 3-6. Nitrogen properties

<u>Property</u>	<u>Value</u>
Chemical symbol	N ₂
Molecular weight	28.01
Color	None
Odor	None
Taste	None
Normal Boiling Point (NBP), °F (°C)	-320.4 (-195.8)
Latent heat of vaporization at NBP, BTU/lb (kJ/kg)	85.6 (199.1)
Critical pressure, psia (kPa)	493 (3399.1)
Critical temperature, °F (°C)	-232.4 (-146.9)
Triple point pressure, psia (kPa)	1.81 (12.48)
Triple point temperature, °F (°C)	-346.0 (-210)
Density at NBP, lb/ft ³ (kg/m ³) (liquid)	50.5 (808.3)
Weight, lb/gal (kg/l) (liquid)	6.745 (0.81)
Expansion ratio, liquid at NBP to SCF (Nm ³)	696.5 (646.4)

Table 3-7. Nitrous Oxide properties

<u>Property</u>	<u>Value</u>
Chemical symbol	N ₂ O
Molecular weight	44.01
Color	None
Odor	Sweet
Taste	Sweet
Normal Boiling Point (NBP), °F (°C)	-127.4 (-88.5)
Latent heat of vaporization at NBP, BTU/lb (kJ/kg)	161.8 (376.1)
Critical pressure, psia (kPa)	1053.7 (7265)
Critical temperature, °F (°C)	97.7 (36.5)
Triple point pressure, psia (kPa)	12.74 (87.8)
Triple point temperature, °F (°C)	-131.4 (-90.8)
Density at NBP, lb/ft ³ (kg/m ³) (liquid)	76.8 (1230.2)
Weight, lb/gal (kg/l) (liquid)	10.27 (1.23)
Expansion ratio, liquid at NBP to SCF (Nm ³)	669.0 (621.1)



INSTRUCTION HANDBOOK

For Installation, Operation & Maintenance

M-3
Rev. 1

Table 3-8. Oxygen properties

<u>Property</u>	<u>Value</u>
Chemical symbol	O ₂
Molecular weight	31.99
Color	Pale blue
Odor	None
Taste	None
Normal Boiling Point (NBP), °F (°C)	-297.3 (-182.9)
Latent heat of vaporization at NBP, BTU/lb (kJ/kg)	91.7 (213)
Critical pressure, psia (kPa)	731.4 (5042.8)
Critical temperature, °F (°C)	-181.4 (-118.6)
Triple point pressure, psia (kPa)	0.0216 (.84)
Triple point temperature, °F (°C)	-361.8 (-218.8)
Density at NBP, lb/ft ³ (kg/m ³)	71.3 (1141)
Weight. lb/gal (kg/l)	9.53 (1.14)
Expansion ratio, liquid at NBP to SCF (Nm ³)	860.9 (799.5)

3.2 Cavitation and NPSH/NPSP

Cavitation

Cavitation is defined as the formation and subsequent collapse of bubbles in a liquid stream due to localized pressure falling below the liquid's vapor pressure. In order to understand this definition, some background information is required.

Vapor pressure is the pressure at which a liquid converts to gas, or the reverse thereof, at a given temperature. Since the vapor pressure changes with temperature, a curve can be established for a particular substance showing its vapor pressure at any temperature between the triple point (where the substance exists simultaneously as a solid, liquid, and gas) and the critical point (above which the substance cannot exist as a liquid). All substances have a vapor pressure curve, each one unique to its particular substance. The vapor pressure curve is also called the saturation or equilibrium curve since the substance is at saturation and in equilibrium between the liquid and gas phases if on the curve. The vapor pressure curves for commonly pumped cryogenic liquids are provided in paragraph 3.3 following.

If a liquid's condition is such that it is on or very near its vapor pressure curve, any drop in pressure, or rise in temperature, or any combination of these, will tend to cause the liquid to boil. This boiling usually starts on a surface in the liquid (such as a pump housing wall, cylinder or impeller) or some impurity particle (such as a piece of frozen carbon dioxide) in the liquid.

In a cryogenic pumping system, the fluid being pumped is almost always very near its vapor pressure curve as it enters the suction port of the pump, where the pressure is at its lowest point. If the pressure is too low for the temperature of the liquid at that point, small bubbles will form at that location. The bubbles occupy more volume than the liquid from which they formed; this transient condition causes the pressure to rise again, thus causing some of the bubbles to collapse back into liquid. This sequence of events is called cavi-



INSTRUCTION HANDBOOK

For

Installation, Operation & Maintenance

M-3
Rev. 1

tation.

Cavitation has two effects on a pump:

One, the collapse of the bubbles causes shock waves to develop which can damage the pump with pitting and erosion.

Two, the bubbles (being gas) cannot be pumped. If a sufficient number of them exist, the pump will cease to operate correctly and flow through the pump will stop or be significantly reduced.

Cavitation can be avoided or corrected by either increasing the pressure at the supply source (thereby increasing subcooling and getting farther from the vapor pressure curve) or by increasing the return line flow (if applicable) which will lower the liquid temperature at the pump suction due to the increased flow rate (lower heat leak per unit of liquid).

Net Positive Suction Head (NPSH)

Net Positive Suction Pressure (NPSP)

Net Positive Suction Head (NPSH) and Net Positive Suction Pressure (NPSP) are very similar terms with essentially identical meanings. NPSH is usually used with centrifugal pumps while NPSP is usually used with positive displacement pumps. In the remainder of this paragraph, only NPSH will be used but it also applies to NPSP.

NPSH can be defined as the difference between the actual pressure and the vapor pressure of the liquid at the pump suction port. The larger the difference, the more NPSH or subcooling exists.

Cryogenic liquid stored in a supply source vessel inherently will gain heat from the ambient regardless of the amount or quality of the vessel's insulation. Therefore, if sufficient time is allowed to elapse, the liquid in the tank will warm up to the temperature required to be on the vapor pressure curve – at which point the liquid in the vessel will begin to boil. If the vessel's vent valve(s) are closed, the pressure will rise in concert with the temperature, thus always staying on the vapor pressure curve. This boiling liquid is said to be "saturated" and there is no difference between the actual pressure and the vapor pressure (no NPSH). Since the pressure at the pump suction must be lower than the pressure in the vessel (if there is no static head) in order to cause liquid flow, it is impossible to pump a liquid that is saturated in the vessel.

To achieve prime and to prevent cavitation, some NPSH must be provided to the pump. The amount of minimum NPSH varies with the size, type and make of pump, and is generally indicated on the nameplate. The NPSH can be provided by static head (that is, elevation of the supply vessel above the pump suction), and/or by building a temporary and artificial pressure in the supply vessel with a pressure buildup coil to achieve subcooling. The artificial pressure must be maintained throughout the pumping cycle to insure proper and efficient pump operation.

If the pumping cycle continues for an extended period of time, it may become impossible to maintain the subcooling by the addition of more vessel pressure since eventually the vessel's maximum pressure will be reached. Should this occur it will become necessary to stop pumping operations, vent the supply vessel to atmospheric pressure and allow it to come to equilibrium, and restart the pump cycle again with renewed subcooling in the vessel.



INSTRUCTION HANDBOOK

For

Installation, Operation & Maintenance

M-3
Rev. 1

3.3 Cryogenic vapor pressure charts

Vapor pressure charts

For reference, the vapor pressure curves of the most commonly pumped cryogenic fluids are provided in the following figures:

- Figure 3-1 Argon (Ar)
- Figure 3-2 Carbon Dioxide (CO₂)
- Figure 3-3 Ethylene (C₂H₄)
- Figure 3-4 Hydrogen (H₂)
- Figure 3-5 Methane (CH₄) (LNG)
- Figure 3-6 Nitrogen (N₂)
- Figure 3-7 Nitrous Oxide (N₂O)
- Figure 3-8 Oxygen (O₂)

Figure 3-1. Argon vapor pressure

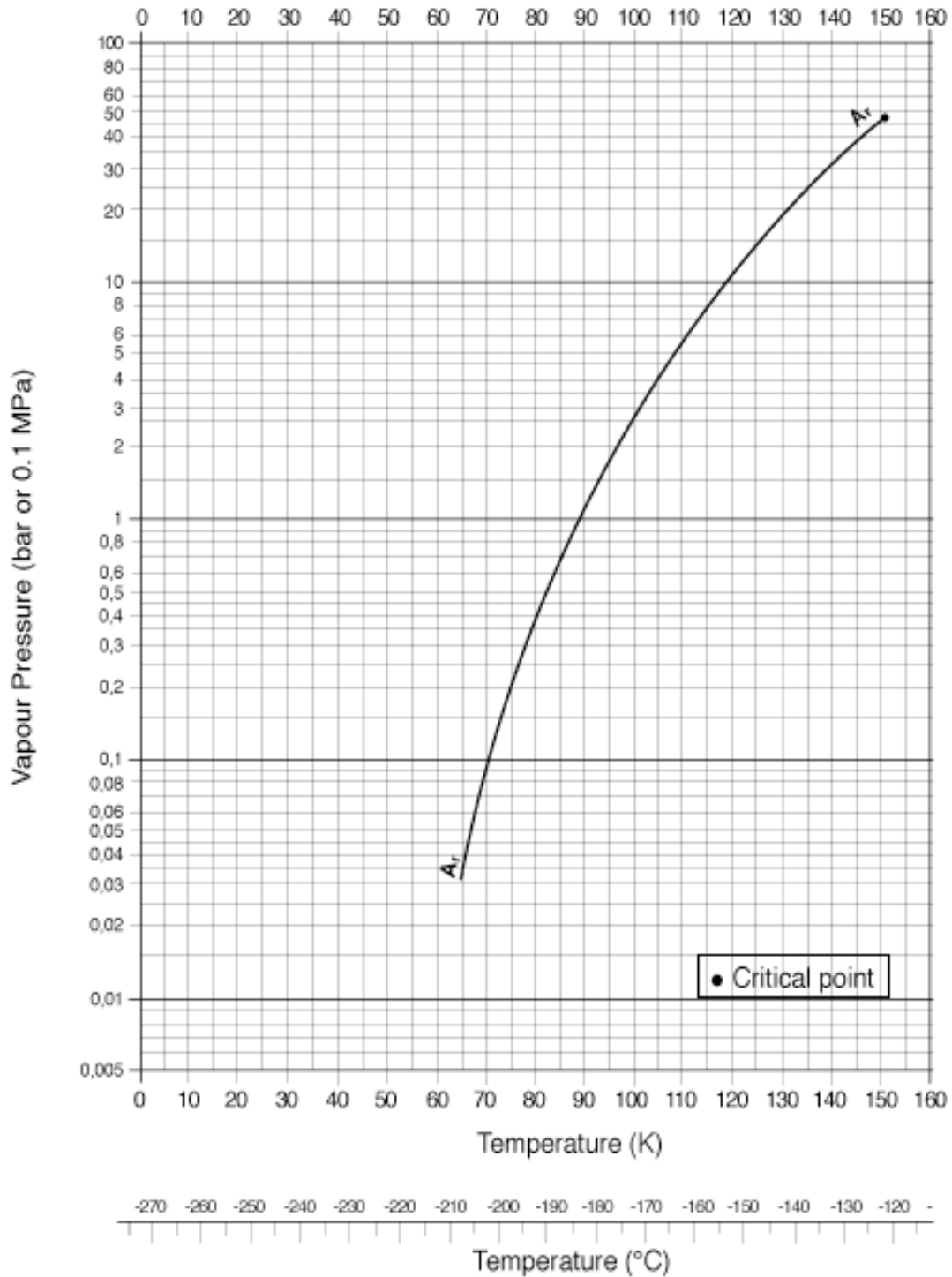


Figure 3-2. Carbon Dioxide vapor pressure

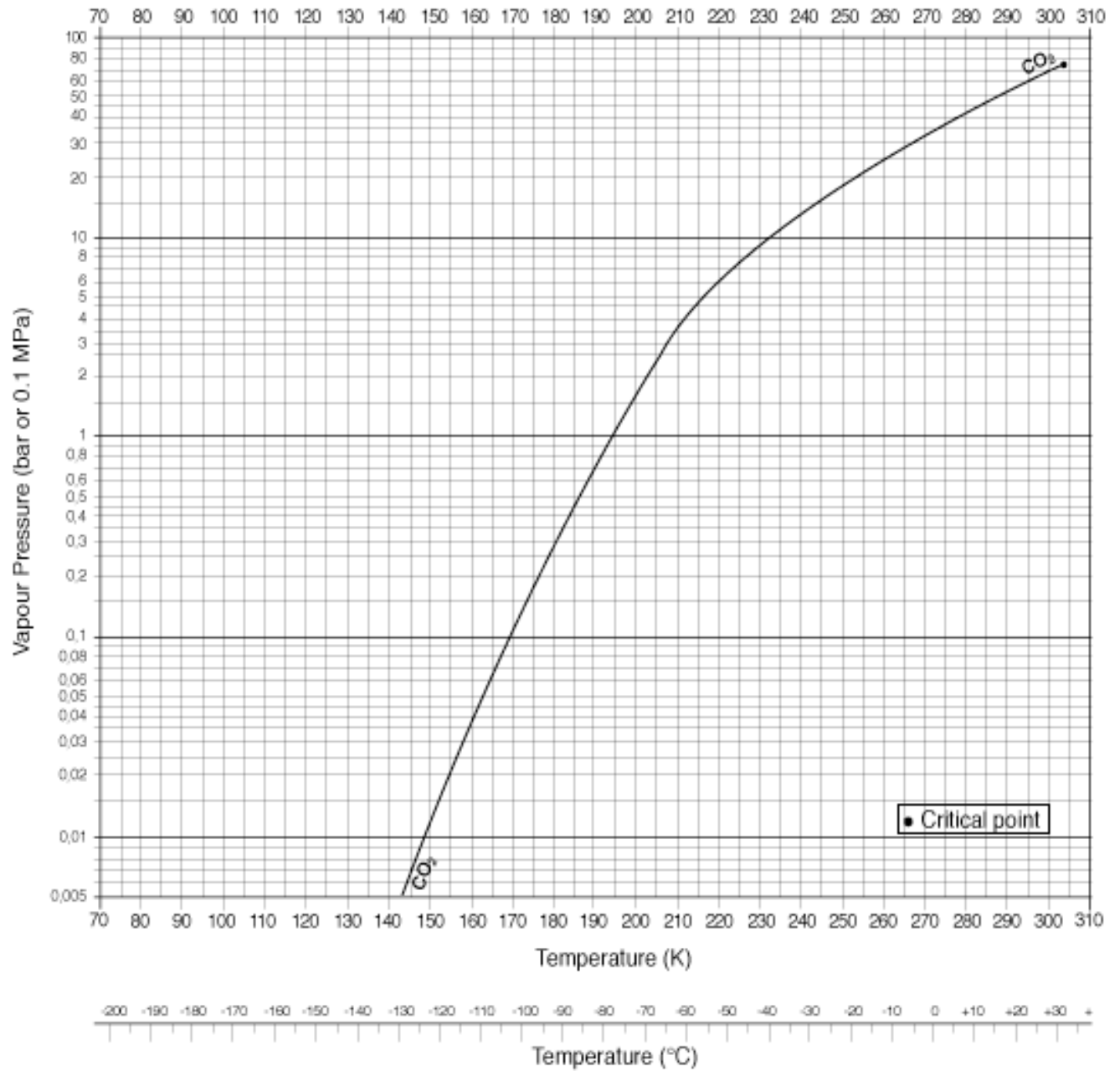


Figure 3-3. Ethylene vapor pressure

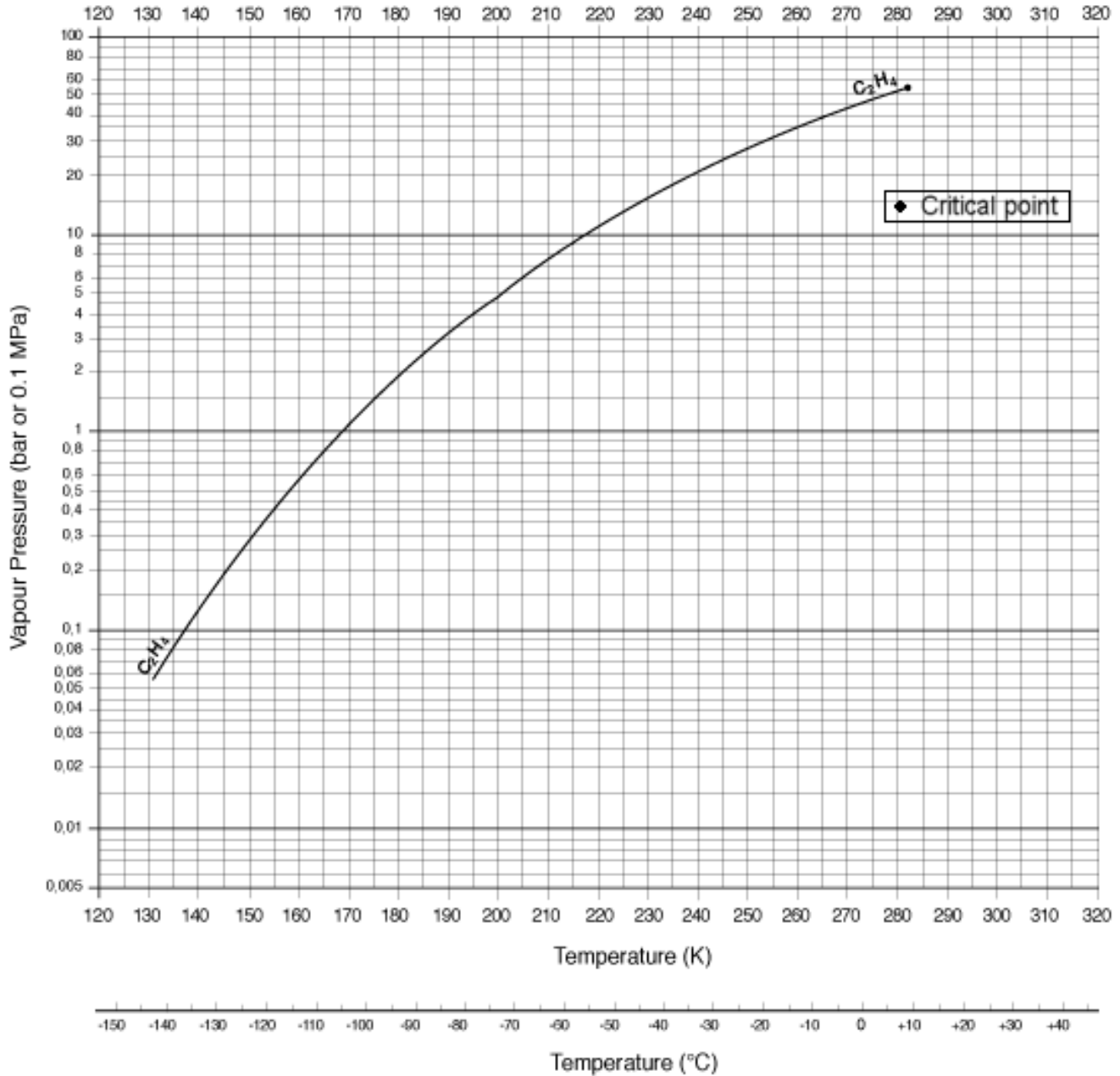


Figure 3-4. Hydrogen vapor pressure

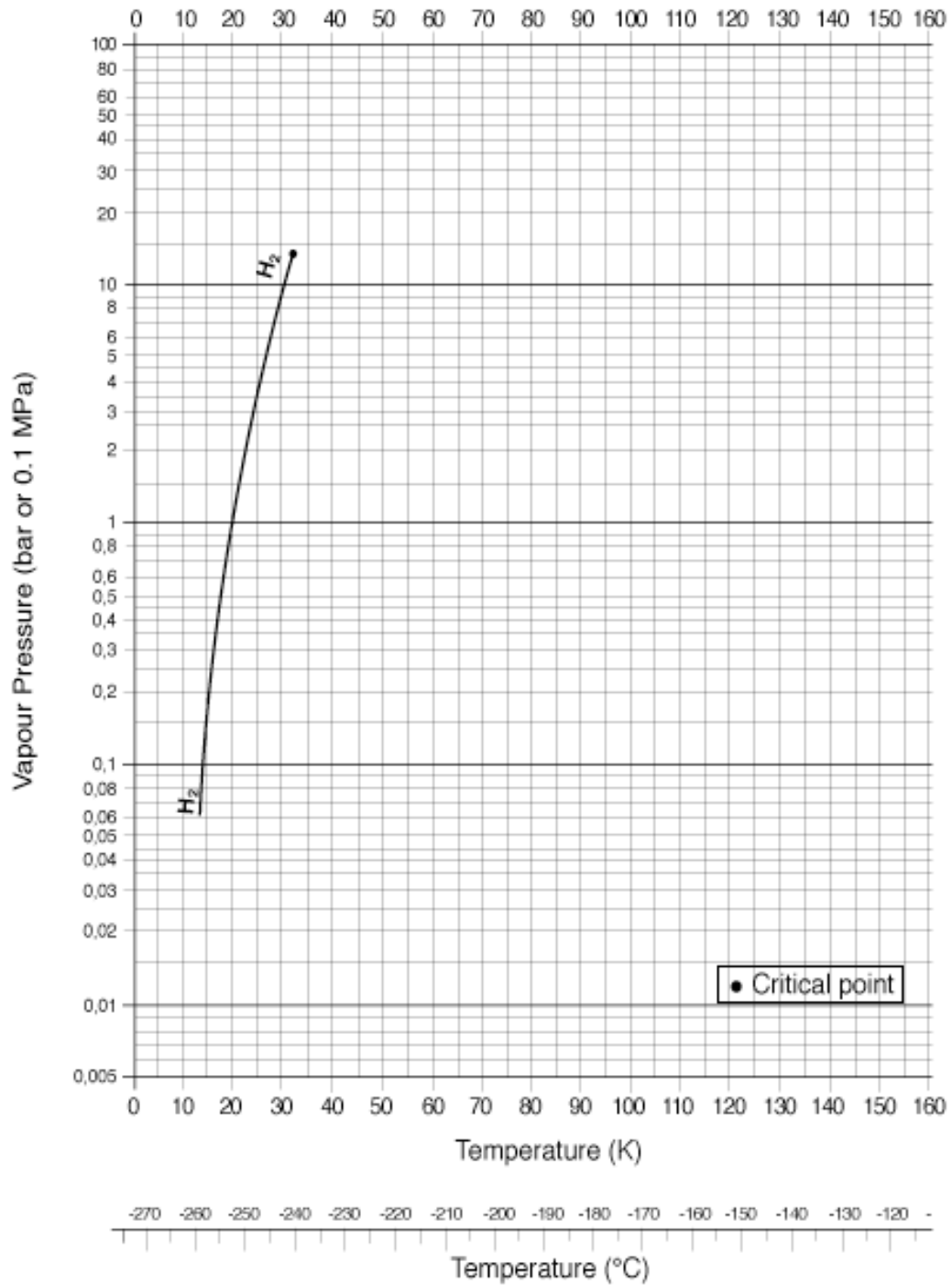


Figure 3-5. Methane vapor pressure

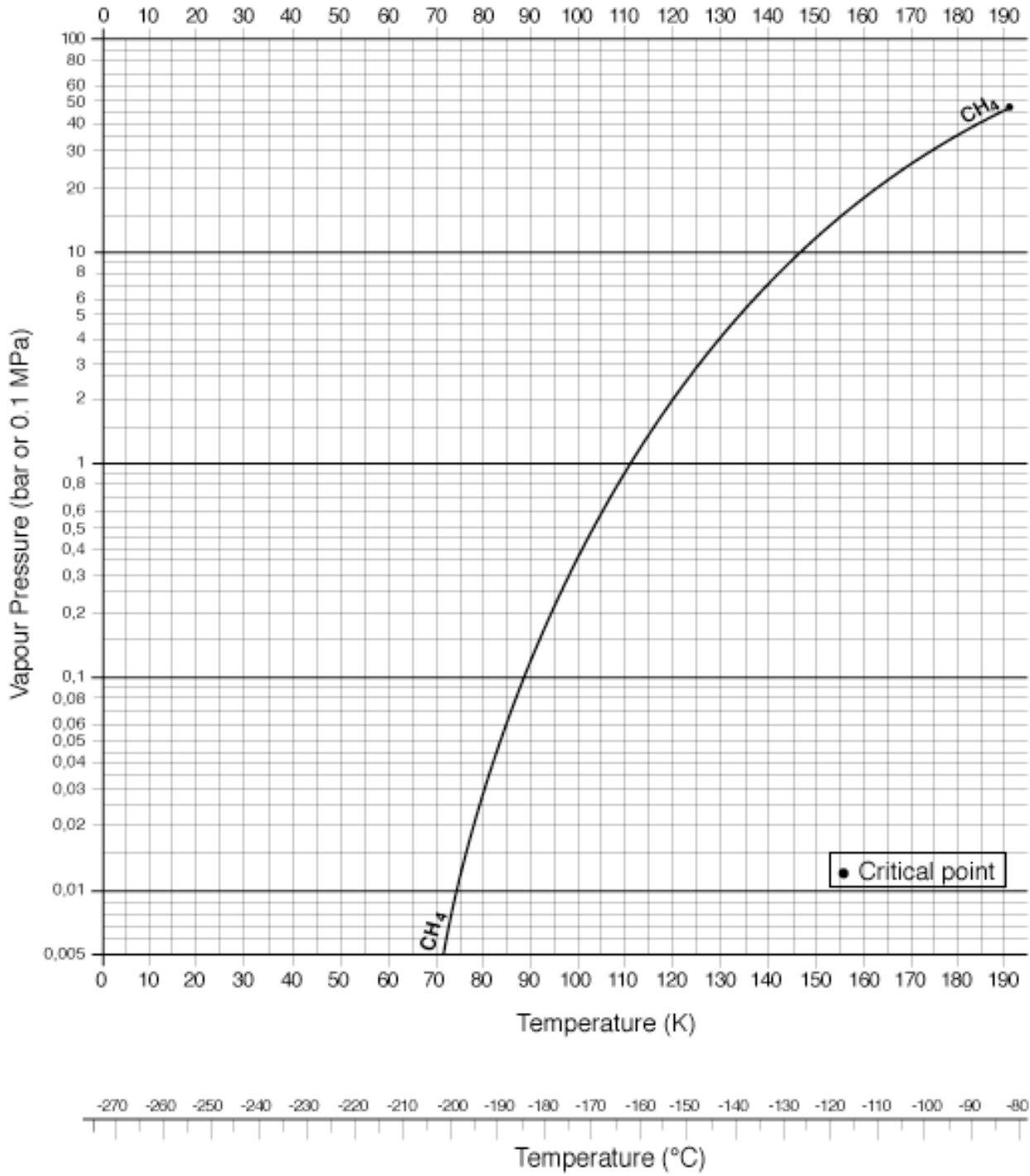


Figure 3-6. Nitrogen vapor pressure

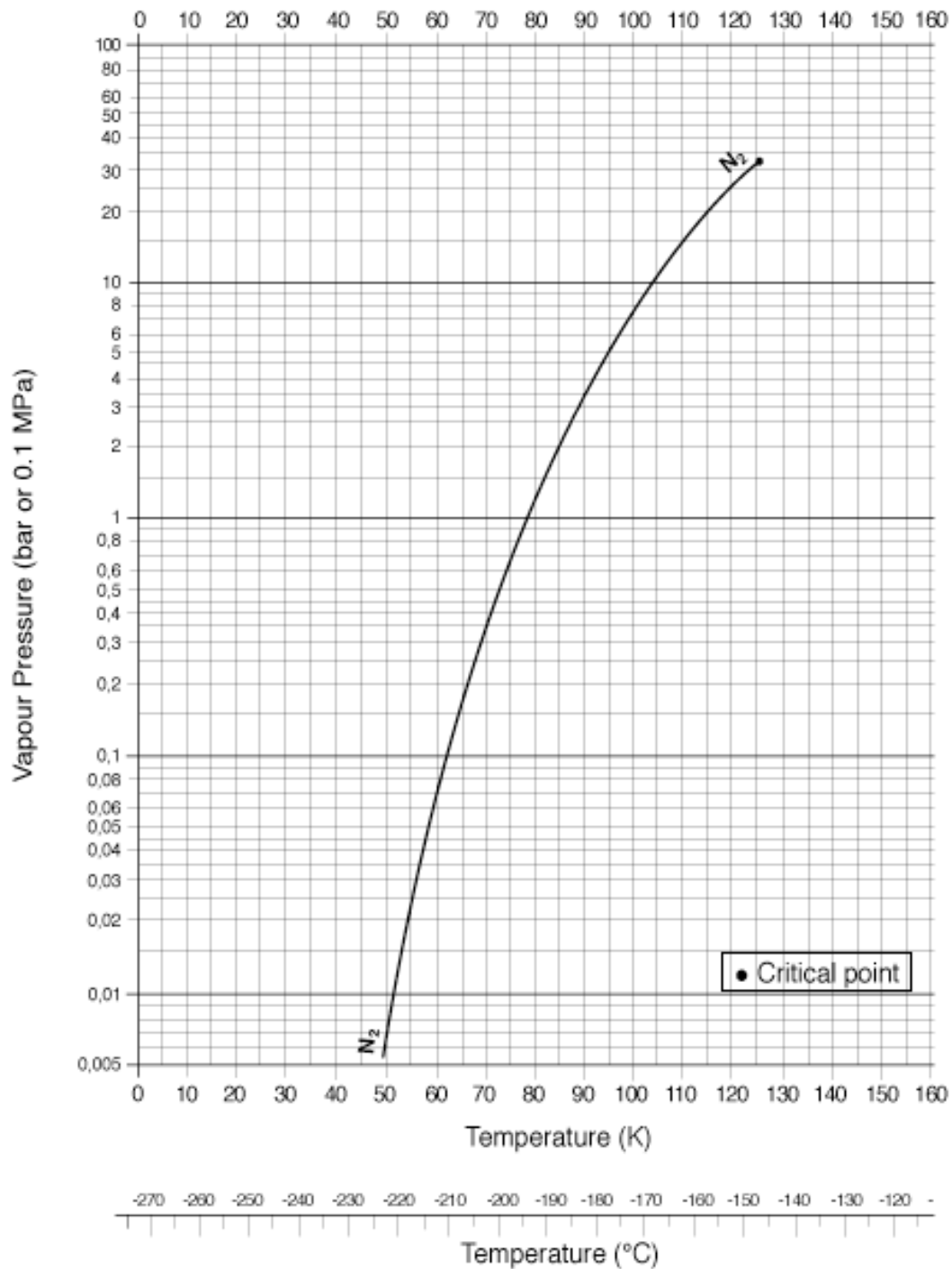


Figure 3-7. Nitrous Oxide vapor pressure

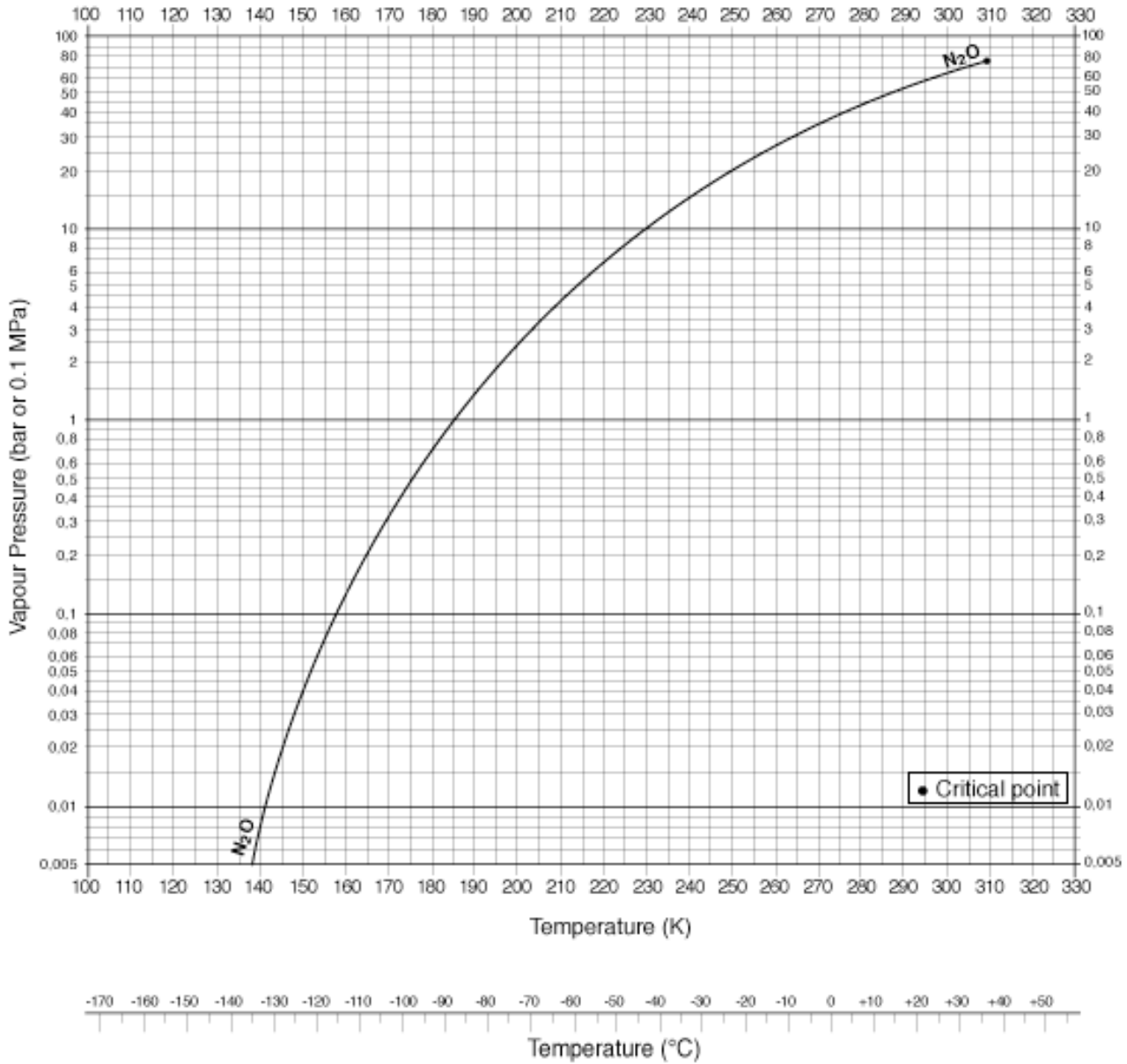
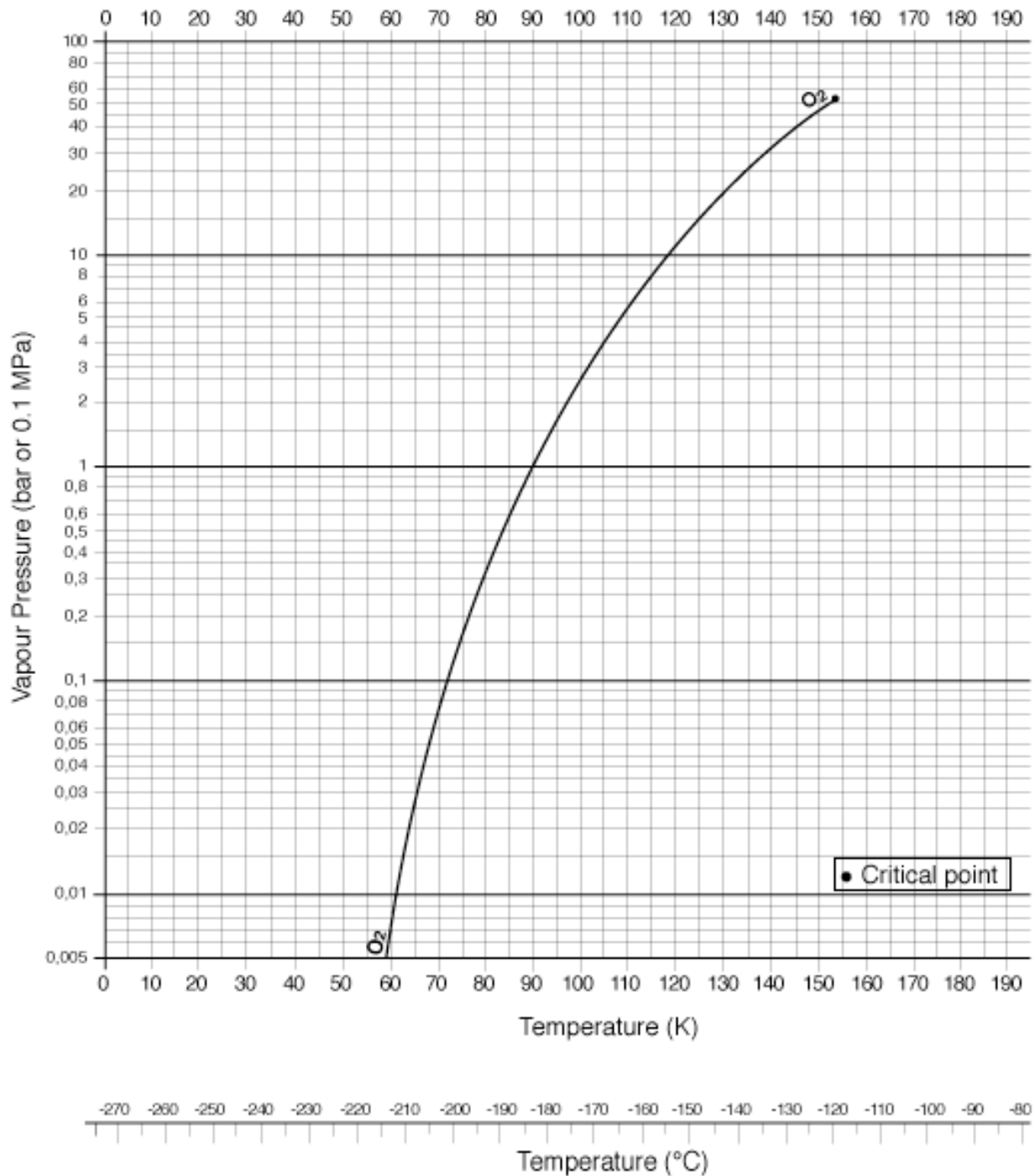


Figure 3-8. Oxygen vapor pressure





INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-3
Rev. 1



4 Design and function

4.1 Overview

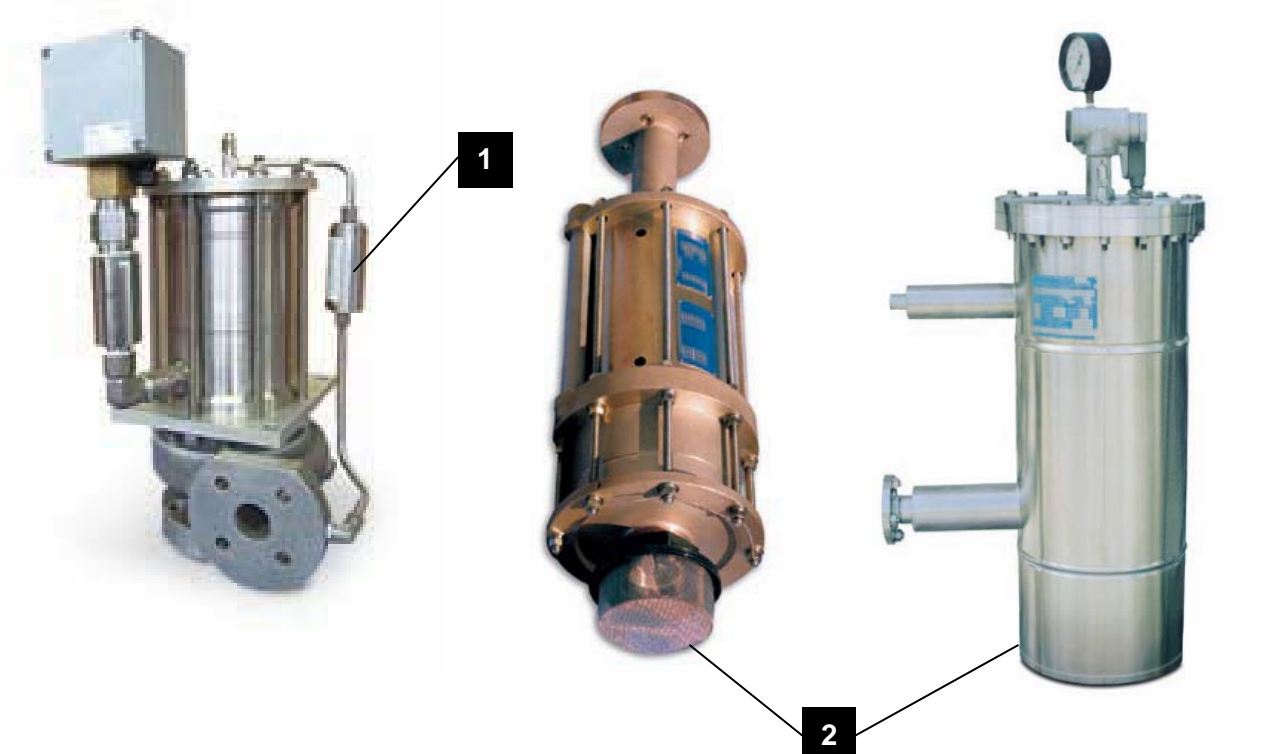


Figure 4-1: Overview of sealless pump assemblies.

- 1 Non-submerged (no sump) sealless pump with flooded motor.
- 2 Submerged sealless pump. Internal flooded pump and motor assembly (left) and installed in sump (right).

Intended use

The purpose of an ACD sealless centrifugal pump is to transfer a cryogenic liquid from a source of supply to a receiving vessel or system with absolutely no loss of the fluid being pumped. A centrifugal type pump is generally chosen over other types if the desired flow rate is relatively high while the pressure rise (or head) is relatively low. Centrifugal pumps are inherently reliable and long-lived due to their mechanical simplicity. The sealless designs are used where the possibility of product loss cannot be tolerated.



INSTRUCTION HANDBOOK

For

Installation, Operation & Maintenance

M-4
CP-NS
Rev. 1

An ACD sealless centrifugal pump is driven by an electric motor that is connected to the pump in direct drive. The standard electric motor is Variable Frequency Drive (VFD) rated.

Figure 4-1 depicts a sealless pump that does not require a sump on the left and a sump-mounted submerged sealless pump in the middle and on the right. The middle picture shows the internal assembly that is mounted inside the sump.

4.2 Safety equipment components

Safety equipment components of a centrifugal pumping system

Several components of safety equipment are required for the completed installation of an ACD centrifugal pump; most of these components are not part of the pump itself and thus not normally supplied by ACD as noted in the following list:

- Suction line pressure relief valve
- Discharge line pressure relief valve
- Suction filter (included on submerged pumps)
- Motor overload protection
- Control system

Depending on the specific type of pump and the installation, several optional components are available including:

- Filter (protection against particles or dirt at suction side)
- EMERGENCY-STOP control unit (at the control cabinet)
- Differential pressure gauge
- Safety relief valve
- Loss of prime detector (cavitation protection)
- Motor overload protection
- Complete skid mounted assembly

Integration into the control system

The pump assembly is intended for use within a system. It does not have its own control system or an autonomous emergency shutdown function.

The emergency shutdown device(s) must be connected so that during interruption of power supply, or activation of power supply after interruption, hazardous situations for personnel and/or property are eliminated.

See also Section 2.6 "Safety equipment".

4.3 Assembly description

Basic description

The pump assembly consists of two functional units:

- Electric motor
- Pump

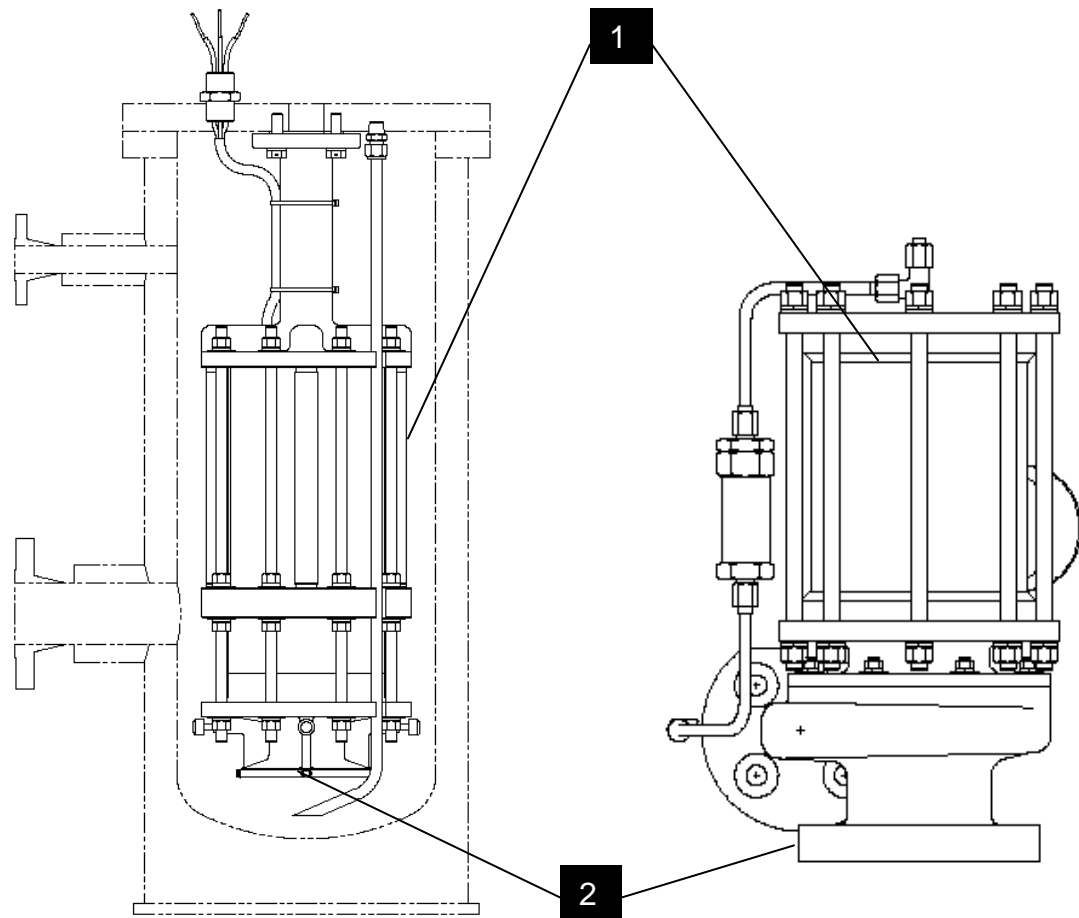


Figure 4-2: Pump assembly

- 1 Electric motor. Submerged type on left and non-submerged on right.
- 2 Pump.

4.3.1 Electric motor

Electric motor

An ACD sealless centrifugal pump is driven by an electric motor that is specifically designed for Variable Frequency Drive (VFD) service. If a VFD is employed, the pump speed can be tailored to the service for best efficiency. The VFD also features “soft-starting” which is a controlled ramp-up of motor speed. Soft-starting allows the pump to achieve prime with less NPSH.

The motor is direct coupled to the pump impeller(s). There is no seal between the pump and motor; the pumped fluid circulates through the motor, thus providing cooling flow to the motor bearings and the windings. The bearings are lubricated with a dry-film lubricant retainer specifically designed and manufactured by ACD for this service.

Due to the flooded motor, the sealless centrifugal pump is not suitable for liquid oxygen service. Do not allow the pump and motor to come in contact with oxygen.

Figure 4-2 depicts electric motor driven sealless pumps with the submerged type on the top and the non-submerged type on the bottom.

4.3.2 Pump

Functional description

A centrifugal pump consists of a rotating impeller contained within a stationary housing. If the pump has only one impeller, it is described as a single stage pump. Pumps may have multiple stages (that is, multiple impellers) depending on the final pressure or head required at the pump discharge port.

The stationary housing incorporates a suction port at the center of the housing face opposite the shaft. The discharge port is located on the periphery of and tangent to the housing radius. The housing internal circumferential shape, called a volute, has a continuously increasing cross-sectional area as the discharge port is approached in the direction of impeller rotation.

With the impeller rotating at design speed, the liquid to be pumped enters the suction port and enters the center of the impeller (called the “eye”). The rotation of the impeller causes the liquid at the eye to travel along the impeller’s blades while gaining speed due to the centrifugal force. The liquid leaves the impeller at a very high speed. The liquid then enters the volute which, due to its increasing area and volume along the liquid’s path, converts most of the liquid’s kinetic energy (speed) into potential energy (pressure or head).

Sealless centrifugal pumps feature electric motors that are flooded with the fluid being pumped. In this type pump, the motor housing becomes part of the pump’s pressure boundary and no shaft seal is required. The elimination of the shaft seal positively removes the possibility of leakage and reduces regular maintenance.

The sealless pumps are vertically oriented (that is, the shaft is vertical) which provides excellent stability of operation and requires the smallest possible footprint.

As stated in paragraph 4.3.1 above, the sealless pump is not suitable for liquid oxygen service.

Two basic designs of sealless centrifugal pumps are available: 1) the submerged type includes a sump that surrounds the pump and motor assembly, thus providing a pump with the lowest possible NPSH resulting in the fastest priming, and 2) the non-submerged type does not have a sump; standard orientations of pump ports are available. This design is simpler, lighter weight, and more compact than the submerged type.

Figure 4-2 identifies the pump in both the submerged (top) and non-submerged (bottom) designs.

4.4 Hazard area

General area

Relief valve discharge

Uninsulated lines

The general hazard area around the pump and the pressure components is two meters (Figure 4-4).

Several specific hazardous areas exist in the installation of any pump in cryogenic liquid service. These areas include the following:

- Relief valve discharge. Any cryogenic relief valve discharge area is hazardous if personnel can be exposed to liquid (or cold gas) in the event of a discharge from the relief valve.
- Uninsulated lines. Uninsulated lines at pump suction and discharge, and the pump housing itself, may be cold enough to cause condensation (liquefaction) of air on the outer surfaces. The condensate thus formed and dripping from the lines is approximately 36% oxygen, considerably higher than normal air (21% oxygen). Any combustible or flammable material in or near this condensate will have a greatly reduced flash point temperature. For this reason the areas surrounding the pump and its uninsulated areas of piping should be very clean and the surface should not be flammable (for example, no asphalt). This condensate is most noticeable in liquid nitrogen service due to its temperature frequently being below the condensation point of air.

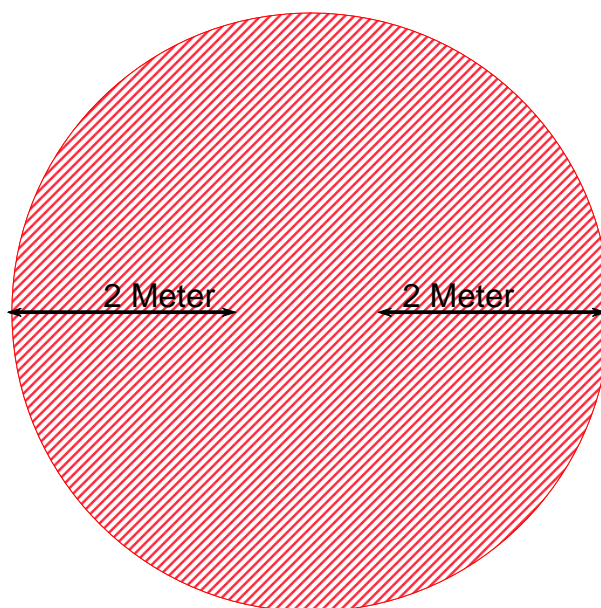


Figure 4-4: Hazard area of the pump.

4.5 Interfaces

Interface description

Interfaces include the suction and discharge ports, and electrical connections to the motor. The following points should be considered regarding these interfaces:

- Suction and discharge ports. These interfaces are flange faces matching standards as shown on the applicable installation drawing. Gaskets used when connecting to these ports must be compatible both with the pump housing material and with the liquid being pumped. Any loads imposed on the pump housing by the attached piping lines must be within the limitations shown on the installation drawing.
- Electrical power. Electrical power connections to the motor must be made in accordance with the motor manufacturer's instructions and also in accordance with local governing codes. The power supply must agree with the motor nameplate voltage and have ampacity (current capacity) at least 20% above motor nameplate Full Load Amps (FLA). Terminal boxes (Figure 4-5) are located on the electric motor.

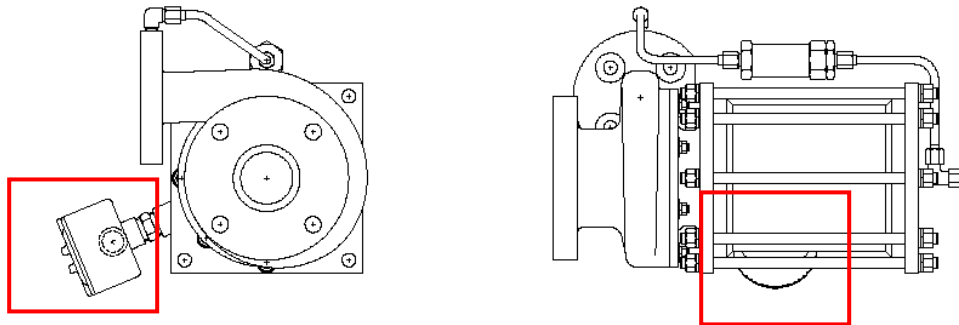


Figure 4-5: Terminal box (typical design)

5 Packaging, Off-loading and Storage



The installation and commissioning are usually carried out by the operator or through an authorized organization.

It is possible that the operator or the operator's maintenance personnel may be required to handle packaging including pump assemblies and/or components during the installation or in normal use. Therefore, the instructions listed below must always be considered.

5.1 Safety instructions

Overhead loads



WARNING!
Danger to life posed by overhead loads!

Loads can pivot out and fall down during lifting processes. This can result in serious injuries or even death.

- Never walk under or in the pivot range of overhead loads.
- Only move loads under supervision, using permitted lifting gear and stops with sufficient bearing capacity.
- Do not use torn or chafed lifting gear (such as cables and belts).
- Do not position lifting gear like cables and belts on sharp edges and corners, do not knot and do not twist.
- When leaving the workplace lower the load.

Off-center center of gravity



WARNING!
Risk of injury posed by falling or tilting packaging pieces!

Packaging pieces can have an off-center center of gravity. With incorrect orientation of the lifting gear, the packaging piece can tilt and fall. Serious injuries can be caused by falling or tilting packaging pieces.

Observe markings and information on center of gravity on the packaging pieces.

- During transport with a crane, orient the crane hook so that it is situated above the center of gravity of the packaging piece.
- Carefully raise the packaging piece and observe whether it tilts. If necessary, change the adjustment of the lifting gear or hook location.

Pivoting out transport piece



WARNING!

Risk of injury posed by pivoting out transport piece!

During transport with a crane, the transport piece can pivot out and cause serious injuries and significant property damage.

- Make sure that during transport no persons, objects or obstacles are situated in the pivot range of the transport piece.

Improper transport



NOTE!

Property damage caused by improper transport!

During improper transport, transport pieces can fall or collapse. Significant property damage can occur.

- During offloading of the transport pieces upon delivery and during internal transport, proceed carefully and observe the symbols and instructions on the package.
- Only use the proposed lift points.
- Only remove packaging right before assembly.

5.2 Delivery inspection

Upon receipt, check the delivery immediately for completeness and transport damage.

In case of externally recognizable transport damage proceed as follows:

- Do not accept delivery or only accept it with reservations.
- Note the scope of the damage on the transport documents or on the delivery note of the shipper.
- Initiate a claim.



Claim any deficiency as soon as it is recognized. Damage compensation claims can only be made within the valid claim deadlines.

5.3 Packaging

For transport

The individual packaging pieces are to be packed according to the expected transport conditions. Only environmentally safe materials may be used for packaging.

Pallets and packaging wood must be heat treated according to IPPC regulation (ISPM No. 15) so that no pests can be brought into other countries via wood or wood packaging.

The packaging should protect the individual components from transport damage, corrosion and other damage up until they are assembled. Consequently, do not destroy the packaging and only remove it right before assembly.

Handling of packaging materials

Dispose of packaging material in accordance with the legal provisions of local regulations.



NOTE!

Hazard to the environment posed by incorrect disposal!

Packaging materials are valuable raw materials and in many cases can be reused or usefully processed and recycled. Improper disposal of packaging materials can cause environmental hazards.

- Dispose of packaging materials in an environmentally sound manner.
- Observe disposal regulations. If necessary, commission a specialist with disposal.

5.4 Off-loading (from delivery truck)

Lifting points

The eyebolts are used for lifting the pump.

In case of a skid, the eyebolts to be used as lift devices are screwed to the base frame and serve for lifting of the pump.

In addition a secure/safe sling can be used for better handling.

5.5 Storage

Storage of packaging pieces

Store packaging pieces under the following conditions:

- Do not store outdoors.
- Store dry and free of dust.
- Protect against solar radiation.
- Avoid mechanical vibrations.
- Storage temperature: 15 to 35°C.
- Relative humidity: max. 60%.
- In case of storage lasting longer than 3 months, regularly check the general condition of all parts and packaging. If necessary refresh or renew the preservation.



INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-5
Rev. 1



6 Installation Instruction

6.1 Safety instructions for installation and initial startup

Electrical installation



DANGER!
Danger due to electrical current!
See paragraph 2.5.2 “Hazards posed by electrical power”.

Liquefied gases and Oxygen deficient atmosphere



DANGER!
Danger due to liquefied gases and oxygen deficient atmosphere!
See paragraph 2.5.4 “Hazard posed by liquefied gases”.

Cryogenic surfaces



DANGER!
Risk of injury from cryogenic surfaces!
See paragraph 2.5.6 “Hazards posed by cryogenic and high temperatures”.

Not for oxygen service



DANGER!
Risk of injury from oxygen service!
The sealless cryogenic pumps are not suitable for use in liquid oxygen service.

Improper installation and first startup



WARNING!
Risk of injury due to improper installation and initial startup!
During installation and initial start-up of a pump assembly, special safety instructions and precautions apply in addition to those provided elsewhere in this manual. Improper installation and initial startup can lead to serious injuries and significant property damage.
These special safety instructions include the following:



INSTRUCTION HANDBOOK

For

Installation, Operation & Maintenance

M-6
CP-NS
Rev. 1

- Before beginning work ensure there is sufficient clearance to other objects.
- Carefully handle open sharp-edged components.
- Ensure order and cleanliness in the installation area! Components and tools lying loosely on or around each other can cause accidents.
- If the pump assembly (motor, drive, and pump) is to be lifted at any time, appropriate methods and lifting points are to be used. Specific lifting instructions are provided in Appendix B.
- Install components correctly. Maintain prescribed screw-tightening sequences and torques.
- Secure components so that they do not fall out or collapse.
- Workmanship. For a safe installation, only personnel qualified in the various trades (welding, brazing, pipefitting, electrical, and inspection), using proper tools, should be authorized to perform the installation tasks.
- Local Codes. Comply with all local codes that apply and have jurisdiction over the various aspects of the pump installation.
- Installation drawing. Fully comply with any safety requirements noted on the installation drawing (Appendix B).
- Ensure the following before initial startup:
 - Make sure that all installation work has been carried out and completed in accordance with the information and instructions in this instruction manual.
 - Make sure that no persons are in the hazard areas at startup.

6.2 Site requirements

Guidelines

The installation site should be carefully chosen and prepared with the following general guidelines:

- Outdoors, weather protected. The pump must be located outdoors. Protection from rain or snow will increase pump reliability and availability. Ventilation must not be impaired. There must be adequate escape routes and free access to first aid and fire protection equipment.
- Level concrete foundation. A raised concrete pad should be provided upon which the pump assembly is to be mounted. During operation and after shutdown, a large quantity of water will be present due to melting of frost and ice from pump and piping. A raised pad will ensure that this water will drain away from pump at all times. The pad must be level within 0.5 cm per linear meter in any direction, or as required by the installation drawing.
- Atmosphere. The ambient air in which the pump is to be installed must be non-corrosive to pump assembly materials. Salt air or salt water spray are particularly to be avoided.
- Power supply. The power supply must be adequate for the intended service of the pump assembly. Electric power of the correct voltage and frequency, with current (amperes) capability of motor Full Load Amps (FLA) plus 20%, or more, must be available. If the motor has a standard across-the-line motor starter, the power supply must be capable of momentarily supplying current six (6) times FLA in order to start the motor. A soft start or VFD controlled motor does not have this last requirement.



INSTRUCTION HANDBOOK

For

Installation, Operation & Maintenance

M-6
CP-NS
Rev. 1

- Location relative to liquid supply source. For best operation, the pump should be located as horizontally close as possible to the liquid supply source and vertically as far below it as possible. This horizontal location will provide the shortest and straightest suction piping which minimizes heat leak (heat gain from surrounding atmosphere) and friction losses while the vertical location will provide the greatest possible static head to the pump suction for lowest NPSH (see Module 3).
- Dedicated liquid supply source connection. If the pump does not include a sump and is to be connected to a liquid supply port on a storage tank, best results will be obtained if the port selected is dedicated to the pump suction with no other services or duties connected. Other services such as economizers and/or pressure buildup coils cause severe disruptions in flow to the pump suction and will cause loss of prime needlessly.
- Cleanliness. The site must be clean with no loose debris, trash, garbage, or other material not necessary to the safe installation and operation of the pump within 2 meters. The site should either be paved with concrete or covered in clean gravel or crushed rock. If the pump is intended to be placed in liquid oxygen service, no flammable materials should be stored or used within 20 meters of the pump and the site near the pump must not be paved with asphalt or any other combustible material.

6.3 Installation

Guidelines



For successful operation of the pump, the installer must comply with the guidelines listed below.

- Suction piping. The suction piping design and installation is of paramount importance to the operation of the pump. Because the liquid being pumped is extremely cold, and must remain so in order to successfully pump it, every means possible to limit heat gain into the liquid flowing to the pump suction and maintain subcooling (see Module 3) must be taken. Gas and liquid traps must be avoided by designing the suction piping to have a continuous slope downwards towards the pump suction. The use of tees, elbows, and other fittings must be minimized since they cause relatively high head loss; tees are especially unsuitable because they automatically cause a gas or liquid trap in addition to the head loss. The line must be sized accurately for the design flow; if it is too small, the head loss will be excessive and if too large the dwell time for the liquid will be greater than necessary, causing excessive heat leak. The line must be adequately supported and consideration must be given to the thermal loads that will be imposed as the line cools from ambient temperature down to operating temperature. If a flexible hose section is utilized as recommended (see Flange loads and piping alignment below), it must incorporate a smooth bore lining fabricated from TFE hose that runs the full length of the section in order to maintain NPSH. If connecting to a storage tank, a dedicated liquid supply port should be used (see 6.2 preceding).
- Return piping (if applicable). Installations in which the pump is connected to a liquid supply vessel should include a return line connected from the pump discharge back to the storage vessel ullage space through the vessel's vent system. This return line acts as a recirculation line, allowing pump startup under low discharge head for easier priming. This piping should be designed similar to the suction piping with a continuous slope upwards from the pump back to the tank with no liquid or gas traps.



INSTRUCTION HANDBOOK

For

Installation, Operation & Maintenance

M-6
CP-NS
Rev. 1

- Flange loads and piping alignment. It is highly recommended that the piping connecting to the pump suction and discharge ports incorporate short flexible hose sections immediately adjacent to the pump ports. These flexible hose sections will decouple the pump from the piping so that no piping loads will be placed on the pump flanges or ports and simultaneously prevent pump vibrations from entering the rigid piping systems. If it is not possible to utilize flexible hose sections, the pipe flanges or fittings that mate to the pump flanges or ports must be aligned both with regard to centerline and to parallelism. Loads must not exceed those shown on the installation drawing provided in Appendix B.
- Insulation. The suction line must be insulated to the maximum extent possible. The line must be insulated along its entire length including all valves and connections. Insulation of the pump housing is not necessary although some benefit may be gained by insulating the pump suction flange or port. Insulation absolutely must include vapor barriers to prevent the ingress of moisture which will destroy the effectiveness of the insulation. The quality (k factor) of the insulation cannot be overemphasized; vacuum jacketing for the suction line will provide the best operation but if it is not chosen, a minimum of 8 cm fiberglass insulation thickness with vapor barrier and jacketing should be used.
- The return line (if applicable) and discharge line do not require insulation for proper operation but it may be necessary to reduce personnel hazards from touch and slippery flooring due to moisture accumulation.
- Valves. Suction line isolation valves, in addition to being constructed and cleaned for cryogenic service, must be selected for minimum head loss (maximum C_v). The best valves are full bore ball or gate types. This valve is never to be used for throttling flow. Only one valve should be installed in the line, as close to the liquid supply port as possible. Only one valve, similar in design to the suction line isolation valve, should be incorporated into the return line (if installed). A pump discharge isolation valve should be provided in the discharge piping. It must also be designed and constructed for cryogenic duty and may, in some applications, be used for throttling the flow.
- Relief valves. Any piping line or pump that can be isolated by valves with liquid still present must have at least one relief valve incorporated to prevent catastrophic overpressure as the liquid boils off into gas. The relief valve should be installed on the pump discharge piping (where the tee causes minimal flow disruption) and set at a pressure that will protect the pump housing and all affected piping. Capacity of the relief valve only needs to accommodate the rate of boiloff; thus the relief valve may be relatively small in size. If required, an additional relief valve of adequate capacity should be installed on the pump discharge to protect from overpressure during operation.
- Cleanliness. Covers are provided for the suction and discharge ports on the pump as well as any other fluid connections as applicable. Covers must also be used on all piping. Covers should not be removed until immediately prior to connection of piping to pump to maintain cleanliness of the pump and system. Prior to connection, visually check ports and pipes to verify that there are no obstructions or foreign material (desiccant bags, for example).
- Purging. After all piping is complete and connected, the system should be purged with dry nitrogen gas to ensure that moisture from ambient air is removed. Any moisture remaining in the system will cause ice to form during cooldown and operation; the ice may cause obstruction to flow and/or damage to the pump.



INSTRUCTION HANDBOOK For Installation, Operation & Maintenance

M-6
CP-NS
Rev. 1

- Electrical. The electrical connections must be properly made at the motor terminal housing after performing a megohmmeter (“Megger”) test to ensure the motor’s insulation is dry and in good condition. Wiring and cabling must be selected for adequate size and insulation based on the anticipated current load and allowable temperature rise. Comply with all local and regional applicable codes.
- Bolting and fastening. Do not tighten bolts fastening pump to pad or skid to final torque until the first time pump has been cooled to operating temperature. This will minimize stresses on piping and pump housing.

6.4 Final assembly checks

Initial tests and inspections

- Personnel: ■ Qualified mechanical technicians
- Protective equipment: ■ Hearing protection
- Safety shoes
- Safety goggles

After the installation is mechanically and electrically complete, the following checks and inspections must be performed prior to initial startup:

1. Inspect system. Check all piping and connections for correct connection and tightness.
2. Pressure test. The entire piping system and pump must be pressure tested, using dry, inert, ambient temperature gas (nitrogen is acceptable) up to the full operating pressure plus 10% (or more if required by local applicable codes). No external leakage or structural deformities are allowed.



NOTE!

ACD supplied components are factory certified and do not require pressure testing. Only the field installed piping and customer-supplied equipment, including final field connections to the pump and/or pump skid components, require pressure testing.

3. Pump rotation. The motor leads are marked either A, B, and C or 1, 2, and 3 and should be connected in that manner for proper rotation. Since no portion of the pump shaft is visible, final verification of pump rotation must be performed at initial startup. If pump does not prime within five (5) seconds, reverse the rotation by reversing any two leads at the motor terminal housing.
4. Cold check. After successfully performing the pressure test preceding, the pump and its piping should be cooled down to operating temperature by opening the suction, discharge, and return valves and inspecting for any deformation due to contraction of the piping. Again, there must be no external leakage.



INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-6
CP-NS
Rev. 1



7 Operation

7.1 Safety during operation

Cryogenic and hot surfaces



DANGER!

Risk of injury posed by cryogenic and hot surfaces!

See paragraph 2.5.6 “Hazards posed by cryogenic and high temperatures”.

Liquefied gases and liquid jet



DANGER!

Danger posed by liquefied gases and liquid jet emerging under high pressure!

See paragraph 2.5.4 “Hazard posed by liquefied gases”.

Control system



NOTE:

The centrifugal pump is installed into a complete pumping installation that incorporates all the various controls into one system.

When incorporating the pumping unit into a complete system with separate automatic controls, care must be taken to insure that all the local regulations and standards are followed. The control logic must be configured so that no hazardous situation can arise due to incorrect operation and that an automatic operational sequence is installed that prevents human error.

Actions and observations

The following personnel qualification and protective equipment are absolutely necessary for work with and in the vicinity of the pump:

- Personnel: ■ Qualified mechanical technicians
- Protective equipment: ■ Hearing protection
- Safety shoes
- Safety goggles

Certain actions and observations should be taken by the operator during pump operation to ensure safe conditions are maintained. These actions and observations include:



INSTRUCTION HANDBOOK

For

Installation, Operation & Maintenance

M-7
CP-NS
Rev. 1

- Observe operation. Frequently observe the pump and drive mechanism for proper operation. Check for any unusual noise, vibration, excessive heat at bearings, or any other condition that is not normal. Check for leaks at all fittings, connections, and seals. Verify that pump is well primed with normal discharge pressure and normal valve settings.
- Rotating equipment. Even though sealless centrifugal pumps have no exposed moving parts, the operator must ensure that all personnel in the area surrounding an operating pump are aware of the potential dangers of rotating equipment.
- Cryogenic surfaces. The operator must ensure that all personnel in the area surrounding an operating pump are aware that the exposed pipe and pump surfaces are extremely cold and may cause injury if touched. In addition, if air condensation occurs (see Section 4.4), the operator must be aware of the potential danger and take any necessary steps to minimize the risk of fire.
- Maintenance. No maintenance should be performed while the pump is operating. All maintenance is to be performed when the pump and related piping have been depressurized, warmed to ambient temperature, and energy source(s) locked out.
- Logs. The operator should maintain logs of the pump operation. Logs should include time and date of entries, pump operating data such as suction and discharge pressure, cumulative operating hours, and any other pertinent data as desired (such as supply tank level and pressure, receiving system data, etc. A "remarks" section should be included in the logs that allow narrative description of any observed abnormalities.

7.2 Preparation for startup

Checklist before putting pump into operation

Prior to a normal pump startup, certain actions are to be taken to ensure successful operation:

- Liquid supply source. Verify that the supply source has sufficient liquid available to complete the anticipated duration of pump operation. Also verify that the liquid condition (degree of subcooling, see section 3) is adequate to provide the required pump NPSH. If necessary, raise the pressure over the liquid in the supply source to temporarily increase subcooling.
- Liquid receiver. Verify that the vessel or system that is to receive the pumped liquid is ready to receive with valves properly aligned and sufficient capacity available.
- Pump assembly. Inspect the pump assembly to verify that pump is in operating condition. Verify that the energy source is connected (or ready to be connected).

Cooldown

If the supply and receiver are prepared for pump operation and the pump itself is also prepared, initiate cooldown by opening the suction and return line valves. The discharge valve should remain closed unless a discharge check valve is included in the system. Liquid will begin to flow through the stationary pump to bring piping and pump down to operating temperature.

7.3 Normal start up

General procedure

If preparation for startup (Section 7.2 preceding) has been completed, the pump should be ready for startup. The following general procedure is to be used:

1. Check for prime. The pump is momentarily started and discharge pressure is observed. If an appropriate discharge pressure is observed, indicating that the pump has primed, the discharge valve can be opened while simultaneously closing the return line valve. If prime is not achieved within five (5) seconds, the pump is to be stopped and cooldown is allowed to continue. Adjustment of pressure in supply source may be required to increase sub-cooling. If pump still does not prime within five seconds and this is the initial startup, check motor rotation by reversing any two leads at the motor terminal housing after removing power from the system.
2. Normal operation. If prime has been achieved, adjust discharge and return line valves as necessary to maintain desired discharge pressure and flow. While operating, the pump assembly is to be checked frequently for continued normal operation. If abnormalities are observed that cannot be removed by valve adjustment, the pump should be stopped and the abnormality investigated. Otherwise, normal operation may continue until the pumping operation is complete or the operator otherwise chooses to stop operation.

7.4 Switching ON/OFF



Pumping operation may be stopped and restarted as necessary for the particular installation. When temporarily stopped, with suction and return valves remaining open, the pump is said to be in "standby". If the system includes a discharge check valve, the discharge isolation valve may remain open; otherwise, it should be shut prior to stopping the pump to prevent backflow. The pump can remain in standby indefinitely.

7.5 Check for leaks

- Personnel: ■ Qualified mechanical technicians
- Protective equipment: ■ Hearing protection
 ■ Safety shoes
 ■ Safety goggles

Prior to and during operation, the pump and its piping system should be frequently checked for leakage. Particular attention is required at these locations:

- Flanges
- Threaded fittings
- Valve packing

If apparent leakage is observed, the operator must determine whether there is actually a leak or if it is an instance of air liquefaction (air condensation) causing drips from an exposed surface. This is ascertained by observing the nature of the apparent leak. If the leak consists of a drip or running liquid, with little or no pressure behind it, that occurs at a low point in the line or on the pump housing and subsequently disappears as frost covers the surface, the leak is most likely air condensation, not a true leak.

Leakage at mechanical joints such as flanges and fittings, as well as at valve packing, may be repaired in place after the system is depressurized and warmed to ambient temperature.

7.6 Emergency shutdown

Actions at pump



The pump must be incorporated in an emergency shutdown chain. The following measures pertain only to the pump and not to other components of the overall system.

In the event of an emergency in which the pump must be secured as quickly as possible, the following actions are to be taken in the order given as time allows:

1. Stop pump.
2. Close suction valve.
3. Close discharge and return valves.
4. Open system vent or drain valve in a safe location to relieve pressure.
5. Remove energy source (open circuit breaker, for example).
6. Secure supply source and receiving system as time allows.

Other actions

In conjunction with above actions, proceed as follows:

1. Immediately activate emergency shutdown by means of the emergency stop button/device.
2. Keep persons out of the hazard zone.
3. If necessary, take first aid measures.
4. Notify the fire department and/or rescue service.
5. Inform responsible persons at the site of operation.
6. Switch off pump assembly and secure against re-engagement.
7. Make access routes open for rescue vehicles.
8. Direct rescue vehicles.

After rescue measures

9. If the severity of the emergency requires, inform the appropriate authorities.
10. Only qualified technical personnel shall be permitted to analyze and correct the cause of the emergency.



INSTRUCTION HANDBOOK For Installation, Operation & Maintenance

M-7
CP-NS
Rev. 1

7.7 Normal shutdown

- Personnel: ■ Qualified mechanical technicians
- Protective equipment: ■ Safety shoes
 ■ Safety goggles

When pumping operation is complete, or at the discretion of the operator, normal shutdown is accomplished as follows:

1. Close discharge valve and open return line valve.
2. Stop pump.
3. Close suction valve.
4. Allow pump and all related piping to warm to ambient temperature, then close return line valve.
5. Secure supply source and receiving system as required.
6. Remove energy source (open circuit breaker, for example).



INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-7
CP-NS
Rev. 1



8 Maintenance

8.1 Safety instructions

Electrical installation



DANGER!

Danger due to electrical current!

Hazard instruction paragraph 2.5.2 “Hazards posed by electrical power.”

Lock out electrical power supply



WARNING!

Danger due to by unauthorized re-engagement!

By unauthorized re-engagement of the power supply during maintenance, there is a risk of serious injury or even death for persons in the hazard zone.

Before beginning work, switch off all power supplies and lock out.

Improperly performed maintenance work



WARNING!

Risk of injury due to improperly performed maintenance work!

Improper maintenance can lead to serious injuries and significant property damage.

- Before beginning work, ensure sufficient installation freedom.
- Ensure order and cleanliness in the installation site! Components and tools lying loosely on or around each other can cause accidents.
- If components were removed, ensure correct re-assembly, reinstall all fastening elements and maintain screw tightening torques.
- Observe the following before recommissioning:
 - Make sure that all maintenance work has been carried out and completed in accordance with the information and instructions in this instruction manual.
 - Make sure that no persons are in the hazard area.
 - Make sure that all covers and safety devices are installed and functioning properly.

Environmental protection

Observe the following instructions for environmental protection during maintenance work:

- At all lubrication sites that are supplied with lubricant by hand, remove the emerging, consumed or excess grease and dispose of it in accordance with the applicable local regulations.
- Trap replaced oil in appropriate containers and dispose of it in accordance with the applicable local regulations.

8.2 Spare parts



WARNING!

Risk of injury due to use of incorrect spare parts!

The use of incorrect or defective spare parts can pose hazards for personnel and can result in damage, incorrect function or total failure.

- Only the manufacturer's original spare parts or spare parts approved by the manufacturer should be used.
- Always contact the manufacturer when uncertain.



Loss of warranty

The use of unapproved spare parts results in the loss of the manufacturer's warranty.

Order spare parts via retailers or directly from the manufacturer. See the title page for contact information and Module 12 for all locations of authorized service centers.

The spare parts list is found in Module 12.

8.3 Post-maintenance activities

After completion of maintenance work and before recommissioning the pump, conduct the following steps:

1. Check all previously loosened screw connections for firm seating.
2. Check whether all previously removed protective devices and covers are reinstalled properly with the corresponding fastening devices.
3. Make sure that all tools used, materials and other equipment were removed from the work area.
4. Clean work area and remove any substances, such as liquids and packaging material.
5. Check and make sure that all pump assembly safety equipment of the pump assembly is functioning properly.

9 Troubleshooting

Possible causes of malfunctions and the steps to eliminate them are described in the following section.

In case of increased occurrence of malfunctions, adjust the maintenance intervals according to the actual operational experience.

In case of malfunctions that cannot be eliminated by following the instructions below, contact the manufacturer. See Module 12 for contact information.

9.1 Safety instructions

Electrical installation



DANGER!
Danger due to electrical current!

Hazard instruction paragraph 2.5.2 “Hazards posed by electrical power.”

Moving components



WARNING!
Risk of injury due to moving components!

Hazard instruction paragraph 2.5.3 “Hazards posed by mechanical devices.”

Liquefied gases



DANGER!
Danger due to liquefied gases!

Hazard instruction paragraph 2.5.4 “Hazard posed by liquefied gases.”

Components exposed to pressure



WARNING!
Danger due to components exposed to pressure!

Hazard instruction paragraph 2.5.5 “Hazards posed by components exposed to pressure.”

Cryogenic and hot surfaces



DANGER!

Danger due to cryogenic and hot surfaces!

Hazard instruction paragraph 2.5.6 “Hazards posed by cryogenic and high temperatures.”

Lock out electrical power



WARNING!

Danger due to unauthorized re-engagement!

By unauthorized re-engagement of the power supply during troubleshooting and elimination of malfunctions, there is a risk of serious injury or even death for persons in the hazard zone.

Before beginning work switch off all power supplies and lock out.

Improperly performed work for troubleshooting



WARNING!

Risk of injury due to improper troubleshooting

Improperly performed work to eliminate malfunctions can lead to serious injuries and significant property damage.

- Before beginning work, ensure sufficient installation freedom.
- Ensure order and cleanliness in the installation area! Components and tools lying loosely on or around each other can cause accidents.
- If components were removed, ensure correct re-assembly, reinstall all fastening elements and maintain screw tightening torques.
- Observe the following before recommissioning:
 - Make sure that all troubleshooting work has been carried out and completed in accordance with the information and instructions in this instruction manual.
 - Make sure that no persons are in the hazard area.
 - Make sure that all covers and safety devices are installed and functioning properly.

Conduct during malfunctions

In principle the following applies:

1. In case of malfunctions that represent imminent risk to persons or property, immediately initiate an emergency shutdown.
2. Determine the cause of the malfunction.
3. If troubleshooting requires work in hazard area, switch off the pump assembly and lock out. Immediately inform responsible individuals at the site of operation about the malfunction.
4. Depending on the type of malfunction, have it eliminated by authorized technical personnel or eliminate it yourself.



The troubleshooting table listed below offers suggestions concerning who is authorized to eliminate the malfunction.

9.2 Troubleshooting table

Qualified personnel



WARNING!

Danger due to unqualified personnel!

Only “Qualified Personnel” listed in the table below should perform any of the actions shown in the table.

Refer to Personnel Requirements instruction paragraph 2.3.1 “Qualifications”.

Problem	Possible Cause	Solution	Qualified Personnel
Pump never primes; no flow and no discharge pressure	Pump turns in the wrong direction	Reverse polarity	Electrical technician
	Insufficient NPSH or cooling	Allow addition pump cool-down and/or increase suction pressure	Mechanical technician
	Gas trap in the suction pipe	Vent the suction pipe	Mechanical technician
	Ice or carbon dioxide blockage in suction or discharge piping or in pump	Warm to ambient and purge with warm nitrogen. Eliminate source of moisture or CO ₂ .	Mechanical technician



INSTRUCTION HANDBOOK

For Installation, Operation & Maintenance

M-9
CP-NS
Rev. 1

Problem	Possible Cause	Solution	Qualified Personnel
Pump cavitates or starts losing pressure	Insufficient NPSH or cooling	Cool again or increase suction pressure	Mechanical technician
	Gas trap in the suction pipe	Vent the suction pipe	Mechanical technician
	Discharge flow of the pump is too high or too low	Adjust the discharge flow with the discharge valve	Mechanical technician
Discharge flow of pump too low	Insufficient NPSH or cooling	Cool again or increase suction pressure	Mechanical technician
	Worn labyrinth or piston rings	Replace parts	Manufacturer
	System backpressure too high	Check installation	Mechanical technician
Motor overloaded	Excessive pump discharge flow	Throttle with discharge valve	Mechanical technician
Pump vibrates	Pump flow insufficient	Increase flow	Mechanical technician
	Foreign particles in the pump	Overhaul pump	Manufacturer
	Impeller(s) unbalanced	Overhaul pump	Manufacturer
	Bearing misaligned or worn	Overhaul pump	Manufacturer
Excessive wear or overheating	Bearing play or tension incorrect	Overhaul pump	Manufacturer
	Contaminated lubricant in bearings	Replace bearings	Manufacturer

9.3 Malfunction elimination

Malfunction elimination instructions are specific to each pump type and are provided in Module 12, Appendix A1.



INSTRUCTION HANDBOOK For Installation, Operation & Maintenance

M-9
CP-NS
Rev. 1

9.4 Recommissioning

After elimination of the malfunction, conduct the following steps for recommissioning:

1. Reset emergency shutdown devices.
2. Acknowledge the malfunction on the control.
3. Make sure that no persons are in the hazard area.
4. Restart pump according to instructions in Module 7.



INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-9
CP-NS
Rev. 1



10 Disassembly and Disposal

When the pump assembly will no longer be used, the pump assembly must be disassembled and disposed of in an environmentally proper and safe manner.

10.1 Safety instructions for disassembly and disposal

Electrical installation



DANGER!
Danger due to electrical current!

Hazard instruction paragraph 2.5.2 “Hazards posed by electrical power.”

Cryogenic surfaces



DANGER!
Risk of injuries due to cryogenic surfaces!

Hazard instruction paragraph 2.5.6 “Hazards posed by cryogenic and high temperatures.”

Improper disassembly



WARNING!
Risk of injury during improper disassembly!

Residual pressure in piping and/or pump, sharp components, tips and corners on or in the pump assembly or on the required tools can cause injury.

- Ensure that all pressure has been vented from the system.
- Ensure sufficient room before beginning work.
- Carefully handle open sharp-edged components.
- Pay attention to order and cleanliness in the workplace! Components and tools lying loosely on or around each other can cause accidents.
- Disassemble components skillfully. Pay attention to the sometimes high intrinsic weight of the components. If necessary, use lifting gear.
- Secure components so that they do not fall out or collapse.
- Consult the manufacturer when uncertain.



INSTRUCTION HANDBOOK

For
Installation, Operation & Maintenance

M-10
Rev. 1

10.2 Disassembly

Before beginning disassembly:

- Switch off pump assembly and lock out electrical power.
- Physically separate the entire power supply from the pump assembly and allow at least 10 minutes for stored capacitor charges to dissipate.
- Vent all pressure in system associated with pump assembly to atmospheric pressure.
- Remove associated items, such as lubricants and electronic components, and remaining packaging materials and dispose of them in an environmentally safe manner.

Then close all lines, remove the purging device (if applicable), properly clean assemblies and components and break down with consideration of applicable local occupational safety and environmental safety provisions.

10.3 Disposal

If no return or disposal agreement has been made, send disassembled components for recycling.

- Scrap metals.
- Send plastic elements to recycling.
- Dispose of other components sorted according to material condition.



NOTE!

Hazard posed to the environment due to incorrect disposal!

Hazards to the environment can develop as a result of incorrect disposal.

- Electrical scrap, electronic components, lubricants and other associated materials must be disposed of by permitted specialists.
- When in doubt seek information concerning environmentally safe disposal from local municipal authorities or disposal specialists.



INSTRUCTION HANDBOOK

For
Installation, Operation & Maintenance

M-11
Rev. 1

11 GLOSSARY OF TERMS

<u>TERM</u>	<u>DEFINITION</u>
Ampacity	The current carrying capacity of an electrical conductor under a particular set of environmental conditions (such as location, ambient temperature, and number of conductors bundled together). Unit of measure is the ampere.
Cavitation	The formation and subsequent collapse of bubbles in a liquid stream due to localized pressure falling below the liquid's vapor pressure. See ¶ paragraph 3.2 for a discussion of cavitation.
Critical point	The end point on the vapor pressure curve above which a substance cannot exist as a liquid regardless of the pressure applied. The critical pressure is the pressure required to maintain the liquid at that point; similarly, the critical temperature is the temperature required at the critical pressure to achieve equilibrium.
Cryogenic liquids (cryogens)	The word <i>cryogenic</i> (adjective) is derived from the Greek <i>kryos</i> , meaning icy cold, and <i>genes</i> , also Greek, meaning born or becoming. A cryogenic fluid is commonly defined as one which exists as a liquid only below -150°C . The noun form is <i>cryogen</i> .
Equilibrium	As used in this manual, equilibrium occurs when a substance is directly on its vapor pressure curve. In equilibrium, a substance has equal numbers of atoms or molecules converting from liquid to gas and back from gas to liquid. Also called saturation.
Head	The traditional term for pressure in pump applications. Originally, in the USA, pump pressures were measured using the height of a column of water in feet as the reference. This column was called a "head". Since pressure equals height of a column multiplied by the density of the liquid in the column, the referenced head in feet of water is a different head in the actual liquid being pumped (if other than water) for a given pressure.
Latent heat of vaporization	Latent heat is the heat required to make a substance change state (phase) with no change in temperature. The addition of latent heat changes a substance from solid to liquid or liquid to gas; the subtraction of latent heat causes phase changes in the opposite direction. Latent heat of vaporization is the specific amount of heat required to change a unit mass of a substance from liquid to gas (or the reverse).
Lock out	The act of ensuring that electrical power, or other energy source, is and will remain removed while personnel are working with related equipment. Generally, the personnel performing the work will install a personal lock on the access to the energy source that only they can remove.



INSTRUCTION HANDBOOK

For

Installation, Operation & Maintenance

M-11
Rev. 1

Megohmmeter (“Megger”)	First produced by the English company Biddle, the Megger provides a source of approximately 500 volts DC to be applied across a circuit’s insulation. The instrument then measures the leakage current occurring as a result of the applied voltage and indicates the insulation effectiveness in megohms (10^6 ohms).
Net Positive Suction Head (NPSH)	The difference between the actual pressure and the vapor pressure of a liquid at the pump suction port. See paragraph 3.2 for a discussion of NPSH. This term generally used with non-positive displacement pumps (such as centrifugal types).
Net Positive Suction Pressure (NPSP)	See <i>Net Positive Suction Head (NPSH)</i> above. This term generally used with positive displacement pumps.
Normal Boiling Point	The boiling point (temperature) of a liquid at standard atmospheric pressure. Another way of stating it is the temperature at which the vapor pressure of a substance is one atmosphere.
Oxygen deficient atmosphere	Normal atmospheric air contains 20.8% oxygen. Most standards consider an oxygen concentration below 19.5% to be deficient for continuous occupation by personnel.
Pump assembly	The pump assembly consists of the pump itself, the driver (electric motor, hydraulic motor, or mechanical drive), and the interposing drive unit (belt box or gear box) if one is installed. The pump assembly does not include any controls or associated valves, piping, or instrumentation.
Saturation	See <i>equilibrium</i> .
Seal, shaft, gas riding	The gas riding shaft seal is a non-contacting design that forms a gas film between the rotating and stationary faces. The film is generated by vaporizing a small amount of the liquid being pumped. This design features long seal life since the faces make contact with each other only when the pump is not running. No wear occurs during operation.
Seal, shaft, labyrinth (single and dual)	Labyrinth shaft seals consist of nesting grooves in both the rotating and stationary parts. The crests of the stationary grooves are centered over the roots of the rotating grooves (and vice versa) to create a close-fitting labyrinth for fluid leakage along the shaft. Each groove acts like a very small annular orifice, thus creating an obstacle to the flow and reducing the pressure at the next groove. This action reduces the leakage to a very small amount. Labyrinth seals may be of single or dual construction. In single construction, an external seal gas (usually nitrogen) is introduced that has a slightly higher pressure than the pressure behind the impeller. By this means the leakage is stopped completely but a small amount of the seal gas will leak into the fluid being pumped. If this is unacceptable, dual labyrinth seals are used in which two seal gases are used. The primary seal gas, located partway down the labyrinth seal, is obtained from the liquid being pumped. The secondary seal gas, which is located near the end of the labyrinth behind the primary gas entrance, is usually nitrogen. A vent is provided from the labyrinth



INSTRUCTION HANDBOOK

For

Installation, Operation & Maintenance

M-11
Rev. 1

between the primary and secondary gas entrances. The pressures of the two gases are regulated such that the primary gas will slightly leak into the pump while the secondary gas, along with a portion of the primary gas, will escape through the vent from the seal. By this means, the product being pumped is not contaminated by the seal gas (since they are both the same fluid) and the vented gas is rendered safe by the mixture with the secondary gas. The gas pressures are controlled by differential pressure regulators. The dual system is usually installed when the pump is in oxygen service.

Labyrinth seals are essentially non-contacting at all times (unless bearings are worn) and thus have extremely long life. The seal gas must be supplied prior to startup; in the case of dual seals, the primary gas must be provided at a pressure above the pump suction pressure from the product supply source until the pump is in operation, at which time the primary gas source will become the pump discharge.

Seal, shaft, mechanical

A standard mechanical shaft seal consists of a shaft-mounted rotating hardened stainless steel ring which continuously bears against a spring-loaded carbon stationary ring. Both rings are precision lapped to be very flat (within three helium light bands or better) so that they effect a seal both statically (pump not running) and dynamically (pump running). Standard mechanical seals must be replaced as a complete assembly. This type seal is the least expensive but has the shortest life due to the constant frictional contact and intolerance of foreign material between the faces. The friction also generates heat which can adversely affect NPSH requirements.

Seal, shaft, mechanical, CFS

The CFS mechanical seal is similar to the standard mechanical seal except that the stationary ring is a composite material, not carbon. The CFS seal has proven to be very reliable, especially if dry running occurs (pump running without fluid in it or severe cavitation) or if ice formation exists in the seal.

Static head

Head (or pressure) due to vertical location. A vertical pipe containing a liquid will have a greater pressure at the bottom than at the top due to the weight of the liquid. This pressure is called static because it does not vary with the gas pressure over the liquid but acts in addition to the gas pressure. In pump applications, static head (if positive) aids in ease of prime and efficient pump operation.

Subcooling

If the temperature of a substance is below the temperature of the vapor pressure at any given pressure, it is said to be subcooled. The farther away from the vapor pressure curve, the more subcooling exists. Subcooling can also be achieved by increasing the pressure above the vapor pressure at any given temperature.

Tetrafluoroethylene (TFE) or Polytetrafluoroethylene (PTFE)

A fluorocarbon compound. Virgin TFE or PTFE in tape or paste form is oxygen compatible and serviceable at cryogenic temperatures.

Trap (gas or liquid)

For liquid, a U-shaped area in a pipe in which the line dips, then returns to essentially the same elevation as existed before the dip. A liquid trap not only adds unnecessary frictional pressure loss, it is



INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-11
Rev. 1

a collection point for solid contaminants. An inverted U-shape forms a trap for gas causing disruptions to liquid flow and increased heat leak into the pipe.

Triple point

The other end point on the vapor pressure curve at which a substance can simultaneously exist as a solid, liquid, and gas.

Vapor pressure

See paragraph 3.2 for a discussion of vapor pressure.



INSTRUCTION HANDBOOK

For

Installation, Operation & Maintenance

M-12
Rev. 1

12 Appendices

The remainder of this handbook consists of two Appendices.

The first, Appendix A, contains information that is specific to the pump type that is indicated by the Model provided on the cover. This information is intended to be used by the on-site authorized technicians that are directly responsible for the operation of the pump assembly and its associated system.

The second, Appendix B, contains information that is specific to the pump indicated not only by the Model but also by the Serial Number provided on the cover. This information consists mainly of engineering data that is included for reference purposes.

Appendix A consists of the following subappendices:

- A1. Description, installation, operation, and troubleshooting
- A2. Maintenance (Cryogenic Industries locations)
- A3. Removal and re-installation
- A4. Maintenance Plan
- A5. Field Trouble Report (FTR)
- A6. Repair Record

Appendix B consists of the following subappendices:

- B1. Intended use
- B2. Pump technical data
 - B2.1 Pump data sheet and performance curve
 - B2.2 Other data
- B3. Drawings
- B4. Spare parts
- B5. Ancillary Equipment (Vendor Data)
- B6. Certificates
- B7. Declaration of Incorporation



INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-12
Rev. 1





INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-12-A
CP-TC34
Rev. 2

INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS

APPENDIX A

Centrifugal Cryogenic Pump Model TC-34

Manufactured by

ACD LLC

ENGLISH - ORIGINAL INSTRUCTIONS

	INSTRUCTION HANDBOOK For Installation, Operation & Maintenance	M-12-A CP-TC34 Rev. 2
---	---	-----------------------------

Appendix A is intended to be used by the on-site authorized technicians that are directly responsible for the operation of the pump assembly and its associated system. This appendix contains the following sections specific to the Model TC-34 sealless pump assembly:

- A1. DESCRIPTION, INSTALLATION, OPERATION, AND TROUBLESHOOTING 1
 - A1.1 TC-34 Description2
 - A1.2 TC-34 Installation.....3
 - A1.3 TC-34 Operation 13
 - A1.4 TC-34 Troubleshooting 15
- A2. MAINTENANCE AND CRYOGENIC INDUSTRIES LOCATIONS 19
 - A2.1 Repairs - General..... 19
 - A2.2 Locations 19
- A3. REMOVAL AND REINSTALLATION21
- A4. MAINTENANCE PLAN23
- A5. FIELD TROUBLE REPORT25
- A6. REPAIR RECORD29

A1. DESCRIPTION, INSTALLATION, OPERATION, AND TROUBLESHOOTING

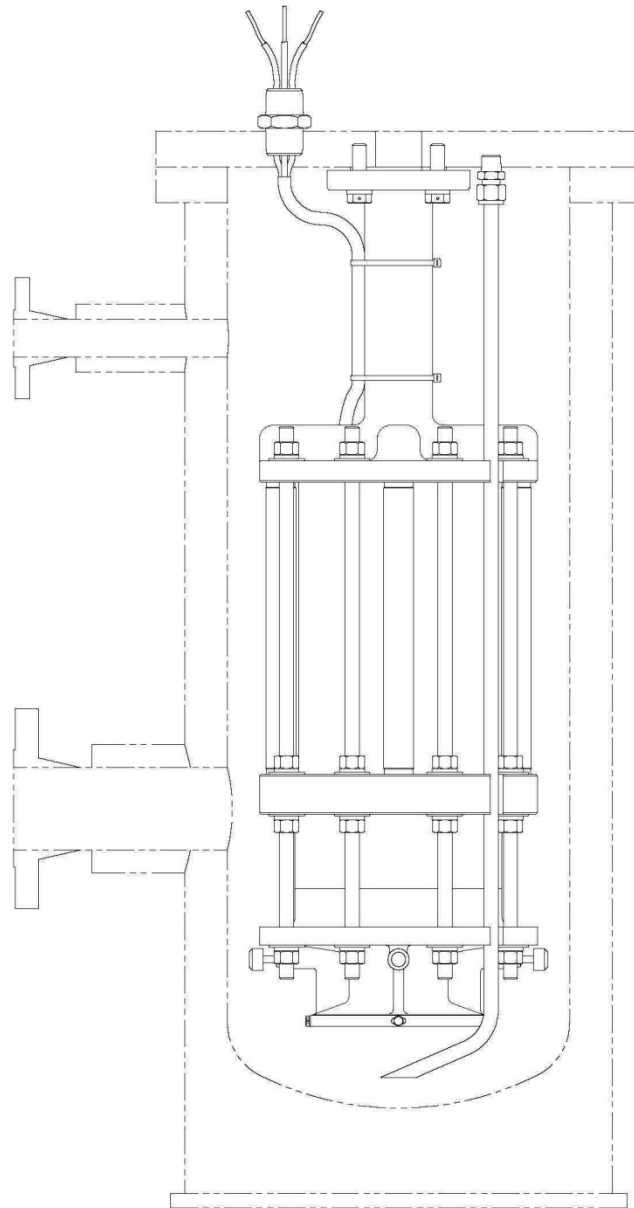


Figure A1. TC-34 Submerged Pump



INSTRUCTION HANDBOOK For Installation, Operation & Maintenance

M-12-A
CP-TC34
Rev. 2

A1.1 TC-34 Description

The Model TC-34 pump assembly is a vertically oriented, two- or four-stage, close coupled pump that is mounted directly on the drive motor, all of which is contained within a sump that is pressurized at pump suction pressure. The TC-34 pump assembly motor is designed to be flooded with the liquid being pumped; thus no shaft seal is employed. The flooded electric motor is part of the standard scope of supply and all components are completely assembled together. The TC-34 pump is capable of flows from approximately 2 to 135 gpm (8 to 510 l/m) and differential heads from 50 to 1,600 feet (15 to 488 meters) depending on the number of stages and speed of the pump drive. The sealless type centrifugal pump is especially suited for installations in which product loss through shaft seal leakage is not tolerable.

The sump, which can be provided either by ACD or the customer, provides a submerged suction condition to achieve the lowest possible NPSH and reliable priming. The sump is available, as an option, with vacuum jacketing for installations in which the best possible insulation is desired for least product loss through heat leak. Vacuum jacketing is especially desirable where the pump is in standby mode for long periods of time.

The standard TC-34 includes a suction filter screen at the pump inlet port and an inducer on the first stage impeller.

The TC-34 motor is specifically designed for Variable Frequency Drive (VFD) applications. The use of a VFD allows the pump speed to be tailored to the specific service, thus providing best efficiency. The motor bearings feature ceramic balls and a glass-filled PTFE/MoS₂ dry-film lubricant impregnated retainer specifically designed and manufactured by ACD for the application. The bearings are cooled by the liquid being pumped; for the bearing nearer the impeller, the liquid flows from behind the second stage impeller, while the far end bearing receives flow through a drilled orifice in the discharge manifold. Both flows exit the motor housing through vent holes which communicate with the sump liquid.

Submerged pumps are inherently not suitable for oxygen service due to the flooded motor design.

Available options include a safety relief valve, loss of prime detection system (cavitation protection), a differential pressure gauge, and the vacuum jacketed sump discussed above.

A1.2 TC-34 Installation



DANGER!

Do not use for oxygen service!

The submerged motor cryogenic pumps are not suitable for use in liquid oxygen service.



DANGER!

Danger due to electrical current!

See paragraph 2.5.2 "Hazards posed by electrical power".



DANGER!

Danger due to liquefied gases and oxygen deficient atmosphere!

See paragraph 2.5.4 "Hazard posed by liquefied gases".



DANGER!

Risk of injury from cryogenic surfaces!

See paragraph 2.5.6 "Hazards posed by cryogenic and high temperatures".



WARNING!

Risk of injury due to improper installation and initial startup!

During installation and initial start-up of a pump assembly, special safety instructions and precautions apply in addition to those provided elsewhere in this manual. Improper installation and initial startup can lead to serious injuries and significant property damage.

These special safety instructions include the following:

- Before beginning work ensure there is sufficient clearance to other objects.
- Carefully handle open sharp-edged components.
- Ensure order and cleanliness in the installation area! Components and tools lying loosely on or around each other can cause accidents.
- If the pump assembly (motor and pump) is to be lifted at any time, appropriate methods and lifting points are to be used. Specific lifting instructions are provided in Appendix B.
- Install components correctly. Maintain prescribed screw-tightening sequences and torques.
- Secure components so that they do not fall out or collapse.
- Workmanship. For a safe installation, only personnel qualified in the various trades (welding, brazing, pipefitting, electrical, and inspection), using proper tools, should be authorized to perform the installation tasks.
- Local Codes. Comply with all local codes that apply and have jurisdiction over the various aspects of the pump installation.



INSTRUCTION HANDBOOK For Installation, Operation & Maintenance

M-12-A
CP-TC34
Rev. 2

- Installation drawing. Fully comply with any safety requirements noted on the installation drawing (Appendix B).
- Ensure the following before initial startup:
 - Make sure that all installation work has been carried out and completed in accordance with the information and instructions in this instruction manual.
 - Make sure that no persons are in the hazard areas at startup.

Installation of the TC-34 pump assembly includes: 1) lifting and mounting to an adequate foundation, 2) connecting the sump inlet, sump return, and discharge ports to appropriate piping, and 3) connecting the motor to a suitable control system.

Lifting. The TC-34 pump assembly, if outside the sump, is to be lifted by a suitable sling placed under and around the pump housing and motor. If already installed in a vacuum jacketed sump, lift assembly by the upper flange cover only; do not lift with sling around sump. A non-jacketed sump may be lifted with a sling.

Mounting. The TC-34 is mounted by use of the mounting provisions made in the sump base. See the Installation drawing provided in Appendix B for the exact dimensions, hole size and hole spacing.

The foundation must have adequate strength for the loads imposed, be well drained, and meet any applicable local codes. If the installation is a stationary system, the foundation should be a minimum of 6 inch (15 cm) thick reinforced concrete with a minimum compressive strength of 3000 psi (20 mPa) and sufficiently raised from the surrounding area for adequate condensate drainage. Fastening to the foundation is preferably accomplished using cast-in-place anchor bolts meeting ASTM F-1554 grade 36 (or equivalent) and sized to closely fit the sump mounting holes (within 1/8" or 3 mm).

In mobile applications, the foundation and mounting provisions must be specifically engineered for the particular installation involved.

Mounting bolt nuts and washers should not be tightened until all piping connections have been made and initial cooldown has been completed.

Piping connections. See ACD drawing 63402 (Figure A1) for the components of a typical piping system. The pump assembly is shipped with covers over the pump ports to maintain internal cleanliness; do not remove these covers until immediately prior to making the connections. Piping must be cleaned as described in Module 6 of this Manual.

Piping materials should be selected for the cryogenic service intended. Austenitic stainless steels and copper both maintain good physical properties at cryogenic temperatures. Copper-bearing alloys such as bronze and brass also work well.

The purpose of the suction line (connected to the lower port of the sump) is to provide cold liquid to the sump. Excess liquid in the sump is returned via the liquid return line (connected to the upper sump port) to the storage tank. To assure there is sufficient liquid in the sump (liquid level in the sump must be above the top bearing before start-up and during operation of the TC-34 pump) it is recommended that the pump be positioned such that the sump return port is below the minimum liquid level in the storage tank.

The suction and return lines to the sump should be as short as possible and preferably with a slope and vacuum insulated.

Short flexible lines at the sump port connections are highly recommended to isolate the piping from any pump vibrations and to compensate for thermal expansion and contraction. They are not to be used, however, for correction of piping misalignment.



INSTRUCTION HANDBOOK For Installation, Operation & Maintenance

M-12-A
CP-TC34
Rev. 2

See the Installation drawing provided in Appendix B for the port sizes and locations. Suction piping should never be smaller in diameter than the sump inlet port size.

As shown on drawing 63402, the TC-34 sump should be protected by a pressure relief valve and a manual vent valve. A sump drain valve may be added if desired but is not required. These items are not included with the pump unless specifically included in the customer's order. Valves and components must meet the requirements of Module 6.

After the initial cooldown of the pump but prior to initial operation, return to the mounting fasteners and tighten them.

Inerting for LNG operation. For the safe operation of a submerged motor pump with LNG (Liquid Natural Gas) or with any other liquefied hydrocarbon gas, it is ESSENTIAL that, before the initial cooldown and startup, the entire installation and in particular the sump and the pump/motor unit are inerted and all oxygen content (including air) is removed from the system.

Oxygen gas and natural gas can form an explosive mixture that can be ignited, for example, by a shorting electric motor wire. Without the presence of oxygen, however, the operation of an electric motor in LNG is safe under all circumstances.

Motor bearing lubrication. The special ball bearings supporting the pump and motor shaft are cooled by the liquid flowing through the pump. No other lubrication is required. It is essential, however, that the cooling flow of liquid is available *at all times* during startup and operation of the pump.

Prior to starting pump rotation, the on-site technician operating the pump must verify that the sump is completely filled with liquid. This assures that the top bearing is submerged in liquid.

The installation of sump inlet and return piping must ensure that, during operation, the flow of liquid will be sufficiently constant to prevent pump cavitation and the resultant loss of cooling flow to the bearings.

To aid in bearing protection, it is recommended that a temperature indicator be installed at the top of the sump or in the return line to monitor the cooling flow. In addition, it is recommended that a differential pressure switch or low pressure switch be installed in the pump discharge line to protect the pump by causing automatic shutdown if cavitation or loss of prime is detected.



NOTE!

The liquid to be pumped must be clean with no particles larger than 10 microns in order to protect the motor bearings. It is recommended that a suitable filter be installed in the sump inlet piping.

Electric cable leadthrough. The electric power cable to the submerged motor passes through a special gastight cable leadthrough located directly on the outside of the sump closing plate. This leadthrough has to fulfill the local regulations for electric connections, in particular when the TC-34 pump is used to handle LNG. On the pump side the cable leadthrough is designed to be gastight for the maximum working (suction) pressure of the sump as well as the minimum gas temperature.

The cable connecting the leadthrough to the junction box and the junction box itself are generally not part of the scope of supply. They must be selected by the customer to meet local electrical codes in force at the installation location.

	INSTRUCTION HANDBOOK For Installation, Operation & Maintenance	M-12-A CP-TC34 Rev. 2
---	---	-----------------------------

Grounding. If the sump is included as part of the scope of supply and the pump has been mounted into the sump at one of ACD's facilities, the pump motor is properly grounded electrically to the sump. If the sump is supplied by others, the facility making the assembly of the pump/motor and sump must ensure that the motor is properly grounded to the sump.

In either case, the pump and sump assembly must also be properly grounded to the installation site in accordance with any electrical codes that are in effect at that location.

Motor control system. The drive motor must be provided with a suitable control system that a) provides a disconnect from the power source, b) protects the motor from overload, and c) provides a local means of emergency stopping. The control system should also have the capability for local starting of the motor. In addition, the control system and its enclosure(s) must meet local electrical codes in force at the installation location.

The variable frequency submerged electric motor rotor and stator are of a special design, exclusively manufactured for ACD. This motor is cooled by the cold liquid handled by the pump. The motor cannot be operated without this cooling medium.

A suitably sized and matched variable frequency drive (VFD) is required to provide the electric power to the motor. Care must be taken that the VFD is located within its prescribed range (maximum distance).

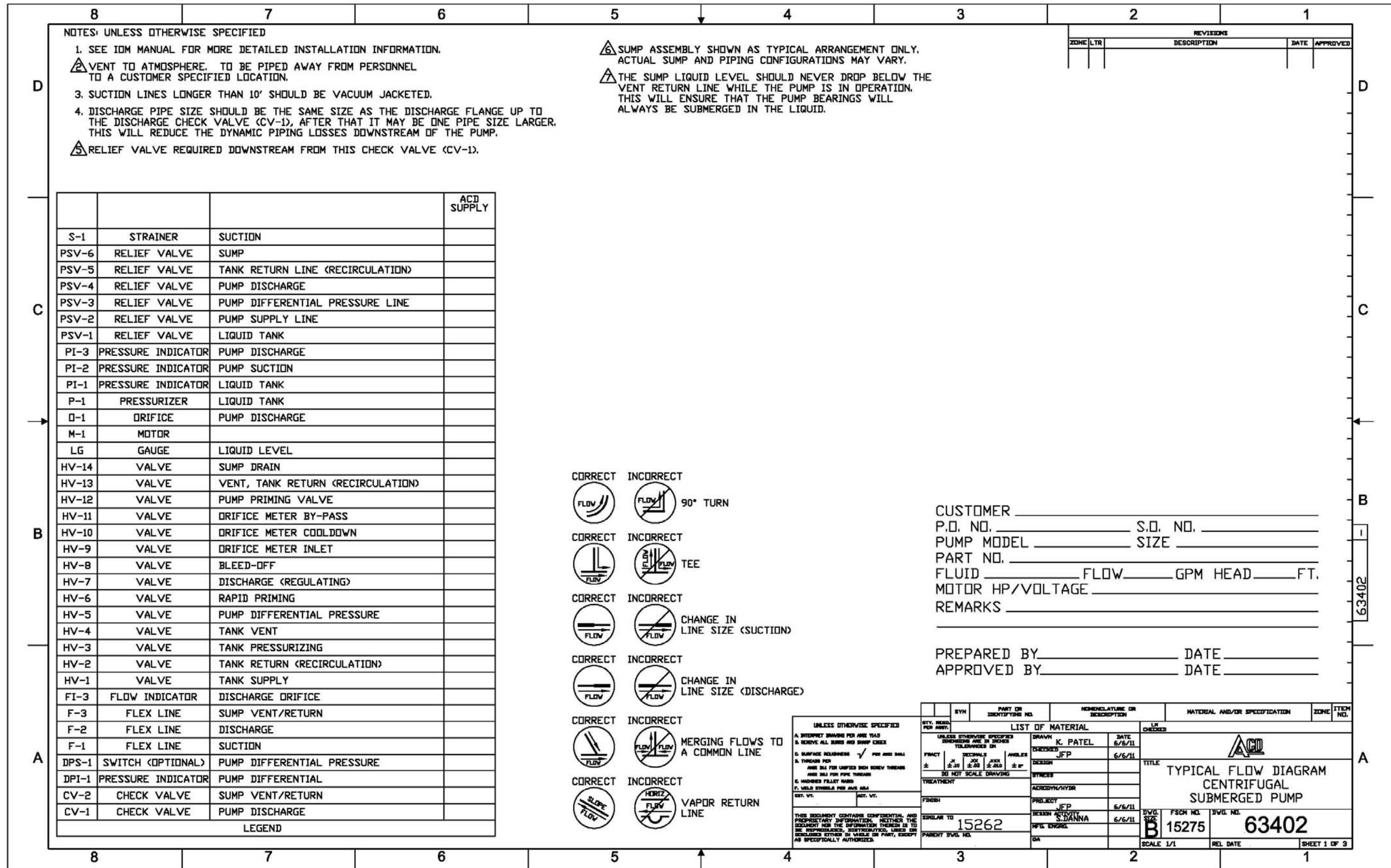


Figure A2. Typical Flow Diagram (Sheet 1)

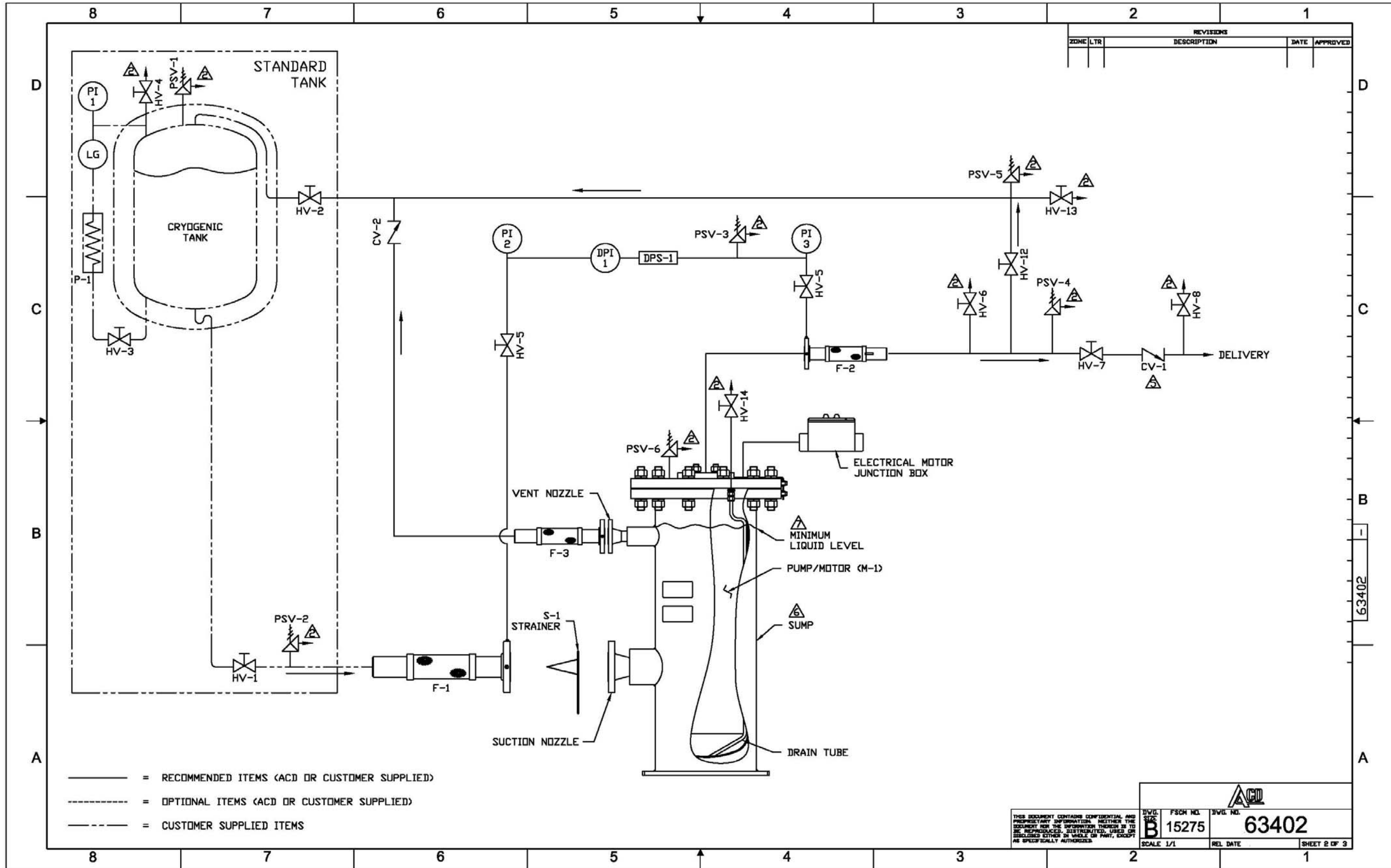


Figure A3. Typical Flow Diagram (Sheet 2)

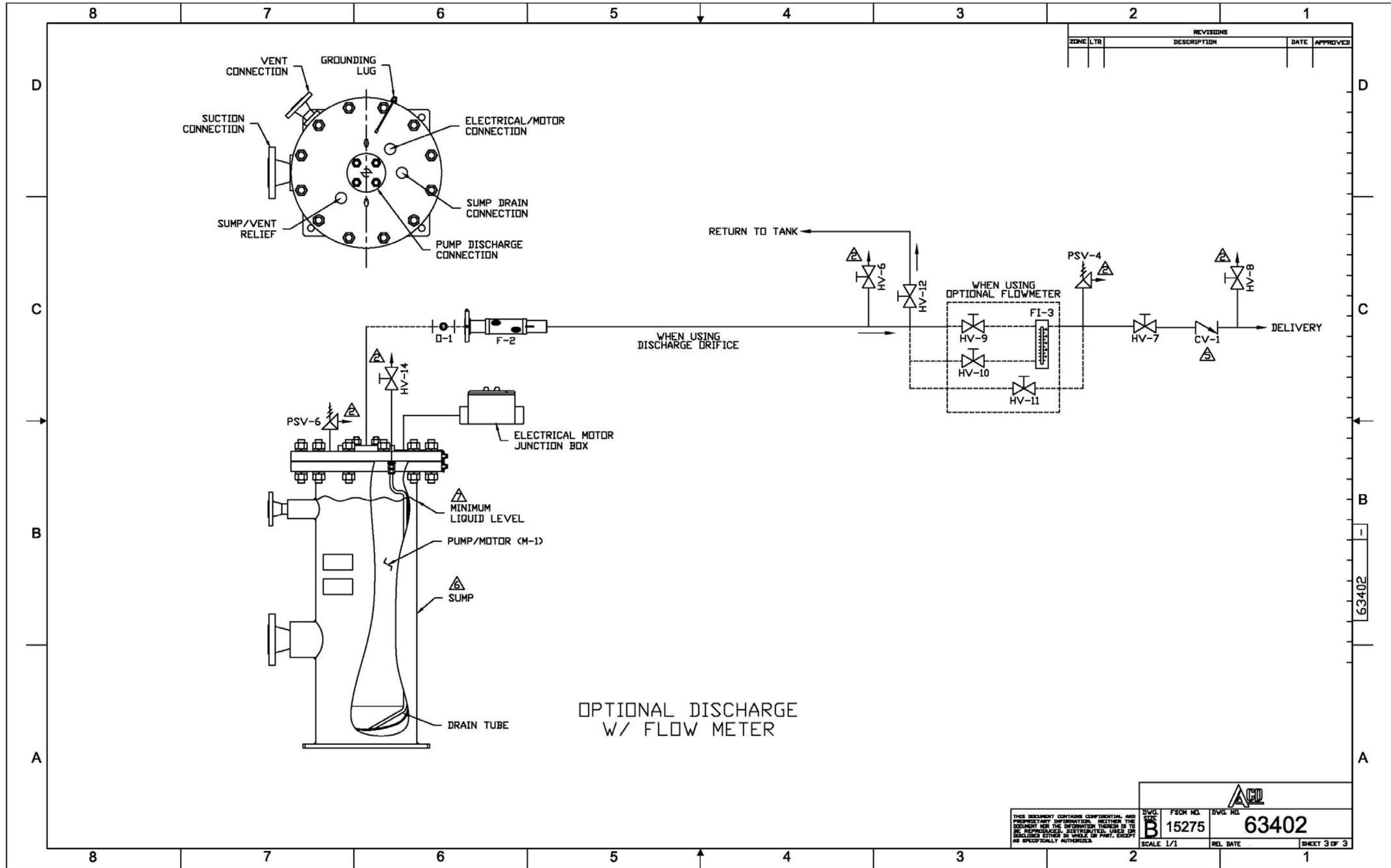


Figure A4. Typical Flow Diagram (Sheet 3)



INSTRUCTION HANDBOOK

For

Installation, Operation & Maintenance

M-12-A
CP-TC34
Rev. 2

A1.3 TC-34 Operation



WARNING!

Do not attempt to operate the pump prior to completion and cleaning of all piping, purging of piping and pump, and checking for pump rotation.



CAUTION!

Never operate the pump with no flow. Valves must be open to allow flow through pump at all times when operating.



NOTE!

Never operate the pump without first cooling down to normal operating temperature.

The operating procedures provided here are based on the Typical Flow Diagram, ACD drawing 63402 (Figure A1).

1. Perform all pre-operational checks. These include the following as a minimum; there may be others depending on the specific installation.
 - a) Verify that the supply source has sufficient liquid for the anticipated pumping operation.
 - b) Verify that power is available to the drive system.
 - c) Verify that receiving system is prepared to receive the pumped liquid.
 - d) Check the current positions of all supply source, receiving system, and pump piping valves. All pump piping valves should be closed prior to operation.
 - e) If the pump is in LNG service, verify that the pump and sump have been inerted with dry nitrogen.
2. If the supply source is a storage vessel that has achieved thermal equilibrium (that is, the liquid contained is boiling at the current pressure in the vessel), it is necessary to raise the pressure sufficiently to create the NPSH required by the pump. Generally, a rise in vessel pressure of 5 to 20 psi (35 to 140 kPa) above equilibrium pressure will be sufficient depending on the particular installation. Raise storage vessel pressure by following these steps:
 - a) Close supply vessel vent valve (HV-4).
 - b) Open supply vessel pressurizing valve (HV-3) until desired pressure is achieved; then close valve. Raise pressure the minimum required to achieve prime so as to conserve liquid.
 - c) Use supply vessel pressurizing valve (HV-3) as required to maintain the necessary pressure rise during the course of pump operation.
 - d) Pump cooldown (step 3) may be initiated simultaneously with pressure building.
3. Begin pump cooldown as follows:
 - a) Fully open sump supply valve (HV-1) and return line valve (HV-2). Liquid will circulate and pump will begin to cool due to gravity flow. Note that the pump will act in parallel with the storage vessel pressurizer coil (P-1), thus assisting in the vessel pressure rise during the cooldown period.
 - b) Open sump vent valve (HV-14) and discharge vent valve (HV-6) to vent gas and speed cooldown.
 - c) If the optional flow meter is installed, also open meter cooldown valve (HV-10).
 - d) If the optional flow meter is installed, but is not to be used during this particular operation, open meter bypass valve (HV-11).



INSTRUCTION HANDBOOK For Installation, Operation & Maintenance

M-12-A
CP-TC34
Rev. 2

- e) Allow sump to fill and pump to cool for at least 15 minutes or until the temperature monitor at the top of the sump (if installed) indicates that the sump is full.
 - f) Adjust valves as necessary to prepare pump for “bypass” operation or “fill” operation. In “bypass” operation, the pump discharge outlet valve (HV-7) is closed while the pump discharge return valve (HV-12) is open; thus, the pumped liquid is returned to the supply vessel. In “fill” operation, the valve positions are reversed with the outlet valve open and the return valve closed.
 - g) When cooldown is complete, start pump. See Caution note above.
4. Start pump by energizing the driver. With VFD operation, pump should start at low speed and “ramp” up to normal operating speed. If pump does not prime within 10 seconds after reaching full speed, stop pump and continue cooldown, raising storage vessel pressure if necessary. When pump primes:
- a) Close pump discharge vent valve (HV-6) and sump vent valve HV-14 (if not previously closed).
 - b) For filling operation, adjust pump discharge outlet valve (HV-7) as required to obtain desired flow and discharge pressure. If necessary, the pump discharge outlet and return valves can both be adjusted partially open to control outlet flow to some lower value (some flow returning to supply vessel) while maintaining pump prime.
 - c) If the optional flow meter is installed, open meter inlet valve (HV-9) after meter and discharge line have cooled; then close meter cooldown valve (HV-10).
 - d) Continue adjusting storage vessel pressure as necessary to maintain prime.
 - e) Note that the sump supply valve (HV-1) is to remain fully open at all times during pump operation.
5. During the pumping operation, take note of the pressure differential indicated by the supply line filter differential pressure gauge (if installed). A rise in differential pressure over time indicates that the filter or strainer (S-1) requires cleaning or replacement.
6. Standby operation: In this type of installation it is not necessary to shut the isolating valves between supply vessel and sump when the pump is not in operation. The valves may be left open so that the pump is continuously cooled down and ready for immediate start-up.
- In case of excessive formation of gas in the top part of the sump, the manual vent valve (HV-14) located directly on top of the sump (and in parallel with the sump relief valve PSV-6) may be temporarily opened for venting.
7. When pumping operation is complete, shut down as follows:
- a) Stop pump by de-energizing driver.
 - b) Close pump discharge outlet valve (HV-7) and open return line valve (HV-12 (if closed).
 - c) Close supply vessel pressurizing valve HV-3 (if open) at storage vessel.
 - d) Close valves as required on receiving system.
 - e) Open discharge vent valve (HV-8) to relieve pressure on discharge line or hose. Reclose when pressure is vented.
 - f) Close sump liquid supply valve (HV-1).
 - g) When frost has disappeared from sump housing or lines, close return line and discharge vent valves (HV-2 and HV-12).
 - h) If pressure in supply storage vessel needs to be reduced after pumping, open supply vessel vent valve (HV-4) as required.
 - i) Verify that all systems are secure.

A1.4 TC-34 Troubleshooting

Possible causes of malfunctions and the steps to eliminate them are described in the following section.

In case of increased occurrence of malfunctions, adjust the maintenance intervals according to the actual operational experience.

In case of malfunctions that cannot be eliminated by following the instructions below, contact the manufacturer. See Section A2 for contact information.



DANGER!
Danger due to electrical current!

Hazard instruction paragraph 2.5.2 "Hazards posed by electrical power."



WARNING!
Risk of injury due to moving components!

Hazard instruction paragraph 2.5.3 "Hazards posed by mechanical devices."



DANGER!
Danger due to liquefied gases!

Hazard instruction paragraph 2.5.4 "Hazard posed by liquefied gases."



WARNING!
Danger due to components exposed to pressure!

Hazard instruction paragraph 2.5.5 "Hazards posed by components exposed to pressure."



DANGER!
Danger due to cryogenic and hot surfaces!

Hazard instruction paragraph 2.5.6 "Hazards posed by cryogenic and high temperatures."



WARNING!
Danger due to unauthorized re-engagement!

By unauthorized re-engagement of the power supply during troubleshooting and elimination of malfunctions, there is a risk of serious injury or even death for persons in the hazard zone.

Before beginning work switch off all power supplies and lock out.



WARNING!

Risk of injury due to improper troubleshooting

Improperly performed work to eliminate malfunctions can lead to serious injuries and significant property damage.

- Before beginning work, ensure sufficient installation freedom.
- Ensure order and cleanliness in the installation area! Components and tools lying loosely on or around each other can cause accidents.
- If components were removed, ensure correct re-assembly, reinstall all fastening elements and maintain screw tightening torques.
- Observe the following before recommissioning:
 - Make sure that all troubleshooting work has been carried out and completed in accordance with the information and instructions in this instruction manual.
 - Make sure that no persons are in the hazard area.
 - Make sure that all covers and safety devices are installed and functioning properly.

Conduct during malfunctions. In principle the following applies:

1. In case of malfunctions that represent imminent risk to persons or property, immediately initiate an emergency shutdown.
2. Determine the cause of the malfunction.
3. If troubleshooting requires work in hazard area, switch off the pump assembly and lock out.

Immediately inform responsible individuals at the site of operation about the malfunction.

4. Depending on the type of malfunction, have it eliminated by authorized technical personnel or eliminate it yourself.



The troubleshooting table listed next offers suggestions concerning who is authorized to eliminate the malfunction.

Qualified personnel



WARNING!

Danger due to unqualified personnel!

Only “Qualified Personnel” listed in the table below should perform any of the actions shown in the table.

Refer to Personnel Requirements instruction paragraph 2.3.1 “Qualifications”.



INSTRUCTION HANDBOOK For Installation, Operation & Maintenance

M-12-A
CP-TC34
Rev. 2

Problem	Possible Cause	Solution	Qualified Personnel
Pump never primes; no flow and no discharge pressure	Pump turns in the wrong direction	Reverse polarity	Electrical technician
	Insufficient NPSH or cooling	Allow addition pump cooldown and/or increase suction pressure	Mechanical technician
	Gas trap in the suction pipe	Vent the suction pipe	Mechanical technician
	Ice or carbon dioxide blockage in suction or discharge piping or in pump	Warm to ambient and purge with warm nitrogen. Eliminate source of moisture or CO ₂ .	Mechanical technician
Pump cavitates or starts losing pressure	Insufficient NPSH or cooling	Cool again or increase suction pressure	Mechanical technician
	Gas trap in the suction pipe	Vent the suction pipe	Mechanical technician
	Discharge flow of the pump is too high or too low	Adjust the discharge flow with the discharge valve	Mechanical technician
	Clogged suction screen	Clean screen	Mechanical technician
Discharge flow of pump too low	Insufficient NPSH or cooling	Cool again or increase suction pressure	Mechanical technician
	Worn labyrinth rings	Replace parts	Manufacturer
Discharge flow of pump too low (continued)	System backpressure too high	Check installation	Mechanical technician
	Clogged suction screen	Clean screen	Mechanical technician
Motor overloaded	Motor too small	Change motor	Manufacturer
	Bearings worn	Overhaul pump motor	Manufacturer
	Excessive pump discharge flow	Throttle with discharge valve	Mechanical technician



INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-12-A
 CP-TC34
 Rev. 2

Problem	Possible Cause	Solution	Qualified Personnel
Pump vibrates	Pump flow insufficient	Increase flow	Mechanical technician
	Foreign particles in the pump	Overhaul pump	Manufacturer
	Impeller unbalanced	Overhaul pump	Manufacturer
	Bearings misaligned or worn	Overhaul motor	Manufacturer
Excessive wear or overheating	Bearing play or preload incorrect	Overhaul motor	Manufacturer
	Contamination in bearings	Replace motor bearings	Manufacturer



INSTRUCTION HANDBOOK For Installation, Operation & Maintenance

M-12-A
CP-TC34
Rev. 2

A2. MAINTENANCE AND CRYOGENIC INDUSTRIES LOCATIONS

A2.1 Repairs - General

Although the design of the pump has been kept as simple as possible, we do not recommend that internal repairs be carried out by the operator. The parts used are extremely precise with very tight tolerances; high precision measuring equipment is required. Should suitable prerequisites be available on site, we will be glad to provide the customers' personnel with the necessary training.

Periodic maintenance is covered in Section A4.

A list of Cryogenics Industries locations is provided below should it become necessary to make contact with authorized repair facilities.

A2.2 Locations

Manufacturing Center



ACD Headquarters
2321 S. Pullman Street
Santa Ana, CA 92705 USA
1.800.525.4216 (USA only)
+1.949.261.7533 • Fax +1.949.261.6285
acd@acdllc.com
www.acdllc.com

CI Sales & Service Company Locations



North America

Atlanta

370 Great Southwest Parkway, Suite F
Atlanta, GA 30336 USA
+1.404.696.8113
Fax +1.404.696.8116
sales@cryoatlanta.com
www.cryoindservice.com

Houston

14014 Interdrive East
Houston, TX 77032 USA
+1.281.590.4800
Fax +1.281.590.4801
sales@cihouston.com
www.cryoindservice.com

Red Deer

7443 Edgar Industrial Dr., #6
Red Deer, Alberta T4P 3R2, Canada
+1.403.352.4436
Fax +1.403.352.4439
sales@cryocanada.com
www.cryoindservice.com

California

2110 S. Lyon Street, Unit H
Santa Ana, CA 92705 USA
+1.949.724.8636
Fax +1.714.641.1921
sales@cryocal.com
www.cryoindservice.com

Pittsburgh

767 State Route 30
Imperial, PA 15126 USA
+1.724.695.1910
Fax +1.724.695.1926
pittcryo@pittcryogenic.com
www.cryoindservice.com

Toronto

530 McNicoll Avenue
Toronto, Ontario M2H 2E1, Canada
+1.416.502.1950
Fax +1.416.502.1952
info@cryocanada.com
www.cryoindservice.com



INSTRUCTION HANDBOOK

For

Installation, Operation & Maintenance

M-12-A
CP-TC34
Rev. 2

CI Sales & Service Company
Locations (continued)



International

Australia

14 Zenith Road
Dandenong, Victoria 3175, Australia
+61.3.9791.7888
Fax +61.3.9769.2788
sales.au@cryoquip.com
www.cryoquip.com

Brasil

Rua Forte do Araxá, #59
Parque Industrial São Lourenço
São Paulo – SP, Brasil CEP: 08340-170
CNPJ: 10.880.587/0001-24
Inscrição Estadual: 148632745116
Tel/Fax +55.11.2015.4288/4289
acd@cibrazil.com
www.cibrazil.com

China

9# Bridge, 02 Provincial Highway
Xianlin County, Yuhang District
Hangzhou, China 311122
+86.571.8869.0788
Fax +86.571.8869.0715
hci@mail.hz.zj.cn
www.cryoindservice.com

Europe (ACD CRYO)

Rheinauenstrasse 2
D-79415 Bad Bellingen, Germany
+49.7635.8105.0
Fax: +49.7635.8965
info@acdcryo.com
www.acdcryo.com

Europe (ACD CRYO)

Gutenbergstrasse 1
CH-4142 Muenchenstein, Switzerland
+41.61.413.0230
Fax: +41.61.413.0233
info@acdcom.com
www.acdcom.com

India

Plot No. 454 GIDC
National Highway No. 8, Por-Ramangamdi
District: Vadodara 391 243, Gujarat, India
+91.265.283 0113
Fax +91.265.283 0112
info@acdcom.com
www.acdcom.com

Korea

476-109 Gongse-ri, Giheung-eup
Yongin-si, Gyeonggi-do, 449-902, Korea
+82.31.286.6114
Fax +82.31.286.6118
info@ci-korea.co.kr
www.cryoindservice.com

Malaysia

No 7A, Jalan Sungai Kayu Ara 32/39
Taman Berjaya Park, Section 32
40460 Shah Alam, Selangor D.Ehsan, Malaysia
+603.5740.8770
Fax +603.5740.8775
cryogen@po.jaring.my
www.cryoindservice.com

A3. REMOVAL AND REINSTALLATION



DANGER!

Danger due to liquefied gases!

Hazard instruction paragraph 2.5.4 “Hazard posed by liquefied gases.”



WARNING!

Danger due to components exposed to pressure!

Hazard instruction paragraph 2.5.5 “Hazards posed by components exposed to pressure.”



DANGER!

Danger due to cryogenic and hot surfaces!

Hazard instruction paragraph 2.5.6 “Hazards posed by cryogenic and high temperatures.”



WARNING!

Danger due to unauthorized re-engagement!

By unauthorized re-engagement of the power supply during removal and reinstallation, there is a risk of serious injury or even death for persons in the hazard zone.

Before beginning work switch off all power supplies and lock out.

Pre-removal verification. Prior to beginning removal of the TC-34 pump, the following steps must be taken to ensure that removal can be safely accomplished:

1. The pump assembly and related piping must be at ambient temperature.
2. Electrical power must be removed and locked out.
3. If the pump is in hazardous service, the pump and its related piping must be purged with nitrogen prior to opening connections.
4. Pressure must be removed from the pump assembly and related piping by venting to atmospheric pressure prior to opening connections.
5. Suction and discharge valves should be locked in the closed position.

Removal. Use the following procedure to properly remove the pump assembly from the installation:

1. Verify that all Pre-removal steps listed above have been accomplished.
2. Disconnect the motor from its control system.
3. Remove sump inlet, return, and discharge port flange fasteners and retrieve gaskets. Discard gaskets.
4. Loosen and remove mounting fasteners.
5. Carefully move the pump assembly away from the piping flanges.
6. Immediately cover piping flanges and pump ports with suitable blind flanges or plastic tight-fitting covers.
7. If blind flanges are used on the piping in the preceding step, the flanges must incorporate a small port through the flange with a line relief valve installed to prevent overpressure conditions in the event a valve is opened and liquid is allowed into the piping.



INSTRUCTION HANDBOOK For Installation, Operation & Maintenance

M-12-A
CP-TC34
Rev. 2

9. The pump assembly can be lifted from the foundation using a suitable sling if sump is not vacuum jacketed. Place the sling around the sump beneath the top cover flange. Do not use sling if the sump is vacuum jacketed. If sump is vacuum jacketed, lift by the top cover flange only.

Reinstallation. Reinstallation is essentially the removal procedure listed above performed in reverse order. The following additional points should be followed:

1. Do not remove piping and port covers until immediately prior to connection.
2. Use new gaskets.
3. Do not tighten foundation fasteners until after piping connections have been made and tightened and pump has been cooled down.
4. Check wiring to motor for correct phasing.



INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-12-A
 CP-TC34
 Rev. 2

A4. MAINTENANCE PLAN

The preventive maintenance work required for an optimal, disruption free operation of the pump assembly is described in the following section.

If increased wear and tear is recognized during regular checks, the required maintenance intervals must be shortened according to the actual wear phenomena. Contact the manufacturer for questions on maintenance work and maintenance intervals. See Appendix A, Section A2 preceding for contact information.

Preventive maintenance for the pump assembly only is described in this section. Operator-supplied equipment are covered in the respective equipment manuals provided in Appendix B.

If operational difficulties or anomalies arise, refer to the Troubleshooting table in section A1 of this Appendix.

Qualified personnel



WARNING!

Danger due to unqualified personnel!

Only “Qualified Personnel” listed in the table below should perform any of the actions shown in the table.

Refer to Personnel Requirements instruction paragraph 2.3.1 “Qualifications”.

Periodic Service and Maintenance

Interval	Maintenance work	Qualified Personnel
Daily	Check for unusual vibration or noises.	Mechanical technician
Weekly	Check fasteners, supports, motor, valves, piping system and instrumentation.	Mechanical technician
Every 4000 hours	Check bearings. Inspect terminal housing interior for deterioration. Check for free flow of lubricating fluid. Clean suction screen.	Manufacturer
Every 8000 hours	Replace bearings	Manufacturer



INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-12-A
CP-TC34
Rev. 2



	<p style="text-align: center;">INSTRUCTION HANDBOOK For Installation, Operation & Maintenance</p>	<p>M-12-A CP-TC34 Rev. 2</p>
---	---	--------------------------------------

A5. FIELD TROUBLE REPORT

Field Trouble Report Form

A blank Field Trouble Report (FTR) form is provided to encourage ACD pump users to report equipment-related problems to the factory for proper follow-up and analysis.

Please make copies of the FTR form (next page) as required. If a problem should occur, fill in the form and contact the nearest Service Center location listed in Appendix A section A2 preceding.



INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-12-A
CP-TC34
Rev. 2



A Cryogenic Industries
C o m p a n y



FIELD TROUBLE REPORT				FTR # _____
Written by/Location	Date	Customer		
Originator/Location	Phone	Fax	E-mail	
User/Location	Phone	Fax	E-mail	
Contact	Phone	Fax	E-mail	
New _____	Recurring _____	Warranty requested? Yes _____ No _____		
ACD Serial #	ACD PN	Description		
ACD SO #	Service	Qty affected	Hrs of operation	
Exact nature of problem				
<i>Following is for ACD Internal Use Only</i>				
Issued by	date	Originator notified		date
Distribution	GM Prod mgr	Eng	QA Other	
ACD engineering evaluation				
Equipment type				
Action required to rectify customer's problem:				
Action taken by	date	CAR/PAR? No _____ Yes, CAR/PAR# _____		
Warranty approved: Yes _____ No _____ by _____ date _____				
Product director approval				date
Customer/originator notified by				date
QA Mgr approval	date	FTR closed	date	



A Cryogenic Industries

C o m p a n y

	INSTRUCTION HANDBOOK For Installation, Operation & Maintenance	M-12-A CP-TC34 Rev. 2
---	---	-----------------------------

A6. REPAIR RECORD

Repair Report Form

A blank Repair Report form is provided to for the ACD pump users to log repairs made to a specific pump assembly over time. The Repair Record file will provide the user with a means to determine trends and repetitious repairs that may be due to installation problems or other factors that can be mitigated, thus reducing future repair expenses.

Please make copies of the Repair Record form (next page) as required.



INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-12-A
CP-TC34
Rev. 2





REPAIR RECORD

Date	Problem	Solution	Mechanic	Approved



A Cryogenic Industries

C o m p a n y



INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS

APPENDIX B

Centrifugal Cryogenic Pump Model TC-34

Manufactured by

ACD LLC

ENGLISH - ORIGINAL INSTRUCTIONS



INSTRUCTION HANDBOOK For Installation, Operation & Maintenance

Appendix B contains all reference and technical data specific to the pump assembly supplied under the Serial Number that appears on the front cover of this manual. The data contained herein are organized into the following sections specific to this pump assembly:

- B1.** Intended use
- B2.** Pump Technical Data
 - B2.1 Pump Data Sheet/performance curve
 - B2.2 Other data
- B3.** Drawings
- B4.** Spare parts
- B5.** Ancillary equipment (vendor data)
- B6.** Certificates
- B7.** Declaration of Incorporation



INSTRUCTION HANDBOOK

For

Installation, Operation & Maintenance

M-12-B1
Rev. 1

B1. INTENDED USE

Intended use

The pump assembly is designed and constructed only for the intended use described in this document.

The pump assembly is **solely** intended for the pumping of cold liquefied gases in accordance with the nameplate details and technical data provided in Appendix B2. The pump must be installed outdoors.

The intended use includes compliance with all the instructions set forth in this instruction manual.

Any use that goes beyond or is different from the intended use shall be deemed **misuse**.



WARNING!

Hazards posed by misuse!

Misuse of the pump can lead to hazardous situations.

- Redesign, retrofitting and modification of the pump assembly or the individual components is prohibited.
- Do not use the pump in buildings.
- The pump is to be installed and operated only in accordance with the specifications described in the technical data provided in this manual.

Claims of any type for damages resulting from misuse are excluded.



INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-12-B1
Rev. 1





INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-12-B2
Rev. 1

B2. PUMP TECHNICAL DATA

The following pages include all technical data that applies to this specific Serial Number pump assembly.
This data include:

- B2.1 Pump Data Sheet and performance curve.
- B2.2 Any other applicable technical data.

Category	1	P
Quantity	5	PMT
Order Date	3/7/2014	
Date Issued	3/14/2014	
Ship Date	5/22/2014	

CENTRIFUGAL PUMP DATA SHEET

Customer Name: **HANGZHOU CRYOGENIC INDUSTRIES**
 Customer P.O.: **SPINV140305**
 Sales: **AJS** Engineer: **JHR**

Sales Order: **18930**
 Revision:
 Rev Date:

REASON FOR REVISION

NAMEPLATE DATA

52222- -1 -2

NAMEPLATE DATA (Metric)

Model	TC-34	Duty	INTERMITTENT	
Assy PN	54715-1	Service	LNG	
Pump Size	1x2x6-4VSL	Capacity	84	GPM
PumpSpeed	6000	Head	1260	Feet
Impeller Dia	6.00	Power	20.0	HP
Serial No.	14189301	NPSHR	5.5	Feet
Through	14189305	Suc Press	10	PSIG
Case Matl	BRONZE/SS	Disch Press	242	PSIG
Hydro Test	0	Max Suc Pr	150	PSIG
		Date Of Mfg		

Model	TC-34	Duty	INTERMITTENT	
Assy PN	54715-1	Service	LNG	
Pump Size	1x2x6-4VSL	Capacity	318	L/MIN
PumpSpeed	6000	Head	384	M
Impeller Dia	152.4	Power	14.9	kW
Serial No.	14189301	NPSHR	1.7	M
Through	14189305	Suc Press	0.7	BARG
Case Matl	BRONZE/SS	Disch Press	16.7	BARG
Hydro Test	0.0	Max Suc Pr	10.3	BARG
		Date Of Mfg		

MOTOR DATA

BEARING DATA

SPECIAL INSTRUCTIONS:
for Submersible Motors

HP	25	Speed	5950	Voltage	460
Phase	3	Poles	2	Amps	32
Hz	102	AK		Frame	
Insul	H	Code	H	S.F.	1.0
Design		Enclosure	SUBMERGED		
ACD PN	54786-1	Auth Vendors			
Coml PN	54784-12	Baldor			
Alt Mtr PN					

	Pump End	Opp. Pump End
Description	6305	6305
ACD PN	25141-4	25141-4
Grease Type		
Quantity, oz		
Interval (hrs)		

CONNECT PHASE ROTATION METER TO MOTOR LEADS. ROTATE PUMP BY HAND IN OPERATING DIRECTION. MARK MOTOR LEADS WITH "A", "B" and "C".

Documents and Submittals

Manual Code	IOM TC34	Pump Code	31
Install Dwg	D-54715	Send Thru Sales	0
Curve No	14-189301/2	Ship With Pump	10

Oxygen Clean Motor Purge
 Oil Tag Lube NamePI

Attach Motor Rotation Label ACD P/N 56589-1 To Motor Fan (if applicable)
 CW Rotation CCW Rotation

- 1) Certificate of Functional Test.
- 2) Certificate of Conformance.
- 3) Certificate of Origin.

DRIVE TYPE

Direct VFD
 JackShaft Hydraulic
 Belted Geared

Ratio :
 : 1

TEST YES NO TEST USING EMS DRIVE YES NO

Test Per ETP-053	Qty	Witness	GPM	PSID	LPM	BARD
Functional/Performance	5	No	1	75	3.1	284
Npsh Test	0		2			
Laby Run In Per EAP-093	No		3			
Disch Pr	291 PSIG	20.1 BARG	4			
Suc Pr	10 PSIG	0.7 BARG	5			
Delta Pr	281 PSID	19.4 BARD	6			
Power	21 BHP	15.7 BkW	7			
			8			

Voltage: Volts
 Pipe Size: Inch mm
 Orifice Dia: Inch mm
 Orifice K:

TEST INSTRUCTIONS

- 1) Functional test in LN2.
- 2) VFD to operate at 86Hz @ 5000 rpm.

SPECIAL INSTRUCTIONS

- 1) Program VFD for constant V/Hz up to the nameplate conditions. Line Voltages lower than 460V will reduce the rated power proportionately. Maximum rated speed in LNG is 6000 RPM. Motor conditions at maximum rated speed of 6000 RPM is 20HP/106Hz/26 Amps.
- 2) Refer to ACD Dwg 60885 for full motor specifications.
- 3) Dual conduit boxes are to be assembled and shipped loose for customer installation.
- 4) Length of Lead Wire (Pump Pressure Side): 40 inches (1 Meter)



Technical Data



Receiver

From

Company name
Department
Issued by
Phone no.
Fax no.
Email address

Hangzhou Cryogenic Industries Co., Ltd.
-
Kenny Yu
+86 571 88690788
+86 571 88690715
kennyu@acd-china.com

ACD, LLC
James Reyes

TC-34, 1 x 2 x 6-4 Stage 54715-X
Installation Drawing

Requested data

Fluid	Methane
Flow	84.0 US g.p.m.
Differential Head	1,259.8 ft
Differential Pressure	231.5 psi
Inlet pressure head	0.0 ft
Inlet pressure	0.0 psi
Available NPSH	5.6 ft

Operating pump data

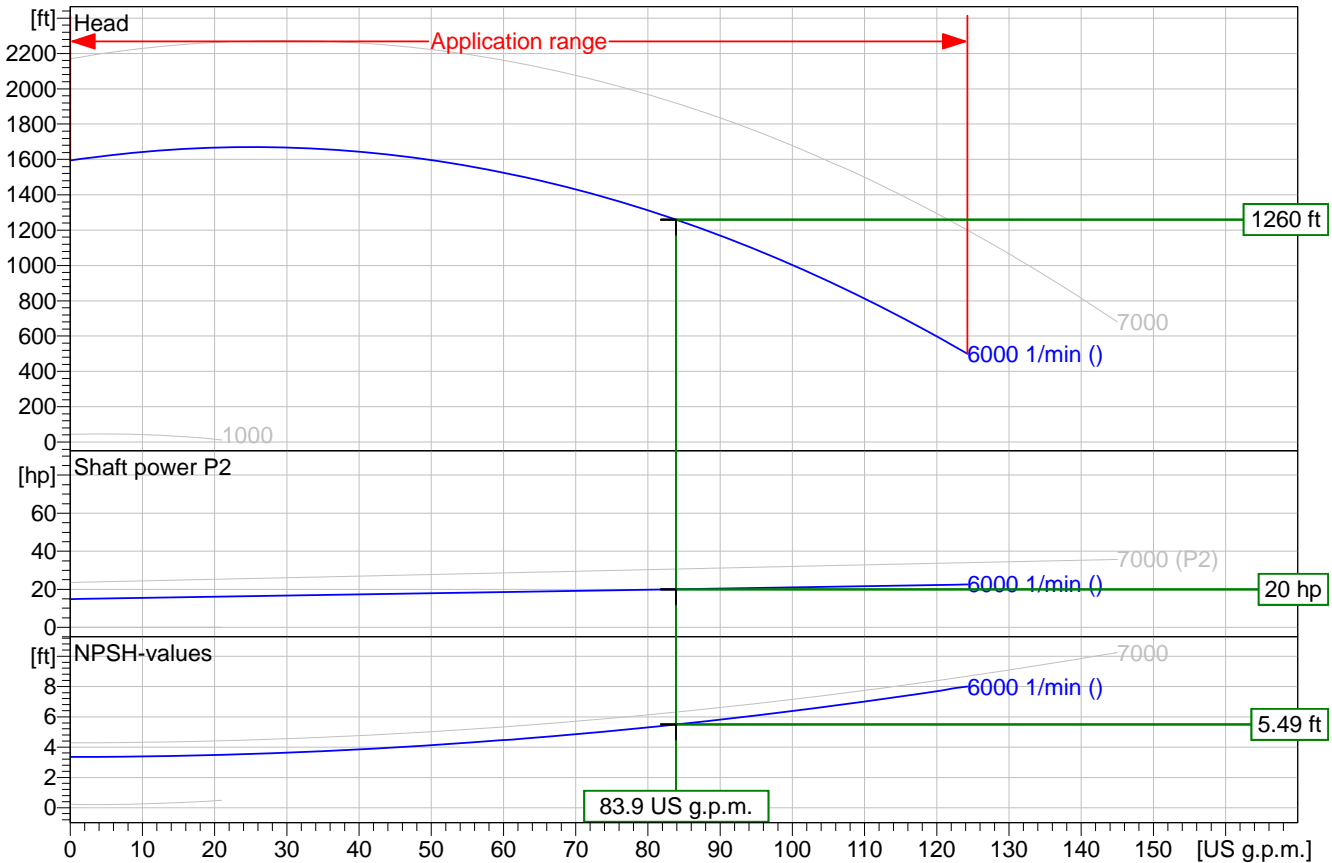
Flow	84.0 US g.p.m.
Differential Head	1,259.8 ft
Shaft power	20.0 hp
Pump efficiency	58 %
Required NPSH	5.5 ft
Pump speed	6,000 rpm
Impeller Ø	6.00 inch
Shaft seal	Vertical Seal Less

Motor data

Frequency	60 Hz
Rated voltage	460 V
Nominal speed	5950 rpm
Number of poles	2
Motor efficiency	86.4 %
Rated power	25.0 hp
Service factor	1.15
Frame size	182T
Motor type	3~
Design standard	NEMA
Degree of protection	IP 54

General data

Weight	
Max. discharge pressure	
Max. suction pressure	
Max. pump speed	
Temperature range	

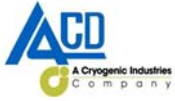


Project SPINV140305
Project ID 14-189301

Created by
Reyes, James

Created on
2014-03-17

Last update
2014-03-17



Technical Data



Receiver

From

Company name
Department
Issued by
Phone no.
Fax no.
Email address

Hangzhou Cryogenic Industries Co., Ltd.
-
Kenny Yu
+86 571 88690788
+86 571 88690715
kennyu@acd-china.com

ACD, LLC
James Reyes

TC-34, 1 x 2 x 6-4 Stage 54715-X
Installation Drawing

Requested data

Fluid	Methane
Flow	318.0 l/min
Differential Head	384.0 m
Differential Pressure	16.0 bar
Inlet pressure head	0.0 m
Inlet pressure	0.0 bar
Available NPSH	1.7 m

Operating pump data

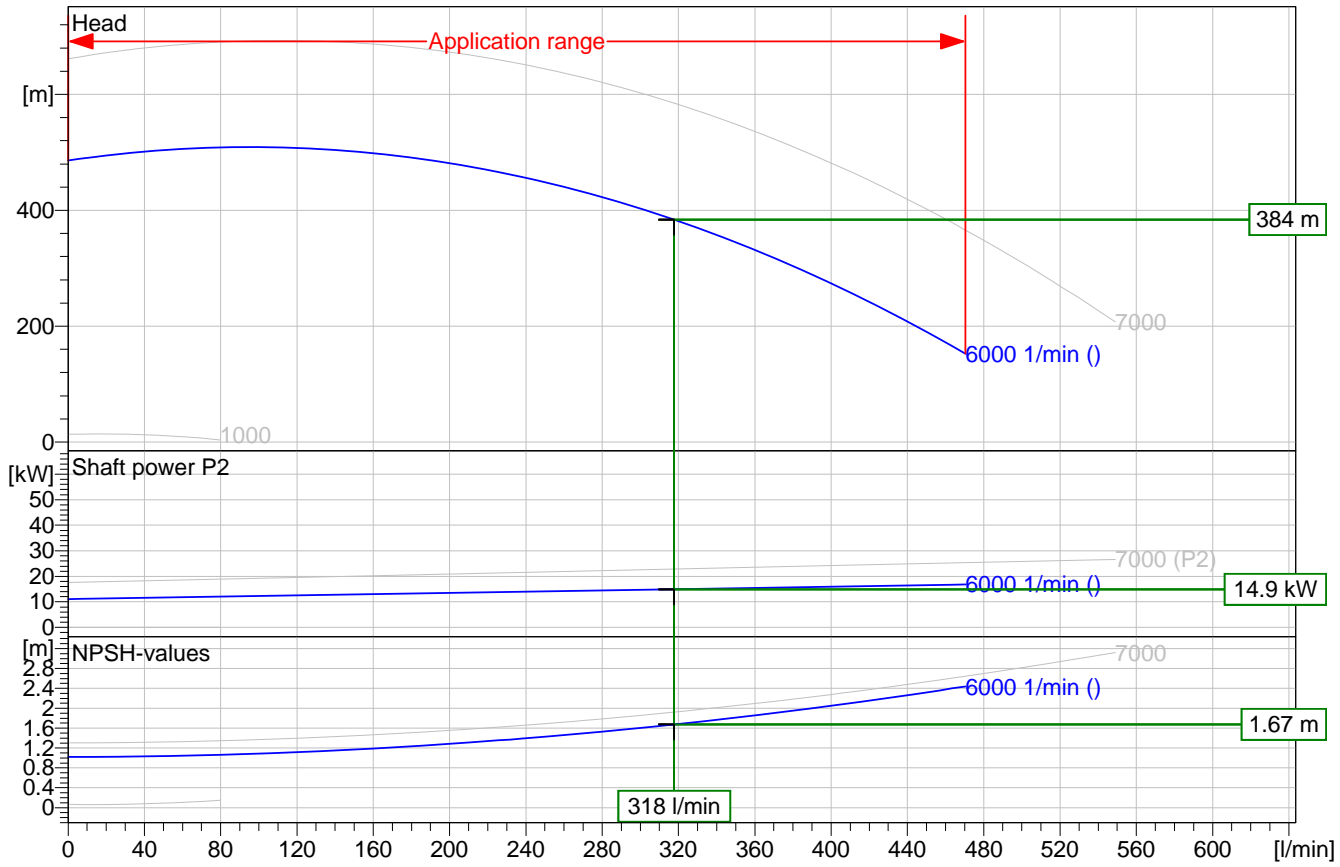
Flow	318.0 l/min
Differential Head	384.0 m
Shaft power	14.9 kW
Pump efficiency	58 %
Required NPSH	1.7 m
Pump speed	6,000 1/min
Impeller Ø	152.40 mm
Shaft seal	Vertical Seal Less

Motor data

Frequency	60 Hz
Rated voltage	460 V
Nominal speed	5950 1/min
Number of poles	2
Motor efficiency	86.4 %
Rated power	18.6 kW
Service factor	1.15
Frame size	182T
Motor type	3~
Design standard	NEMA
Degree of protection	IP 54

General data

Weight	
Max. discharge pressure	
Max. suction pressure	
Max. pump speed	
Temperature range	



Project	SPINV140305	Created by	Created on	Last update	
Project ID	14-189302	Reyes, James	2014-03-17	2014-03-17	Page 3 / 4



INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-12-B2
Rev. 1



CAUTION: Conax Technologies sealing glands should be installed by suitably qualified personnel in accordance with relevant safety rules and with proper regard to safe working practices.

Conax Technologies sealing glands have lubricant applied at the factory. Substitution of factory-supplied lubricant will affect seal integrity. Lubrication prevents thread galling and minimizes friction between mating metallic components to maximize sealing gland performance when a catalog-specified torque is applied. Weld mount models should be relubricated after the body is welded in place. If the gland has been cleaned before assembly, it should also be relubricated prior to assembly.

Lubricant should be used any time a sealing gland assembly is opened for replacement or adjustment of the probe(s), wires or sealant. By re-lubricating the gland body threads and load bearing surface of the cap, proper load transfer (sealant compression) can be achieved. See page 16 for lubrication instructions.

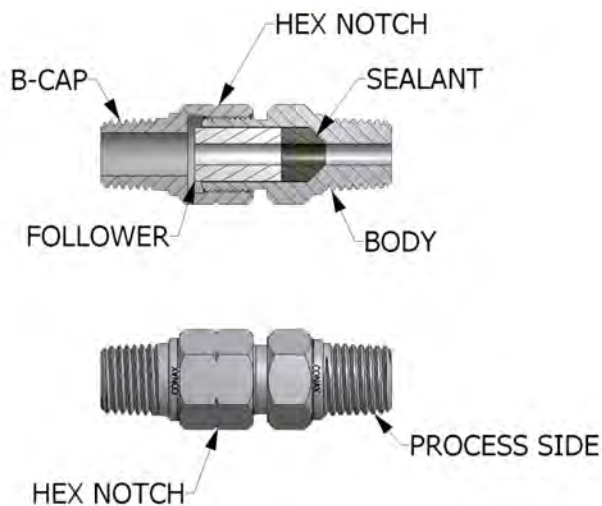
Conax Technologies recommends the use of thread sealant tape or dopant on NPT threads during installation of the gland to the vessel.

Flange mounted glands should be assembled prior to mounting to the vessel.

A Note on B Caps:

When using a sealing gland assembly with a B Cap, it is sometimes easy to confuse which NPT thread screws into the process side. If installed backwards, leakage will occur between the cap and body straight thread.

A hex notch (as shown below) has been added to the cap to simplify identification. When properly installed, the hex notch will appear on the non-process side of the assembly.



Please Note: Glands previously purchased may have "Conax" engraved on a cap hex surface in lieu of the hex notch. When properly installed the lettering will appear on the non-process side of the assembly (the cap). Please consult the factory with any questions before installing.

Guidelines for Sealant Replacement

Conax Technologies recommends the following procedures to facilitate sealant replacement:

1. Ensure that all system pressurization has been removed before beginning sealant replacement.
2. Untorque and remove the sealing gland cap.
3. Remove the follower and sealant. Depending on the application, the element may also need to be removed.

Follower Removal: Tight manufacturing tolerances are used between the follower OD and the bore of the sealing gland body. As the follower is extracted, a vacuum can be created between the follower and sealant, making it difficult to remove the follower by hand. It may be necessary to clamp the exposed portion of the follower with pliers or a similar tool to gain the additional clamping force needed to remove the follower. If this is necessary, take care to avoid damage to the follower.

Sealant Removal: Teflon, Neoprene, and Viton sealants can generally be removed in one piece. Grafoil and Lava Sealants must be removed in multiple pieces, using a rigid "picking" instrument to break apart the sealant. During this process, be careful to avoid damage to the sealing gland body. Deep scratches or gouges may result in potential leak paths during future use of the gland assembly.

4. Thoroughly clean the internal configuration of the sealing gland body with de-ionized water or cleaning alcohol (depending on the application) to remove any sealant residue.
5. Reassemble per applicable assembly instructions.

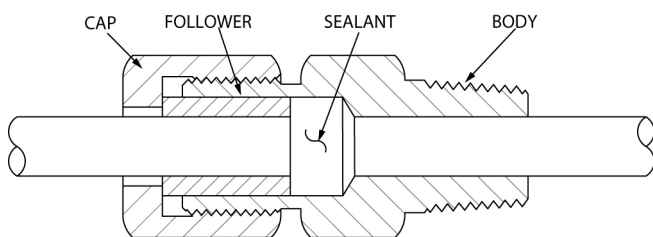
For Hex-Style PG Series Glands

For assembly separate from the vessel:

1. Verify that the total probe length is sufficient for your desired immersion.
2. Thread the cap over the probe with the female thread facing the process (see diagram).
3. Thread the follower over the probe. For MPG and PG2 assemblies with bores smaller than 0.093", the follower may have a larger bore on one side. The larger bore diameter must be adjacent to the cap and the smaller bore diameter adjacent to the sealant.
4. Be sure you are using the correct sealant for your working pressure and temperature. Thread the sealant over the probe with the cone facing the process.
5. Thread the gland body over the probe.
6. Slide the sealant into the gland body.
7. Slide the follower after the sealant.
8. Push on the follower until the sealant is firmly seated.
9. Thread the cap on finger tight.
10. Secure the gland body into a vice.
11. Make the final adjustment of immersion length.
12. Using a torque wrench, tighten the cap to the specified torque (see chart).
13. The assembly is now ready for use. Apply a wrench to the gland body flats – not the cap – for mounting to the vessel.

For assembly directly into a vessel:

1. Verify that the total probe length is sufficient for your desired immersion.
2. Mount the gland body into the vessel wall. This may be done by threading or welding, depending on the mounting style. When using a weld mount, the gland must be disassembled prior to welding to protect the sealant.
3. Thread the cap over the probe with the female thread facing the process (see diagram).
4. Thread the follower over the probe so that the follower is between the cap and the process. For MPG and PG2 assemblies with bores smaller than 0.093", the follower may have a larger bore on one side. The larger bore diameter must be adjacent to the cap and the smaller bore diameter adjacent to the sealant.
5. Be sure you are using the correct sealant for your working pressure and temperature. Thread the sealant over the probe so that the sealant is between the follower and the process, and the cone of the sealant faces the process.
6. Insert the probe through the body into the process.
7. Slide the sealant into the gland body.
8. Slide the follower after the sealant.
9. Push on the follower until the sealant is firmly seated.
10. Thread the cap on finger tight.
11. Make the final adjustment of immersion length.
12. Apply a backer wrench to the gland body flats to prevent rotation during torquing.
13. While holding the backer wrench firmly in place, use a torque wrench to tighten the cap to the specified torque (see chart).
14. The assembly is now ready for use.



PG Series Torque Requirements

	Neoprene/Viton		Teflon		Lava		Grafoil	
	(ft-lbs)	(N-m)	(ft-lbs)	(N-m)	(ft-lbs)	(N-m)	(ft-lbs)	(N-m)
MIC	N/O	N/O	7-9 in-lbs	0.8-1	45-50 in-lbs	5-5.6	45-50 in-lbs	5-5.6
MPG	55-60 in-lbs	6.2-6.7	55-60 in-lbs	6.2-6.7	75-80 in-lbs	8-9	55-60 in-lbs	6.2-6.7
PG2	30-35	40-47	15-20	20-27	40-45	54-61	35-40	47.6-54.4
PG4	55-60	74-81	55-60	74-81	125-140	170-190	90-100	122-136
PG5	55-60	74-82	90-100	122-136	200-220	272-299	90-100	122-136
PG6	165-170	224-231	300-325	408-442	N/O	N/O	N/O	N/O

N/O = Not Offered

For Large Bore, Flange - Cap PG Series Glands

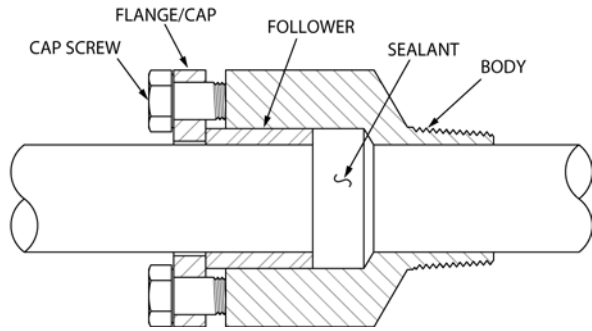
For assembly separate from the vessel:

1. Verify that the total length of the cable/probe provides sufficient length for your desired immersion and leads.
2. Thread the flange/cap over the probe (see diagram).
3. Thread the follower over the probe.
4. Be sure you are using the correct sealant for your working pressure and temperature. Thread the sealant over the probe with the cone facing the process. (Sealant may be in more than one layer.)
5. Thread the gland body over the probe.
6. Slide the sealant into the gland body.
7. Slide the follower after the sealant.
8. Push on the follower until the sealant is firmly seated.
9. Slide the flange/cap into place after the follower.
10. Insert the 6 cap screws in place and finger tighten.
11. Secure the gland body into a vice.
12. Make the final adjustment of immersion length.
13. Using a torque wrench, tighten the cap screws to the specified torque (see chart). The cap screws should be progressively tightened in the order 1-4-2-5-3-6.
14. The assembly is now ready for use. Apply a wrench to the gland body flats for mounting to the vessel.

For assembly directly into a vessel:

1. Verify that the total length of the cable/probe provides sufficient length for your desired immersion and leads.
2. Mount the gland body into the vessel wall. This may be done by threading or welding, depending on the mounting style. When using a weld mount, the gland must be disassembled prior to welding to protect the sealant.
3. Thread the flange/cap over the probe (see diagram).
4. Thread the follower over the probe so that the follower is between the cap and the process.
5. Be sure you are using the correct sealant for your working pressure and temperature. Thread the sealant over the probe so that the sealant is between the follower and the process, and the cone of the sealant faces the process. (Sealant may be in more than one layer.)
6. Insert the probe through the body into the process.
7. Slide the sealant into the gland body.
8. Slide the follower after the sealant.
9. Push on the follower until the sealant is firmly seated.
10. Slide the flange/cap into place after the follower.
11. Insert the 6 cap screws in place and finger tighten.
12. Make the final adjustment of immersion length.
13. Use a torque wrench to tighten the cap screws to the specified torque (see chart). The cap screws should be progressively tightened in the order 1-4-2-5-3-6.
14. The assembly is now ready for use.

Large Bore PG Series Torque Requirements



	Viton		Lava		Grafoil		Teflon
	(ft-lbs)	(N-m)	(ft-lbs)	(N-m)	(ft-lbs)	(N-m)	
Standard 1-1/4 NPT							
PG7-50	35	48	35	48	35	48	CF
PG7-1000	14	19	35	48	35	48	CF
PG7-75P	35	48	35	48	35	48	CF
PG7-1250	14	19	35	48	35	48	CF
PG7-100P	35	48	35	48	35	48	CF
Weld Neck Mount (Weld Neck Length 1.01")							
PG7(SWM7/S316L)-50P	35	48	35	48	35	48	CF
PG7(SWM7/S316L)-1000	14	19	35	48	35	48	CF
PG7(SWM7/S316L)-75P	35	48	35	48	35	48	CF
PG7(SWM7/S316L)-1250	14	19	35	48	35	48	CF
PG7(SWM7/S316L)-100P	35	48	35	48	35	48	CF

For Hex-Style EG Series

EG series sealing glands are shipped from the factory already torqued to the correct value and ready for installation. These instructions are provided in the event you choose to disassemble and need to reassemble the gland or if you provide your own electrode. Weld mount styles are shipped untorqued, as the gland must be disassembled prior to welding to protect the sealant.

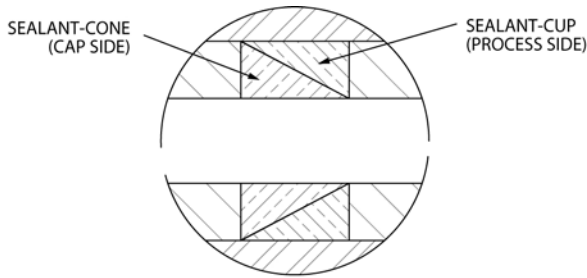
For assembly separate from the vessel:

1. Be sure you are using the correct sealant for your working pressure and temperature.
2. Thread one ceramic insulator over the electrode (see diagram)
3. Thread the sealant over the electrode. The tapered end of the sealant should face the process. Note: EG-375 and EG-500 Lava sealants use a two-piece cone and cup design. Insert the cup first with the tapered end facing away from the process. Then insert the cone so that the tapered end fits inside the cup. The cone must face the process.
4. Thread the second ceramic insulator over the electrode.
5. Insert the insulators, sealant and electrode as assembled into the gland body until the ceramic insulator is stopped by the shoulder in the gland. Hold the electrode to prevent it from dropping through.

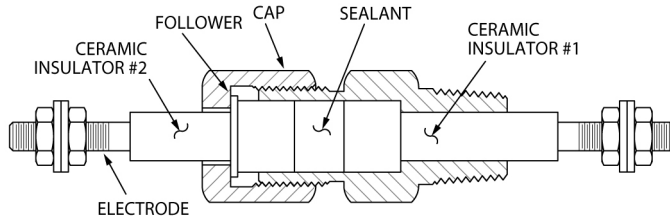
6. Thread the follower over the insulator. Seat the undercut edge onto the insulator shoulder.
7. Thread the cap onto the body until finger tight.
8. Secure the gland body into a vice.
9. Adjust the electrode to the correct position ensuring that the ceramic insulators are firmly seated and aligned.
10. Using a torque wrench, tighten the cap to the specified torque (see chart).
11. Install the nuts and washers on the non-process side of the assembly.
12. Mount the assembly to the vessel. Apply a wrench to the gland body flats – not the cap – when mounting to the vessel.
13. Install the nuts and washers on the process side of the assembly.
14. Make the appropriate electrical connections to the electrode using ring-tongue, lug-type or spade terminals. These are positioned between the washers. The nuts should be tightened securely.
15. The assembly is now ready for use.

For assembly directly into a vessel:

1. Be sure you are using the correct sealant for your working pressure and temperature.
2. Mount the gland body into the vessel wall. This may be done by threading or welding, depending on the mounting style. When using a weld mount, the gland must be disassembled prior to welding to protect the sealant.
3. Thread one ceramic insulator over the electrode (see diagram).
4. Thread the sealant over the electrode. The tapered end of the sealant should face the process. Note: EG-375 and EG-500 Lava sealants use two-piece cone and cup designs. Insert the cup first with the tapered end facing away from the process. Then insert the cone so that the tapered end fits inside the cup. The cone must face the process.
5. Thread the second ceramic insulator over the electrode.
6. Insert the insulators, sealant and electrode as assembled into the cap thread end of the gland body until the ceramic insulator is stopped by the shoulder in the gland. Hold the electrode to prevent it from dropping through.
7. Thread the follower over the insulator. Seat the undercut edge onto the insulator shoulder.
8. Thread the cap onto the body until finger tight.
9. Adjust the electrode to the correct position ensuring that the ceramic insulators are firmly seated and aligned.
10. Apply a backer wrench to the gland body flats to prevent rotation during torquing.
11. While holding the backer wrench firmly in place, use a torque wrench to tighten the cap to the specified torque (see chart).
12. Install the nuts and washers on the non-process side of the assembly.
13. Install the nuts and washers on the process side of the assembly.
14. Make the appropriate electrical connections to the electrode using ring-tongue, lug-type or spade terminals. These are positioned between the washers. The nuts should be tightened securely.
15. The assembly is now ready for use.



CONE AND CUP SEALANT



EG Series Torque Requirements

	Neoprene/Teflon/Viton		Lava	
	(ft-lbs)	(N-m)	(ft-lbs)	(N-m)
EG-093	17-20	23-27	10-12	13-16
EG-125	25-30	34-40	25-30	34-40
EG-187	25-30	34-40	25-30	34-40
EG-250	40-45	54-61	60-65	81-88
EG-312	35-40	47-54	50-55	68-74
EG-375	50-55	68-74	180-200	244-272
EG-500	50-55	68-74	180-200	244-272

For EG-750 (Flange-Cap)

EG series sealing glands are shipped from the factory already torqued to the correct value and ready for installation. These instructions are provided in the event you choose to disassemble and need to reassemble the gland or if you provide your own electrode. When using a weld mount, the gland must be disassembled prior to welding to protect the sealant.

For assembly separate from the vessel:

1. Be sure you are using the correct sealant for your working pressure and temperature.
2. Thread one ceramic insulator over the electrode (see diagram). Note: the longer insulator must be used on the body side (toward the process).
3. Thread the sealant over the electrode. The tapered end of the sealant should face the process. Note: Lava sealants use two-piece cone and cup designs. Insert the cup first with the tapered end facing the process. Then insert the cone so that the tapered end fits inside the cup. The cone must face the process.
4. Thread the short ceramic insulator over the electrode.
5. Insert the insulators, sealant and electrode as assembled into the gland body until the ceramic insulator is stopped by the shoulder in the gland. Hold the electrode to prevent it from dropping through.

6. Slide the flange/cap into place after the insulator.
7. Insert the 6 cap screws in place and finger tighten.
8. Secure the gland body into a vice.
9. Adjust the electrode to the correct position ensuring that the ceramic insulators are firmly seated and aligned.
10. Use a torque wrench to tighten the cap screws to 10-12 ft-lbs (13-16 N-m) per bolt for Teflon or 25-30 ft-lbs (34-40 N-m) per bolt for Lava. The cap screws should be progressively tightened in the order 1-4-2-5-3-6.
11. Install the nuts and washers on the non-process side of the assembly.
12. Mount the assembly to the vessel. Apply a wrench to the gland body flats when mounting to the vessel.
13. Install the nuts and washers on the process side of the assembly.
14. Make the appropriate electrical connections to the electrode using ring-tongue, lug-type or spade terminals. These are positioned between the washers. The nuts should be tightened securely.
15. The assembly is now ready for use.

For assembly directly into a vessel:

1. Be sure you are using the correct sealant for your working pressure and temperature.
2. Mount the gland body into the vessel wall. This may be done by threading or welding, depending on the mounting style. When using a weld mount, the gland must be disassembled prior to welding to protect the sealant.
3. Thread one ceramic insulator over the electrode (see diagram). Note: the longer insulator must be used on the body side (toward the process).
4. Thread the sealant over the electrode. The tapered end of the sealant should face the process. Note: Lava sealants use two-piece cone and cup designs. Insert the cup first with the flat side facing the process. Then insert the cone so that the tapered end fits inside the cup. The cone must face the process.
5. Thread the short ceramic insulator over the electrode.
6. Insert the insulators, sealant and electrode as assembled into the cap thread end of the gland body until the ceramic insulator is stopped by the shoulder in the gland. Hold the electrode to prevent it from dropping through.
7. Slide the flange/cap into place after the insulator.
8. Insert the 6 cap screws in place and finger tighten.
9. Adjust the electrode to the correct position ensuring that the ceramic insulators are firmly seated and aligned.
10. Use a torque wrench to tighten the cap screws to 10-12 ft-lbs (13-16 N-m) per bolt for Teflon or 25-30 ft-lbs (34-40 N-m) per bolt for Lava. The cap screws should be progressively tightened in the order 1-4-2-5-3-6.
11. Install the nuts and washers on the non-process side of the assembly.
12. Install the nuts and washers on the process side of the assembly.

13. Make the appropriate electrical connections to the electrode using ring-tongue, lug-type or spade terminals. These are positioned between the washers. The nuts should be tightened securely.
14. The assembly is now ready for use.

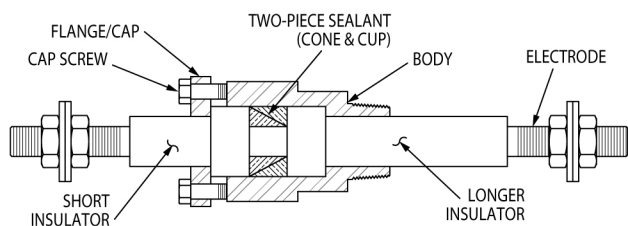


Figure 3

For Hex-Style EGT/HEGPK Series:

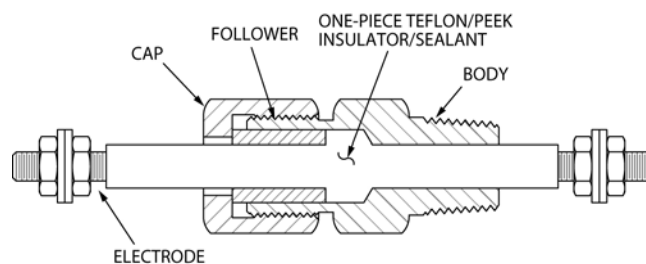
EGT and HEGPK series sealing glands are shipped from the factory already torqued to the correct value and ready for installation. These instructions are provided in the event you choose to disassemble and need to reassemble the gland or if you provide your own electrode. When using a weld mount, the gland must be disassembled prior to welding to protect the Teflon sealant.

For assembly separate from the vessel:

1. Thread the Teflon/PEEK sealant/insulator over the electrode.
The tapered end must face the process (see diagram).
2. Insert the sealant/insulator and electrode as assembled into the gland body until the sealant/insulator is stopped by the shoulder in the gland. Hold the electrode to prevent it from dropping through the body.
3. Insert the follower.
4. Thread the cap onto the body until finger tight.
5. Secure the gland body into a vice.
6. Adjust the electrode to the correct position ensuring that the sealant/insulator is firmly seated.
7. Using a torque wrench, tighten the cap to the specified torque (see chart).
8. Install the nuts and washers on the non-process side of the assembly.
9. Mount the assembly to the vessel. Apply a wrench to the gland body flats – not the cap – when mounting to the vessel.
10. Install the nuts and washers on the process side of the assembly.
11. Make the appropriate electrical connections to the electrode using ring-tongue, lug-type or spade terminals. These are positioned between the washers. The nuts should be tightened securely.
12. The assembly is now ready for use.

For assembly directly into a vessel:

1. Mount the gland body into the vessel wall. This may be done by threading or welding, depending on the mounting style. When using a weld mount, the gland must be disassembled prior to welding to protect the sealant.
2. Thread the Teflon/PEEK sealant/insulator over the electrode. The tapered end must face the process (see diagram).
3. Insert the sealant/insulator and electrode as assembled into the cap thread end of the gland body until the sealant/insulator is stopped by the shoulder in the gland. Hold the electrode to prevent it from dropping through the body.
4. Insert the follower.
5. Thread the cap onto the body until finger tight.
6. Adjust the electrode to the correct position ensuring that the sealant/insulator is firmly seated and aligned.
7. Apply a backer wrench to the gland body flats to prevent rotation during torquing.
8. While holding the backer wrench firmly in place, use a torque wrench to tighten the cap to the specified torque (see chart).
9. Install the nuts and washers on the non-process side of the assembly.
10. Install the nuts and washers on the process side of the assembly.
11. Make the appropriate electrical connections to the electrode using ring-tongue, lug-type or spade terminals. These are positioned between the washers. The nuts should be tightened securely.
12. The assembly is now ready for use.



EGT/HEGPK Series Torque Requirements

	Teflon		PEEK	
	(ft-lbs)	(N-m)	(ft-lbs)	(N-m)
EGT-093	5-6	6-8	—	—
EGT/HEGPK-125	10-15	13-20	30	40
EGT/HEGPK-187	25-30	34-40	70	95
EGT/HEGPK-250	25-30	34-41	70	95
EGT/HEGPK-375	35-40	47-54	180	244
EGT/HEGPK-500	35-40	47-54	180	244
EGT-750	75-80	102-108	—	—

For EGT-1000 (Flange-Cap)

EGT series sealing glands are shipped from the factory already torqued to the correct value and ready for installation. These instructions are provided in the event you choose to disassemble and need to reassemble the gland or if you provide your own electrode. When using a weld mount, the gland must be disassembled prior to welding to protect the Teflon sealant.

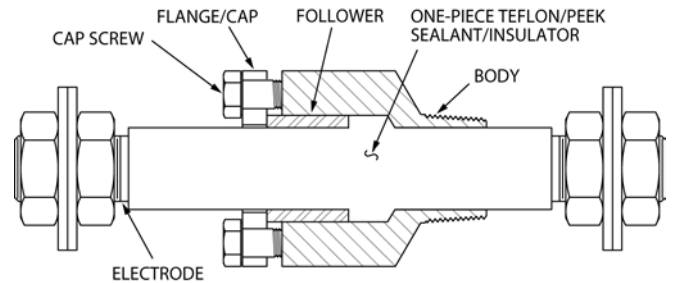
For assembly separate from the vessel:

1. Thread the Teflon sealant/insulator over the electrode. The tapered end must face the process (see diagram).
2. Insert the sealant/insulator and electrode as assembled into the gland body until the sealant/insulator is stopped by the shoulder in the gland. Hold the electrode to prevent it from dropping through the body.
3. Insert the follower.
4. Slide the flange/cap into place after the follower.
5. Thread the 6 cap screws in place and finger tighten.
6. Secure the gland body into a vice.
7. Adjust the electrode to the correct position ensuring that the sealant/insulator is firmly seated.
8. Use a torque wrench to tighten the cap screws to 54-60 in-lbs (6-7 N-m) per bolt. The cap screws should be progressively tightened in the order 1-4-2-5-3-6.
9. Install the nuts and washers on the non-process side of the assembly.
10. Mount the assembly to the vessel. Apply a wrench to the gland body flats when mounting to the vessel.
11. Install the nuts and washers on the process side of the assembly.
12. Make the appropriate electrical connections to the electrode using ring-tongue, lug-type or spade terminals. These are positioned between the washers. The nuts should be tightened securely.
13. The assembly is now ready for use.

For assembly directly into a vessel:

1. Mount the gland body into the vessel wall. This may be done by threading or welding, depending on the mounting style. When using a weld mount, the gland must be disassembled prior to welding to protect the sealant.
2. Thread the Teflon sealant/insulator over the electrode. The tapered end must face the process (see diagram).
3. Insert the sealant/insulator and electrode as assembled into the gland body until the sealant/insulator is stopped by the shoulder in the gland. Hold the electrode to prevent it from dropping through the body.
4. Insert the follower.
5. Slide the flange/cap into place after the follower.
6. Insert the 6 cap screws in place and finger tighten.
7. Adjust the electrode to the correct position ensuring that the sealant/insulator is firmly seated and aligned.

8. Use a torque wrench to tighten the cap screws to 54-60 in-lbs (6-7 N-m) per bolt. The cap screws should be progressively tightened in the order 1-4-2-5-3-6.
9. Install the nuts and washers on the non-process side of the assembly.
10. Install the nuts and washers on the process side of the assembly.
11. Make the appropriate electrical connections to the electrode using ring-tongue, lug-type or spade terminals. These are positioned between the washers. The nuts should be tightened securely.
12. The assembly is now ready for use.



For MK Series

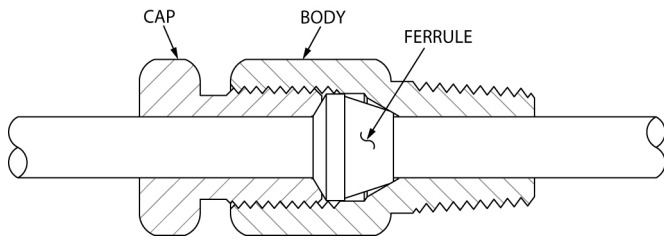
For assembly separate from the vessel:

1. Verify that the total length of the wire/probe provides sufficient length for your desired immersion and leads.
2. Thread the cap over the probe with the male thread facing the process (see diagram).
3. Thread the ferrule over the probe with the cone facing the process.
4. Thread the gland body over the probe.
5. Slide the ferrule into the gland body.
6. Thread the cap on finger tight.
7. Secure the gland body into a vice.
8. Make the final adjustment of immersion length.
9. Using a torque wrench, tighten the cap to the specified torque (see chart).
10. The assembly is now ready for use. Apply a wrench to the gland body flats for mounting to the vessel.

For assembly directly into a vessel:

1. Verify that the total length of the wire/probe provides sufficient length for your desired immersion and leads.
2. Mount the gland body into the vessel wall.
3. Thread the cap over the probe with the male thread facing the process (see diagram).
4. Thread the ferrule over the probe with the cone facing the process.
5. Insert the probe through the body into the process.
6. Insert the ferrule into the gland body.
7. Thread the cap on finger tight.
8. Make the final adjustment of immersion length.
9. Apply a backer wrench to the gland body flats to prevent rotation during torquing.

- While holding the backer wrench firmly in place, use a torque wrench to tighten the cap to the specified torque (see chart).
- The assembly is now ready for use.



MK Series Torque Requirements

Catalog Number	Torque	
	(ft-lbs)	(N-m)
MK-062-A	10	14
MK-125-A	12	16
MK-187-A	18	24
MK-250-A	30	41
MK-375-A	50	68

TG Series:

For Models TG-14-1; TG-20, 2 & 4 hole; TG-24, 2 & 4 hole, all MTGs

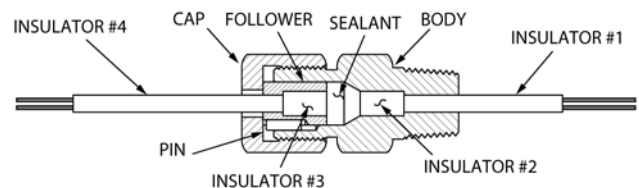
For assembly separate from the vessel:

- Verify that the total length of wire provides a sufficient length for your desired immersion and leads.
- Thread the cap over the wires.
- Thread the follower over the wires so that keyway faces the cap.
- Thread on insulator #4 (see diagram).
- Thread on insulator #3.
- Be sure you are using the correct sealant for your working pressure and temperature. Thread on the sealant so that the cone of the sealant faces the process.
- Thread on insulator #2.
- Thread insulator #1 over the wire.
- Pass the process side of the wires through the body.
- Slide the insulators and sealant into the body.
- Slide the follower on over insulator #4 and insulator #3 until it completely covers insulator #3.
- Push on the follower until the sealant and insulators are firmly seated. Be careful not to crimp the wires between the insulators and sealant.
- Align the follower and body to create a full keyway.
- Place the pin in the keyway.
- Thread the cap on finger tight.
- Secure the gland body into a vice.
- Adjust the wires to the correct position.

- Using a torque wrench, tighten the cap to the specified torque (see chart).
- The assembly is now ready for use. Apply a wrench to the gland body flats - not the cap - for mounting to the vessel.

For assembly directly into a vessel:

- Verify that the total length of wire provides a sufficient length for your desired immersion and leads.
- Mount the gland body into the vessel wall. This may be done by threading or welding, depending on the mounting style. When using a weld mount, the gland must be disassembled prior to welding to protect the sealant.
- Thread the cap over the wires.
- Thread the follower over the wires so that keyway faces the cap.
- Thread on insulator #4 (see diagram).
- Thread on insulator #3.
- Be sure you are using the correct sealant for your working pressure and temperature. Thread on the sealant so that the cone of the sealant faces the process.
- Thread on insulator #2.
- Thread insulator #1 over the wire.
- Pass the process side of the wires through the body.
- Slide the insulators and sealant into the body.
- Slide the follower on over insulator #4 and insulator #3 until it completely covers insulator #3.
- Push on the follower until the sealant and insulators are firmly seated. Be careful not to crimp the wires between the insulators and sealant.
- Align the follower and body to create a full keyway.
- Place the pin in the keyway.
- Thread the cap on finger tight.
- Adjust the wires to the correct position.
- Apply a backer wrench to the gland body wrench flats to prevent rotation during torquing.
- While holding the backer wrench firmly in place, use a torque wrench to tighten the cap to the specified torque (see chart).
- The assembly is now ready for use.



TG Series:

For Models TG-8-2; TG-14, 2-8 hole; TG-18, 6 & 8 hole; TG-20, 6-16 hole

For assembly separate from the vessel:

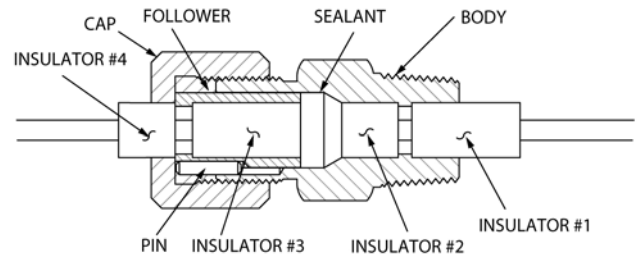
- Verify that the total length of wire provides a sufficient length for your desired immersion and leads.
- Thread insulator #4 (see diagram) over the wire.
- Thread the cap over the wire.
- Thread the follower over the wires so that the keyway faces the cap.

5. Thread on insulator #3.
6. Be sure you are using the correct sealant for your working pressure and temperature. Thread on the sealant with the cone facing the process.
7. Thread on insulator #2.
8. Insert the wires and insulator assembly through the process end of the gland body.
9. Thread insulator #1 over the wire until the insulator is stopped by the body shoulder.
10. Slide insulator #2 into the body until the insulator is stopped by the body shoulder.
11. Slide the sealant, followed by the follower, into the body.
12. Push on the follower until the sealant and insulators are firmly seated. Be careful not to crimp the wires between the insulators and sealant.
13. Slide insulator #4 so that it butts against the follower.
14. Align the follower and body to create a full keyway.
15. Place the pin in the keyway.
16. Thread the cap on finger tight.
17. Secure the gland body into a vice.
18. Adjust the wires to the correct position.
19. Using a torque wrench, tighten the cap to the specified torque (see chart).
20. The assembly is now ready for use. Apply a wrench to the gland body flats – not the cap – for mounting to the vessel.

For assembly directly into a vessel:

1. Verify that the total length of wire provides a sufficient length for your desired immersion and leads.
2. Mount the gland body into the vessel wall. This may be done by threading or welding, depending on the mounting style. When using a weld mount, the gland must be disassembled prior to welding to protect the sealant.
3. Thread insulator #4 (see diagram) over the wire.
4. Thread the cap over the wire.
5. Thread the follower over the wires so that the keyway faces the cap.
6. Thread on insulator #3.

7. Be sure you are using the correct sealant for your working pressure and temperature. Thread on the sealant with the cone facing the process.
8. Thread on insulator #2.
9. Insert the wires and insulator assembly through the process end of the gland body.
10. Thread insulator #1 over the wire from the inside of the vessel and through the process side of the gland body until the insulator is stopped by the body shoulder.
11. Slide insulator #2 into the body until the insulator is stopped by the body shoulder.
12. Slide the sealant, followed by the follower, into the body.
13. Push on the follower until the sealant and insulators are firmly seated. Be careful not to crimp the wires between the insulators and sealant.
14. Slide insulator #4 so that it butts against the follower.
15. Align the follower and body to create a full keyway.
16. Place the pin in the keyway.
17. Thread the cap on finger tight.
18. Adjust the wires to the correct position.
19. Apply a backer wrench to the gland body wrench flats to prevent rotation during torquing.
20. While holding the backer wrench firmly in place, use a torque wrench to tighten the cap to the specified torque (see chart).
21. The assembly is now ready for use.



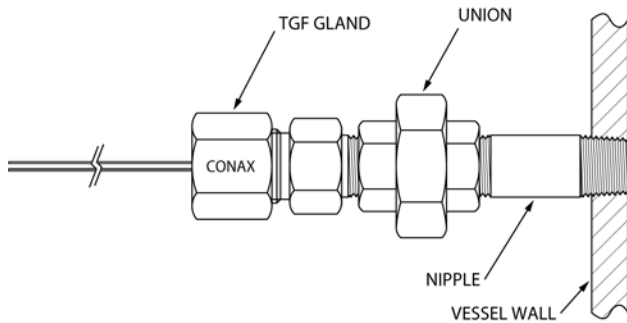
TG Series Torque Requirements

Gland	Number of Holes	Neoprene		Viton		Teflon		Lava	
		(ft-lbs)	(N-m)	(ft-lbs)	(N-m)	(ft-lbs)	(N-m)	(ft-lbs)	(N-m)
MTG-24	2,4	20-25	27-34	20-25	27-34	20-25	27-34	30-35	40-47
MTG-20	2,4	20-25	27-34	20-25	27-34	20-25	27-34	30-35	40-48
MTG-14	1	20-25	27-34	20-25	27-34	20-25	27-34	30-35	40-49
TG-24	2,4	25-30	34-40	25-30	34-40	30-35	40-48	40-45	54-61
TG-20	2,4	25-30	34-40	25-30	34-40	30-35	40-48	40-45	54-61
TG-20	6,8	45-50	61-68	45-50	61-68	50-55	68-74	125-140	170-190
TG-20	16	75-85	102-115	75-85	102-115	75-85	102-115	200-220	272-299
TG-18	6,8	45-50	61-68	45-50	61-68	50-55	68-74	125-140	170-190
TG-14	1	25-30	34-40	25-30	34-40	30-35	40-48	40-45	54-61
TG-14	2,3,4	45-50	61-68	45-50	61-68	50-55	68-74	125-140	170-190
TG-14	6,8	75-85	102-115	75-85	102-115	75-85	102-115	200-220	272-299
TG-8	2	75-85	102-115	75-85	102-115	75-85	102-115	200-220	272-299
TG-20	24	NA	NA	95-100	129-136	95-100	129-136	300-310	408-422

Model TGF – TG Assembly with High Temperature Wire
Model TG24T – TG Assembly with 24AWG Teflon
Insulated Wire

Model TGF and TG24T series sealing glands are shipped from the factory already torqued to the correct value and ready for installation. These instructions are provided for installation of the assembled gland. In the event you choose to disassemble and need to reassemble the gland, see the instructions for the MHC Series.

When using a weld mount, the gland must be disassembled prior to welding to protect the sealant.



Recommended Method Using a Nipple-Union

Required Materials: Pipe Nipple, Schedule 40, Carbon Steel or Stainless Steel Union, 150 lb., Carbon Steel or Stainless Steel

For longer length lead wires, this mounting method eliminates additional stress and potential wire entanglement caused by the rotation of the wires during the mounting operation.

1. Install the nipple and half union assembly into the vessel wall.
2. Uncoil and straighten the leads on the pressure side of the gland.
3. Thread the mating half of the union over the leads.
4. Assemble the union onto the mounting thread of the sealing gland. Use the gland body flats to hold/secure the gland while mating the gland with the union.

For High Density Assemblies – HD Series

1. High Density assemblies use a number of different gland types. Select the appropriate gland for your application.
2. Secure the gland body into the vessel wall. The remaining gland parts are best assembled on a flat surface such as a work table or a clean floor.
3. Install the seat and insulators if applicable, depending on the gland type (see instructions for that gland type).
4. Install the sealant.
5. Install the follower and pin if applicable.
6. Insert the leads through the gland body and insert the high density assembly (as now assembled) into the body until the seat or insulator is firmly seated. Position the stainless steel sheath so that an approximately equal amount extends on each side of the gland.

5. Pass the leads through the nipple-union assembly mounted on the vessel wall.
6. Position the two parts of the union and assemble the nipple-union assembly.
7. Remove wire markers on the process side after installation, as the adhesive-backed material could contaminate the process (depending on the application).

TGF Series Torque Requirements

Catalog Number	Number of Holes	Viton-Teflon	
		(ft-lbs)	(N-m)
MTG-F	2,4	72-78 in-lbs	8-9
TG-24F	2,4	10-12	13-16
TG-20F	2,4	10-12	13-16
TG-20F-14	2,4	25-30	34-40
TG-20F	6,8	25-30	34-40
TG-20F	16	60-65	81-88
TG-20F	24	70-75	95-102

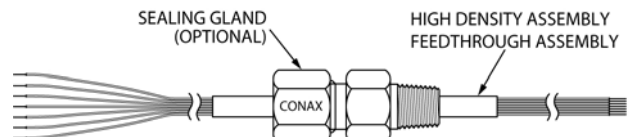
TG24T Series Torque Requirements

Catalog Number	Number of Holes	Torque for Teflon Sealant w/ T/C Wire Except Type T		Torque for Grafoil Sealant and Teflon w/ Copper or Type T Wire	
		(ft-lbs)	(N-m)	(ft-lbs)	(N-m)
MTG-24T	2,4	20-25	24-34	72-78 in-lbs	8-9
TTG-24T	2,4	30-35	40-47	10-12	13-16
TG-24T	6,8	50-55	67-74	25-30	34-40
TG-24T	12,16	75-85	102-115	60-65	81-88
TG-24T	24	95-100	129-136	70-75	95-102

Optional Method for TG24T

1. Uncoil and straighten the leads on the pressure side.
2. Pass the leads through the mounting thread port on the vessel.
3. Screw/tighten the gland into the vessel. Apply the wrench to the gland body flats, not the cap.
4. Remove wire markers on the process side after installation, as the adhesive-backed material could contaminate the process (depending on the application).

7. Thread the cap on finger tight.
8. Apply a backer wrench to the gland body flats. Using a torque wrench, apply the appropriate torque for that gland style.
9. The assembly is now ready for use.



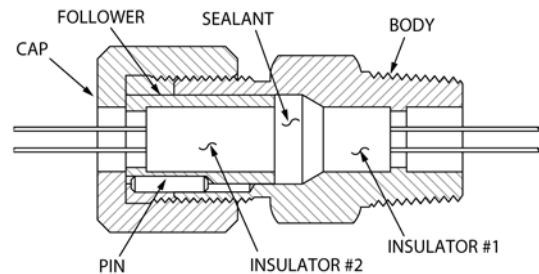
MHC Series:

For assembly separate from the vessel:

1. Verify that the total length of wire/probes provides a sufficient length for your desired immersion and leads.
2. Thread the cap over the wires.
3. Thread the follower over the wires so that the keyway faces the cap.
4. Thread on insulator #2 (see diagram).
5. Be sure you are using the correct sealant for your working pressure and temperature. Thread on the sealant with the cone facing the process.
6. Thread on insulator #1.
7. Pass the process side of the wires/probes through the body.
8. Slide the insulators, sealant and follower into the body.
9. Push on the follower until the sealant and insulators are firmly seated. For wire assemblies, be careful not to crimp the wires between the insulators and sealant.
10. Align the follower and body to create a full keyway.
11. Place the pin in the keyway.
12. Thread the cap on finger tight.
13. Secure the gland body into a vice.
14. Adjust the wires to the correct position.
15. Using a torque wrench, tighten the cap to the specified torque (see chart).
16. The assembly is now ready for use. Apply a wrench to the gland body flats – not the cap – for mounting to the vessel.

For assembly directly into a vessel:

1. Verify that the total length of wire/probes provides a sufficient length for your desired immersion and leads.
2. Mount the gland body into the vessel wall. This may be done by threading or welding, depending on the mounting style. When using a weld mount, the gland must be disassembled prior to welding to protect the sealant.
3. Thread the cap over the wires.
4. Thread the follower over the wires so that the keyway faces the cap.
5. Thread on insulator #2 (see diagram).
6. Be sure you are using the correct sealant for your working pressure and temperature. Thread on the sealant with the cone facing the process.
7. Thread on insulator #1.
8. Pass the process side of the wires/probes through the body.
9. Slide the insulators, sealant and follower into the body.
10. Push on the follower until the sealant and insulators are firmly seated. For wire assemblies, be careful not to crimp the wires between the insulators and sealant.
11. Align the follower and body to create a full keyway.
12. Place the pin in the keyway.
13. Thread the cap on finger tight.
14. Adjust the wires to the correct position.
15. Apply a backer wrench to the gland body wrench flats to prevent rotation during torquing.
16. While holding the backer wrench firmly in place, use a torque wrench to tighten the cap to the specified torque (see chart).
17. The assembly is now ready for use.



MHC Series Torque Requirements

Catalog Number	Neoprene		Viton		Teflon		Lava		Grafoil	
	(ft-lbs)	(N-m)	(ft-lbs)	(N-m)	(ft-lbs)	(N-m)	(ft-lbs)	(N-m)	(ft-lbs)	(N-m)
MHC1	20-25	27-34	20-25	27-34	20-25	27-34	30-35	40-47	25-30	27-34
MHC2-020	25-30	34-40	25-30	34-40	30-35	40-47	40-45	61-68	35-40	47-54
MCH2-032	25-30	34-40	25-30	34-40	30-35	40-47	40-45	61-68	35-40	47-54
MHC2-040	25-30	34-40	25-30	34-40	30-35	40-47	40-45	61-68	40-45	61-68
MHC2-062	25-30	34-40	25-30	34-40	30-35	40-47	40-45	61-68	40-45	61-68
MCH4	45-50	61-68	45-50	61-68	50-55	68-74	125-140	170-190	90-100	122-136
MHC5	75-85	102-115	75-85	102-115	75-85	102-115	200-220	272-299	150-165	204-224
MHC5-032-24	N/O	N/O	95-100	129-136	95-100	1129-136	300-310	408-422	250-265	340-360

PL Series:

PL glands are shipped from the factory already torqued to the correct value and ready for installation. These instructions are provided in the event you choose to disassemble and reassemble the gland. Weld mount styles are shipped untorqued as the gland must be disassembled prior to welding to protect the sealant. PL glands are provided with Teflon sleeves on the body and cap to protect against wire chafing. Do not remove these sleeves.

When using a Grafoil sealant, the insulators on PL glands are chamfered around the holes. Insulators for other sealants are not chamfered. Do **not** interchange.

For assembly separate from the vessel:

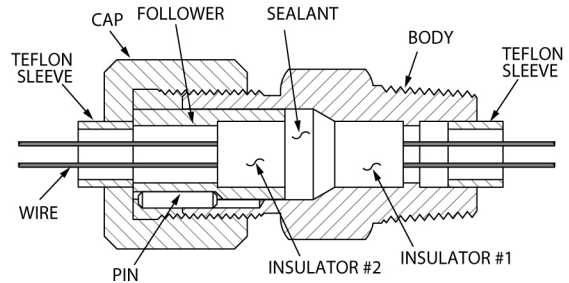
1. Verify that the total length of wire provides a sufficient length for your desired immersion and leads.
2. Thread on insulator #1 (see diagram).
3. Be sure you are using the correct sealant for your working pressure and temperature. Thread on the sealant with the cone facing the process.
4. Thread on insulator #2.
5. Slide on the follower, so that the keyway faces the cap.
6. Pass the process side of the wires through the body.
7. Push on the follower until the sealant and insulators are firmly seated. Be careful not to crimp the wires between the insulators and sealant.
8. Align the follower and body to create a full keyway.
9. Place the pin in the keyway.
10. Thread the cap on finger tight.
11. Secure the gland body into a vice.
12. Adjust the wires to the correct position.
13. Using a torque wrench, tighten the cap to the specified torque (see chart).
14. The assembly is now ready for use. Apply a wrench to the gland body flats – not the cap – for mounting to the vessel.

For assembly directly into a vessel:

1. Verify that the total length of wire provides a sufficient length for your desired immersion and leads.
2. Mount the gland body into the vessel wall. This may be done by threading or welding, depending on the mounting style. When using a weld mount, the gland must be disassembled prior to welding to protect the sealant.
3. Thread on insulator #1 (see diagram).
4. Be sure you are using the correct sealant for your working pressure and temperature. Thread on the sealant with the cone facing the process.
5. Thread on insulator #2.
6. Slide on the follower, so that the keyway faces the cap.
7. Pass the process side of the wires through the body.
8. Push on the follower until the sealant and insulators are firmly seated. Be careful not to crimp the wires between

the insulators and sealant.

9. Align the follower and body to create a full keyway.
10. Place the pin in the keyway.
11. Thread the cap on finger tight.
12. Adjust the wires to the correct position.
13. Apply a backer wrench to the gland body flats to prevent rotation during torquing.
14. While holding the backer wrench firmly in place, use a torque wrench to tighten the cap to the specified torque (see chart).
15. The assembly is now ready for use.



PL Series Torque Requirements

	Number of Holes	Grafoil		Teflon	
		(ft-lbs)	(N-m)	(ft-lbs)	(N-m)
PL-20	2,3,4	90-100	122-136	60-70	81-95
PL-20	6,8	150-165	204-224	90-100	122-136
PL-20	18	250-265	340-360	125-140	170-190
PL-18	1	20-30	27-40	12-15	16-20
PL-18	2,3,4	90-100	122-136	60-70	81-95
PL-18	6,8	150-165	204-224	90-100	122-136
PL-18	10,12	250-265	340-360	125-140	170-190
PL-16	2,3,4	90-100	122-136	60-70	81-95
PL-16	6,8	150-165	204-224	90-100	122-136
PL-16	10,12	250-265	340-360	125-140	170-190
PL-14	1	25-30	34-40	12-15	16-20
PL-14	2	90-100	122-136	60-70	81-95
PL-14	3,4,6,8	150-165	204-224	90-100	122-136
PL-14	10,12	250-265	340-360	125-140	170-190
PL-12	2,3,4,6	150-165	204-224	90-100	122-136
PL-10	2,3,4	150-165	204-224	80-90	108-122
PL-8	2	150-165	204-224	75-85	102-115
PL-8	3	250-265	340-360	125-140	170-190

Minimum recommended wire bend radius - 10 times the wire diameter

MHM Series For Hex-Style Models MHM2-MHM5

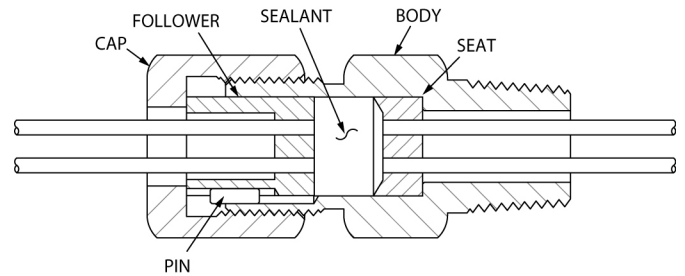
For assembly separate from the vessel:

1. Verify that the probe length is sufficient for your desired immersion.
2. Thread the cap over the probes with the female thread facing the process (see diagram).
3. Thread the follower over the probes with the keyway towards the cap.
4. Be sure you are using the correct sealant for your working pressure and temperature. Thread the sealant over the probes with the cone facing the process.
5. Thread the seat over the probes with the concave side facing the sealant.
6. Thread the gland body over the probes.
7. Push on the follower until the sealant and seat are firmly positioned in the gland body.
8. Align the follower and body to create a full keyway.
9. Place the pin in the keyway.
10. Thread the cap on finger tight.
11. Secure the gland body into a vice.
12. Make the final adjustment of immersion length.
13. Using a torque wrench, tighten the cap to the specified torque (see chart).
14. The assembly is now ready for use. Apply a wrench to the gland body flats – not the cap – for mounting to the vessel.

For assembly directly into a vessel:

1. Verify that the probe length is sufficient for your desired immersion.
2. Mount the gland body into the vessel wall. This may be done by threading or welding, depending on the mounting style. When using a weld mount, the gland must be disassembled prior to welding to protect the sealant.
3. Thread the cap over the probes with the female thread facing the process (see diagram).
4. Thread the follower over the probes with the keyway towards the cap.
5. Be sure you are using the correct sealant for your working pressure and temperature. Thread the sealant over the probes with the cone facing the process.
6. Thread the seat over the probes with the concave side facing the sealant.
7. Insert the probes through the body into the process.
8. Push on the follower until the sealant and seat are firmly positioned in the gland body.
9. Align the follower and body to create a full keyway.
10. Place the pin in the keyway.
11. Thread the cap on finger tight.
12. Make the final adjustment of immersion length.
13. Apply a backer wrench to the gland body flats to prevent rotation during torquing.

14. While holding the backer wrench firmly in place, use a torque wrench to tighten the cap to the specified torque (see chart).
15. The assembly is now ready for use.



MHM Series For Flange-Cap Model MHM6

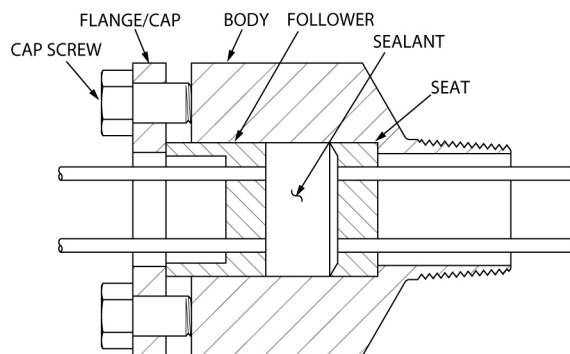
For assembly separate from the vessel:

1. Verify that the probe length is sufficient for your desired immersion.
2. Thread the flange/cap over the probes (see diagram).
3. Thread the follower over the probes with the counterbore towards the cap.
4. Be sure you are using the correct sealant for your working pressure and temperature. Thread the sealant over the probes with the cone facing the process. (Sealant may be in more than one layer.)
5. Thread the seat over the probes with the concave side facing the sealant.
6. Thread the gland body over the probes.
7. Push on the follower until the sealant and seat are firmly positioned in the gland body.
8. Slide the flange/cap into place after the follower.
9. Thread the 6 cap screws in place and finger tighten.
10. Secure the gland body into a vice.
11. Make the final adjustment of immersion length.
12. Using a torque wrench, tighten the cap screws to 30-35 ft.- lbs. (40-47 N-m) per bolt. The cap screws should be progressively tightened in the order 1-4-2-5-3-6.
13. The assembly is now ready for use. Apply a wrench to the gland body flats for mounting to the vessel.

For assembly directly into a vessel:

1. Verify that the probe length is sufficient for your desired immersion.
2. Mount the gland body into the vessel wall. This may be done by threading or welding, depending on the mounting style. When using a weld mount, the gland must be disassembled prior to welding to protect the sealant.
3. Thread the flange/cap over the probes (see diagram).
4. Thread the follower over the probes with the counterbore towards the flange/cap.

- Be sure you are using the correct sealant for your working pressure and temperature. Thread the sealant over the probes with the cone facing the process. (Sealant may be in more than one layer.)
- Thread the seat over the probes with the concave side facing the sealant.
- Insert the assembly through the body.
- Push on the follower until the sealant and seat are firmly positioned in the gland body.
- Slide the flange/cap into place to contact the follower.
- Thread the 6 cap screws in place and finger tighten.
- Make the final adjustment of immersion length.
- Use a torque wrench to tighten the cap screws to 30-35 ft-lbs (40-47 N-m) per bolt. The cap screws should be progressively tightened in the order 1-4-2-5-3-6.
- The assembly is now ready for use.



MHM Series Torque Requirements

Catalog Number	Neoprene		Viton		Teflon		Lava		Grafoil	
	(ft-lbs)	(N-m)	(ft-lbs)	(N-m)	(ft-lbs)	(N-m)	(ft-lbs)	(N-m)	(ft-lbs)	(N-m)
MHM2	25-30	34-40	25-30	34-40	25-30	34-40	25-30	34-40	25-30	34-40
MHM4	80-90	108-123	80-90	108-123	80-90	108-123	125-140	170-190	110-120	150-163
MHM5	120-130	163-176	120-130	163-176	150-165	204-224	200-220	272-299	175-190	238-258

For Split Glands – SPG and DSPG Series

For assembly separate from the vessel:

- Verify that the probe length is sufficient for your desired immersion.
- Secure the gland body into a vice.
- Thread the cap over the probes/wires with the female thread facing the process (see diagram).
- Insert the probes/wires through the body.
- Assemble the mating halves or quarters of the seat around the probes/wires with the concave side facing away from the process.
- Slide the assembled seat into the body.
- Be sure you are using the correct sealant for your working pressure and temperature. Assemble the mating halves or quarters of the sealant around the probes/wires with the cone facing the process. Grafoil sealants are numbered sequentially and must be assembled in sequence.
- Slide the assembled sealant into the body.
- Assemble the mating halves or quarters of the follower around the probes/wires with the keyway facing the cap.

- Slide the assembled follower into the body.
- Push on the follower until the sealant and seat are firmly positioned in the gland body.
- Align the follower and body to create a full keyway.
- Place the pin in the keyway.
- Thread the cap on finger tight.
- Make the final adjustment of immersion length.
- Using a torque wrench, tighten the cap to the specified torque (see chart).
- The assembly is now ready for use. Apply a wrench to the gland body flats – not the cap – for mounting to the vessel.

For assembly directly into a vessel:

- Verify that the probe length is sufficient for your desired immersion.
- Mount the gland body into the vessel wall. This may be done by threading or welding, depending on the mounting style. When using a weld mount, the gland must be disassembled prior to welding to protect the sealant.

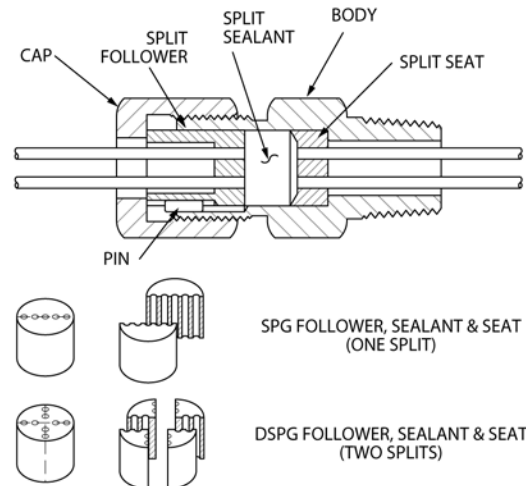
SPG/DSPG Series Torque Requirements

Catalog Number	Viton		Teflon		Lava		Grafoil	
	(ft-lbs)	(N-m)	(ft-lbs)	(N-m)	(ft-lbs)	(N-m)	(ft-lbs)	(N-m)
SPG75	25-30	34-40	25-30	34-40	25-30	34-40	N/O	N/O
DSPG75	25-30	34-40	25-30	34-40	25-30	34-40	N/O	N/O
SPG100	80-90	108-122	80-90	108-122	125-140	170-190	110-120	150-163
DSPG100	80-90	108-123	80-90	108-123	125-140	170-190	110-120	150-163
SPG150	120-130	163-176	150-165	204-224	200-220	272-299	175-225*	238-306
DSPG150	120-130	163-176	150-165	204-224	200-220	272-299	175-225*	238-306

* When applying torque to SPG150 and DSPG150 models with 0.40" diameters or less containing Grafoil Sealants, torque to 200 ft.-lbs., then retorquing to 225 ft. - lbs. after 24 hours.

3. Thread the cap over the probes/wires with the female thread facing the process (see diagram).
4. Insert the probes/wires through the body.
5. Assemble the mating halves or quarters of the seat around the probes/wires with the concave side facing away from the process.
6. Slide the assembled seat into the body.
7. Be sure you are using the correct sealant for your working pressure and temperature. Assemble the mating halves or quarters of the sealant around the probes/wires with the cone facing the process.
8. Slide the assembled sealant into the body.
9. Assemble the mating halves or quarters of the follower around the probes/wires with the keyway facing the cap.
10. Slide the assembled follower into the body.
11. Push on the follower until the sealant and seat are firmly positioned in the gland body.
12. Align the follower and body to create a full keyway.
13. Place the pin in the keyway.
14. Thread the cap on finger tight.

15. Make the final adjustment of immersion length.
16. Apply a backer wrench to the gland body flats to prevent rotation during torquing.
17. While holding the backer wrench firmly in place, use a torque wrench to tighten the cap to the specified torque (see chart).
18. The assembly is now ready for use.



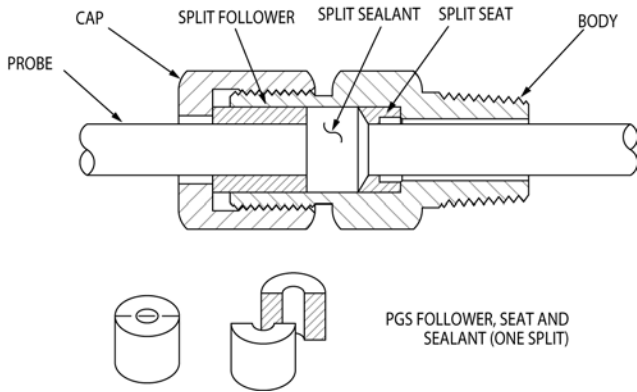
For Split Glands – PGS Series

For assembly separate from the vessel:

1. Verify that the probe length is sufficient for your desired immersion.
2. Secure the gland body into a vice.
3. Thread the cap over the probe with the female thread facing the process (see diagram).
4. Insert the probe through the body.
5. Assemble the mating halves of the seat around the probe with the concave side facing away from the process.
6. Slide the assembled seat into the body.
7. Be sure you are using the correct sealant for your working pressure and temperature. Assemble the mating halves of the sealant around the probe with the cone facing the process.
8. Slide the assembled sealant into the body.
9. Assemble the mating halves of the follower around the probe with the counterbore facing the cap.
10. Slide the assembled follower into the body.
11. Push on the follower until the sealant and seat are firmly positioned in the gland body.
12. Thread the cap on finger tight.
13. Make the final adjustment of immersion length.
14. Using a torque wrench, tighten the cap to the specified torque (see chart).
15. The assembly is now ready for use. Apply a wrench to the gland body flats – not the cap – for mounting to the vessel.

For assembly directly into a vessel:

1. Verify that the probe length is sufficient for your desired immersion.
2. Mount the gland body into the vessel wall. This may be done by threading or welding, depending on the mounting style. When using a weld mount, the gland must be disassembled prior to welding to protect the sealant.
3. Thread the cap over the probe with the female thread facing the process (see diagram).
4. Insert the probe through the body.
5. Assemble the mating halves of the seat around the probe with the concave side facing away from the process.
6. Slide the assembled seat into the body.
7. Be sure you are using the correct sealant for your working pressure and temperature. Assemble the mating halves of the sealant around the probe with the cone facing the process.
8. Slide the assembled sealant into the body.
9. Assemble the mating halves of the follower around the probe with the counterbore facing the cap.
10. Slide the assembled follower into the body.
11. Push on the follower until the sealant and seat are firmly positioned in the gland body.
12. Thread the cap on finger tight.
13. Make the final adjustment of immersion length.
14. Apply a backer wrench to the gland body flats to prevent rotation during torquing.
15. While holding the backer wrench firmly in place, use a torque wrench to tighten the cap to the specified torque (see chart).
16. The assembly is now ready for use.

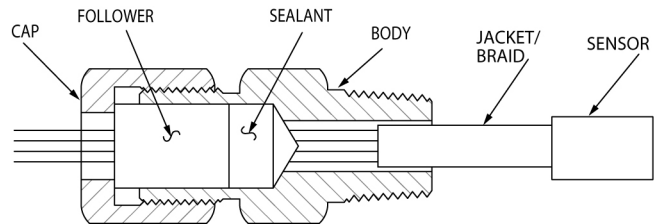


PGS Series Torque Requirements

Gland Series	Viton		Teflon		Lava		Grafoil	
	(ft-lbs)	(N-m)	(ft-lbs)	(N-m)	(ft-lbs)	(N-m)	(ft-lbs)	(N-m)
PG2S	30-35	40-47	15-20	20-27	40-45	54-61	35-40	47-54
PG4S	55-60	74-81	55-60	74-81	125-140	170-190	90-100	122-136
PG5S	55-60	74-82	90-100	122-136	200-220	272-299	90-100	122-137

For BSWS Series

1. Identify the type of gland to be assembled. If the sensor leads have an outer jacket or braid, trim this back to the point where it will enter the gland body when installed (see diagram). This will expose the individual insulated leads.
2. Install the sensor securely in its housing. Place the gland body over the leads and mount it in the enclosure or bearing housing mounting thread.
3. Slide the sealant with the cone facing the process over the leads into the gland body until seated. Individual holes are provided for each lead.
4. Slide the follower over the leads and insert it into the gland body. Ensure that the wires are correctly positioned.
5. Place the cap over the leads and finger tighten.
6. Make the final adjustment of lead length.
7. Apply a backer wrench to the gland body flats to prevent rotation during torquing.
8. While holding the backer wrench firmly in place, use a torque wrench to tighten the cap to the specified torque (see chart).
9. The assembly is now ready for use.



BSWS Series Torque Requirements

Catalog Number	Viton	
	(ft-lbs)	(N-m)
BSWS4	3-5	4-6
BSWS5	12-15	16-20

Lubricant Application Instructions

Conax Technologies sealing glands have lubricant applied at the factory. Substitution of factory-supplied lubricant will affect seal integrity. Lubrication prevents thread galling and minimizes friction between mating metallic components to maximize sealing gland performance when a catalog-specified torque is applied. Lubrication should be used any time a sealing gland assembly is opened for replacement or adjustment of the probe(s), wires or sealant. By re-lubricating the gland body threads and load bearing surface of the cap, proper load transfer (sealant compression) can be achieved.

Lubricant kits are available from Conax Technologies in convenient, single application, disposable packages with the applicator included. Conax Technologies recommends use of this lubricant to ensure gland performance.

Hex-Style Sealing Glands MK Series

1. Apply a small amount of lubricant, a tear drop equivalent, in two to three places, equally spaced, to the ferrule top. Refer to Figure 1.
2. Apply a single line of lubricant to the full length of the straight thread on the cap. Refer to Figure 1.
3. Assemble the sealing gland per MK sealing gland instructions.

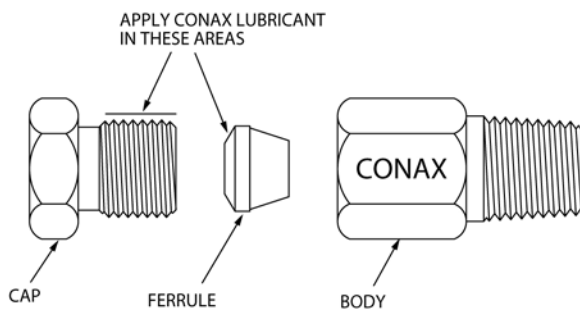


Figure 1

PG, MHM, MHC, TG, PL, EG, EGT, SPG, DSPG, PGS and BSWS Series

1. Apply a small amount of lubricant, tear drop equivalent, in two to three places, equally spaced, to the top of the follower. Do not allow the lubricant to directly contact the sealant or the elements you are sealing. Refer to Figure 2.

2. Apply a single line of lubricant to the full length of the straight thread on the gland body. Refer to Figure 2.
3. Assemble the sealing gland per applicable sealing gland instructions.

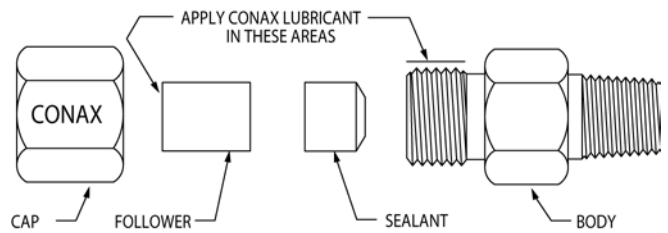


Figure 2

Flange-Cap Style Sealing Glands PG, MHM, EG and EGT Series

1. Apply a small amount of lubricant, tear drop equivalent, in two to three places, equally spaced, to the underside of the hex cap screw on each of the six (6) hex cap screws. Do not allow the lubricant to directly contact the sealant or the elements you are sealing. Refer to Figure 3.
2. Apply a single line of lubricant to the full thread length on each of the six (6) hex head screws. Refer to Figure 3.
3. Assemble the sealing gland. Apply torque per applicable gland chart.

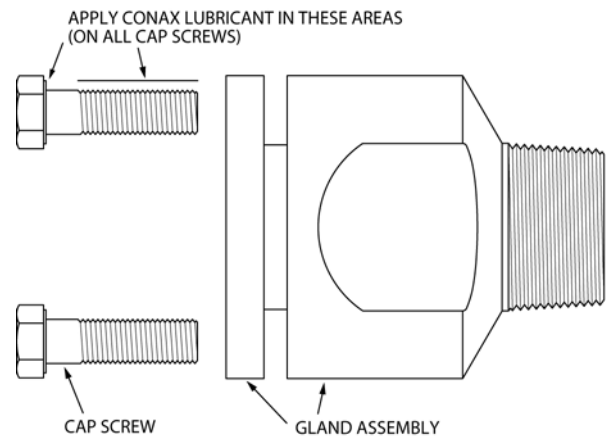


Figure 3

CAUTION: Lubricant may cause mild eye irritation. Do not use for lubrication of aluminum or magnesium parts.

This product is not an OSHA hazardous material, as defined in 29 CFR 1910.120. This product contains CAS #9002839, Ethene, chlorotrifluoro-homopolymer. 24-Hour Emergency Phone 1-800-733-3665. HMIS Rating System: Health 0, Flammability 0, Reactivity 1. For industrial use only.



2300 Walden Avenue • Buffalo, New York 14225
FAX: 716-684-7433 • Phone: 716-684-4500 • 1-800-223-2389
e-mail: info@conaxtechnologies.com

www.conaxtechnologies.com



Conax Technologies is a registered trademark of Conax Technologies. Teflon is a registered trademark of E.I. DuPont de Nemours Company.
Viton is a registered trademark of Dupont Dow Elastomers, LLC. Grafoil is a registered trademark of UCAR International, Inc.
PEEK is a registered trademark of Victrex plc.



INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-12-B3
Rev. 1

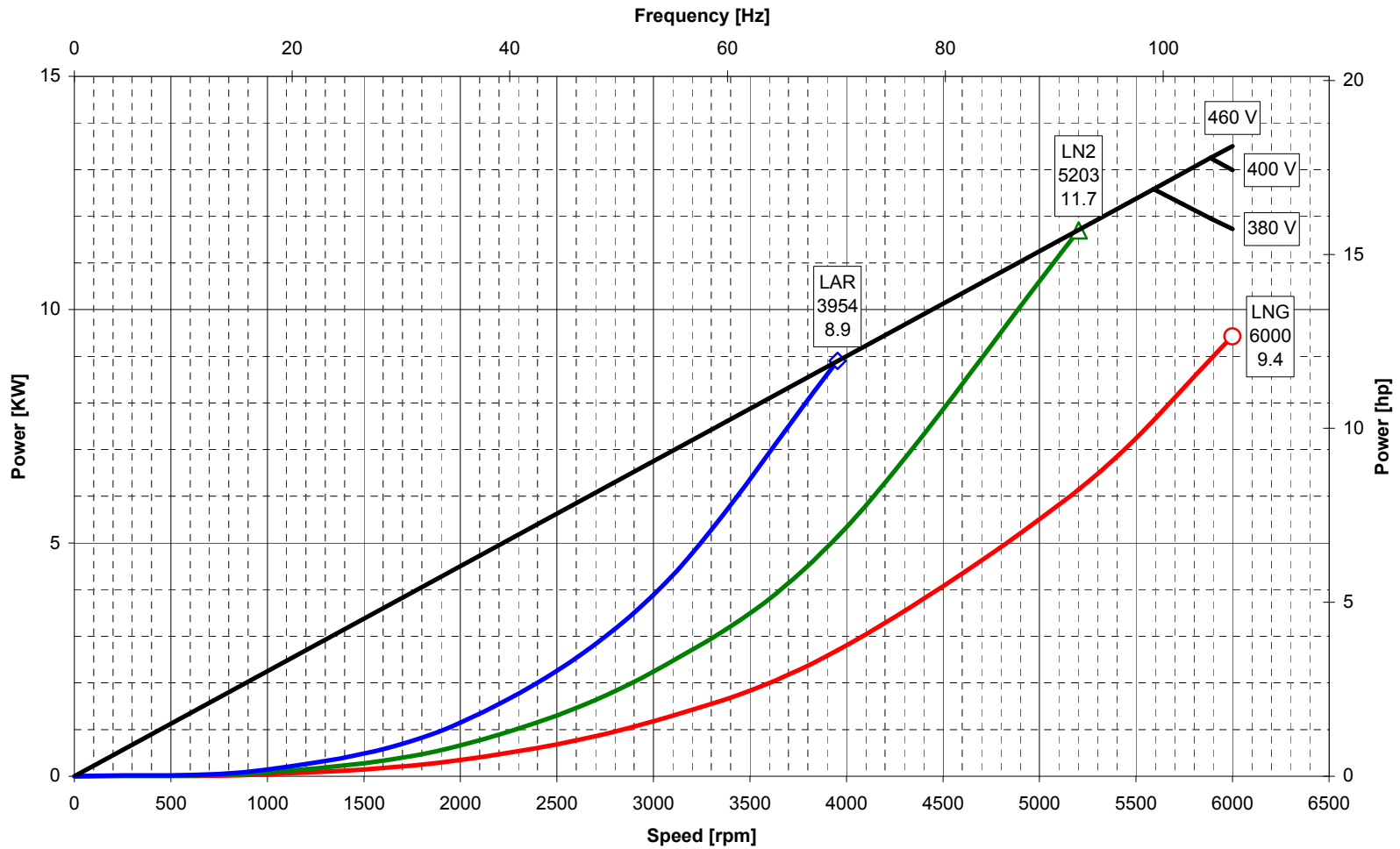
B3. DRAWINGS

The following pages include all drawings that apply to this specific pump assembly.

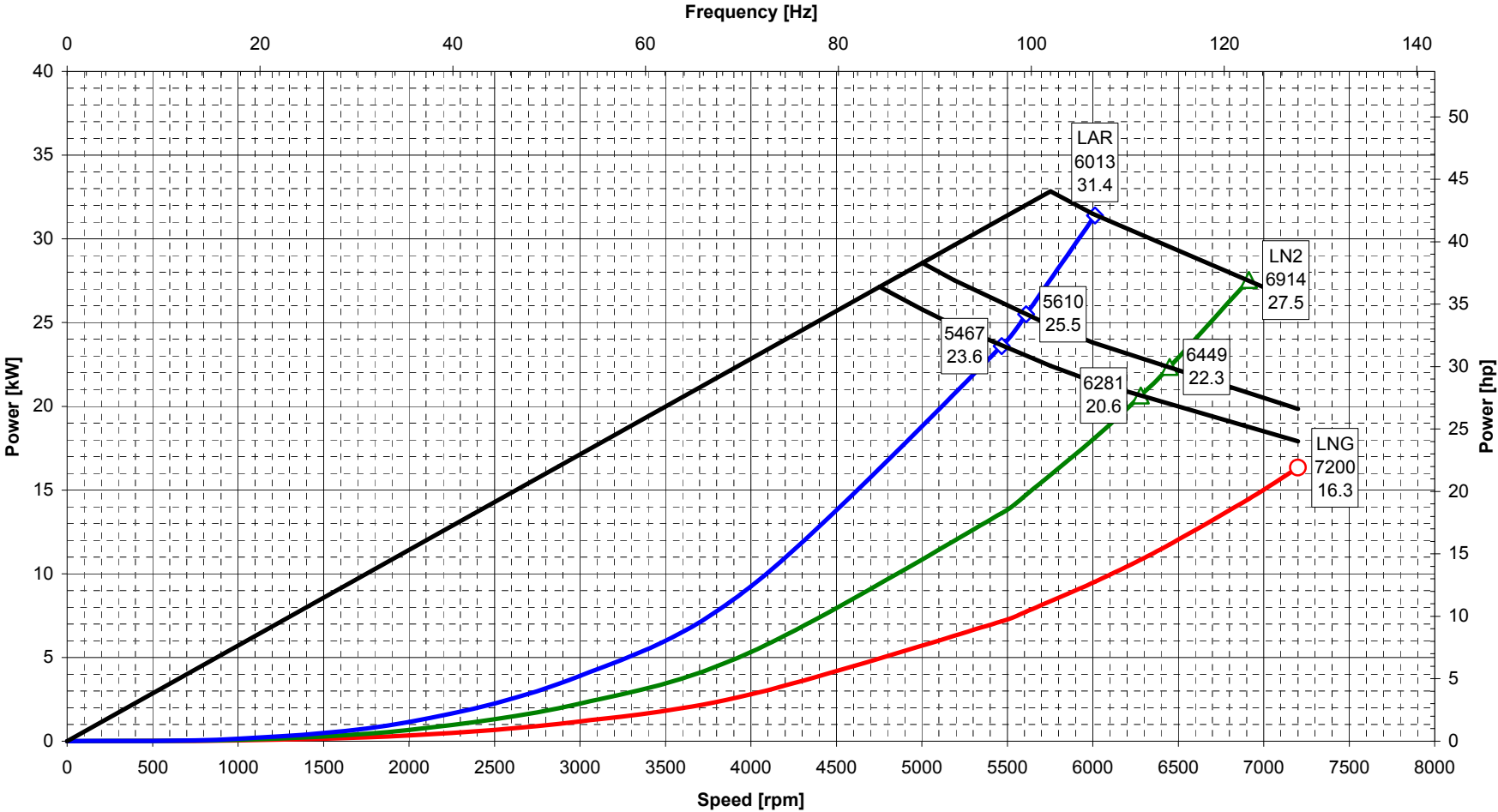
**ACD Submerged Pump Series
Model TC34
Power Specification**

Pump Size		1 x 2 x 6 - 2S			1 x 2 x 6 - 2S			1 x 2 x 6 - 4S			
Pump P/N		54095-1			59435-1			54715-1			
Stator P/N		52071-2			54784-2			54784-2			
Voltage		V	460	400	380	460	400	380	460	400	380
Rated Power	Power	hp	18.1	17.8	16.9	44.0	38.3	36.4	44.0	38.3	36.4
		KW	13.5	13.3	12.6	32.8	28.6	27.1	32.8	28.6	27.1
	Speed	rpm	6000	5890	5590	5750	5000	4750	5750	5002	4752
	Frequency	Hz	106	104	99	102	89	84	102	89	84
	Slip	%	6%			6%			6%		
	Current	A	25.4			55.3			55.3		
	Efficiency	%	83%			85%			85%		
PF	%	91%			88%			88%			
Rated Speed	Power	hp	18.1	17.4	15.7	35.2	26.6	24.0	35.2	26.6	24.0
		KW	13.5	13.0	11.7	26.2	19.8	17.9	26.2	19.8	17.9
	Speed	rpm	6000			7200			7200		
	Frequency	Hz	106			128			128		
Current	A	25.4	24.9	23.6	44.2	38.4	36.5	44.2	38.4	36.5	
LAR - Argon (1.398 SG)	Speed	rpm	3950			6010	5610	5470	4990	4870	
	Frequency	Hz	70			107	99	97	89	86	
	Power	hp	11.9			42.1	34.2	31.6	38.2	35.54	
		KW	8.9			31.4	25.5	23.6	28.5	26.5	
	Current	A	25.4			50.0	43.3	41.2	55.3	52.3	
	Head	ft	242			559	487	462	755	719	
		m	74			170	148	141	230	219	
	DP	psid	147			340	296	281	459	437	
		bard	10.1			23.4	20.4	19.4	31.6	30.1	
Flow	gpm	73			111	103	101	78	76		
	lpm	276			419	391	381	295	287		
LN2 - Nitrogen (0.809 SG)	Speed	rpm	5200			6910	6450	6280	6000	5730	5590
	Frequency	Hz	92			123	114	111	106	102	99
	Power	hp	15.7			36.9	30.0	27.7	38.3	33.4	31.0
		KW	11.7			27.5	22.3	20.6	28.5	24.9	23.1
	Current	A	25.3			38.2	33.7	32.2	45.3	41.4	39.5
	Head	ft	419			740	643	610	1090	995	947
		m	128			225	196	186	332	303	289
	DP	psid	147			259	226	214	382	349	332
		bard	10.1			17.9	15.6	14.8	26.4	24.1	22.9
Flow	gpm	96			127	119	116	94	89	87	
	lpm	363			482	450	438	354	338	330	
LNG - Methane (0.425 SG)	Speed	rpm	6000			7200			6000		
	Frequency	Hz	106			128			106		
	Power	hp	12.6			21.9			20.1		
		KW	9.4			16.3			15.0		
	Current	A	18.2			24			26		
	Head	ft	557			801			1090		
		m	170			244			332		
	DP	psid	103			136			201		
		bard	7.1			9.4			13.8		
Flow	gpm	111			133			94			
	lpm	419			503			354			

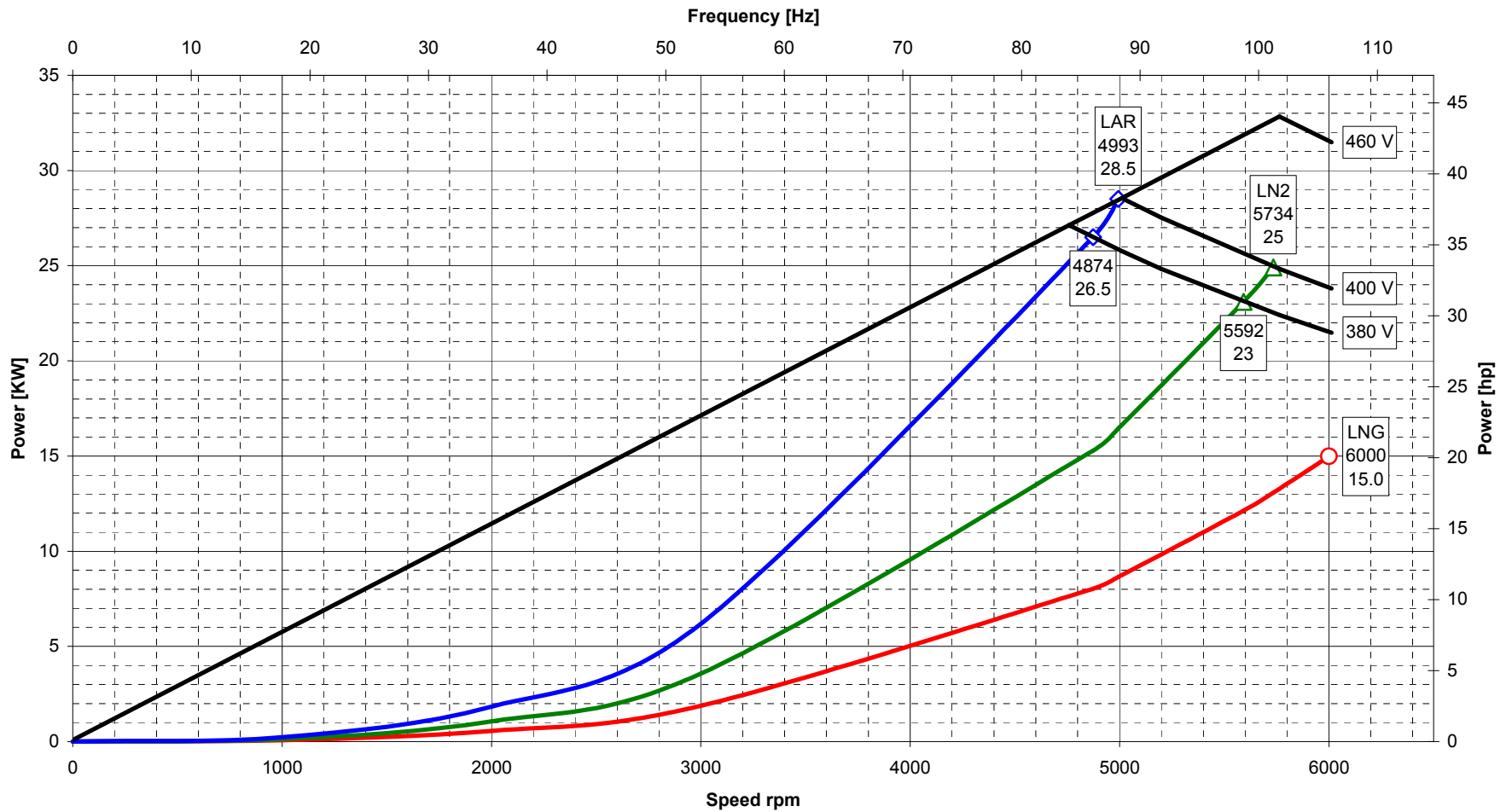
TC34 1x2x6-2S P/N 54095 Fluid Rated Power
52071-2 Stator Voltage Rated Power
6% Slip - 3.8 V/Hz Ramp



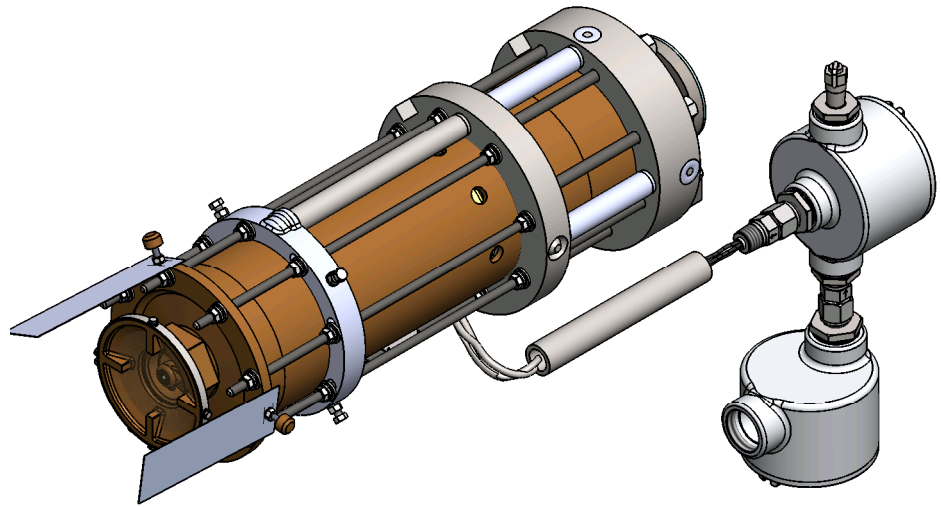
TC34 1x2x6-2S P/N 59435 Fluid Rated Power
54784-2 Stator Voltage Rated Power
6% Slip - 4.5 V/Hz Ramp
400 V



**TC34 1x2x6-4S P/N 54715 Fluid Rated Power
 54784-2 Stator Voltage Rated Power
 6% Slip - 4.5 V/Hz Ramp
 400V**



- NOTES: UNLESS OTHERWISE SPECIFIED.
- 1 SEE PUMP DATA SHEET OR ENGINEERING FOR IMPELLER DIAMETER AND NAMEPLATE DATA.
 - 2 TORQUE ALL FASTENERS PER VALUES IN TORQUE TABLE.
 - 3 CONNECT STATOR LEAD/PASSTHRU LEAD CONNECTIONS USING NON - INSULATED CRIMPING SLEEVE CONNECTOR (i.e. T & B, C10-12) AND THEN SOLDER. COVER STATOR LEAD/PASSTHRU LEAD CONNECTIONS WITH TEFLON TUBING TO FIT. FIRST, SHRINK FIT ONE LAYER OF 89913-112 AND THEN SHRINK FIT ANOTHER LAYER OF 89913-113 ON TOP. (CONNECTIONS BY CUSTOMER).
 - 4 TAG PHASE ROTATION A, B, C OR 1, 2, 3 FOR COUNTER CLOCKWISE ROTATION LOOKING AT INDUCER.
 - 5 SEE DRAWING 55621 FOR ASSEMBLY AND BALANCING OF ROTATING PARTS. SEE NOTE 3 OF DWG 55621.
 - 6 INSTALL AND HEAT SHRINK, ITEM 63, FULL LENGTH OF MOTOR LEADS.
 7. SEE -10 FOR RECOMMENDED SPARES, CLEAN FOR STANDARD SERVICE PER ACD ECP-007. TO BE PACKAGED INDIVIDUALLY AND AS A KIT.
 - 8 SHIP LOOSE FOR CUSTOMER INSTALLATION.
 - 9 SECURE SCREWS (ITEM 73) WITH LOCTITE 242 (ITEM 74). DRILL AND TAP INTO HOUSING (ITEM 39) 1/4" DEEP. DO NOT BREAK THRU. REPLACE WIRE CONNECTION SET SCREWS (6 PLACES) WITH ITEM 76 (SOCKET HEAD). SAFETY WIRE SHOULD NOT INTERFERE WITH TERMINAL BLOCK.
 10. SEE DRAWING D-54715 FOR INSTALLATION INFORMATION.
 - 11 SEE DRAWING 60885 FOR SUBMERGED MOTOR POWER SPECIFICATIONS.
 - 12 INSTALL PASS THRU HARNESS WITH ARROW IN DIRECTION SHOWN.
 - 13 ATTACH ONE NAMEPLATE TO THE PUMP AS SHOWN AND SAFETY WIRE THE ADDITIONAL NAMEPLATES TO THE PUMP. CUSTOMER WILL INSTALL THE ADDITIONAL NAMEPLATES ON THE SUMP USING DOUBLE SIDED TAPE.
 - 14 ANGULAR CONTACT BEARING TO BE INSTALLED AS SHOWN WITH OUTER RACE SHOULDER SIDE AWAY FROM ROTOR.
 - 15 TORQUE TO 120-130 LB-IN.
 - 16 APPLY LOCTITE ITEM 74 TO ONE THREADED END OF STUDS PRIOR TO INSTALLING TO MANIFOLD, ITEM 33. "DOUBLE NUT" EACH STUD WITH ITEM 51 AND TORQUE TO 372 TO 396 INCH LBS. REMOVE "DOUBLE NUTS" AFTER TORQUING.
 - 17 USE SAFETY WIRE ITEM 58 ON IMPELLER SCREW AS REQUIRED.
 - 18 SNUG 10-24 FASTENERS AND TORQUE TO FINAL VALUE USING STAR PATTERN SEQUENCE.



BASIC DASH NO. (TABLE 1)					
DASH NO.	PASS THRU	OTHER	MOTOR RATING $\Delta 11$	MOTOR PART NO.	RECOMMENDED SPARES
-1	61189-1	DUAL CONDUIT BOX	25HP/460V/102HZ	54784-2	-10
-2	61189-4	SINGLE CONDUIT BOX			
-3	61189-1	PASS THRU TERMINAL BLOCK			
-4	NONE	PASS THRU TERMINAL BLOCK			

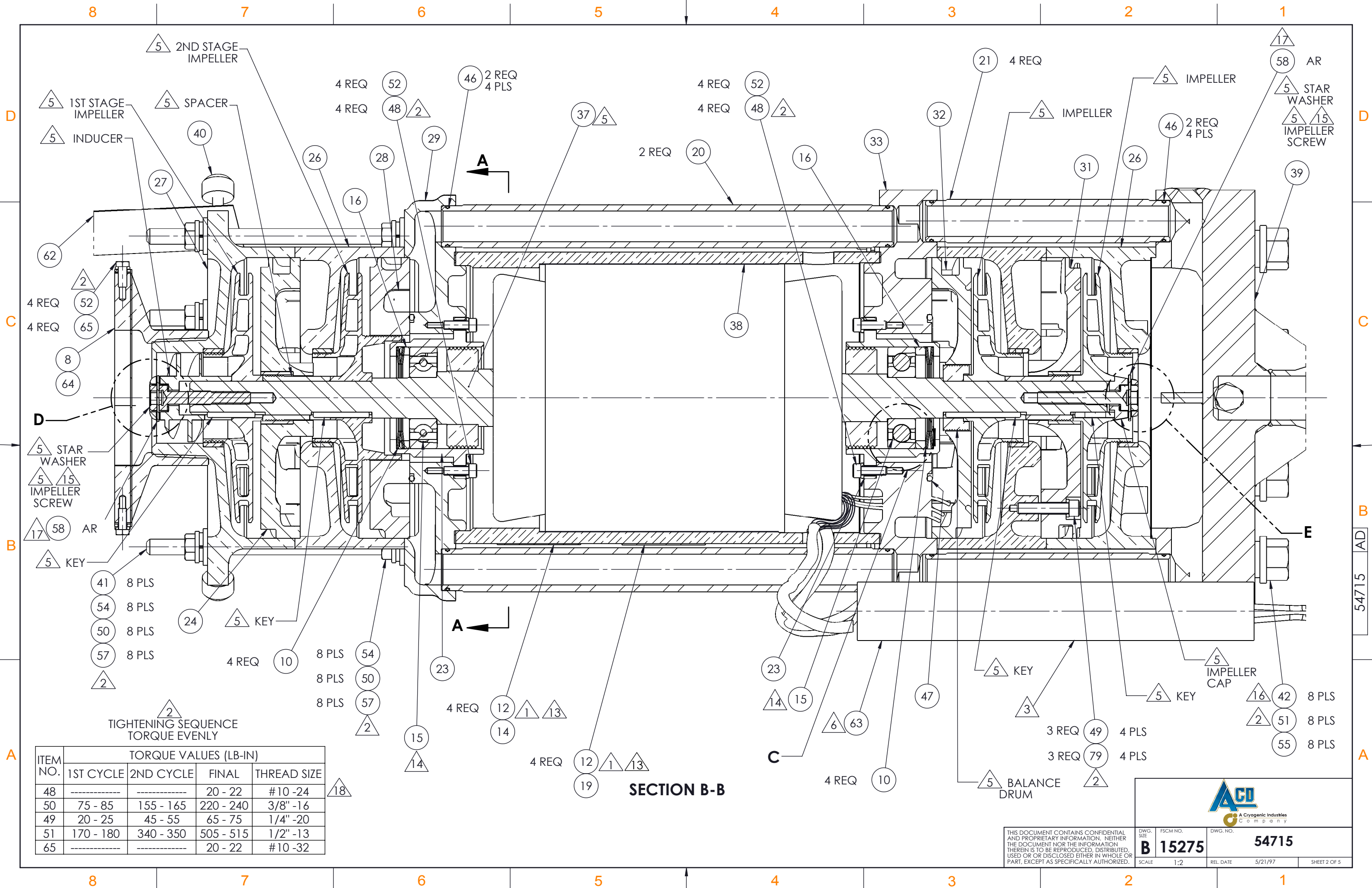
-	-	-	-	-	1	-	54715-22	PASS THRU ASSY (SINGLE)	83
-	-	-	-	-	-	1	54715-21	PASS THRU ASSY (DUAL)	82
-	-	-	2	2	2	2	63833-2	NAMEPLATE, TC-34, ATEX APPROVED - OBSO	81
-	-	-	16	16	16	16	89109-158	NUT, 0.3750-16 UNC-2B SS410 FLANGED SI	80
-	-	-	18	18	18	18	86311-146	WASHER, WEDGE LOCK 0.2500 SS316	79
-	-	1	1	1	1	1	60885-DWG	DRAWING 60885	78
-	-	-	6	6	-	-	99004-257	SCREW SET 0.2500-28 UNF-3A 0.6250 LONG	76
-	-	1	-	-	-	-	54715-DWG	DRAWING	75
-	-	-	0.01	0.01	0.01	0.01	99900-012	LOCTITE MLD STRENGTH (FOR LOCKING SCR	74
-	-	-	2	2	-	-	89106-159	CAP, SCREW 8-32 UNC-2A 1.25 LG SS18-8	73
-	-	-	1	1	-	-	02267-013	BLOCK, TERMINAL 600V 65A #18 TO #4 AWG	72
-	-	-	4	4	4	4	86311-010	WASHER, LOCK SPRING, HELICAL 0.3125 RG	69
-	-	-	4	4	4	4	99000-054	NUT 0.3125-18 UNC-2B SS18-8 0.5000 HEX	68
-	-	-	4	4	4	4	99002-055	BOLT 0.3125-18 UNC-2A 0.7500 LONG SS18	67
1	-	-	-	-	-	-	61189-4	GLAND, POWER LEAD PASSTHRU FITTING CON	66
-	-	-	4	4	4	4	99002-012	BOLT 10-32 NF-2A 0.5000 LONG SS18-8 0.	65
-	-	-	1	1	1	1	56287-1	SCREEN ASSY, AC/TC-34	64
-	-	54	54	54	54	54	89913-108	TUBE, HEAT SHRINKABLE, NOM/RECOVERED S	63
-	-	-	2	2	2	2	57824-1	TAG, INSTALLATION ADJUSTMENT	62
-	-	1	1	1	1	1	00635-006	GASKET GARLOCK BLUE-GARD STYLE 3000 L	61
-	-	36	36	36	36	36	99900-341	WIRE, SAFETY 0.0320 DIA SS302 CONDA	59
-	-	36	36	36	36	36	99900-002	WIRE, SAFETY 0.0460 DIA SS18-8 ANLD	58
-	-	-	24	24	24	24	99001-660	WASHER, FLAT 0.3750 SS18-8 0.4061 ID X	57
-	-	-	8	8	8	8	99001-048	WASHER, LOCK 0.5000 SS18-8 RGLR (FREE	55
-	-	-	24	24	24	24	99001-038	WASHER, LOCK 0.3750 SS18-8 RGLR (FREE	54
-	-	-	12	12	12	12	86311-145	WASHER, WEDGE LOCK #10 SS316	52
-	-	-	8	8	8	8	89109-159	NUT, 0.5000-13 UNC-2B SS410 FLANGED HE	51
-22	-21	-10	-4	-3	-2	-1	PART NUMBER	DESCRIPTION	ITM

REVISIONS										
LTR	DESCRIPTION	DATE	APPROVED							
AD	SEE ECN	3/14/14	VU/MR/SD							
-	-	-	24	24	24	24	89109-158	NUT, 0.3750-16 UNC-2B SS410 FLANGED SI	50	
-	-	-	12	12	12	12	99005-051	SCREW CAP 0.2500-20 UNC-2A 1.2500 LONG	49	
-	-	-	8	8	8	8	99005-267	SCREW CAP 0.1900-24 UNC-3A 0.6250 LONG	48	
-	-	2	2	2	2	2	80240	O RING 3.75000 INCH ID X 4.00000 INCH	47	
-	-	12	12	12	12	12	80020	O RING 0.87500 INCH ID X 1.00000 INCH	46	
-	-	1	-	-	-	-	70182-180	KEY, SQUARE 1/8" BERYLLIUM COPPER ASTM	45	
-	-	2	-	-	-	-	70182-135	KEY, SQUARE 1/8" BERYLLIUM COPPER ASTM	44	
-	-	1	-	-	-	-	70182-095	KEY, SQUARE 1/8" BERYLLIUM COPPER ASTM	43	
-	-	-	8	8	8	8	70036-095	STUD, FULL THREAD 304 SST .500-13 UNC-	42	
-	-	-	8	8	8	8	70022-185	STUD, FULL THREAD .375-16 UNC-2A 18.50	41	
-	-	-	3	3	3	3	54788-1	BUMPER ASSY	40	
-	-	-	1	1	1	1	54787-1	MANIFOLD, DISCHARGE UPPER	39	
-	-	-	1	1	1	1	54786-1	MOTOR HOUSING & STATOR ASSY	38	
-	-	-	1	1	1	1	55621-1	SHAFT ASSY BALANCED 6" 4 STAGE SUBMERG	37	
-	-	-	1	1	1	1	54778-1	MANIFOLD DISCHARGE INTERMEDIATE	33	
-	-	-	1	1	1	1	54777-1	DIFFUSER, 4TH STAGE CLOCKWISE ROTATION	32	
-	-	-	1	1	1	1	54775-11	DIFFUSER, 3RD STAGE CLOCKWISE ROTATION	31	
-	-	-	1	1	1	1	55143-1	MANIFOLD, DISCHARGE LOWER	29	
-	-	-	1	1	1	1	54076-2	DIFFUSER, SECOND STAGE	28	
-	-	-	1	1	1	1	54074-1	HOUSING, SUCTION	27	
-	-	-	3	3	3	3	54073-1	HOUSING, DIFFUSER	26	
-	-	-	1	1	1	1	3500222-11	DIFFUSER ASSY	24	
-	-	-	2	2	2	2	53802-2	RETAINER, BEARING LOWER	23	
-	-	-	4	4	4	4	52364-2	TUBE, DISCHARGE	21	
-	-	-	2	2	2	2	52364-1	TUBE, DISCHARGE	20	
-	-	-	2	2	2	2	52222-1	NAMEPLATE CENTRIFUGAL - DATA SHEET INF	19	
-	-	-	2	2	2	2	26932-1	SPACER	16	
-	-	2	2	2	2	2	25141-4	BALL BEARING ASSY (SOURCE CONTROL DRAW	15	
-	-	-	2	2	2	2	16268-1	NAMEPLATE, AC MOTOR	14	
-	-	8	8	8	8	8	99006-001	SCREW DRIVE #2 X 0.1250 LONG STEEL ZIN	12	
-	-	-	8	8	8	8	09402	SPRING, BELLEVILLE 2.421 OD X 1.595 ID	10	
-	1	-	-	-	-	-	09053-016	DRAIN AND BREATHER SST 1/2" NPTM CROUS	9	
-	-	-	1	1	1	1	56292-1	HOUSING, SUCTION SCREEN	8	
-	1	-	-	-	-	-	07027-128	REDUCER, BUSHING 1.2500 X 0.5000 3000	7	
1	2	-	-	-	-	-	05420-06	REDUCER, BUSHING 1.2500 X 0.7500 SS304	6	
-	1	-	-	-	-	-	06517-06	REDUCER, BUSHING 1.5000 X 0.7500 SS304	5	
1	1	-	-	-	-	-	02719-015	CONDUIT BOX ELECTROGALVANIZED BODY/COV	4	
-	1	-	-	-	-	-	02719-01	CONDUIT BOX AL ALY BODY/COVER 90 DEG 2	3	
1	2	-	-	1	-	-	61189-1	GLAND, POWER LEAD PASSTHRU FITTING CON	2	
-	-	2	-	-	-	-	00052	WASHER, STAR 0.3125 BRONZE INT. (.030	1	
-22	-21	-10	-4	-3	-2	-1	PART NUMBER	DESCRIPTION	ITM	

UNLESS OTHERWISE SPECIFIED: A.J) INTERPRET DRAWING PER ANSI Y14.5 B.J) REMOVE ALL BURRS AND SHARP EDGES C.J) SURFACE ROUGHNESS 125 PER ANSI B46.1 D.J) THREADS PER ANSI B1.1 FOR UNIFIED SCREW THREADS ANSI B2.1 FOR PIPE THREADS E.J) MACHINED FILLET RADII: R F.J) WELD SYMBOLS PER AWS A2.4		UNLESS OTHERWISE SPECIFIED DIMENSION ARE IN INCHES TOLERANCES ON: FRACTIONS: .X .XX .XXX DECIMALS: ±.10 ±.03 ±.010 ANGLES: ±1°		THIRD ANGLE PROJECTION DRAWN: _____ DATE: 5-16-97 CHECKED: A.C.K. DESIGN DESIGN: _____ STRESS: _____ 16MAY97 TREATMENT: _____ AERODYN./HYDR: _____ FINISH: _____ PROJECT: _____		 PUMP ASSEMBLY 1 X 2 X 6"-4 STAGE TC-34, SUBMERGED	
EST. WT. 260 LBS. ACT. WT. _____		SIMILAR TO 54095/57650 PARENT DWG. NO. FINAL		DESIGN ACTIVITY: J.F. PAJE 9/18/13 MGF. ENGRG.: C.T. BRYANT 5/20/97 QA		DWG. NO. 54715 FSCM NO. B 15275 DWG. NO. 54715	
THIS DOCUMENT CONTAINS CONFIDENTIAL AND PROPRIETARY INFORMATION. NEITHER THE DOCUMENT NOR THE INFORMATION THEREIN IS TO BE REPRODUCED, DISTRIBUTED, USED OR DISCLOSED EITHER IN WHOLE OR PART, EXCEPT AS SPECIFICALLY AUTHORIZED.		SCALE 1:12		REL. DATE 5/21/97		SHEET 1 OF 5	

D
C
B
A

D
C
B
AD
54715
A



TIGHTENING SEQUENCE
TORQUE EVENLY

ITEM NO.	TORQUE VALUES (LB-IN)			THREAD SIZE
	1ST CYCLE	2ND CYCLE	FINAL	
48	-----	-----	20 - 22	#10 -24
50	75 - 85	155 - 165	220 - 240	3/8" -16
49	20 - 25	45 - 55	65 - 75	1/4" -20
51	170 - 180	340 - 350	505 - 515	1/2" -13
65	-----	-----	20 - 22	#10 -32

SECTION B-B

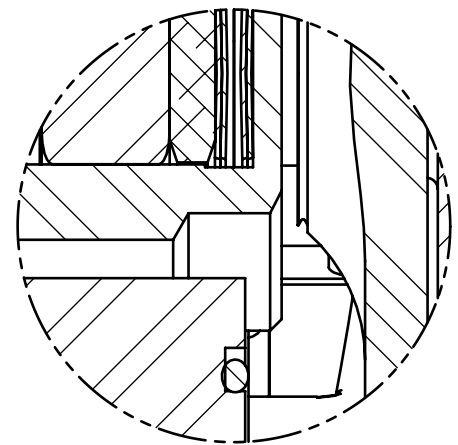
ACO
A Cryogenic Industries
Company

DWG. NO. B 15275	DWG. NO. 54715
SCALE 1:2	REL. DATE 5/21/97
SHEET 2 OF 5	

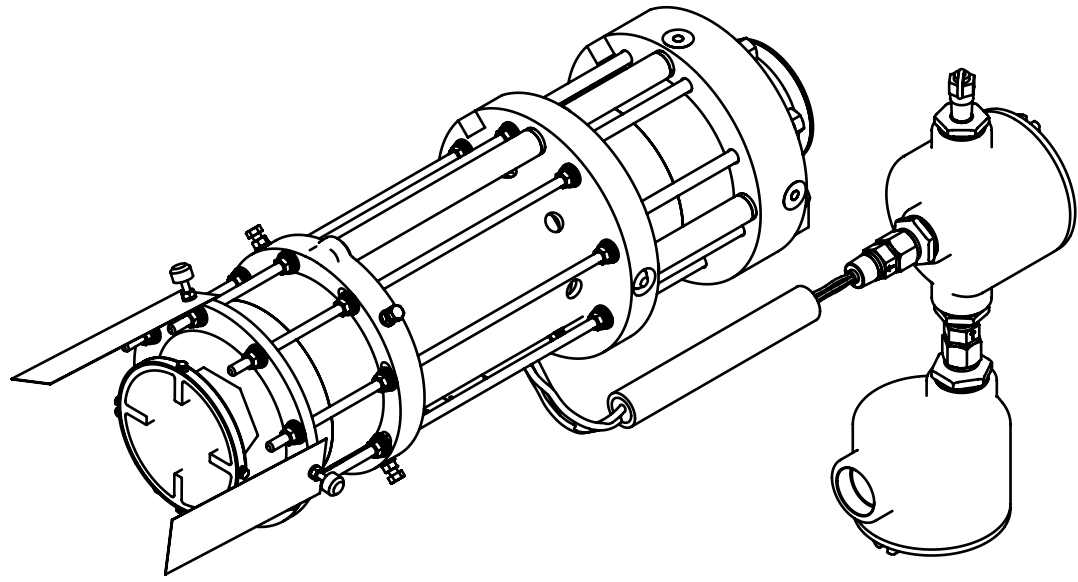
THIS DOCUMENT CONTAINS CONFIDENTIAL AND PROPRIETARY INFORMATION. NEITHER THE DOCUMENT NOR THE INFORMATION THEREIN IS TO BE REPRODUCED, DISTRIBUTED, USED OR DISCLOSED EITHER IN WHOLE OR PART, EXCEPT AS SPECIFICALLY AUTHORIZED.

8 7 6 5 4 3 2 1

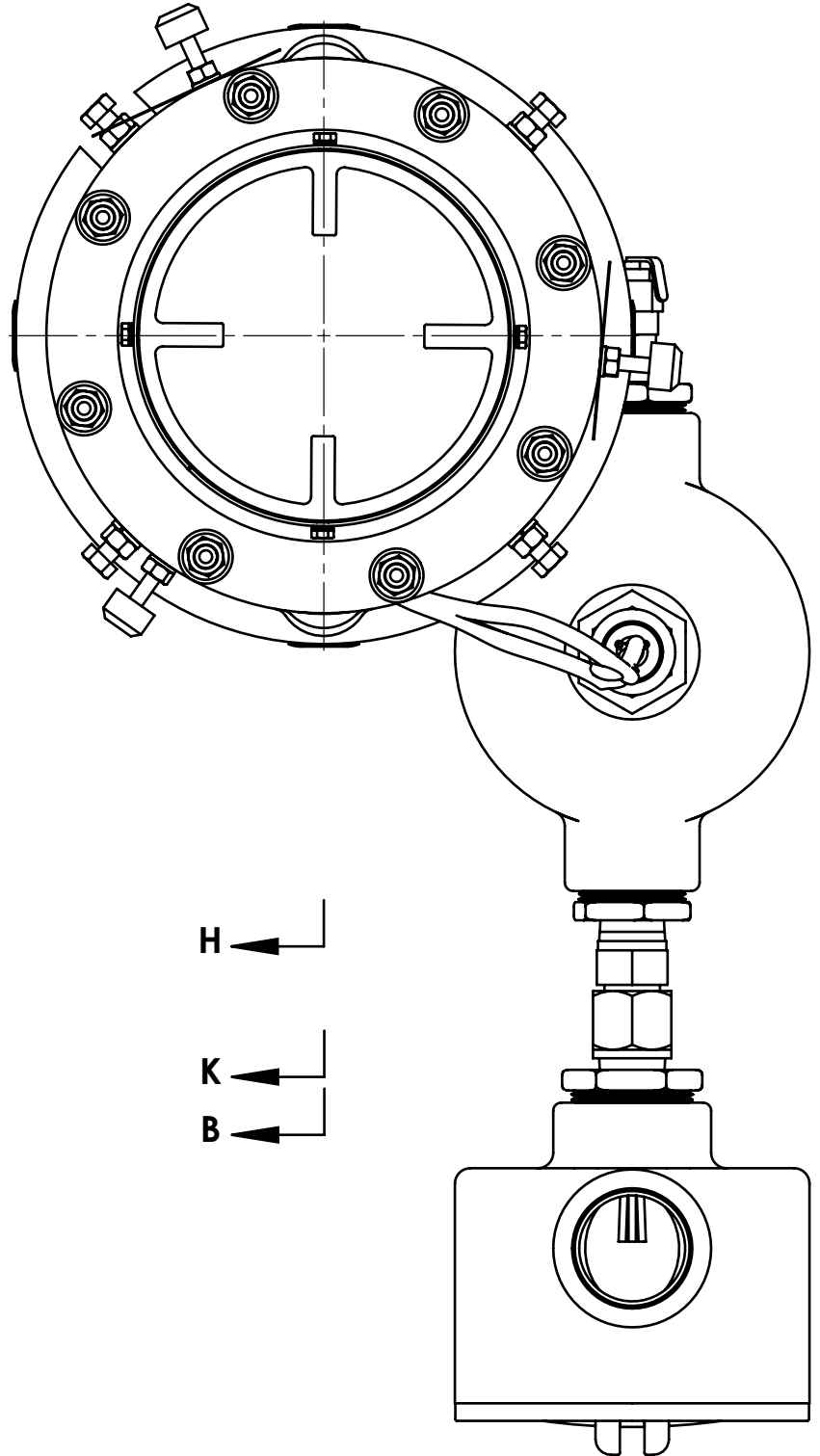
B
K
H



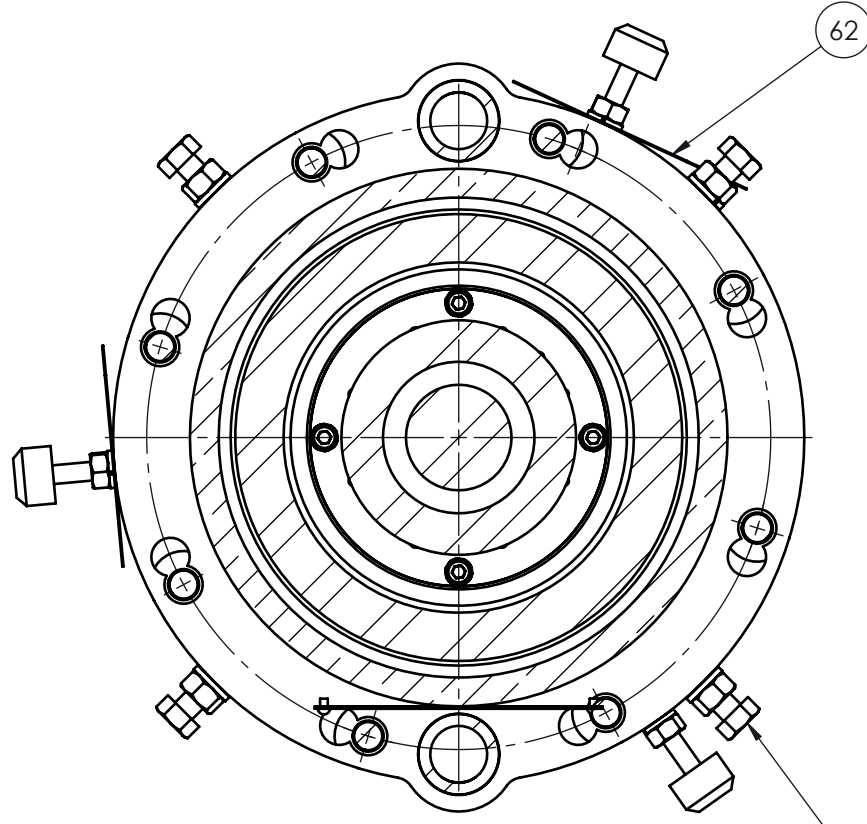
ASSEMBLY DETAIL C



-1 ASSY SHOWN

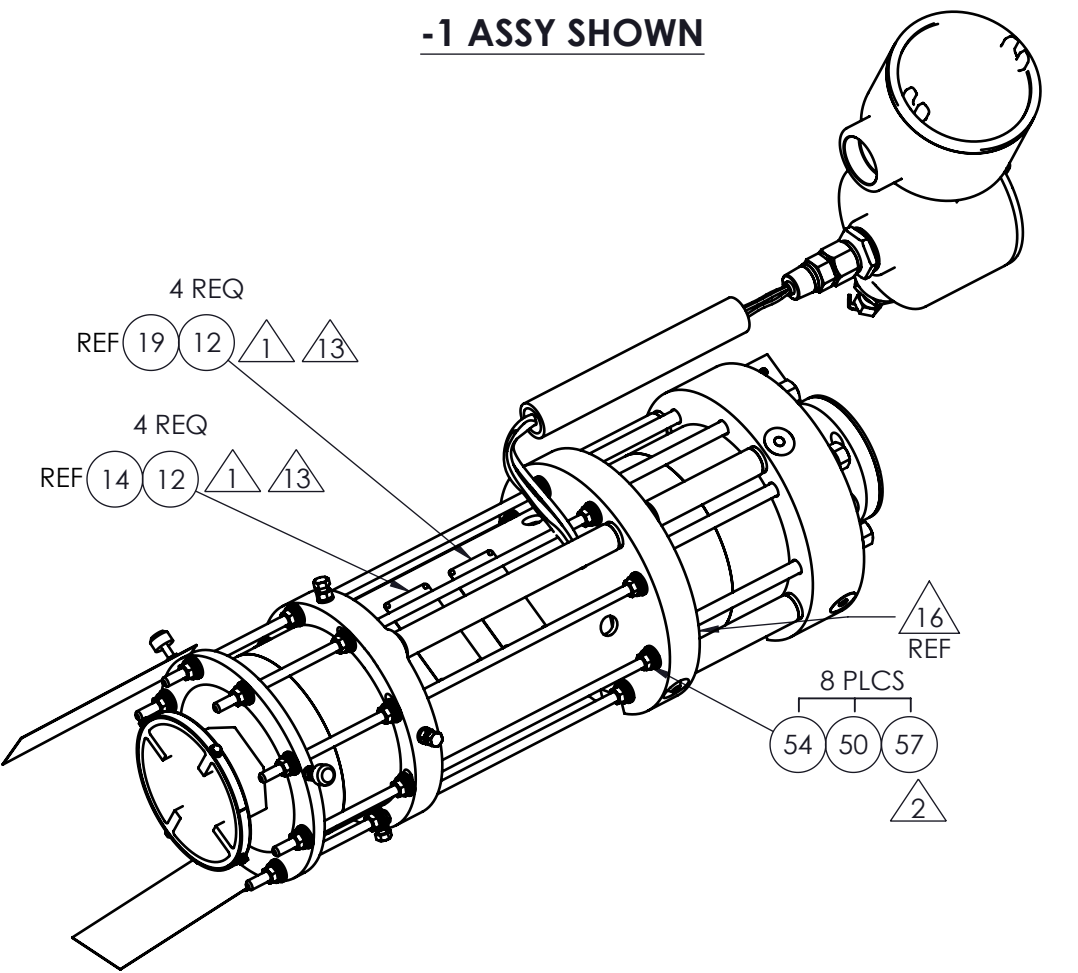


H
K
B



SECTION A-A

67
68
69 } 4 REQ



4 REQ
REF 19 12 1 13

4 REQ
REF 14 12 1 13

8 PLCS
54 50 57
2

16
REF



THIS DOCUMENT CONTAINS CONFIDENTIAL AND PROPRIETARY INFORMATION. NEITHER THE DOCUMENT NOR THE INFORMATION THEREIN IS TO BE REPRODUCED, DISTRIBUTED, USED OR DISCLOSED EITHER IN WHOLE OR PART, EXCEPT AS SPECIFICALLY AUTHORIZED.		DWG. SIZE: B	FSCM NO.: 15275	DWG. NO.: 54715
SCALE: 1:3	REL. DATE: 5/21/97	SHEET 3 OF 5		

8 7 6 5 4 3 2 1

D
C
B
A

D
C
B
A

AD
54715

8 7 6 5 4 3 2 1

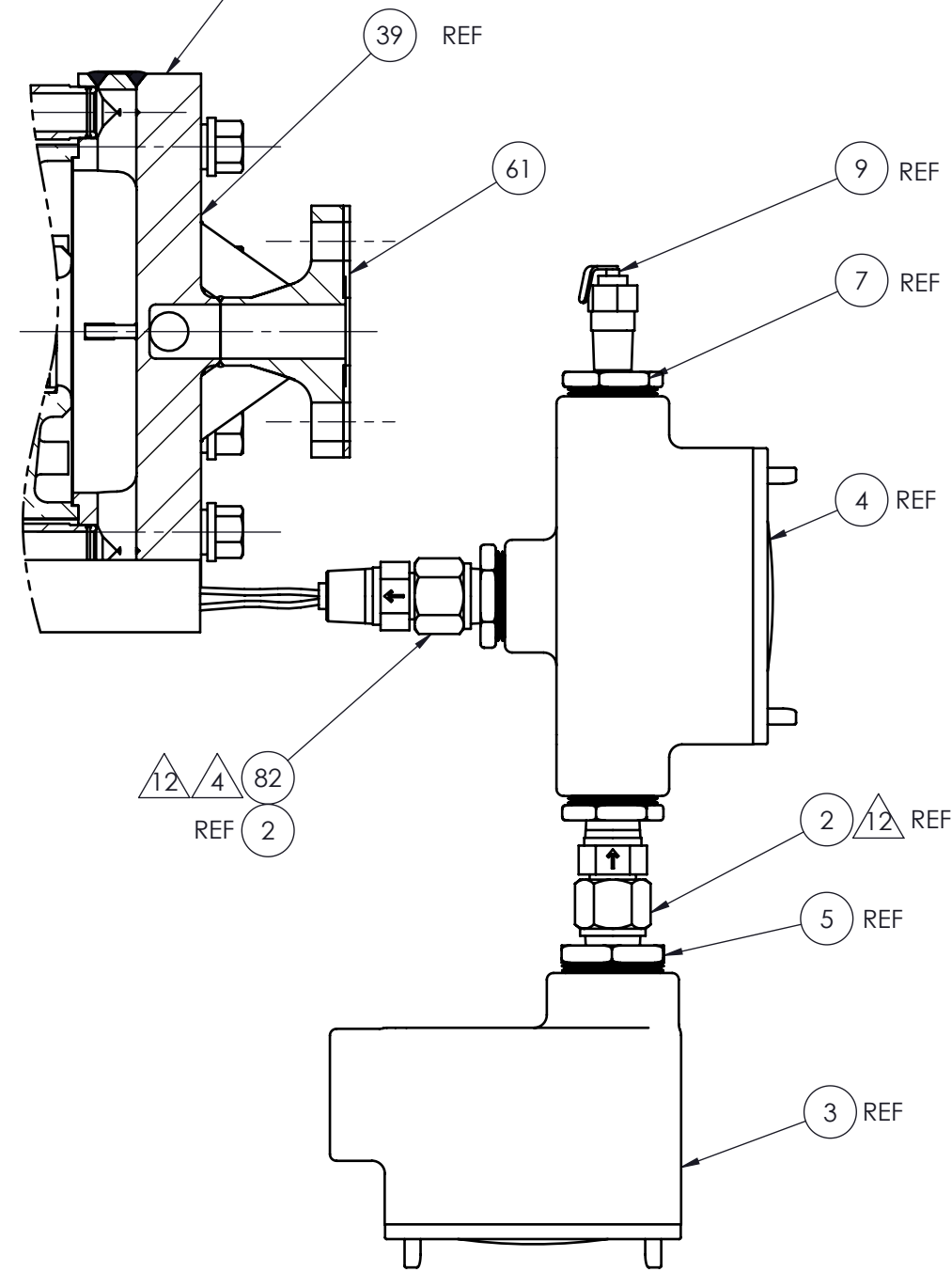
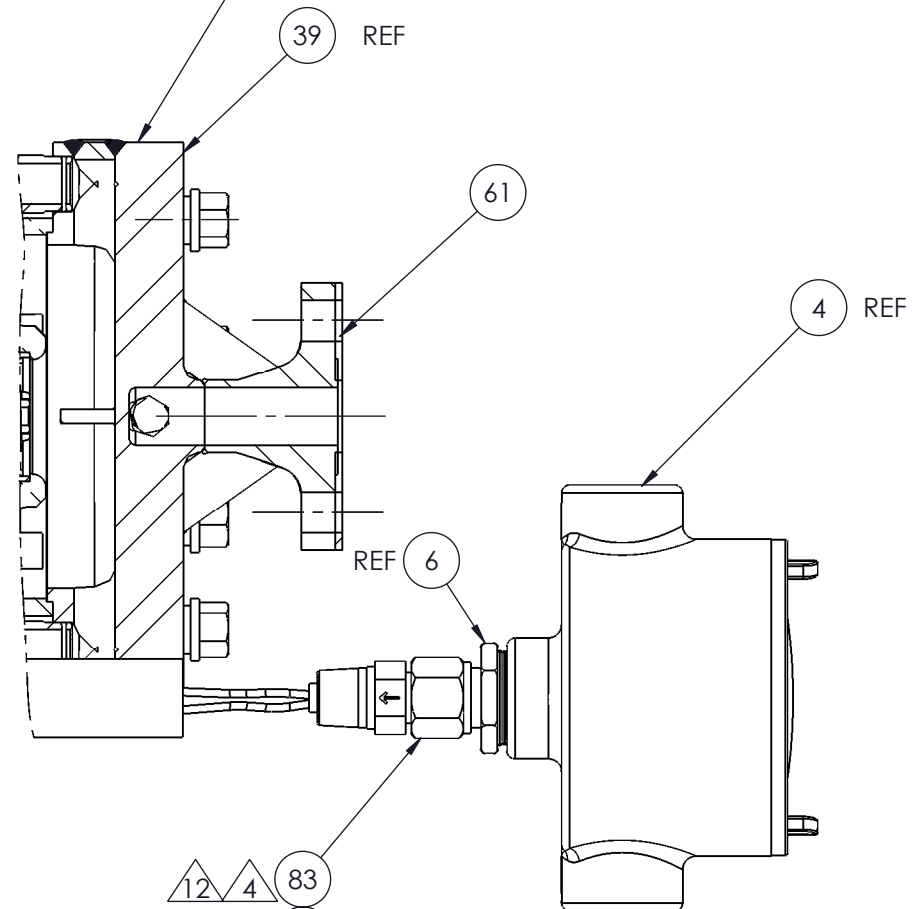
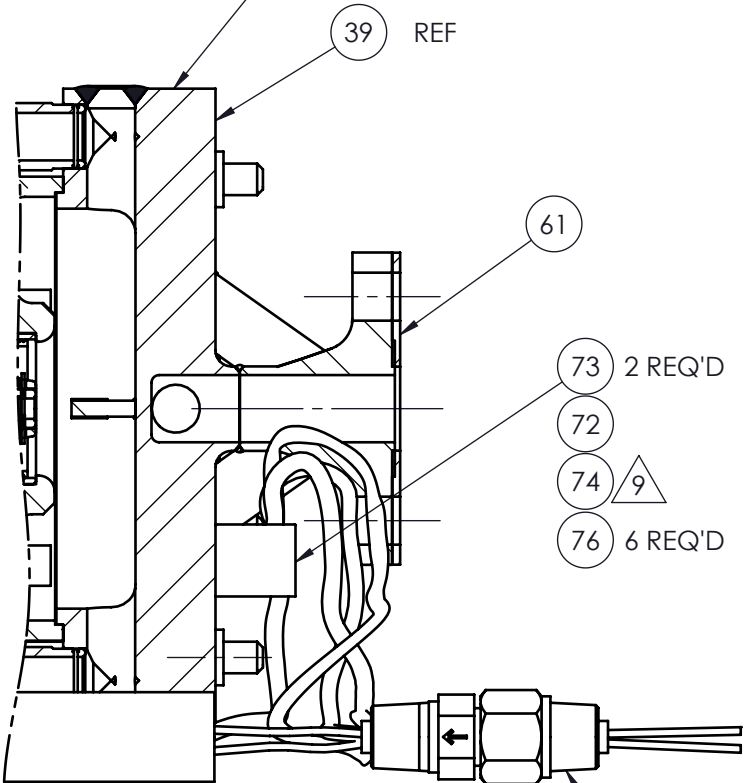
D
C
B
A

D
C
B
A

ALIGN, ITEM 39, SO THIS "COVER" WELD PLUG ALIGNS WITH TUBE, ITEM 20, FROM 2ND STAGE

ALIGN, ITEM 39, SO THIS "COVER" WELD PLUG ALIGNS WITH TUBE, ITEM 20, FROM 2ND STAGE

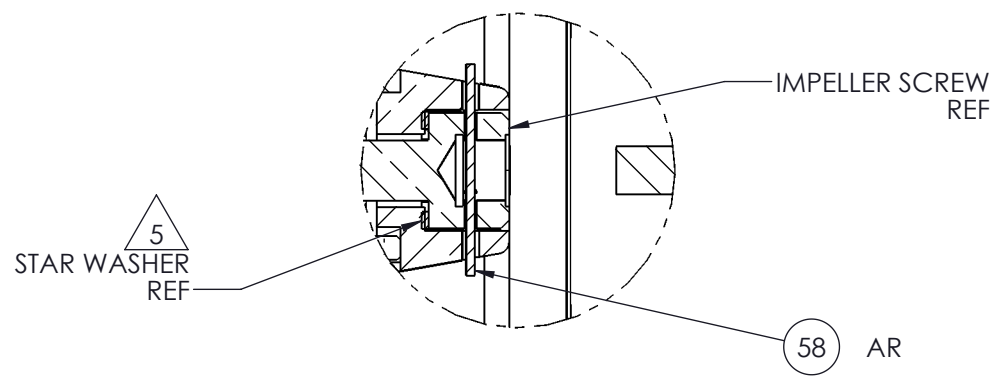
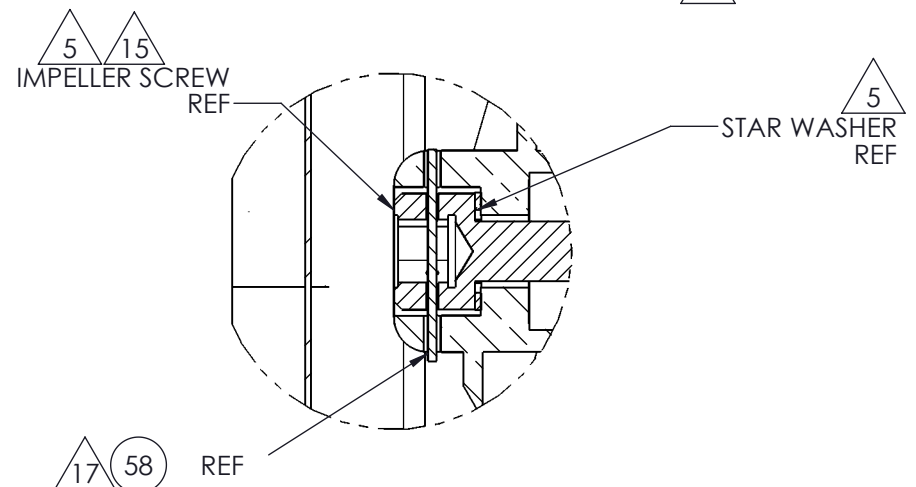
ALIGN, ITEM 39, SO THIS "COVER" WELD PLUG ALIGNS WITH TUBE, ITEM 20, FROM 2ND STAGE



-3 & -4 ASSEMBLIES

-2 ASSEMBLY

-1 ASSEMBLY



**DETAIL D
SCALE 1:1**

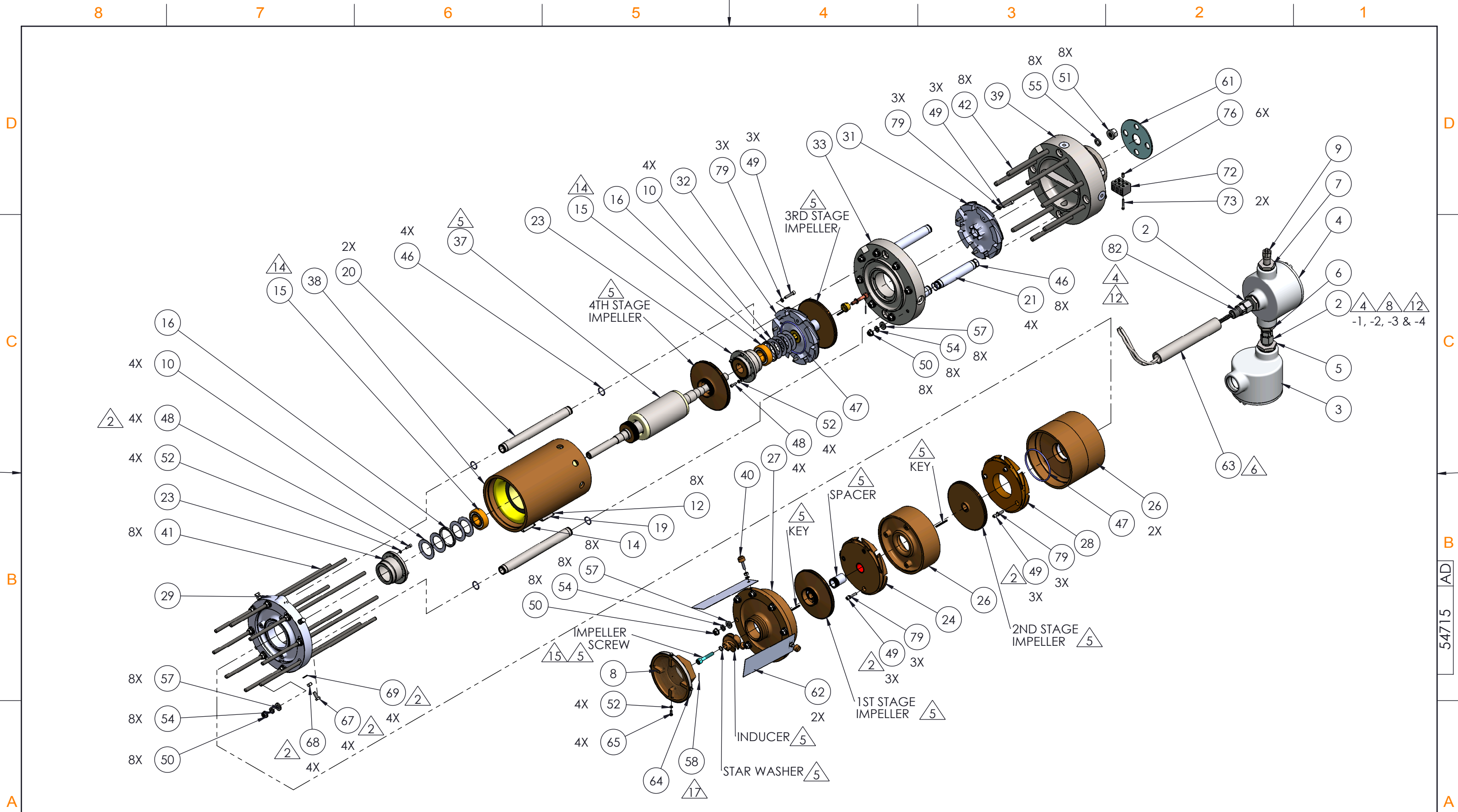
**DETAIL E
SCALE 1:1**

THIS DOCUMENT CONTAINS CONFIDENTIAL AND PROPRIETARY INFORMATION. NEITHER THE DOCUMENT NOR THE INFORMATION THEREIN IS TO BE REPRODUCED, DISTRIBUTED, USED OR OR DISCLOSED EITHER IN WHOLE OR PART, EXCEPT AS SPECIFICALLY AUTHORIZED.			
DWG. NO. B 15275	FSCM NO.	DWG. NO. 54715	REL. DATE 5/21/97
SCALE 1:3,5			SHEET 4 OF 5

8 7 6 5 4 3 2 1

54715 AD





<small>THIS DOCUMENT CONTAINS CONFIDENTIAL AND PROPRIETARY INFORMATION. NEITHER THE DOCUMENT NOR THE INFORMATION THEREIN IS TO BE REPRODUCED, DISTRIBUTED, USED OR DISCLOSED EITHER IN WHOLE OR PART, EXCEPT AS SPECIFICALLY AUTHORIZED.</small>			
DWG. NO. B 15275	FSCM NO.	DWG. NO. 54715	INDUSTRIES COMPANY
SCALE 1:8	REL. DATE 5/21/97	SHEET 5 OF 5	

8

7

6

5

4

3

2

1

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
E	SEE ECN	7/24/12	VU/SD

NOTES: UNLESS OTHERWISE SPECIFIED.

1. REFERENCE TOP ASSEMBLY DRAWING AND APPLICABLE DASH NO. TO DETERMINE ITEMS DEPICTED.

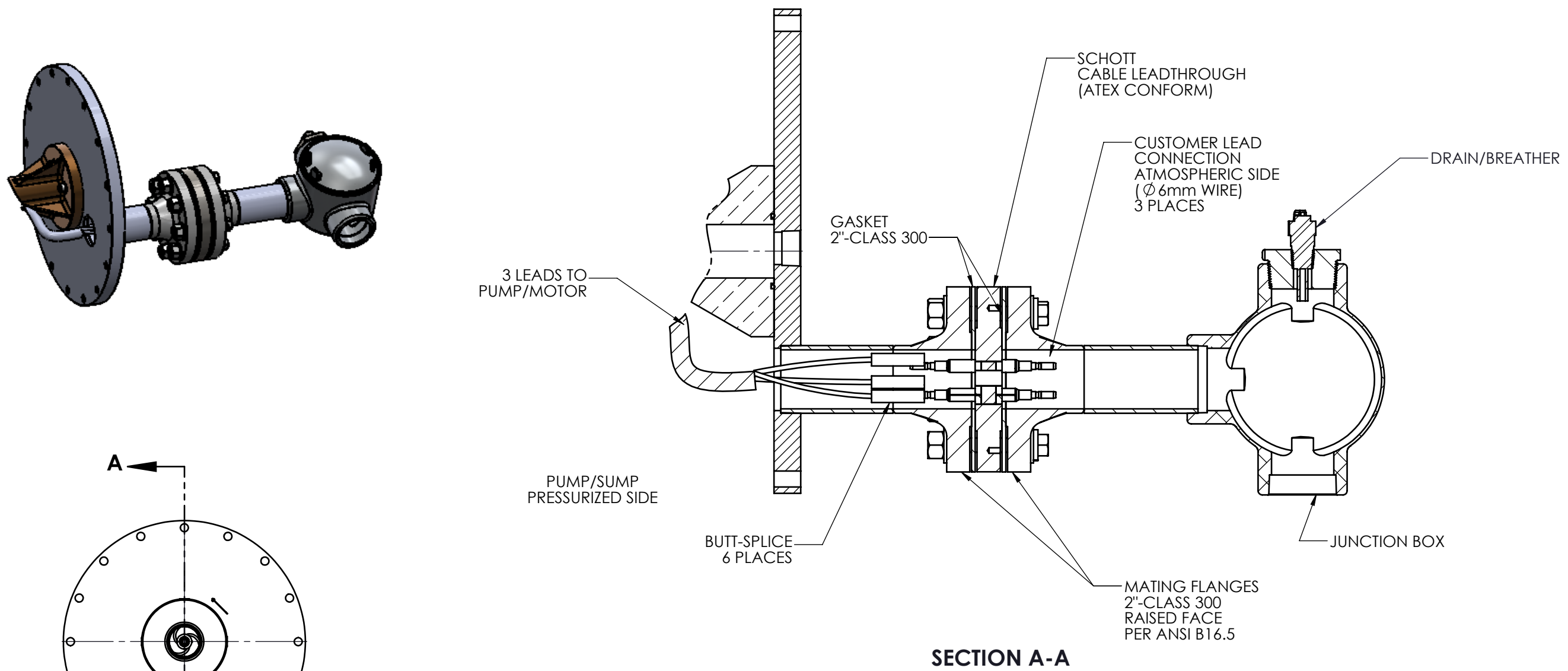
2. DIMENSIONS ARE IN INCH [mm].

3. DIMENSIONS MAY BE ±1/4" [6].

4. SUMP, PIPING, JUNCTION BOXES & CONNECTIONS ARE TO BE SUPPLIED BY THE CUSTOMER UNLESS OTHERWISE SPECIFIED.

5. SEE MOTOR NAMEPLATE TO DETERMINE VFD SETTINGS TO OBTAIN VOLTS/CYCLE RATIO NOTED BY VOLTAGE AND Hz ON NAMEPLATE.

6. SUMP IS TYPICALLY SUPPLIED BY CUSTOMER. SUMP AND COVER TO BE CONFIGURED SIMILAR TO 55282. SUMP DIMENSIONS & CONFIGURATION MAY VARY BY MANUFACTURER.



SECTION A-A

ALTERNATE ATEX CONFORM CABLE LEADTHROUGH SHOWN

UNLESS OTHERWISE SPECIFIED: A.) INTERPRET DRAWING PER ANSI Y14.5 B.) REMOVE ALL BURRS AND SHARP EDGES C.) SURFACE ROUGHNESS PER ANSI B46.1 D.) THREADS PER ANSI B1.1 FOR UNIFIED SCREW THREADS ANSI B2.1 FOR PIPE THREADS E.) MACHINED FILLET RADII: R F.) WELD SYMBOLS PER AWS A2.4	UNLESS OTHERWISE SPECIFIED DIMENSION ARE IN INCHES TOLERANCES ON: FRACTIONS DECIMALS ANGLES ±1/8" ±.10 ±.03 ±.010 ±1°	THIRD ANGLE PROJECTION		
		DRAWN CHECKED DESIGN STRESS AERODYN./HYDR PROJECT DESIGN ACTIVITY MGF. ENGRG. QA	DATE 17APR97	
EST. WT. LBS. ACT. WT.	FINISH SIMILAR TO D-60960/D-55805 PARENT DWG. NO. 54715	DWG. SIZE B	FSCM NO. 15275	DWG. NO. D-54715
THIS DOCUMENT CONTAINS CONFIDENTIAL AND PROPRIETARY INFORMATION. NEITHER THE DOCUMENT NOR THE INFORMATION THEREIN IS TO BE REPRODUCED, DISTRIBUTED, USED OR OR DISCLOSED EITHER IN WHOLE OR PART, EXCEPT AS SPECIFICALLY AUTHORIZED.		SCALE 1:4	REL. DATE 5/9/97	SHEET 1 OF 2

8

7

6

5

4

3

2

1

D

C

B

A

D

C

B

A

D-54715

8 7 6 5 4 3 2 1

D

C

B

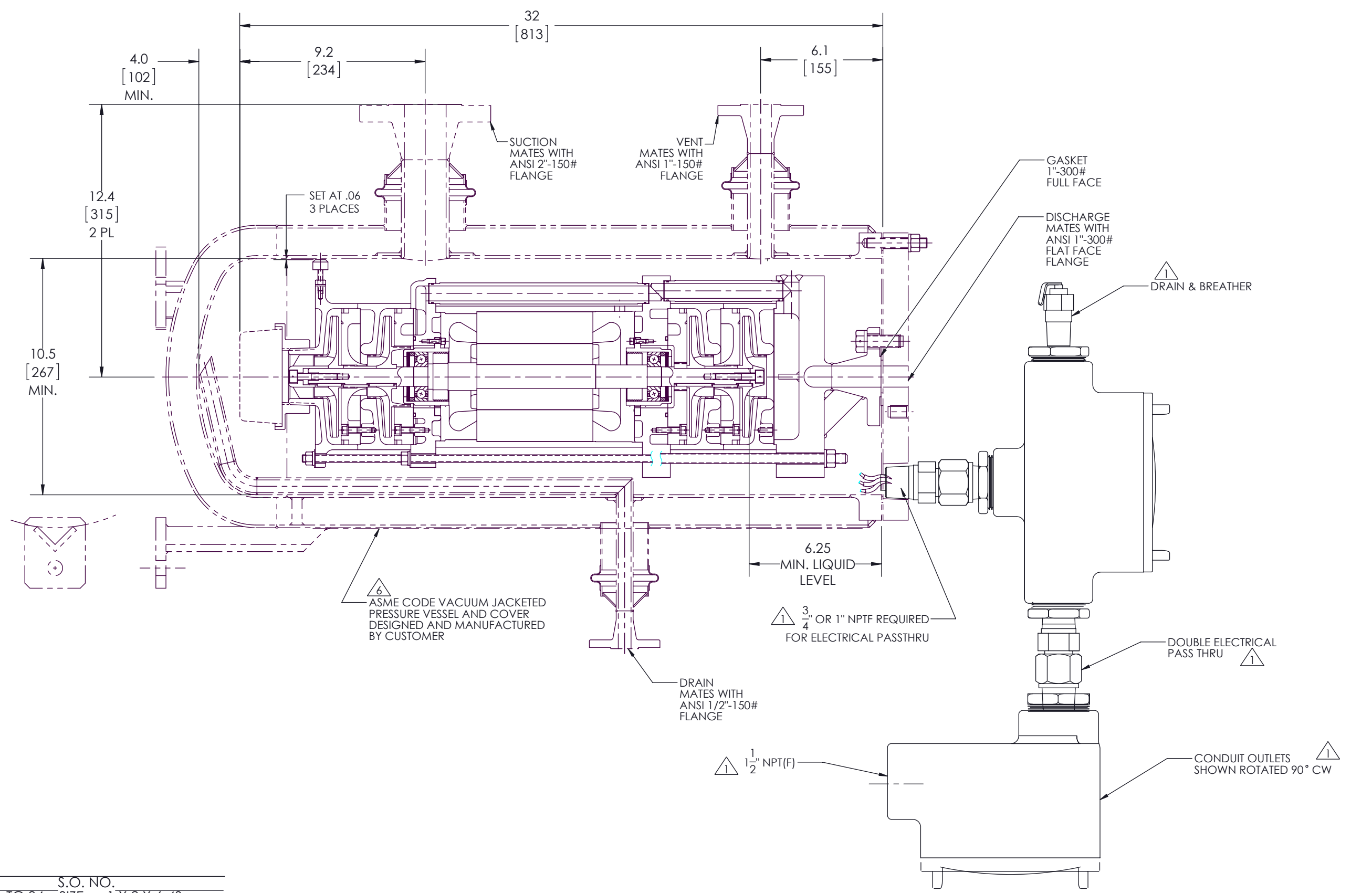
A

D

C

B


A



D-54715 E

CUSTOMER _____
 P.O. NO. _____ S.O. NO. _____
 PUMP MODEL TC-34 SIZE 1 X 2 X 6-4S
 PART NO. _____
 FLUID _____ FLOW _____ GPM(LPM) HEAD _____ FT(M).
 MOTOR HP _____
 REMARKS _____

PREPARED BY _____ DATE _____
 APPROVED BY _____ DATE _____

 <small>AGI CORPORATION</small> <small>2000 W. 10TH AVENUE</small> <small>CHICAGO, ILLINOIS 60640</small>		D-54715
THIS DOCUMENT CONTAINS CONFIDENTIAL AND PROPRIETARY INFORMATION. NEITHER THE DOCUMENT NOR THE INFORMATION THEREIN IS TO BE REPRODUCED, DISTRIBUTED, USED OR DISCLOSED EITHER IN WHOLE OR PART, EXCEPT AS SPECIFICALLY AUTHORIZED.	DWG. NO. B 15275 SCALE 1:16	FSCM NO. _____ REL. DATE 5/9/97
		SHEET 2 OF 2

8 7 6 5 4 3 2 1

NOTES: UNLESS OTHERWISE SPECIFIED

- SEE IOM MANUAL FOR MORE DETAILED INSTALLATION INFORMATION.
- VENT TO ATMOSPHERE. TO BE PIPED AWAY FROM PERSONNEL TO A CUSTOMER SPECIFIED LOCATION.
- SUCTION LINES LONGER THAN 10' SHOULD BE VACUUM JACKETED.
- DISCHARGE PIPE SIZE SHOULD BE THE SAME SIZE AS THE DISCHARGE FLANGE UP TO THE DISCHARGE CHECK VALVE (CV-1), AFTER THAT IT MAY BE ONE PIPE SIZE LARGER. THIS WILL REDUCE THE DYNAMIC PIPING LOSSES DOWNSTREAM OF THE PUMP.
- RELIEF VALVE REQUIRED DOWNSTREAM FROM THIS CHECK VALVE (CV-1).

- SUMP ASSEMBLY SHOWN AS TYPICAL ARRANGEMENT ONLY. ACTUAL SUMP AND PIPING CONFIGURATIONS MAY VARY.
- THE SUMP LIQUID LEVEL SHOULD NEVER DROP BELOW THE VENT RETURN LINE WHILE THE PUMP IS IN OPERATION. THIS WILL ENSURE THAT THE PUMP BEARINGS WILL ALWAYS BE SUBMERGED IN THE LIQUID.
- SEE DRAWING 15262 FOR TYPICAL FLOW DIAGRAM FOR MECHANICAL SEAL CENTRIFUGAL PUMP. SEE DRAWING 61405 FOR TYPICAL FLOW DIAGRAM FOR LABYRINTH SEAL CENTRIFUGAL PUMP. SEE DRAWING 65869 FOR TYPICAL FLOW DIAGRAM FOR SEALLESS CENTRIFUGAL PUMP.
- INSTALL TEE FITTING FOR THERMOCOUPLE OR RTD FOR "COOLDOWN READY FEATURE". LOCATION OF TEE FITTING WITHIN 24 INCHES [610mm] FROM PUMP DISCHARGE PORT/ FLANGE CONNECTION. SEE TABLE 1 FOR INITIAL INTERLOCK SET POINT. THIS SET POINT SHOULD BE ADJUSTED IN THE FIELD ACCORDINGLY BASED ON AMBIENT AND PUMP INLET CONDITIONS.

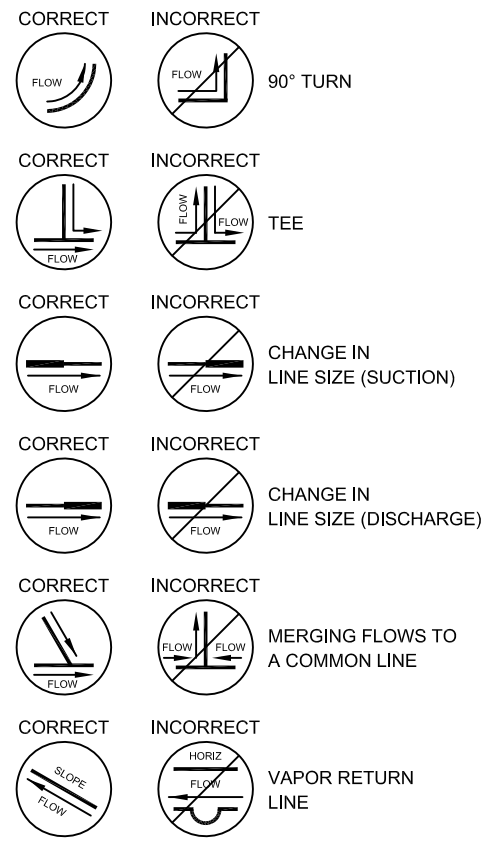
REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	C	SEE ECN	10/4/13	HR/SD

D
C
B
A

D
C
B
A

			ACD SUPPLY
TE-1	TEMP. ELEMENT	PUMP COOLDOWN READY	
S-1	STRAINER	SUCTION	
PSV-6	RELIEF VALVE	SUMP	
PSV-5	RELIEF VALVE	TANK RETURN LINE (RECIRCULATION)	
PSV-4	RELIEF VALVE	PUMP DISCHARGE	
PSV-3	RELIEF VALVE	PUMP DIFFERENTIAL PRESSURE LINE	
PSV-2	RELIEF VALVE	PUMP SUPPLY LINE	
PSV-1	RELIEF VALVE	LIQUID TANK	
PI-3	PRESSURE INDICATOR	PUMP DISCHARGE	
PI-2	PRESSURE INDICATOR	PUMP SUCTION	
PI-1	PRESSURE INDICATOR	LIQUID TANK	
P-1	PRESSURIZER	LIQUID TANK	
O-1	ORIFICE	PUMP DISCHARGE	
M-1	MOTOR		
LG	GAUGE	LIQUID LEVEL	
JB-1	JUNCTION BOX	ELECTRICAL MOTOR	
HV-14	VALVE	SUMP DRAIN	
HV-13	VALVE	VENT, TANK RETURN (RECIRCULATION)	
HV-12	VALVE	PUMP PRIMING VALVE	
HV-11	VALVE	ORIFICE METER BY-PASS	
HV-10	VALVE	FLOW METER REFERENCE, TOP	
HV-9	VALVE	FLOW METER REFERENCE, BOTTOM	
HV-8	VALVE	BLEED-OFF	
HV-7	VALVE	DISCHARGE (REGULATING)	
HV-6	VALVE	RAPID PRIMING	
HV-5	VALVE	PUMP DIFFERENTIAL PRESSURE	
HV-4	VALVE	TANK VENT	
HV-3	VALVE	TANK PRESSURIZING	
HV-2	VALVE	TANK RETURN (RECIRCULATION)	
HV-1	VALVE	TANK SUPPLY	
FI-3	FLOW INDICATOR	DISCHARGE FLOW METER	
F-3	FLEX LINE	SUMP VENT/RETURN	
F-2	FLEX LINE	DISCHARGE	
F-1	FLEX LINE	SUCTION	
DPS-1	SWITCH (OPTIONAL)	PUMP DIFFERENTIAL PRESSURE	
DPI-1	PRESSURE INDICATOR	PUMP DIFFERENTIAL	
CV-2	CHECK VALVE	SUMP VENT/RETURN	
CV-1	CHECK VALVE	PUMP DISCHARGE	

COOLDOWN READY (TABLE 1)	
FLUID	SET POINT °F (°C)
NITROGEN	-280 (-175)
ARGON	-260 (-160)
METHANE	-220(-140)

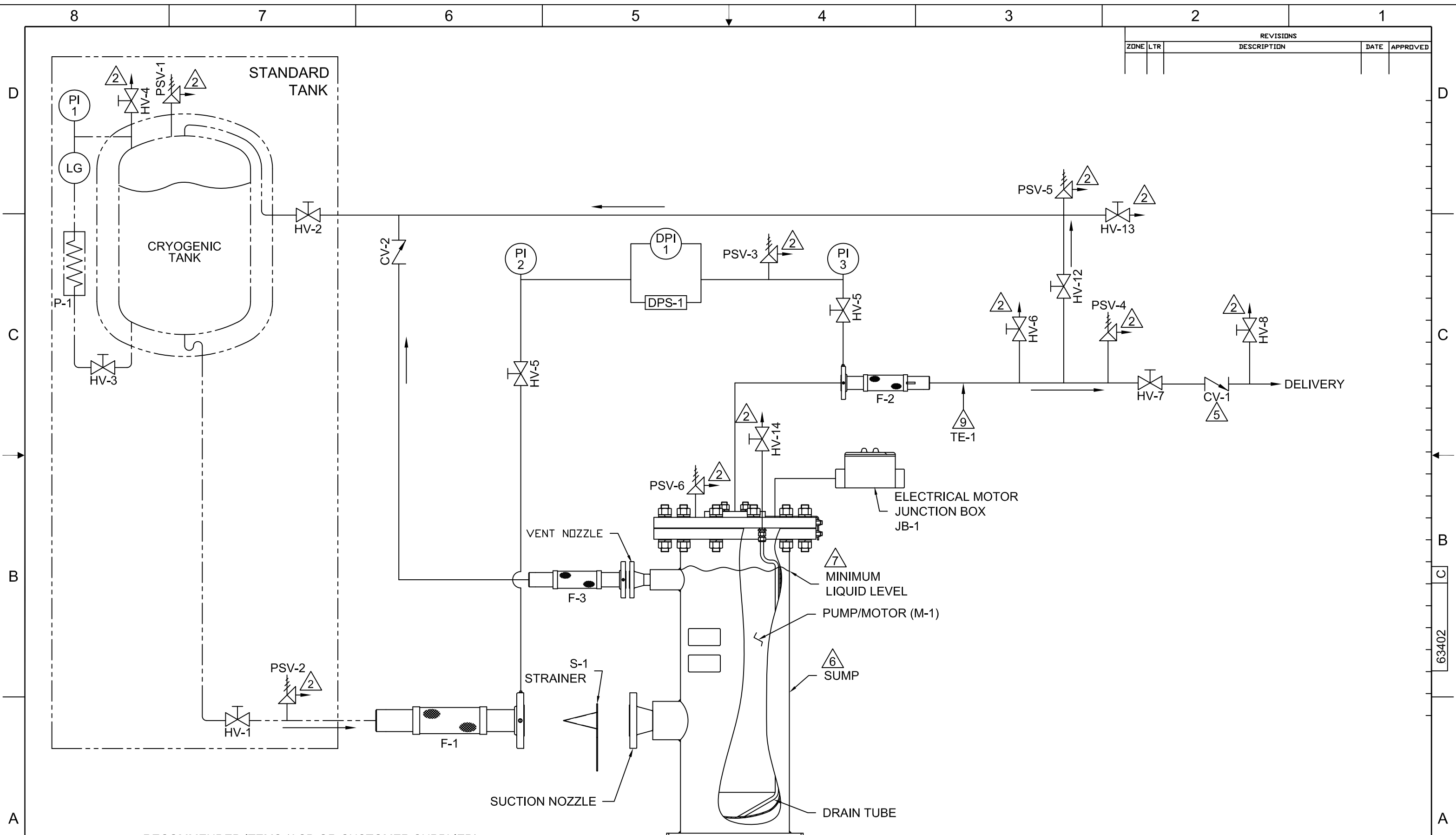


CUSTOMER _____
 P.O. NO. _____ S.O. NO. _____
 PUMP MODEL _____ SIZE _____
 PART NO. _____
 FLUID _____ FLOW _____ GPM HEAD _____ FT.
 MOTOR HP/VOLTAGE _____
 REMARKS _____

PREPARED BY _____ DATE _____
 APPROVED BY _____ DATE _____

QTY. REQD. PER ASSY.	SYM	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL AND/OR SPECIFICATION	ZONE	ITEM NO.
UNLESS OTHERWISE SPECIFIED						
A. INTERPRET DRAWING PER ANSI Y14.5						
B. REMOVE ALL BURRS AND SHARP EDGES						
C. SURFACE ROUGHNESS ✓ PER ANSI B46.1						
D. THREADS PER ANSI B1.1 FOR UNIFIED INCH SCREW THREADS						
E. MACHINED FILLET RADIUS						
F. WELD SYMBOLS PER AWS A5.4						
EST. WT. _____ ACT. WT. _____						
THIS DOCUMENT CONTAINS CONFIDENTIAL AND PROPRIETARY INFORMATION. NEITHER THE DOCUMENT NOR THE INFORMATION THEREIN IS TO BE REPRODUCED, DISTRIBUTED, USED OR DISCLOSED EITHER IN WHOLE OR PART, EXCEPT AS SPECIFICALLY AUTHORIZED.						
LIST OF MATERIAL		DRAWN K. PATEL		DATE 6/6/11		
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES IN		CHECKED JFP		DATE 6/6/11		
FRACT .X DECIMALS .XX ANGLES .XXX ± ±.10 ±.09 ±.010 ± 2°		DESIGN				
DO NOT SCALE DRAWING		STRESS				
TREATMENT		AERODYN/HYDR				TITLE TYPICAL FLOW DIAGRAM CENTRIFUGAL SUBMERGED PUMP
FINISH		PROJECT JFP		DATE 6/6/11		
SIMILAR TO 15262/61405/65869		DESIGN ACTIVITY S.DANNA		DATE 6/6/11		
PARENT DWG. NO.		MFG. ENGRG.				
GA		DWG. SIZE B		FSCM NO. 15275		DWG. NO. 63402
SCALE 1/1		REL DATE 6/8/11		SHEET 1 OF 3		

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED



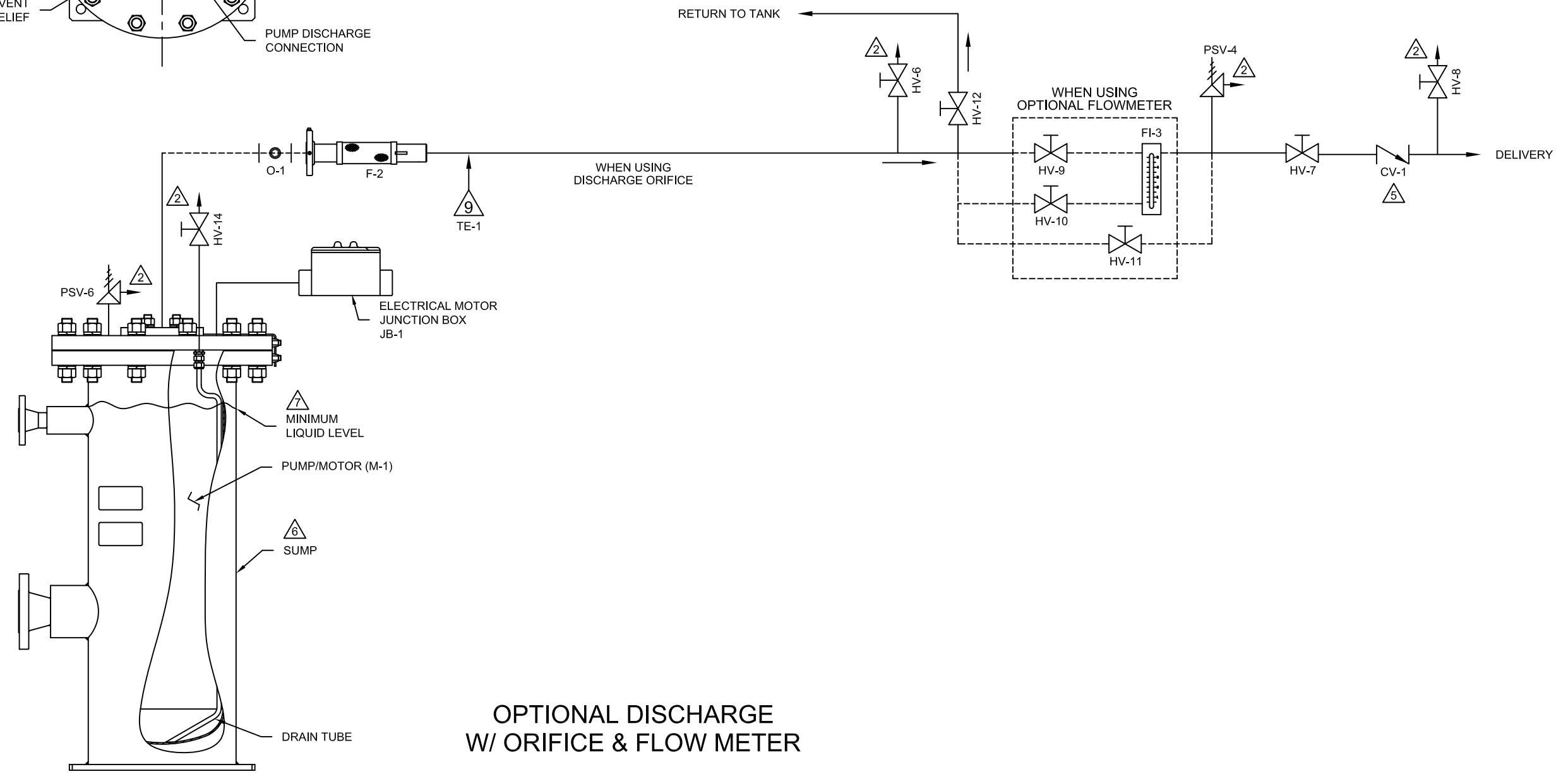
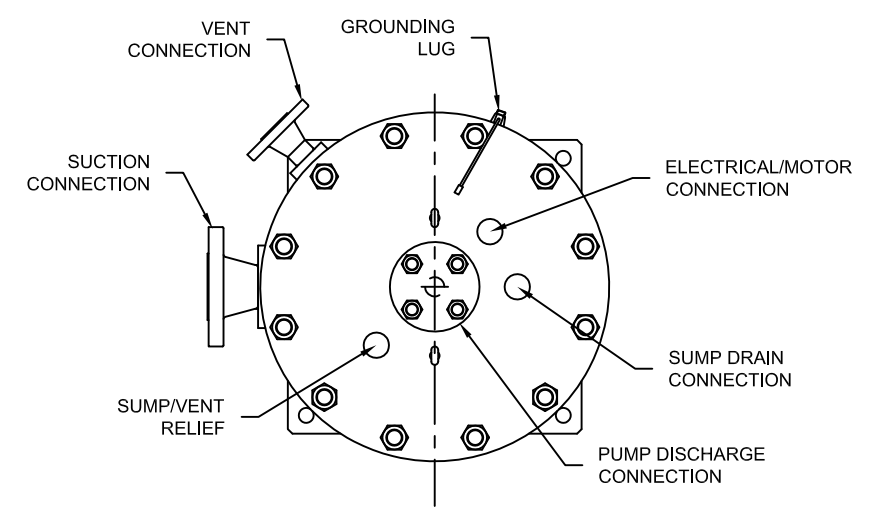
- = RECOMMENDED ITEMS (ACD OR CUSTOMER SUPPLIED)
- - - = OPTIONAL ITEMS (ACD OR CUSTOMER SUPPLIED)
- - - - - = CUSTOMER SUPPLIED ITEMS

THIS DOCUMENT CONTAINS CONFIDENTIAL AND PROPRIETARY INFORMATION. NEITHER THE DOCUMENT NOR THE INFORMATION THEREIN IS TO BE REPRODUCED, DISTRIBUTED, USED OR DISCLOSED EITHER IN WHOLE OR PART, EXCEPT AS SPECIFICALLY AUTHORIZED.

DWG. SIZE B	FSCM NO. 15275	DWG. NO. 63402
SCALE 1/1	REL DATE 6/8/11	SHEET 2 OF 3

63402

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED



OPTIONAL DISCHARGE
W/ ORIFICE & FLOW METER

THIS DOCUMENT CONTAINS CONFIDENTIAL AND PROPRIETARY INFORMATION. NEITHER THE DOCUMENT NOR THE INFORMATION THEREIN IS TO BE REPRODUCED, DISTRIBUTED, USED OR DISCLOSED EITHER IN WHOLE OR PART, EXCEPT AS SPECIFICALLY AUTHORIZED.

DWG. SIZE	FSCM NO.	DWG. NO.
B	15275	63402
SCALE	REL DATE	SHEET 3 OF 3
1/1	6/8/11	

63402



INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-12-B3
Rev. 1





INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-12-B4
Rev. 1

B4. SPARE PARTS

The following pages include a list of all available spare parts for this specific pump assembly.



INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-12-B4
Rev. 1





INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-12-B5
Rev. 1

B5. ANCILLARY EQUIPMENT (VENDOR DATA)

The following pages include all data for ancillary equipment. Accessory and optional (if any) equipment data, including vendor manuals and/or catalog information, are provided in this section.



INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-12-B5
Rev. 1





INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-12-B6
Rev. 1

B6. CERTIFICATES

The following pages include all certification documentation for this specific pump assembly.



CERTIFICATE OF ORIGIN

CUSTOMER	HANGZHOU CRYOGENIC INDUSTRIES
PURCHASE ORDER NO	SPINV140305
ACD SALES ORDER NO.	18930
DESCRIPTION	TC34 Centrifugal Pump
PART #	54715-1
SERIAL #	14189301-5
QTY	5
SPECIFICATIONS	ACD Standard

ACD, LLC declares that the goods manufactured against the above order, are products of the United States of America:

Material shipped against your purchase order has been manufactured in the U.S.A. in accordance with all customer documents required by contract as well as applicable ACD drawings, specifications, and procedures.

Products have been fabricated, inspected, assembled and tested as required in accordance with the ACD Quality System certificate no. QSC-08582 complying to ISO 9001.

Records of manufacture which contain traceability of material and evidence of acceptance by inspection and test are on file at ACD and may be examined by you or your duly assigned representative upon request, materials used in the manufacture of this item were selected for us in accordance with industry standards.

A handwritten signature in black ink, appearing to read 'Dato', written over a horizontal line.

Quality Management

June 6, 2014



CERTIFICATE OF CONFORMANCE

CUSTOMER	HANGZHOU CRYOGENIC INDUSTRIES
PURCHASE ORDER NO	SPINV140305
ACD SALES ORDER NO.	18930
DESCRIPTION	TC34 Centrifugal Pump
PART #	54715-1
SERIAL #	14189301-5
QTY	5
SPECIFICATIONS	ACD Standard

The material delivered conforms to the requirements specified in your purchase order, ACD engineering drawings, procedures and listed specifications. There are no governing codes or standards that apply to our pumps.

Part was installed following the instructions issued by the manufacturer.

The ACD standard practice for determining wall thickness, flange thicknesses and other stressed parts are calculated utilizing SEP (Sound Engineering Practices).

Products have been fabricated, inspected, assembled, and tested as required in accordance with the ACD quality system complying with ISO-9001-2008.

Records of manufacture which contain traceability of material and evidence of acceptance by inspection and test are on file at ACD and may be examined by you or your duly assigned representative upon request. Materials used in the manufacture of this item were selected for use in accordance with industry standards.

Quality Management

June 6, 2014

CENTRIFUGAL PUMP TEST DATA RECORD

SO	18930	MODEL	TC34	PUMP	DESIGN	TEST	FIELD	
WO	477830	SIZE	1X2X6-4VSL	SPEED				rpm
CUSTOMER	Hawazhan Cyo	P/N	S1715-1	FLOW				gpm
PROJECT	SPJNV1A0305	S/N	189189302	HEAD				ft
DATE	6-2-19	IMP. DIA.	6.00	POWER				hp
TECHNICIAN	R. MARTINEZ			EFFICIENCY				%
		START TIME		NPSHR				ft
WITNESS		STOP TIME		SG				-
		PIPE DIA	2	VOLTAGE				V
ENGINEER		ORIFICE DIA	1.38	CURRENT				A
		ORIFICE K	38.7	FREQ.				Hz

PLEASE REFER TO PUMP DATA SHEET FOR TEST INSTRUCTIONS

MEASURED DATA

POINTS	FLOW DP psid	DELTA P psi	P SUCT psig	P DISCH psig	MOTOR SPEED rpm	MOTOR VOLTAGE V	MOTOR CURRENT A	FREQ. Hz	MOTOR POWER % of OL	P VAPOR psig	NPSHA in H2O	TIME
1	3.1	281	28	309		760	44.6	89	649			
2												
3												
4												
5												
6												
7												
8												
9												
10												

SEAL GAS DATA (if re)

POINTS	PRIMARY GAS				SECONDARY GAS				MIXTURE OUT		TIME	
	PRESS SUPPLY psig	PRESS SEAL psig	PRESS REF psig	FLOW SCFM	PRESS SUPPLY psig	PRESS SEAL psig	PRESS REF psig	FLOW SCFM	FLOW SCFH	TEMPERATURE °F		
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												

ADDITIONAL DATA (IF REQ')

	NOISE		TEMPERATURE (see data sheet)			
	dba	T1				°F
N1						
N2						
N3						
	VIBRATION					
	mils	T1				°C
V1						
V2						
V3						

Motor Oil Used

Comments/Notes

JMC 6/3/19



INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-12-B6
Rev. 1





INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-12-B7
Rev. 1

B7. DECLARATION OF INCORPORATION

The following page provides a copy of the Declaration of Incorporation for this specific pump assembly.



INSTRUCTION HANDBOOK
For
Installation, Operation & Maintenance

M-12-B7
Rev. 1

