TEIKOKU USA INC
CHEMPUMP

ALP™
ADVANCED LOW-PROBABILITY AMMONIA TRANSFER PUMP

TYPE-F (Plan 1-SD)

0104QM Multi-Stage Pressurized Circulation Pump

INSTRUCTION MANUAL

for Installation, Operation, and Maintenance

IOM-23-ALP1SD-1122 November 2022

Introduction

Thank you for purchasing the Advanced Low-Probability Ammonia Transfer Pump (ALP™).
Please carefully read this instruction manual and all Safety Warnings prior to use.

Safety Terms

Please pay close attention to these terms. When you see them in this manual, read the information thoroughly and follow the instructions given.

Attention!

Indicates careful attention is required. The instruction includes protective information for the device and product.

Caution!

Ignoring this warning can cause personal injury and/or damage to the device and product.

Hazard!

Ignoring this warning can cause serious injury or even death. It can also be used to alert against unsafe practices.

NOTE: *Information included in NOTES gives additional helpful information and recommendations.*

Applicable Standards and Regulations

The Type-F (Plan 1-SD) pressurized circulation ALP multi-stage pump conforms to the following standards:

1. Japanese Industrial Standard (JIS)
2. Japan Electrical Manufacturers' Standard (JEM)
3. American Society of Mechanical Engineers (ASME) B-16.5
4. Canadian Standards Association (CSA): UL 778 CSA 22.2 No 108
5. International Institute of Ammonia Refrigeration (IIAR): ANSI/IIAR 2-2014

Product Warranty Period

This product is warranted for two years from date of delivery. Please refer to Teikoku USA's Terms and Conditions of Sale for additional warranty coverage and restrictions.

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Safety Warnings

Important:
Before operating the canned motor pump, read these Safety Warnings and this entire Instruction Manual to avoid improper operation.
It is essential for your safety and to avoid disaster.

Attention!

Do not run dry!

If the pump is allowed to run dry, the bearings, sleeves, and other components could be damaged and serious overheating of the motor windings can occur.

Attention!

Avoid rapid temperature changes!

Large changes in temperature must be avoided. Rapid changes can cause leaks to occur in gaskets. Published procedures for proper heating and cooling must be followed. If published procedures are not available, check with Teikoku before operating the equipment.

Caution!

Hot – Do not touch!

Motor and pump can be hot, even when pumping cold liquids.

Caution!

If motor trips, do not restart before determining the cause!

Restarting the motor before ascertaining the cause may result in excessive heat, causing pump or motor failure.

Hazard!

Do not remove internal bolts in terminal box.

If it is necessary to remove the terminal box for any reason, first loosen the bolts by 2 or 3 turns to check if any internal pressure or liquid is present. You must take measures if the possibility exists that the gas or liquid is toxic or hazardous to personnel or the environment.

Hazard!

Do not remove any bolts on pump, motor, or drain plugs!

The internal pressure can be higher than the atmosphere. Ensure that the pump and motor are properly de-pressurized and decontaminated prior to performing any work. Proper protective measures must be taken if the possibility exists that the gas or liquid is toxic or hazardous to personnel or the environment.

Hazard!

Always assume that there is liquid left in the pump!

There is always the possibility that residual liquid could remain in the pump and motor in spite of thorough decontamination. Pay particular attention to the clearance between the shaft and the impeller, bearings, sleeves, bearing housings, internal bolting and gaskets. You must take adequate precautions to protect personnel and the environment if the liquid could be considered hazardous.

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Overview

Teikoku's revolutionary Advanced Low-Probability Ammonia Transfer Pump (ALP) sets a new industry standard for operating efficiency and safety in ammonia transfer systems. Utilizing a smaller and more powerful motor than those typically coupled to fixed-speed pumps, Type-F (Plan 1-SD) pressurized circulation ALP multi-stage pumps rotate faster in a more compact package with enhanced rotor-dynamic effects. This increases reliability with the same secondary containment features synonymous with all Teikoku pump solutions. Driven by any commercially available variable frequency drive (VFD), Type-F (Plan 1-SD) pressurized circulation ALP multi-stage pumps feature advanced hydraulics for low flow, high head, low NPSHr performance that can be tuned to variable process requirements.

The pump is manufactured in accordance with the latest industry requirements governing design for safety and containment. Refer to the data package submitted in response to the order covering the supply of this pump for the details of rating and specifications, as well as any *Inspection Certificates of Performance* that may have been supplied in response to order requirements.

Please keep this manual with the drawings and inspection certificates.

1. General Information

IMPORTANT! *NRTL certification per UL 778 and CAN/CSA C22.2 No. 108-14 requires operation with oil filled stator winding*

1.1 General Design and Operation

The Type-F (Plan 1-SD) pressurized circulation ALP multi-stage pump is a combined multi-stage centrifugal pump and squirrel cage induction electric motor designed and produced as a single hermetically-sealed unit. The pump impellers are enclosed and mounted on one end of the motor rotor shaft, which extends from the motor section into the pump impeller casings. The motor rotor is hermetically sealed or "canned" with a corrosion resistant, non-magnetic, alloy shell to isolate it from contact with the pumped liquid being circulated through the liquid cooled motor assembly. The rotating rotor and shaft assembly and it's supporting thin film liquid lubricated bearings, operate immersed in the circulating liquid, functioning as both a motor coolant and bearing lubricant. The motor stator winding is also canned with a corrosion resistant, non-magnetic, alloy liner, to simultaneously isolate it from the same circulating liquid.

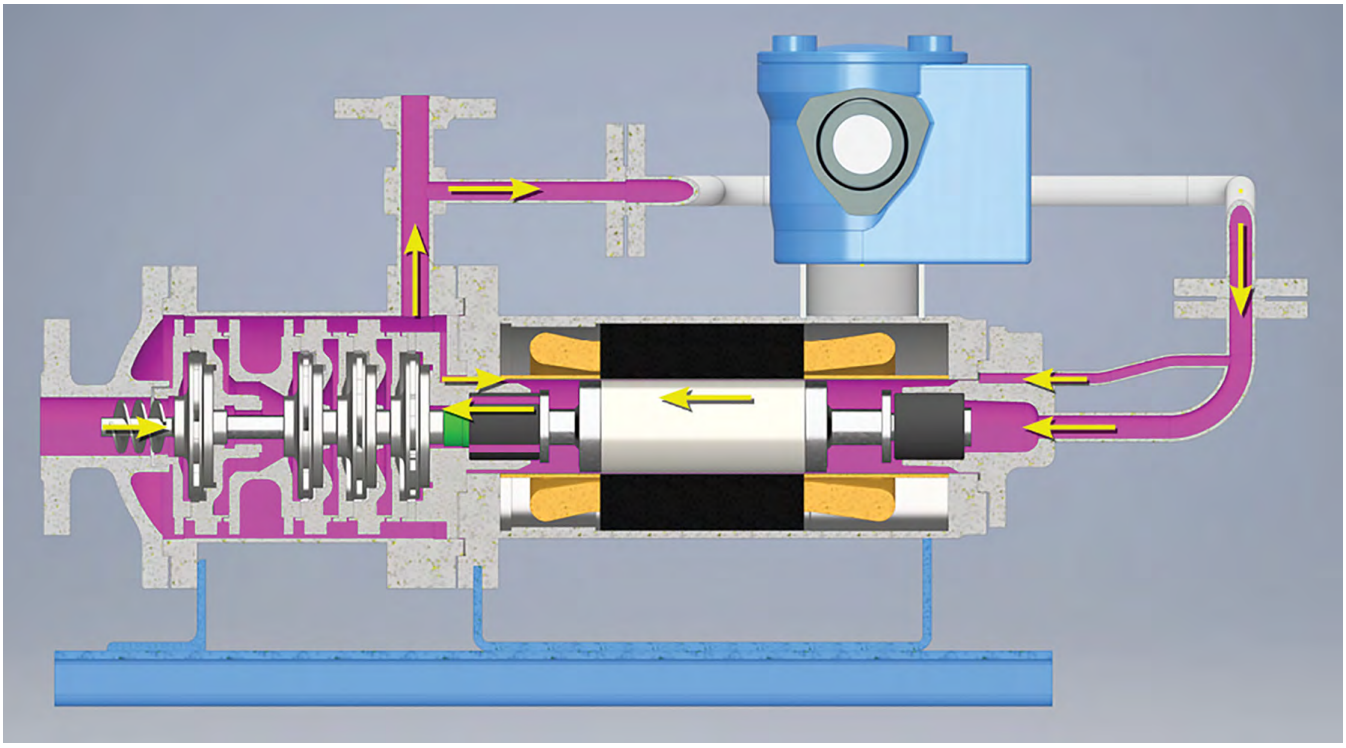
The Type-F (Plan 1-SD) pressurized circulation ALP multi-stage pump is characterized by the use of an external circulation pipe to channel a portion of pump discharge flow of highly volatile fluids and liquefied gases into the rotor cavity of the motor. Through flow and pressure control mechanisms designed into canned motor pump assembly, the circulating fluid is pressurized above its vapor pressure to assure required motor cooling and the establishment of the bearing liquid film for rotating element support.

The flow path of the Type-F (Plan 1-SD) pressurized circulation ALP multi-stage pump is shown in Figure 1-1 and Figure 1-2. The circulating liquid is channeled from the discharge flange to the motor section through the circulation pipe. The circulating liquid first lubricates the rear bearing, then passes over the rotor, cooling the motor, moves forward to lubricate the front bearing and then exits the motor section through the front bearing housing. The fluid returns to the high-pressure region of the final stage impeller for joining the pump discharge flow.

The Type-F (Plan 1-SD) pressurized circulation ALP multi-stage pump offers an advanced low probability machine through true secondary containment provided as a standard design feature. In the event of a primary containment can failure, the motor external shell or band assembly, which is designed for the same pressure as the pump, in conjunction with the motor's leakproof terminal plate, provides complete secondary containment. This standard feature prevents any release of the process liquid out to the atmosphere.

A standard feature of the Type-F (Plan 1-SD) pressurized circulation ALP multi-stage pump is the patented Teikoku Rotary Guardian (TRG™) bearing wear monitor. The TRG is an electrical meter that continuously monitors the condition of the bearings enabling data based preventative maintenance scheduling. For more information on the TRG see Section 2.3.1.

Figure 1-1. Type-F (Plan 1-SD) Pressurized Circulation ALP Multi-stage Pump



The Type-F (Plan 1-SD) pressurized circulation ALP multi-stage pump is a precision built unit that with proper operation and maintenance will provide years of trouble-free, leakproof service. The entire unit is mounted on a fabricated steel base cradle. Operation is unaffected by the mounting or operating position, eliminating the need for any costly alignment procedures.

1.2 Stator Assembly

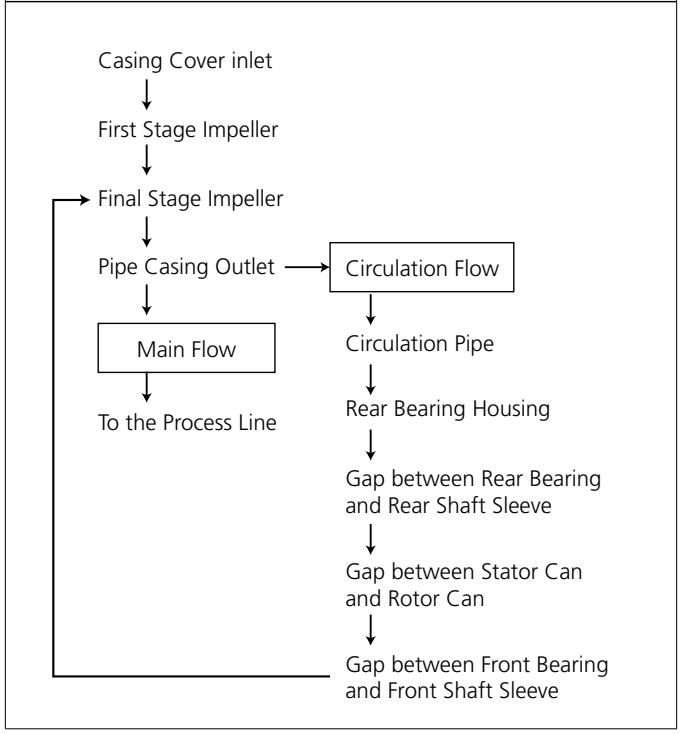
The stator assembly consists of a set of three-phase windings designed for use with Pulse Width Modulated (PWM) Variable Frequency Drive (VFD) power for 50 HZ to 120 HZ operation. Stator laminations are of low-silicon grade steel. Laminations and windings are mounted inside the cylindrical stator band. End bells, welded to the stator band, close off the ends of the stator assembly. The stator liner is, in effect, a cylindrical can placed in the stator bore and welded to the rear end bell and front end bell to hermetically seal off the windings from contact with the liquid being pumped.

Terminal leads from the windings are brought into an electrical terminal box. Motor lead wires are isolated from the users' conduit line by a leakproof terminal plate assembly mounted inside the terminal box. The design of the stator assembly in conjunction with the leakproof terminal plate assembly provides an advanced low probabilty true positive secondary containment.

1.3 Rotor Assembly

The rotor assembly is a squirrel cage induction rotor constructed and machined for use in the Type-F (Plan 1-SD) pressurized circulation ALP multi-stage pump. It consists of a machined corrosion-resistant shaft, laminated core with cast aluminum bars and end rings, corrosion-resistant end covers, and a corrosion-resistant can.

Figure 1-2. Flow Path



The rotor end covers are welded to the shaft and also to the rotor can which surrounds the outside of the rotor, thus hermetically sealing off the rotor core from contact with the liquid being pumped.

The impellers are keyed to the shaft and held in place with a lock bolt and lock washer. The shaft is fitted with replaceable shaft sleeves and thrust collars. These parts are pinned or keyed to prevent rotation. Axial movement is restricted by the thrust collars contacting the face of the front and rear motor bearings.

1.4 Liquid Film Journal Bearings

The liquid film journal bearings for the Type-F (Plan 1-SD) pressurized circulation ALP multi-stage pump are carbon graphite as standard and are machined with special helix grooves through the bore to assure adequate liquid circulation at the journal area. Each liquid film journal bearing is manufactured to close tolerances for a high degree of concentricity and is held in a bearing housing by a retaining screw. Liquid film journal bearings are easily replaced by removing the retaining screw and sliding the bearing from its housing.

1.5 Thrust Collars and Shaft Sleeves

All Type-F (Plan 1-SD) pressurized circulation ALP multi-stage pump models are equipped with thrust collars, providing a replaceable surface against which axial loads can be carried during process upset conditions. The shaft is also fitted with replaceable shaft sleeves. Both the thrust collars and shaft sleeves are constructed of 316SS with a Stellite wear surface for long life. These parts are pinned or keyed to prevent rotation.

1.6 Internal Cooling Flow

Flow paths of the Type-F (Plan 1-SD) pressurized circulation ALP multi-stage pumps are shown in Figure 1-1 and Figure 1-2. The circulating liquid is channeled into the motor section by the circulation pipe connected to the discharge flange. The circulating liquid lubricates the rear liquid film journal bearing, passes over the rotor core cooling the motor, lubricates the front liquid film journal bearing and then returns to the main flow at the inlet of the final stage impeller. The flow rate is controlled by a restriction orifice mounted in the circulation pipe.

1.7 Automatic Thrust Balance

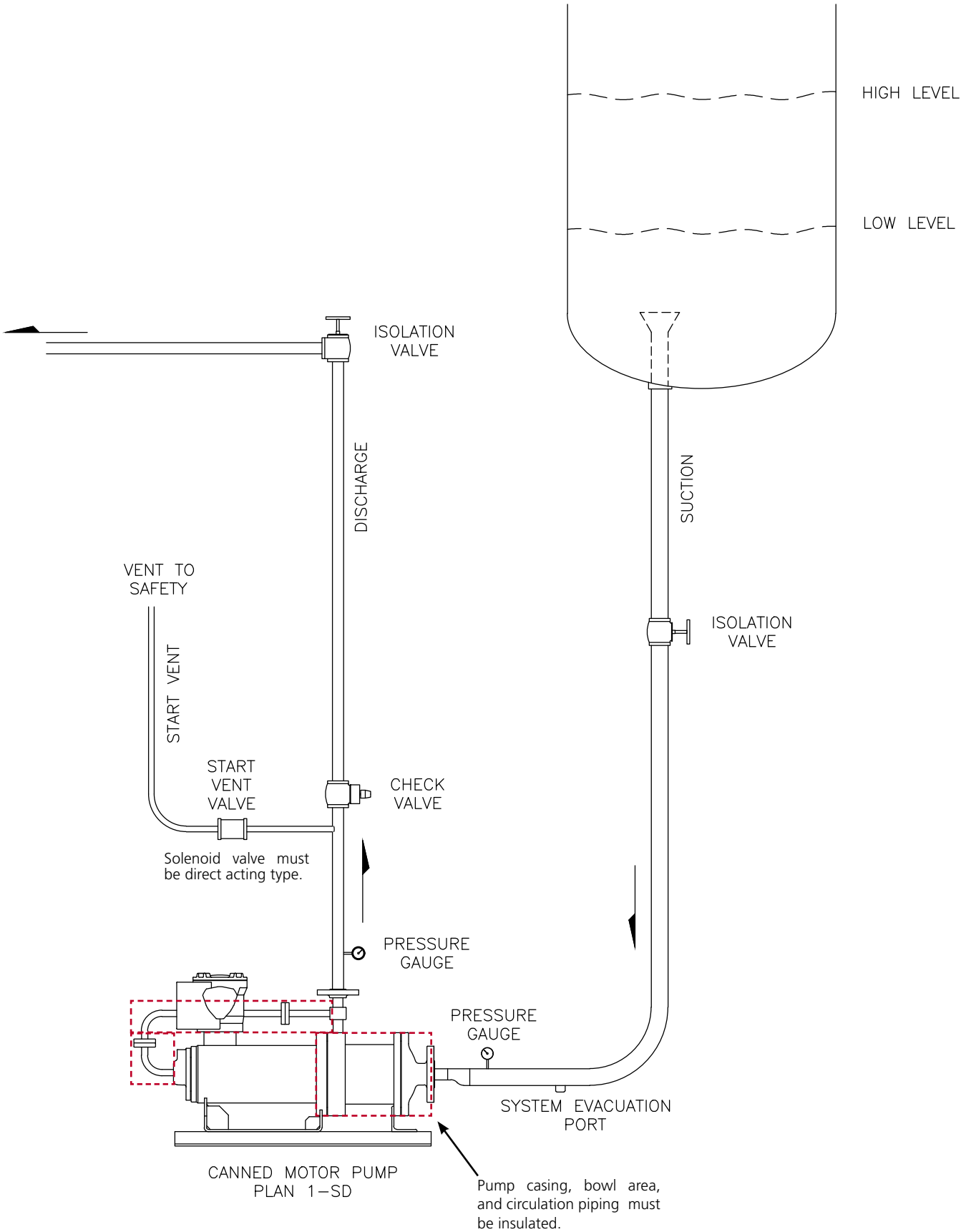
Based on hydraulic principles, Type-F (Plan 1-SD) pressurized circulation ALP multi-stage pump automatic thrust balance is accomplished by the pressure of the pumped liquid itself, operating in a balance chamber at the front and rear of the impeller.

When a change in load shifts the position of the impeller away from the balance condition, there is an equalizing change of hydraulic pressure in the balance chamber, which immediately returns the impeller-rotor assembly to the balanced position.

1.8 ALP Pump NH_3 Transfer System Requirements

Figure 1-3 shows a typical anhydrous ammonia transfer system setup to support a Type-F (Plan 1-SD) pressurized circulation ALP multi-stage pump for installation, commissioning and operation.

Figure 1-3. Typical NH_3 Transfer System Requirements



2. Installation

2.1 Receipt Inspection

1. Avoid rough handling during loading, transportation and unloading.
2. Visually inspect the shipping container for evidence of damage during shipment.
3. Check unit to see that suction, discharge, and any other connections are covered.
4. Inspect the suction, discharge and any other connections gasket seating surface to be certain that they are clean of foreign matter and free from nicks, gouges, and scratches.
5. Check all nameplate data against shipping papers.
6. Take care not to damage circulation pipe.

2.1.1 Storage Note

In situations where a Type-F (Plan 1-SD) pressurized circulation ALP multi-stage pump is to be stored for a period of time prior to installation and where the climate experiences wide temperature changes and high humidity, the terminal box, suction and discharge flange, and any other openings must be sealed to prevent moisture from entering the internals of the pump. Teikoku's long term storage procedures are available upon request.

2.2 Structural

The pump design and construction eliminates the necessity of aligning the pump and motor. The pump should be supported from the mountings provided. It should be mounted in such a way as to have its weight properly supported. Suction and discharge piping must be properly supported and aligned so that no strain is placed on the pump casing.

1. Remove burrs and sharp edges from flanges when making up joints.
2. When connecting flanged joints, be sure inside diameters match within 1/16" so as not to impose a strain on the pump casing.
3. Use pipe hangers or supports at intervals as necessary.

2.2.1 Pump Location

Locate the pump as close as possible to the liquid supply with a positive suction head. Location of the pump and arrangement of the system should be such that sufficient Net Positive Suction Head (NPSH) is provided over vapor pressure of the liquid at the pump inlet. NPSH requirements at the design point are stated on the pump order data sheet.

Note: *Experience has proven that most pump troubles result from poor suction conditions including insufficient NPSH. The suction line must have as few pressure drops as possible and available NPSH MUST be greater than required NPSH.*

Depending on job conditions, available NPSH can sometimes be increased to meet the NPSH required by the pump for satisfactory operation. NPSH can be tailored by changes in the piping, in liquid supply level, and by several other methods. Refer to Appx. E. Troubleshooting.

2.2.2 Mounting and Alignment

Base plate assemblies are offered on all models. Simply set the pump on a foundation strong enough to support its weight. There is no need to bolt down or grout a Type-F (Plan 1-SD) pressurized circulation ALP multi-stage pump.

Be sure that the suction and discharge piping is properly aligned so that no strain is placed on the pump casing by out-of-line piping.

2.2.3 Piping Data

Observe the standards of the Hydraulic Institute and International Institute of Ammonia Refrigeration when sizing and making up suction and discharge piping. Refer to Figure 1-3 and Appx. D piping layout for multi-stage pressurized circulation pump and follow these procedures:

1. Remove burrs and sharp edges when making up joints.
2. When using flanged joints, be sure inside diameters match properly. When gasketing flanged joints, do not cut flow hole smaller than flange opening.
3. Use pipe hangers or supports at necessary intervals.
4. Provide for pipe expansion when required by liquid temperature.

When welding joints, avoid possibility of welding shot entering the suction or discharge line, and thereby entering the pump.

Caution!

CAUTION

Do not weld pipe when it is connected to pump.

5. Do not spring piping when making up any connections.
6. Make suction piping as straight as possible, avoiding unnecessary elbows. Where necessary, use 45-degree or long-sweep 90-degree fittings.
7. Make suction piping short, direct, and never smaller in diameter than suction opening of pump. The suction pipe should be one or two sizes larger than pump suction port, depending on piping length. The suction pipe should have 10x diameter straight run between the pump suction inlet and the first fitting.
8. Ensure that all joints in suction piping are airtight.
9. When installing valves and other fittings, position them to avoid formation of air pockets.
10. Permanently mounted suction filters are not recommended.

11. Pump casing, bowl area, and circulation piping must be insulated. Do not insulate motor section of pump.

It is extremely important to design and size the suction system to minimize pressure losses and to be sure that the pump will not be starved for liquid during operation. NPSH problems are a result of improper suction systems.

The suction pipe should be one or two sizes larger than pump suction port, depending on piping length. Use the largest pipe size practical on suction piping and keep piping short and free from elbows, tees or other sources of pressure drop.

If elbows, tees or valves must be used, locate them 10 pipe diameters upstream from the pump suction inlet. When reducing to pump suction port diameter, use eccentric reducers with flat side on top to avoid air pockets.

A vent line back to the suction vessel is required in the discharge pipe. The connection for the vent line in the discharge pipe must be between the pump discharge flange and the first block valve and/or check valve. Install a block valve in the vent line. When a solenoid valve is used for the start vent, the solenoid valve should be the direct acting type. Program the solenoid valve to be open when the pump is off and closed when the pump is on. Refer to Appx. D piping layout for the Type-F (Plan 1-SD) pressurized circulation ALP multi-stage pump.

Figure 2-1. Teikoku TRG Bearing Wear Monitor

If discharge pipe length is normal, pipe diameter can be the same size as the pump discharge port diameter. If discharge piping is of considerable length, use one or two size larger diameter pipe.

If the pump is to discharge into a closed system, an elevated tank or if there are multiple pumps connected together, place a check valve in the discharge line close to the pump.

NOTE: *Install properly sized pressure gauges in suction and discharge lines between the pump and the first block and/or check valve so that operation of the pump and system can be easily observed. Should cavitation, vapor lock, or unstable operation occur, widely fluctuating discharge pressures will be observed. Such gauges provide a positive means of determining actual system conditions and can be used to great advantage in evaluating system problems.*

2.3 Electrical and Instrumentation

2.3.1 TRG Bearing Wear Monitor

The TRG is an electrical meter that continuously monitors the condition of the bearings. The TRG is mounted on the electrical junction box as standard.

The TRG meter operates on the principle of induced voltage. There are two TRG coils located inside the stator 180° apart. A magnetic field is created in the stator by current flowing through the stator windings. In addition, a magnetic field is created by induced currents in the rotor. When the rotor is perfectly centered in the stator, the two magnetic fields are essentially balanced. When bearing wear occurs and the gap between the rotor and stator decreases, an imbalance in the magnetic fields causes a differential induced voltage in the TRG coils. This differential voltage is indicated on the TRG voltmeter.

The initial display of the TRG meter is adjusted in the Teikoku factory, but each meter will show subtle differences. To check bearing wear using the TRG meter, use the color change (Green, Yellow, Red) as a reference. If the increase of TRG readings is 0.3 or more, stop the pump and check bearings.

Table 2-1. Conditions Indicated on the TRG Meter

The TRG meter has a colored scale which is divided into three zones: Green (0 to 0.5), Yellow (0.5 to 0.75), Red (0.75 to 1)

AT TRIAL OPERATION			DURING OPERATION		
Indication	Condition	Solution	Indication	Diagnosis	User Actions
Full scale or 1-Volt	incorrect wiring	change power cable connection	Green	Good	No action
Yellow to Red	phase failure	check connection of cables	Yellow or voltage increase of > 0.3 V from initial indication	Bearings worn to caution level	Plan routine maintenance
Green	normal	connection is correct	Red or voltage increased of > 0.5 V from initial indication	Immediate maintenance required	Shutdown immediately and replace worn parts

HAZARD **Hazard!** Do not operate if TRG meter condition is RED.

The Teikoku Rotary Guardian (TRG) signal is affected by motor load. Changes in operating frequency or hydraulic load may increase or decrease signal.

Keeping records of the TRG meter reading in conjunction with motor amp readings will provide a good indication of when the pump will require maintenance.

2.3.2 Optional Inverter Operation

If commercial power is directly applied, the heat generation will increase and the motor may be damaged. Be sure to turn on the power through the inverter.

Caution!

CAUTION

Do not operate this pump without a Pulse Width Modulated Variable Frequency Drive.

Optional parts such as AC/DC reactor and a line noise filter for speed inverter is recommended.

For Type-F (Plan 1-SD) pressurized circulation ALP multi-stage pumps purchased with the Teikoku Speed Guardian (TSG) VFD and ALP Transfer Pump Controller, please see the TSG manual (A-31365) supplied with the speed controller for more details of operation. Please refer to Appx. N for the TSG layout drawing and Appx. O for the TSG wiring diagram.

Table 2-2 shows typical VFD parameter settings required to properly operate Teikoku's high-speed motor. Please refer to the manufacturer's drive-specific user manual for setting additional user parameters.

Table 2-2. Inverter Parameter Settings

Rated Motor Voltage	190V	380V
Rated Motor Current	42 Amps	21 Amps
Nominal (Base) Motor Frequency	80Hz	80 Hz
Rated Motor Power	10.8 kW	10.8 kW
Acceleration Value	5 seconds or less	5 seconds or less
Deceleration	5 seconds or less	5 seconds or less
Upper Limited Frequency	120Hz	120Hz
Lower Limited Frequency	60Hz or Start Hz	60Hz or Start Hz
Starting Frequency	See note*	See note*
V/F Control	Variable Torque	Variable Torque
PWM (Carrier) Frequency	2kHz or More	2kHz or More

***Note:** *Use system resistance curve (pressure vs. flow) and pump performance curve (head/pressure vs. flow) to select a starting frequency. Always lean toward a lower frequency if unsure of what frequency to use (this will prevent overloading of the motor). Once the pump is started, frequency can be increased to achieve required flow. Verify flow within 10-20 seconds of operation,and set drive to shut down if flow is not achieved (minimum output power setting).*

2.3.3 Optional Rotor Cavity Thermowell

Type-F (Plan 1-SD) pressurized circulation ALP multi-stage pumps can be supplied with an optional rotor cavity thermowell for user installation of an RTD or thermocouple to monitor rotor cavity temperature to indicate a lack of circulation flow. Lack of circulation flow is indicative of pump dry running conditions or a clogged circulation pipeline.

If the pump supplied is equipped with a thermowell, please refer to Appx. K for recommendations on the size and type of temperature-indicating instrument to be installed in the thermowell.

Temperature setpoints for alarm or shutdown conditions may vary from pump to pump depending on system operating temperatures. Please contact Teikoku for specific setpoint recommendations.

3. Operation

IMPORTANT! *NRTL certified per UL 778 & CAN/CSA C22.2 No. 108-14 for operation between 50 HZ to 120 HZ with Pulse Width Modulated (PWM) Variable Frequency Drive (VFD) power.*

3.1 Procedure Before Initial Start

Attention!

Before starting the pump for the first time, make sure suction and discharge piping are free of tools, nuts, bolts, or other foreign matter. Save time and money by checking before start-up.

3.2 Preparation and Trial Operation

The following devices are recommended for protection of canned motor pump:

- Over-current relay
- Leak current check relay

Teikoku can supply a special low-current relay that is useful for protecting pumps. In addition, Type-F (Plan 1-SD) pressurized circulation ALP multi-stage pumps require a liquid level sensor (switch) and method to monitor differential pressure.

3.2.1 Setting of Thermal Overload Protective Device

Set the thermal overload protective device at the rated current indicated on the nameplate. It is effective as a protecting device for canned motors to set the thermal overload protective device at as low current as possible. When operating current is far lower than rated current, set the thermal overload protective device on the operating current not the rated current. Generally, it is recommended to set the thermal overload protective device at the following values:

- Variation of voltage and load is small: operating current times 1.1
- Variation of voltage and load is big: operating current times 1.25

Attention!

Do not set the thermal overload protective device at more than the full load amps (FLA) listed on the name tag.

3.2.2 Setting of Overload Relay

Because of the rated electrical current at normal output in the canned motor is higher than that in general motors, set at the current rate indicated on the name plate and a data sheet. When operating, the electrical current is far below the rated current. Setting the relay based on the operating current and not the rated current is highly recommended.

3.2.3 Priming and Venting

Type-F (Plan 1-SD) pressurized circulation ALP multi-stage pumps are multi-stage centrifugal pumps designed to deliver required transfer rates against high differential pressures. As shown in Appx. D, a start vent connection prior to discharge line check valve is required to assure that all trapped vapors are removed from this sealess pump design.

Caution!

Startup prior to fully venting pump will result in vapor locking of the pump and lead to immediate bearing failure.

Complete priming should be carried out in the following order:

1. Verify discharge valve is 100% closed
2. Open suction valve 100%
3. Open discharge pipe start vent valve 100%

   NOTE: *Start vent valve should be open when pump is off line and closed when pump is in operation.*
4. Wait until frost or condensation forms over entire pump, motor and vent pipe.

3.2.4 Rotation Check (Teikoku Rotary Indicator TRC-1)

Centrifugal pump impellers must rotate in the proper direction to deliver rated head and capacity. The impeller must rotate in the same direction as the arrow cast on the pump casing.

Caution!

Pump and motor must be fully primed, vented, and liquid full prior to checking direction of rotation.

The Type-L TRG Meter A45 C does not provide direction of rotation. The Teikoku TRC-1 hand-held direction of rotation indicator is available from Teikoku USA. This portable device can be used to confirm the rotation of any motor. See Figure 3-1.

1. Set VFD speed to 60 Hz.
2. Verify suction valve is 100% open.
3. Set discharge valve 10% to 20% open.
4. Set start valve at 100% closed.
5. Switch on the pump for 3 to 5 seconds.
6. Check indication of TRC-1 hand-held rotation indicator. See Figure 3-1.
7. If direction of rotation is not correct, swap any two of the electrical supply leads and repeat rotation check.
8. Once direction of rotation has been verified, stop the pump and leave it for several minutes.
9. Once you have determined correct rotation, tag correctly connected main power leads, in accordance with motor lead markings.

Attention!

It is recommended that the unit be run as little as possible with a closed discharge valve in order to prevent excessive overheating of the liquid circulating within the unit.

3.3 Starting Procedure

Caution!

Do not start or operate pump unless fully primed and liquid full.

Caution!

Limit 3 starts per hour.

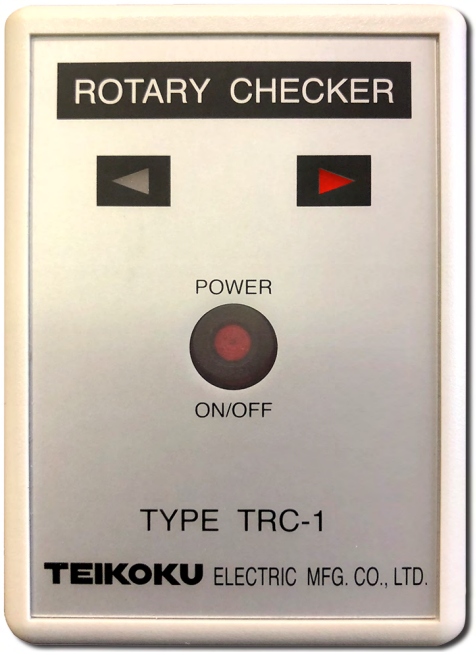
Caution!

Do not continuously cavitate the pump.

Attention!

The pump should not be allowed to run for more than one minute with the discharge valve fully closed.

Figure 3-1. Teikoku Rotary Indicator TRC-1



Attention!

Wait a minimum of 20 minutes between starts.

After priming, venting, and checking the direction of rotation, put the pump in operation as follows:

1. Set VFD speed to required Hz for desired differential pressure. For differential pressure vs speed see Appx. G and Appx. H.
2. Set the valve in the suction line to 100% open.
3. Set the valve in the discharge line to 100% open.
4. Set the start vent valve to 100% closed. When a solenoid valve is used for the start vent verify that the solenoid valve is open when the pump is off line and closed when pump is in operation.
5. Start the pump. Pump should operate with very low noise and vibrations. Excessive or abnormal noise or vibrations should be corrected immediately.
6. Adjust VFD speed as required to achieve specified flow rate.
7. Once pump is operational, check the reading of the TRG meter. Record initial reading for comparison to future readings. Check indication of TRG meter. See Table 2-1
8. During any start up sequence, caution must be exercised not to exceed full load ampere rating indicated on the nameplate.
9. If the unit has not been run for a period of two weeks or more, the following inspections should precede its operation:
   A. Check terminal box for moisture.
   B. Upon starting, check for excessive noise, vibration, erratic speeds or excessive amp draw.

Caution!

If the pump appears to be air bound as a result of the unit not being properly primed, do not continue operation. Locate and correct the conditions that prevent proper priming before attempting to start the unit.

3.4 Operation Details

The TRG meter should be checked periodically during operation. If the initial reading (TRG) was not recorded, then the color coding system shown in Figure 2-1 may be used to determine bearing changing intervals.

Hazard!

Do not operate if TRG meter condition is RED.

Discharge pressure should be checked frequently during operation. Pressure should be stable in a non-variable closed loop although the discharge pressure gauge needle may show small fluctuations.

Check motor amps at normal operations. Verify motor amps are within the expected range. Pump should never be operating above the rated full load amps listed on the name tag.

In some cases, the liquid supply may contain an excessive amount of air or gas, which will tend to separate from the liquid and remain in the passages of the pump. This results in the pump losing its prime and becoming air bound with a marked reduction in capacity. The discharge pressure gauge will show large fluctuations if this occurs. Stop the pump and vent per Section 3.2.3.

If any abnormal noise or vibration is observed, stop the pump and check for possible causes, see Appx. E. Troubleshooting

3.5 Shutdown Procedure

Shutdown as follows:

1. Stop the pump (de-energize the motor).
2. Open start vent valve.
3. If pump is to be removed from service shut discharge, suction, and start vent valves. Immediately remove refrigerant from pump.

Attention!

If the pump is to be shut down for a long period of time or if there is danger of freezing, after stopping the pump, shut all valves, and drain the entire pump and connected piping.

4. Maintenance

IMPORTANT! *NRTL certification per UL 778 & CAN/CSA C22.2 No. 108-14 requires operation with oil filled stator winding. Original supply includes inert FC-770 oil or AmpCool 240 oil fill after maintenance should be confirmed for NRTL compliant operation.*

4.1 Recommended Tools for Disassembly, Reassembly, and Inspection

Table 4.1 Recommended Tools

Size	Description
Metric socket wrenches	For pump casing, pipe casing, circulation pipe, and rear bearing housing bolts, rear shaft sleeve retaining bolt, and impeller retaining bolt.
Metric hex wrenches	For bearing retaining screws. For front bearing housing and internal multi-stage components retaining bolt.
.200" or greater travel dial indicator	To measure endplay.
Dial calipers	To measure wear of components and the "g" gap.
Torque wrench	To measure bolt tightness.
Channel-lock pliers	To bend up tabs on lock washers.

4.2 Disassembly

Caution!

CAUTION

Observe and adhere to the end user specific lock out tag out procedures.

Caution!

CAUTION

Oil filled motor. Junction box must be in upright positions when removing the junction box and terminal plate.

Attention!

ATTENTION

Match mark components to establish location during reassembly. Be careful of small parts that can be lost.

1. Disconnect the power cables from the connection box prior to disassembly.

Hazard!

HAZARD

Safety hazard to personnel will exist if power cables are not disconnected.

2. Fully close valves in discharge, suction, and utility piping.
3. Drain pump per end user specific procedures.
4. Since piping loads may exist, insert bracing under piping.
5. Remove discharge and suction flange bolting.

Hazard!

HAZARD

Always assume that there is liquid left in the pump.

6. Remove anchor bolting in order to slide entire pump including casing out of piping. Transport pump to maintenance shop.
7. Match mark external components.
8. Remove circulation pipe bolting. Remove circulation pipe, orifice plate, and gaskets.
9. Remove front support foot.
10. Remove casing bolts and slide casing off. Be careful not to allow the casing to bind to or drop onto the inducer. Be careful not to spill any remaining liquid that may have been trapped in casing. Remove casing gasket.
11. Remove o-ring from diffuser plate.
12. Measure and record the end play.
13. Remove pipe casing bolts and slide pipe casing off multi-stage assembly. Remove gasket.
14. Match mark internal components.
15. To remove inducer, extend tabs of lock washer and remove impeller bolt. Slide inducer off rotor shaft.
16. Remove socket head cap screws and remove diffuser plate.
17. Slide first stage impeller off rotor shaft and mark as #1.
18. Remover impeller key.
19. Remove socket head cap screws and remove first diffuser.
20. Slide adjusting washers off rotor shaft. Record quantity and thickness. The adjusting washers may come off with first-stage diffuser.
21. Remove socket head cap screws and remove first bowl.
22. Remove set screw and slide sleeve off rotor shaft.
23. Slide second stage impeller off rotor shaft and mark as #2.
24. Remove impeller key.
25. Remove socket head cap screws and remove second diffuser and bowl.
26. Remove adjusting washers. Record quantity and thickness.
27. Slide third stage impeller off rotor shaft and mark as #3.
28. Remove impeller key
29. Remove socket head cap screws and remove third diffuser and bowl.
30. Remove adjusting washers. Record quantity and thickness.
31. Slide fourth stage impeller off rotor shaft and mark as #4.
32. Remove impeller key

33. Remove socket head cap screws and remove front bearing housing from stator assembly.

Hazard!

HAZARD

Exercise care while removing this housing because of liquids which may be contained in the stator assembly.

34. Remove adjusting washers. Record quantity and thickness.
35. Remove rear bearing housing bolts and remove rear bearing housing from stator assembly. Remove rear bearing housing gasket.

Hazard!

HAZARD

Exercise care while removing this housing because of liquids which may be contained in the stator assembly.

36. Remove rotor assembly. Place on a clean cloth to avoid damage. During the removal of the rotor, take care in handling to prevent damage to the rotor or stator because the rotor will drop once the armature clears the stator assembly and the rotor shaft may hit the stator liner if not properly supported.
37. Remove set screw and slide spacer off rotor shaft. Remove front shaft sleeve and front thrust collar. Anti-rotation pin/key may be loose and fall out.

Caution!

CAUTION

Do not forcibly remove shaft sleeve. If shaft sleeve does not slide off easily it may be required to machine or cut the shaft sleeve off the rotor shaft.

38. To remove rear shaft sleeve and thrust collar, bend tabs up on lock washer and unscrew bolt. This bolt has left hand threads.
39. Remove rear shaft sleeve and rear thrust collar. Anti-rotation pin/key may be loose and fall out.
40. To remove bearings, remove set screw, slide out bearing, and remove flat washer.
41. Remove bearing adjusting washer(s) from rear bearing housing. Note quantity and measure thickness.

4.3 Inspection

4.3.1 Bearings

Check the following points:

1. Thrust face for scratches and chips. Refer to Figure 4-3 (L), for excess wear on thrust surface. (Check this dimension after bearing has been removed.)
2. Wear inside of bearing bore. Refer to Figure 4-3 (A-B).

4.3.2 Shaft Sleeves and Thrust Collars

The rotor assembly shaft sleeves and thrust surfaces should also be visually inspected at the bearing contact area for general appearance and uniform wear.

Excessive undercutting, pitting, or scoring is cause for replacement.

Check the following points:

1. Corrosion
2. Contact marks and wear.

4.3.3 Rotor Assembly Inspection

The complete rotor assembly should be visually inspected for cracks, breaks, pitting, or corrosion which might destroy the effectiveness of the hermetically sealed rotor end covers and sleeve. Check rotor assembly shafts for straightness.

4.3.4 Stator Assembly Inspection

The complete stator assembly should be visually inspected for cracks, breaks, pitting, or corrosion of the stator liner which may destroy the effectiveness of the barrier. Inspect the inside of the electrical junction box for corrosion and moisture. Teikoku recommends performing a megger and resistance check on the motor winding.

4.3.5 General Inspection

1. Inspect the threads on both ends of the rotor shaft to ensure they are not damaged. Type-F (Plan 1-SD) pressurized circulation ALP multi-stage pumps have right-hand threads, except the rear rotor bolt which has left-hand threads.
2. Be sure that all mating faces are free of nicks and burrs so that they will have a smooth face ensuring a good seal. Clean off any trace of old gasket material.
3. Make sure all parts are clean. Inaccessible area may be cleaned with a small brush or pointed tool.
4. The impeller, casing, and front bearing housing should be inspected for wear. If excessive grooving or scoring of the rings areas, hubs, and bores is evident, these components must be repaired or replaced.
5. On the rear bearing housing, inspect the ports for circulation line to ensure that the ports are clear and free of obstructions.
6. Inspect the circulation line restriction orifice for evidence of corrosion and/or erosion. Verify orifice hole size is correct.

4.4 Reassembly

1. Clean and dry all parts. Reassemble in the reverse manner of disassembly. Reassembly requires adjustment of end play and impeller “g” gap.
2. Install adjusting washer(s) into rear bearing housing. Quantity and thickness of adjusting washers is as required for proper rotor end play.

Attention!

ATTENTION

Both motor bearings have spiral and straight grooves Figure 4-2. The front bowl bearing has only straight grooves. Figure 4-1

3. Insert bearing with flat washer into bearing housings. On the motor bearings the end of the bearing with the V grooves should be visible after installation. Position flat washer side of bearing in line with set screw hole. While holding bearing down, tighten set screw.

Caution!

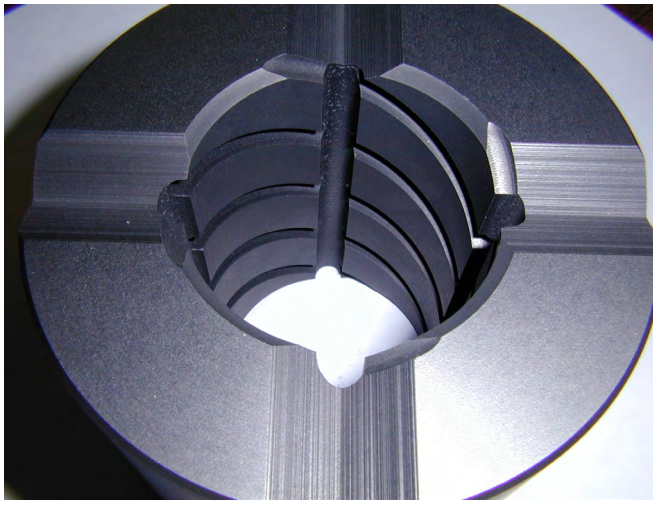
CAUTION

Do not over-tighten set screw as damage to bearing may occur.

4. On rear end of rotor, install anti-rotation pin/key.
5. Slide on rear thrust collar, verifying that the thrust collar is installed correctly. The coated side of the thrust collar should be positioned facing outboard with the chamfer side facing inboard.
6. Slide on the rear shaft sleeve, ensuring that the shaft sleeve is tight against the thrust collar and is engaged in the anti-rotational key or pin.
7. Install the flat washer, lock washer, and lock bolt, ensuring that the lock washer tab is engaged in the slot in the shaft sleeve. Torque lock bolt per Table 4-5. This bolt has left hand threads. Bend up tabs on lock washer.
8. On the front end of rotor, install anti-rotation pin/key.
9. Slide on front thrust collar, verifying that the thrust collar is installed correctly. The coated side of the thrust collar should be positioned facing outboard with the chamfer side facing inboard.
10. Slide on the front shaft sleeve ensuring that the shaft sleeve is tight against the thrust collar and is engaged in the anti-rotational key or pin.
11. Slide on spacer and tighten set screw while holding spacer tight against sleeve.
12. Slide assembled rotor into stator with rear end of rotor extending out of the stator.
13. Install the rear bearing housing gasket. Slide the rear bearing housing onto the rotor shaft and slide the rear bearing housing and rotor into the stator. Tighten bolting evenly using a star or cross pattern. Torque bolts per Table 4-5.
14. Slide front bearing housing onto rotor and into stator. Install bolting. Tighten bolting evenly using a star or cross pattern. Torque bolts per Table 4-5. Verify that the rotating assembly rotates freely by hand with no binding or metal to metal contact.
15. Check rotor assembly end play. End play should be within the range indicated in Table 4-4. If the end play does not fall within this range, remove rear bearing housing, remove rear bearing and increase or decrease the adjusting washer quantitiy and thickness as required.
16. Measure "g" gap as per Figure 4-4 to determine quantity and thickness of adjusting washers. Install required adjusting washers.
17. Install impeller key. Slide fourth stage impeller onto rotor shaft.
18. Install third stage diffuser and bowl. Install cap screws. Tighten bolting evenly using a star or cross pattern. Torque bolting per Table 4-5. Verify end play per Table 4-4.
19. Measure "g" gap as per Figure 4-4 to determine quantity and thickness of adjusting washers. Install required adjusting washers.
20. Install impeller key. Slide third stage impeller onto rotor shaft.
21. Install second stage diffuser and bowl. Install cap screws. Tighten bolting evenly using a star or cross pattern. Torque bolting per Table 4-5. Verify end play per Table 4-4.
22. Measure"g" gap as per Figure 4-4 to determine quantity and thickness of adjusting washers. Install required adjusting washers.
23. Install impeller key. Slide second stage impeller onto rotor shaft.
24. Install sleeve with set screw inboard. Install set screw and tighten while holding sleeve tight against impeller.

Figure 4-1. First Bowl Bearing – Only Straight Grooves

Figure 4-2. Motor Bearings – Spiral and Straight Grooves

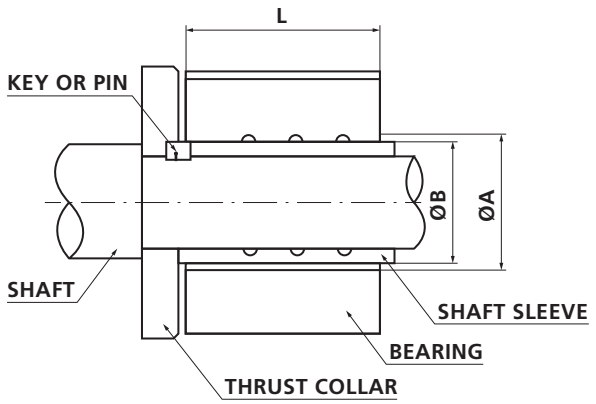


25. Install first stage bowl. Install cap screws. Tighten bolting evenly using a star or cross pattern. Torque bolting per Table 4-5. Verify end play per Table 4-4.
26. Install first stage diffuser. Install cap screws. Tighten bolting evenly using a star or cross pattern. Torque bolting per Table 4-5. Verify end play per Table 4-4.
27. Measure "g" gap as per Figure 4-4 to determine quantity and thickness of adjusting washers. Install required adjusting washers.
28. Install impeller key. Slide first stage impeller onto rotor shaft.

Table 4-2. Impeller Axial Gap

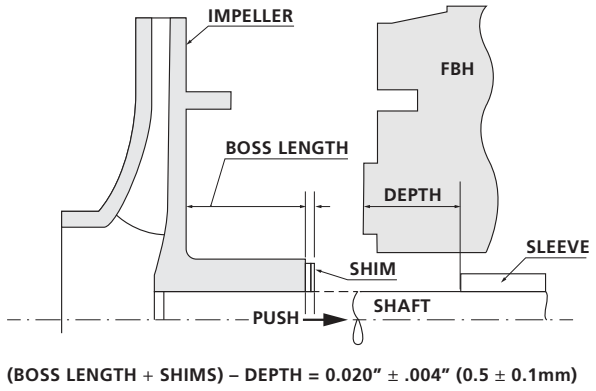
Pump	"g" adjusted
0104QM	0.5 mm +0.1, -0.1mm 0.020" +0.004", -0.004"

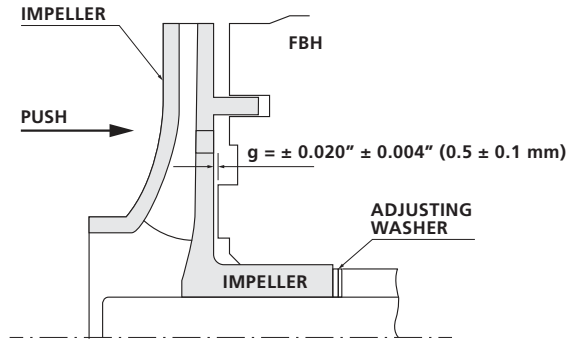
Figure 4-3. Bearing Wear Limits

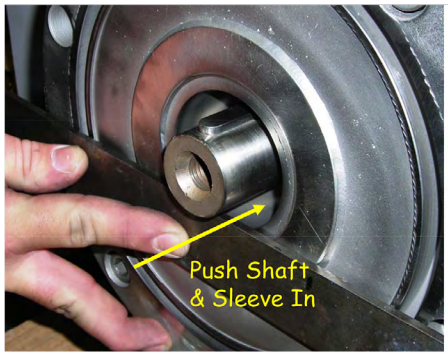


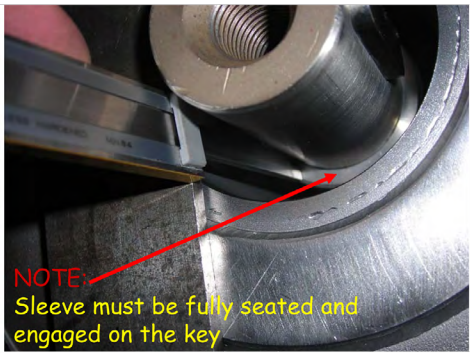
29. Install diffuser plate. Install cap screws. Tighten bolting evenly using a star or cross pattern. Torque bolting per Table 4-5. Verify end play per Table 4-4.
30. Slide inducer onto rotor shaft. Install flat washer, lock washer, and impeller lock bolt. Torque impeller nut lock per Table 4-5. Verify end play per Table 4-4. Bend lock washer locking tabs up onto flat side of impeller lock bolt head.
31. Check for free rotation.Assembled pump should rotate freely by hand with no binding or metal to metal contact.
32. Install pipe casing gasket. Install pipe casing. Install cap screws. Tighten bolting evenly using a star or cross pattern. Torque bolting per Table 4-5.
33. Install o-ring on diffuser plate
34. Install case gasket. Install case. Install bolting except for bottom two bolts.
35. Install front support foot. Install bolting. Tighten bolts between foot and base finger tight.
36. Tighten case bolting evenly using a star or cross pattern. Torque bolts per Table 4-5.
37. Tighten bolting between support and base. Torque bolts per Table 4-5.
38. Adjust support bolting as required and tighten in place.
39. Install circulation pipe gasket. Install circulation pipe orifice plate. Install circulation pipe. Install circulation pipe bolting. Tighten bolting evenly using a star or cross pattern. Torque bolts per Table 4-5.
40. Check for free rotation. Assembled pump should rotate freely by hand with no binding or metal to metal contact

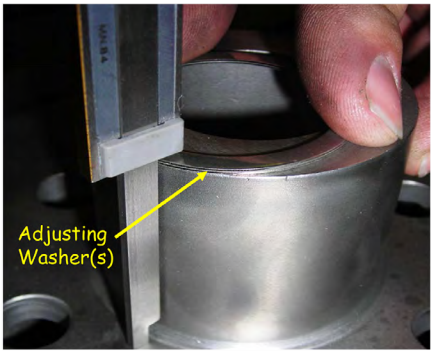
Figure 4-4. Measurement of "g" Gap











4.5 Service Policy

Any Teikoku USA product, damaged or inoperative for any reason, can be repaired at the Teikoku service centers at minimal cost and returned to the customer as quickly as possible. Refer to the Pump Repair Receipt Policy in the Appx. Q.

Caution!

CAUTION

Before returning units to the factory for examination or repair, clean and decontaminate the pump and/or parts thoroughly to prevent corrosive attack during shipment or injury to personnel handling returned equipment. Tag pump with information regarding the fluid it was handling and operating conditions at the time of failure. See Appx. P. Decontamination Form

Proper service will be facilitated with the proper submittal of a Teikoku USA Decontamination Form. The Decontamination Form and the Pump Repair Receipt Policy are available from the factory, from the Teikoku USA field representatives, and from the Appendix of this instruction manual.

4.6 Spare Parts

Teikoku USA recommends to have on hand at least one complete repair kit for each pump model. The repair kit includes the bearings, sleeves, thrust collars, gaskets, o-rings, and lock washers. When ordering spare parts, provide the serial number and model number; then give the part name which is noted on the sectional drawing, Appx. C. When ordering an impeller, include the diameter, which can be noted from the pump order acknowledgment or from the pump nameplate.

Figure 4-5. Type-F (Plan 1-SD) Model Number Indentification Code Example

F42-**217**P4BL-0104**Q**M4-JR

MOTOR FRAME — IMPELLER SIZE

Table 4-3. Bearing Wear Limit

Motor Frame Number*	øA – øB		L	
	Inch	mm	Inch	mm
216, 217	0.016	0.4	1.94	49.2
316			2.33	59.2

* See Figure 4-5

Table 4-4. End Play

Motor Frame Number*	End-Play	
	Inch	mm
216, 217	0.043 – 0.067	1.1 – 1.7
316		

* See Figure 4-5

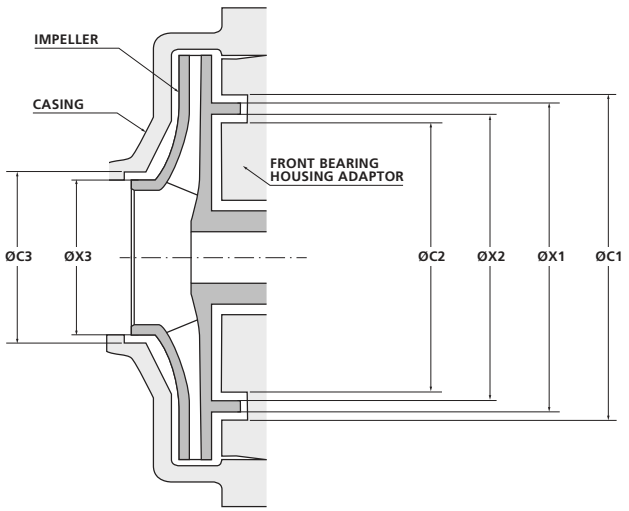
Table 4-5. Tightening Torques

Bolt Size	Torque (ft.lb.)	Bolt Size	Torque (ft.lb.)
Rotor (304SS, 304LSS, 316SS, 316LSS) Note: Rear rotor bolts have left-hand threads			
M10	13	M18	73
M12	22	M20	109
M14	34	M22	145
M16	55	M24	181
Front Bearing Housing (304SS, 304LSS, 316SS, 316LSS)			
M6	3.0	M12	22
M8	6.0	M14	34
M10	13	M16	55
Set Screw (316SS, 316LSS)			
M5	0.95	M8	4.4
M6	1.3		
Pump Casing for Flat Gasket (304SS)			
M6	3.0	M12	22
M8	6.0	M14	34
M10	13	M16	55
Pump Casing for Spiral Wound Gasket (SCM435)			
M10	42	M14	116
M12	73	M16	181

Table 4-6. Torque Values for Motor Terminal Connections – Terminal Box and Connection Stud Size

Terminal Box Size	Connection Stud Size	Torque Values	
	U, V, W	ft.lb	Nm
Small (S)	M6	2.9	4

Table 4-7. Pump Ring Clearance (Standard Horizontal Pump)



Casing Size		C1 – X1	X2 – C2	C3 – X3
0104 Q	in.	0.031 – 0.035	0.031 – 0.043	0.028 – 0.031
	mm	0.78 – 0.88	0.78 – 1.08	0.70 – 0.80

NOTE: All clearances are values in diameter.

Appendix

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Appx. B. Outline F-210P-0104Q, 1-SD 22
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Appx. A. Motor Pump Data Sheet

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27881 State Route 7
Marietta, OH 45750
Phone: 740-538-5332
Fax: 740-538-5015

Page:
Revision:
Date:

MOTOR PUMP DATA SHEET

Sold To			
Ship To		**Quantity**	
Order No.		**Sct. Flng.**	1.5" 300# RF
		Dsch. Flng.	0.75" 300# RF
Model	F42-217P4BL-0104QM4-JR	**Paint Color**	Gray
Cust. Item No.			
Serial No.			

OPERATING CONDITIONS

TDH	Per Variable Speed Curve (ft)		**Capacity**	Per Variable Speed Curve (GPM)	
NPSH ava./req.	NA / 3 ft at maximum speed		**Suction Press.**	Assumed Ample	
Fluid	Anhydrous NH_3				
Sp. Gr. at P.T.	0.7 to 0.6	**Vis. at P.T.**	0.18 cP	**Pumping Temp**	-58F to +20F
Vap. Press at P.T.	46 (psia)	**Melting Point**	NA	**Suspended Solid**	NA

MOTOR (Three Phase Induction Motor) 460 Volt, 3 Phase

Rated Input Power	10.8 kW	**Rated Current**	21.0 A	**Starting Current**	57 A
Nominal Speed Range	3450 to 7200 RPM	**Insulation Class**	220 deg C (Class R)	**Bear. W. Detector**	TRG w/Noise Filter
Thermal Cutout Set.	428 F			**Area Classification**	Ordinary with NRTL Certification

MATERIALS

Casing	304 SS	**Impeller**	304 SS	**Shaft**	304SS
Stator Liner	C276	**Rotor Can**	316L SS	**Bearing**	Carbon Graphite
Sleeve Thrust Collar	316SS/Stellite	**Gasket**	PTFE	**Stator Oil Fill**	FC-770 or Ampcool 240

CIRCULATION

Type	Plan 1-SD Pressurized Circulation				
Fluid	NA	**Flow**	NA	**Pressure**	NA

UTILITIES REQUIRED

Water Jacket	No				
Fluid	NA	**Flow**	NA	**Pressure**	NA
Temperature	NA				
Heat Exchanger	NA				
Fluid	NA	**Flow**	NA	**Pressure**	NA

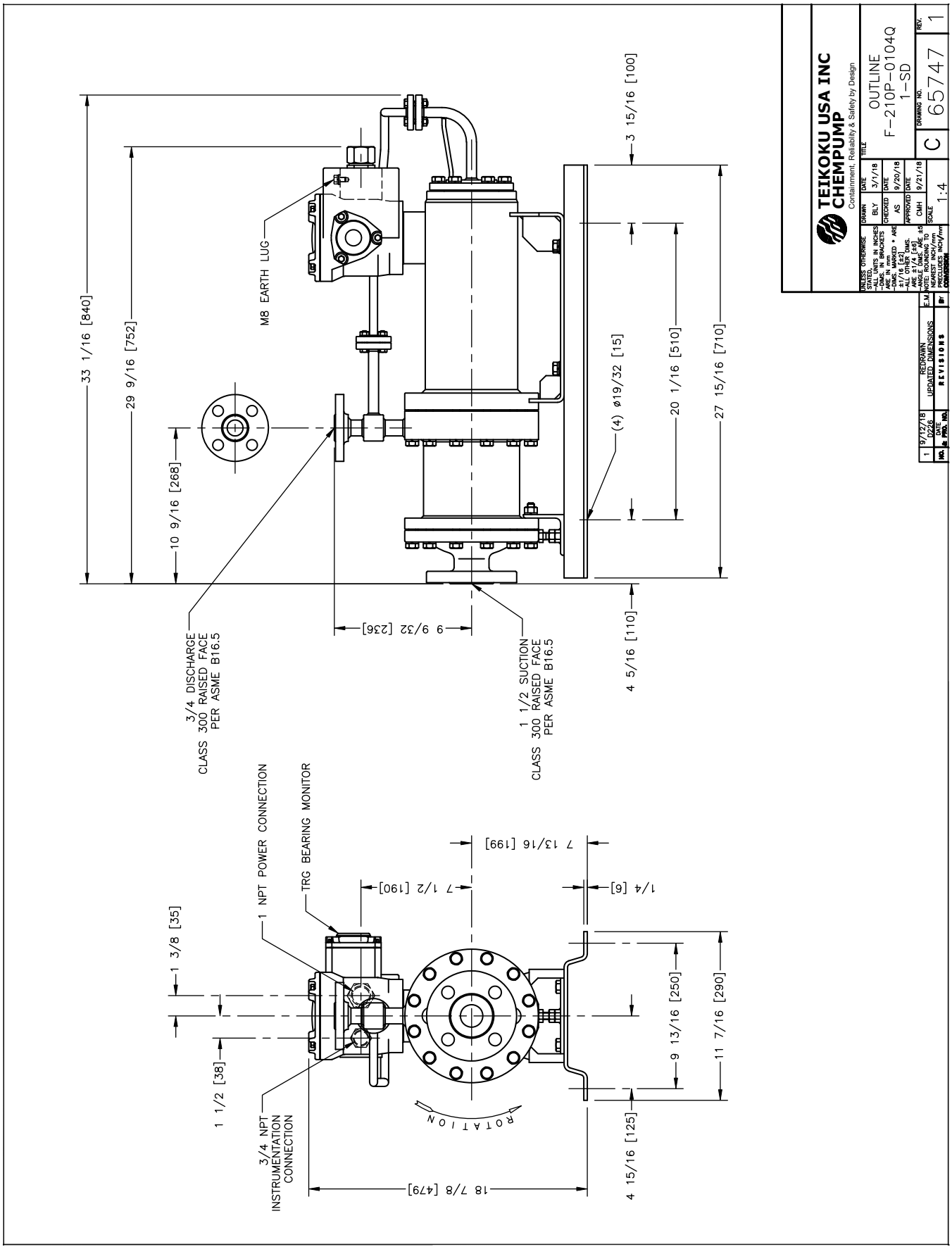
DRAWINGS

Outline	65747 -1	**Cross Section**	69044 -1	**Reference Perf. Curve**	NH_3 Multi-Speed
Connection Diag	4N-6300-01	**Terminal Box**	36608 -1	Material List	Included

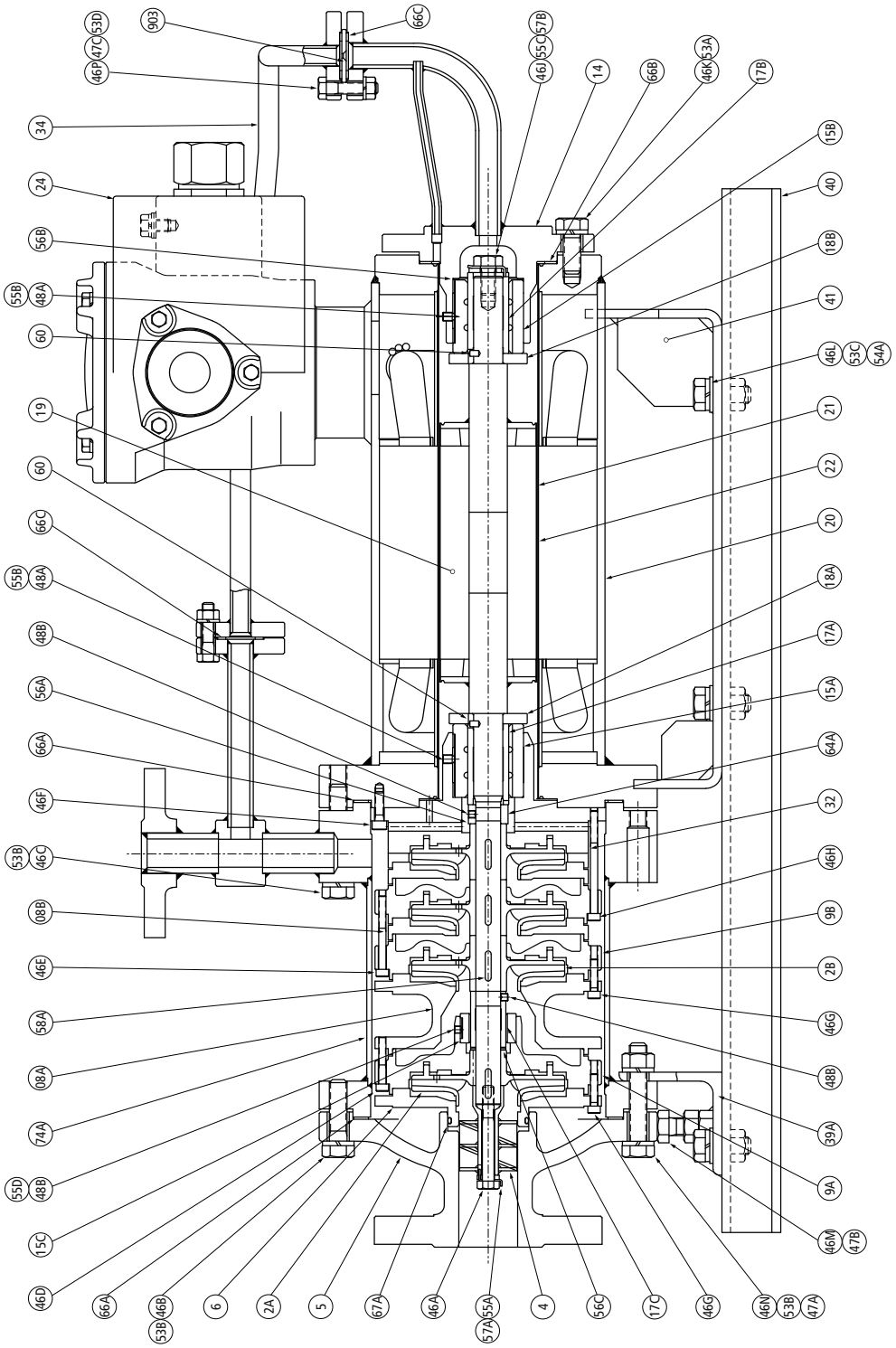
REMARKS:
-15 kW Rated VFD required for operation and full curve coverage
-All ratings are for use with Anhydrous NH_3.
-For operation with liquid over 0.7 SG, consult factory as operating limits will apply
-For operation between -58^{O}F and +20^{O}F only
-Max Flow at 120Hz is 26gpm
-Lower limit of operating frequency is 50Hz
-V/F Inverter Programming: 380V / 80Hz

Additional Ref Drawings: Piping Layout 4N-8621, Allowable Piping Forces and Moments DP0015

Appx. B. Outline F-210P-0104Q, 1-SD



Appx. C. Sectional View (F42-217P4BL-0104QM4-JR)



2A	Impeller
2B	Impeller
4	Inducer
5	Casing Cover
6	Diffuser Plate
8A	Bowl
8B	Bowl
9A	Diffuser
9B	Diffuser
14	R.B.Housing
15A	Bearing
15B	Bearing

15C	Bearing
17A	Shaft Sleeve
17B	Shaft Sleeve
17C	Shaft Sleeve
18A	Thrust Collar
18B	Thrust Collar
19	Rotor Assembly
20	Stator Assembly
21	Rotor Can
22	Stator Can
24	Terminal Box Ass'y
32	F.B. Housing

34	Circulation Pipe
39A	Stand Asesmbly
40	Base
41	Holder
46A	Bolt
46B	Bolt
46C	Bolt
46E	Bolt
46F	Bolt
46G	Bolt
46H	Bolt

46J	Bolt
46K	Bolt
46L	Bolt
46M	Bolt
46N	Bolt
46P	Bolt
47A	Nut
47B	Nut
47C	Nut
48A	Set Screw
48B	Set Screw
53A	Spring Washer

53B	Spring Washer
53C	Spring Washer
53D	Spring Washer
54A	Plain Washer
55A	Washer
55B	Washer
55C	Washer
55D	Washer
56A	Adjusting Washer
56B	Adjusting Washer
56C	Adjusting Washer
57A	Lock Washer

57B	Lock Washer
58A	Key
60	Pin
64A	Spacer
66A	Gasket
66B	Gasket
66C	Gasket
67A	O-Ring
74A	Pipe Casing
903	Orifice

69044

Appx. D. Type-F (Plan 1-SD) Installation Instructions

Teikoku Type-F (Plan 1-SD) Pressurized Circulation ALP Multi-stage Pump

These instructions describe the recommended method for installation of the pressurized circulation piping on Teikoku Type-F, Plan 1-SD pumps, which are specifically designed to handle highly volatile fluids and liquified gasses. These instructions also include recommendations for the suction pipe and the vent pipe.

1. Vent Piping

The purpose of these recommendations is to vent any vapors that form inside the pump and discharge pipe. Trapped vapors in pump and discharge pipe will create a vapor lock condition. In the event of a vapor lock condition, the pump will be damaged from liquid vaporization and/or overheating. Following these recommendations will allow the vapor to flow freely back to the suction tank.

a. The vent pipe must be connected to the discharge pipe before the check valve and block valve.
b. Connect the vent pipe to the vapor zone in the suction tank.
c. Never install a check valve in the vent pipe.
d. The vent pipe must be continuously rising to the suction tank.
e. This line must never be down-slope at any point, as this will create vapor traps.
f. Install a start vent valve in vent pipe. Start vent valve should be open when pump is off line and closed when pump is in operation.
g. This line must be individual for each pump. Never combine these lines.
h. Never connect this pipe to the suction, discharge or minimum flow pipes.

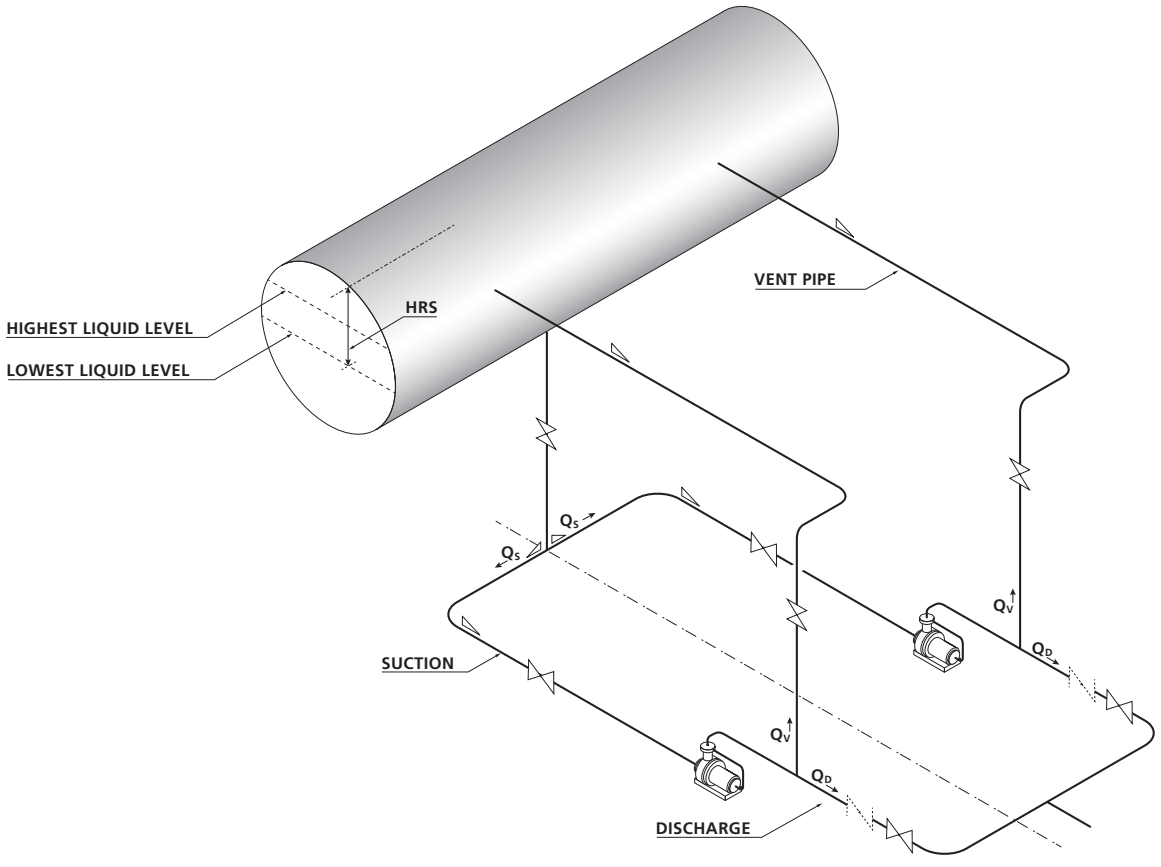
2. Suction Pipe

a. Suction pipe shall be constantly falling until it reaches the pump suction.
b. If any reducer is installed in the suction line, the reducer must be eccentric and must be installed with the flat side on top.
c. Straight run of 5 to 10 x diameter is recommended before pump suction inlet.

3. Discharge Pipe

a. A check valve and a block valve must be installed after the vent pipe connection.
b. In multiple pump installations, individual piping must be used.

Pressurized Circulation Piping Layout



Appx. E. Troubleshooting

Teikoku Type-F (Plan 1-SD) Pressurized Circulation ALP Multi-stage Pump

Problem	Probable Cause	Suggested Solution
Failure to deliver required capacity	Pump not primed.	Reprime pump in accordance with Section 3.2.3
	Air leaks in suction piping.	Locate leaks and eliminate.
	Motor not energized.	Check motor wiring. See Section 2.3 and Appx. N
	Motor windings burnt-out or grounded.	Check electrical continuity of windings and is negative response, stator assembly needs to be replaced.
	Low suction head.	Correct suction side of system to ensure availability of design NPSH.
	Discharge head too high.	Correct discharge side of system to ensure proper operating conditions.
	Discharge valve closed or partially opened.	Open discharge valve until rated discharge pressure is obtained.
	Impeller clogged.	Remove obstructions in impeller.
	Wrong direction of rotation.	Reverse any two motor leads and check with phase sequence meter. See Section 3.2.4.
	Damaged impeller	Impeller must be repaired or replaced.
Insufficient pressure	Pump not primed.	Reprime pump in accordance with Section 3.2.3
	Air leaks in suction piping.	Locate leaks and eliminate.
	Motor not energized.	Check motor wiring. See Section 2.3
	Motor windings burnt-out or grounded.	Check electrical continuity of windings and is negative response, stator assembly needs to be replaced.
	Low suction head.	Correct suction side of system to ensure availability of design NPSH.
	Discharge valve open too wide.	Close down discharge valve until rated discharge pressure is obtained.
	Impeller clogged.	Remove obstructions in impeller.
	Wrong direction of rotation.	Reverse any two motor leads
	Damaged impeller	Impeller must be repaired or replaced.
Pump loses prime after starting	Pump not properly primed at starting.	Reprime pump in accordance with Section 3.2.3.
	Excessive change in suction vessel pressure.	Locate source pressure fluctuations and correct as required.
	Air or gas in liquid.	Locate source of gas or air entrainment and correct.
	Low suction head.	Correct suction side of system to ensure availability of design NPSH.
Pump takes too much power	Shaft bent.	Replace rotor assembly or straighten shaft if bend not too great.
	Rotating element binds.	Replace bearings (see Section 4) as a result of excessive wear or check for presence of foreign material in rotor chamber
	Electrical short.	Check electrical continuity of all phases of the motor winding and replace stator assembly if necessary
Pump vibrates	Foundation not sufficiently rigid.	Tighten all bolts on the pump base and base supporting structure.
	Impeller partially clogged.	Remove obstructions in the impeller.
	Shaft bent.	Replace rotor assembly or straighten shaft if bend is not too great.
	Worn bearings.	Replace bearings (see Section 4). Check for presence of foreign material.
	Rotating element rubbing stator liner.	Replace bearings (see Section 4), Check stator liner and rotor can for wear. Repair and/or replace as required.
Motor running hot	Motor operating at overload condition.	Make sure pump is operating at design point and conditions specified when purchased.
	Pump is operating below minimum flow.	Increase flow through the pump.
	Pump is running dry.	Check suction line for obstructions and closed valves
	Reverse circulation line plugged.	Check reverse circulation line and orifice for blockage. Verify all valves in reverse circulation line are 100% open.

TEIKOKU USA INC
CHEMPUMP

TRC-1

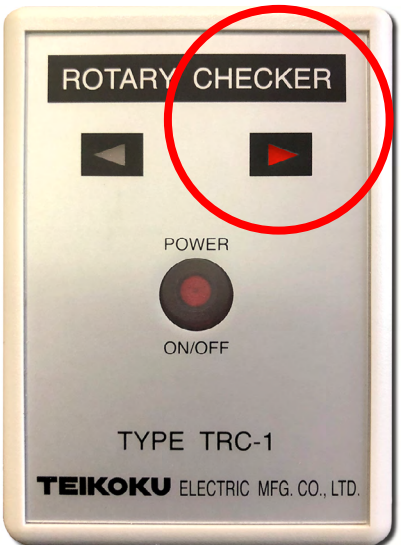
Teikoku Rotary Checker
Hand-held Direction of Rotation Indicator

The design of canned motor pumps is such that the rotating element cannot be seen while it is in operation. For this reason, Teikoku supplies an internal rotation indicator with a majority of our pumps. However, there are some instances where this device is not supplied, so we recommend purchasing the TRC-1. This simple device takes the guesswork out of confirming the correct rotation of the motor. It is light, compact, and easy to use. Not only can this be used on Teikoku canned motors, but other three-phase induction motors as well.

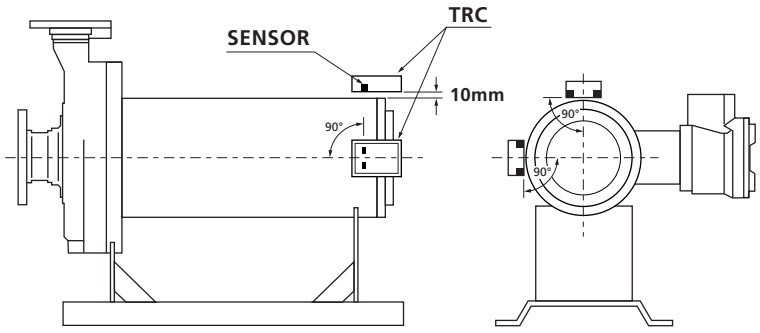
- **Place TRC-1 on an operating motor as illustrated below.**
- **The arrow that lights up indicates the direction of rotation.**
- **There is an arrow on the pump case that indicates the correct direction of rotation.**

Specifications:

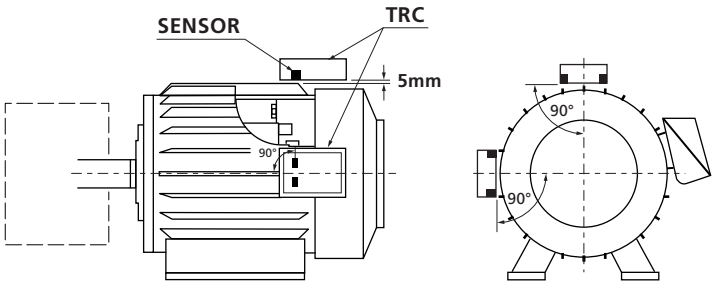
Size: 2.6"W x 3.6"L x 1.1" H (66.mm x 92mm x 28mm)
External Case : ABS plastic
Battery operated : 9V



TEIKOKU CANNED MOTOR PUMP



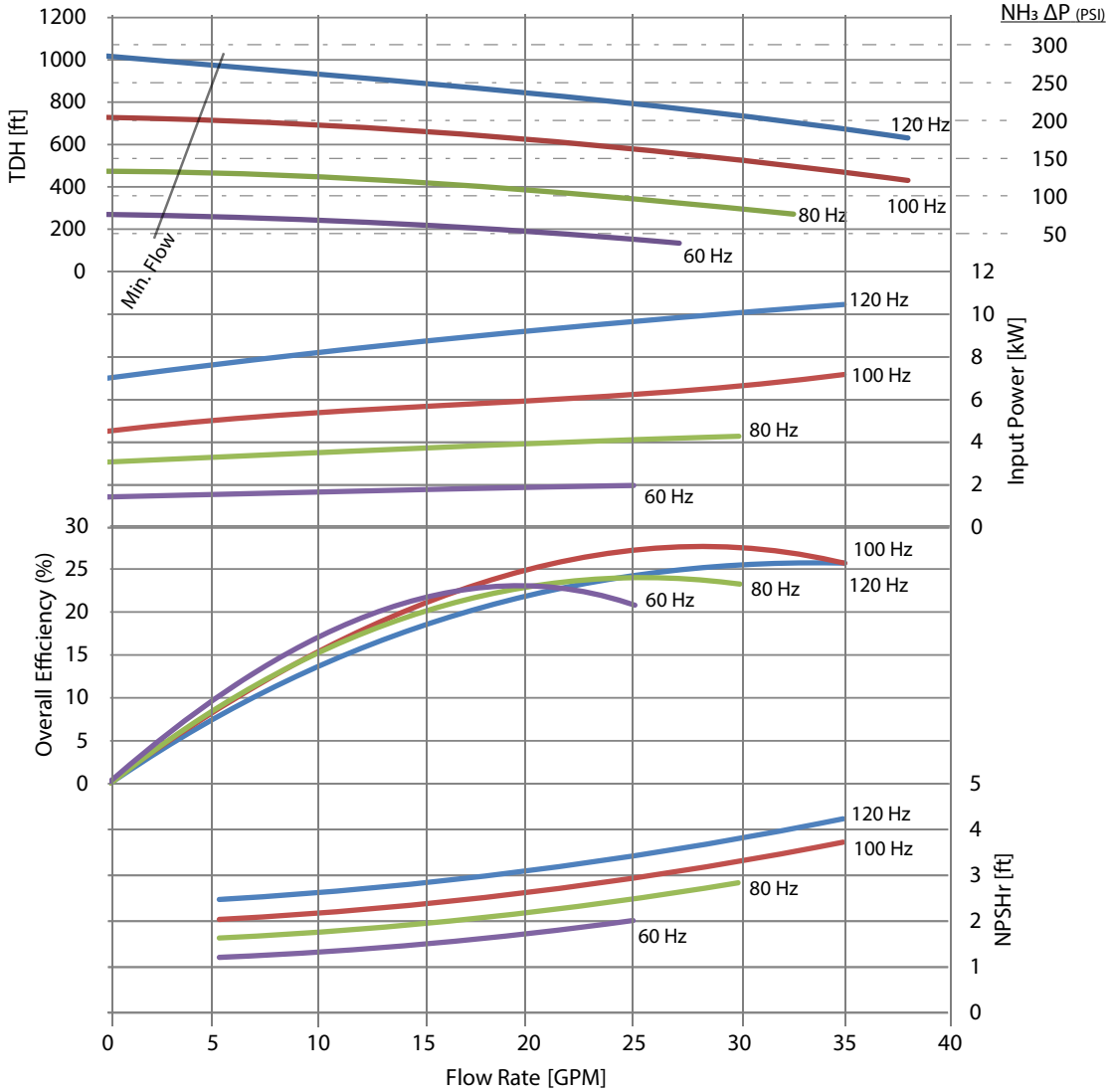
THREE-PHASE INDUCTION MOTOR



Appx. G. NH_3 Reference Curve (20°F)

Estimated Performance Curve (20°F)

Model	F42-217P4BL-0104QM4-JR			
Frequency Range	60-120 Hz	Total Head	Per multi-speed curve	ft
Voltage	380 V	Capacity	Per multi-speed curve	gpm
Phase	3	Min. Flow	5.28 gpm	
Pole	2	Fluid	Aqueous NH_3	
Input Range	1.6 - 10.8 kW	Temp.	20 °F	
Current Range	6.8 - 21.0 A	S.G.	0.65	Vis. 0.18 cp



REV.	Date	Description

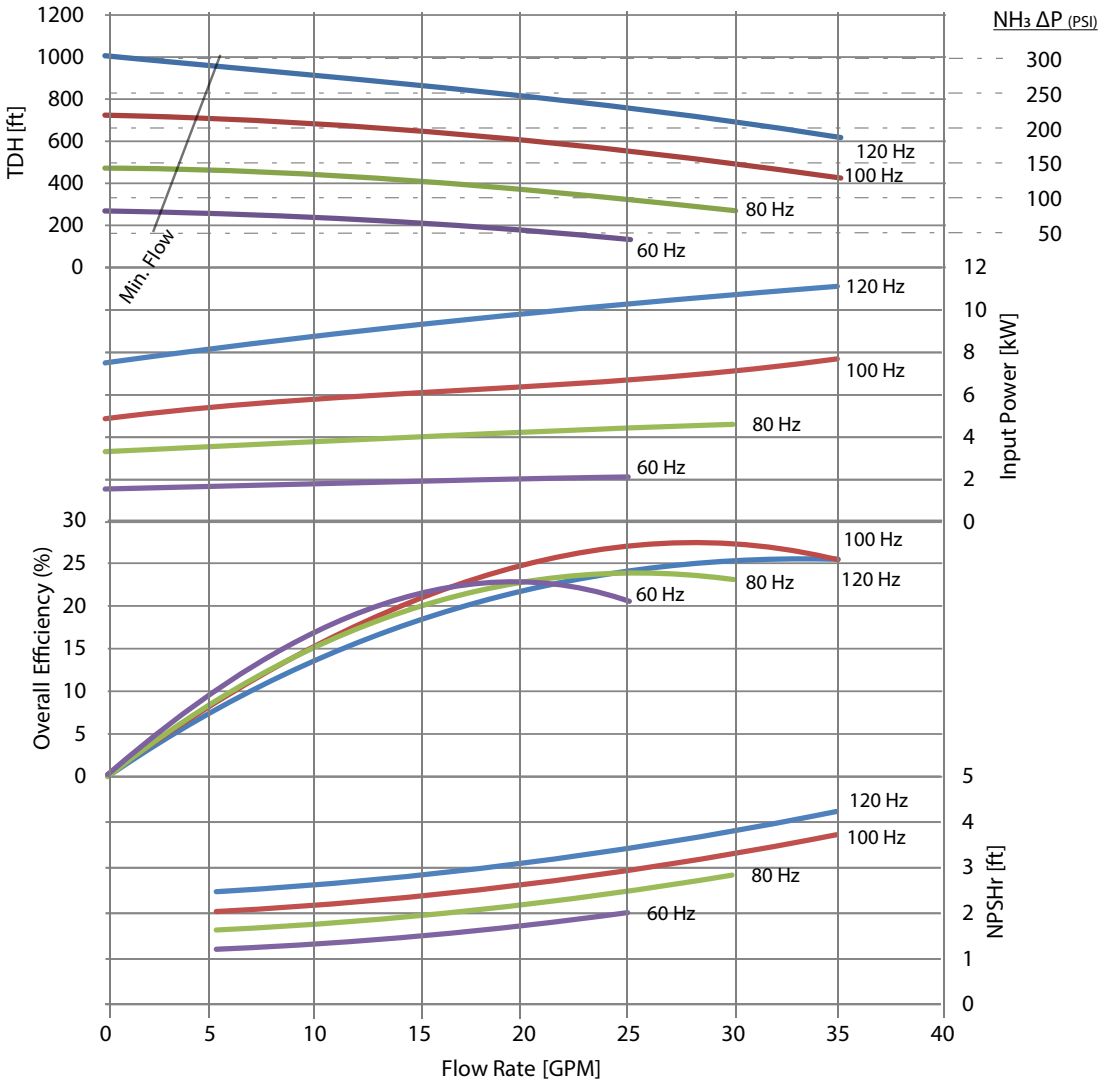
APPROVED BY	CHEKED BY	DRAWN BY

TEIKOKU USA INC

Appx. H. NH_3 Reference Curve (-50°F)

Estimated Performance Curve (-50°F)

Model	F42-217P4BL-0104QM4-JR			
Frequency Range	60-120 Hz	Total Head	Per multi-speed curve	ft
Voltage	380 V	Capacity	Per multi-speed curve	gpm
Phase	3	Min. Flow	5.28 gpm	
Pole	2	Fluid	Aqueous NH_3	
Input Range	1.6 - 10.8 kW	Temp.	-50 °F	
Current Range	6.8 - 21.0 A	S.G.	0.70	Vis. 0.31 cp



REV.	Date	Description

APPROVED BY	CHEKED BY	DRAWN BY

TEIKOKU USA INC

Appx. I. Type 217-120 Motor Data Sheet

Motor Characteristics Data Sheet

Type	**217P-120Hz**						
Rating							
Voltage (V)	380	Frequency(Hz)	120	Pole	2		
Rated output(kW)	8.1	Rated current(A)	21.0	Thermal class	220		
Terminal resistance						Max.output(%)	132
Resistance (Ω)	0.976	Temperature (℃)	20			Max.torque(%)	146
No-load test						Starting torque(%)	73.5
Voltage (V)	380	Current (A)	5.89	Input (kW)	1.642	Starting current(A)	676
Locked test						Starting p.f(%)	30.4
Voltage (V)	380	Current (A)	50.0	Input (kW)	10.00	Starting time (s)	<2
Load (%)	0	25	50	75	100	125	150
(kW)	0.0	2.0	4.1	6.1	8.1	10.1	12.2
Current (A)	5.9	8.0	11.0	14.8	21.0	26.4	–
Input (kW)	1.64	3.72	5.90	8.24	10.83	14.04	–
Power Factor (%)	42.4	71.0	81.5	84.9	84.8	80.8	–
Efficiency (%)	0.0	54.5	68.6	73.7	74.8	72.1	–
Slip (%)	0.0	1.17	2.48	4.04	6.09	9.80	–
Speed (min^{-1})	7200	7116	7021	6909	6761	6495	–
Torque(N·m)	0.0	2.7	5.5	8.4	11.4	14.9	–

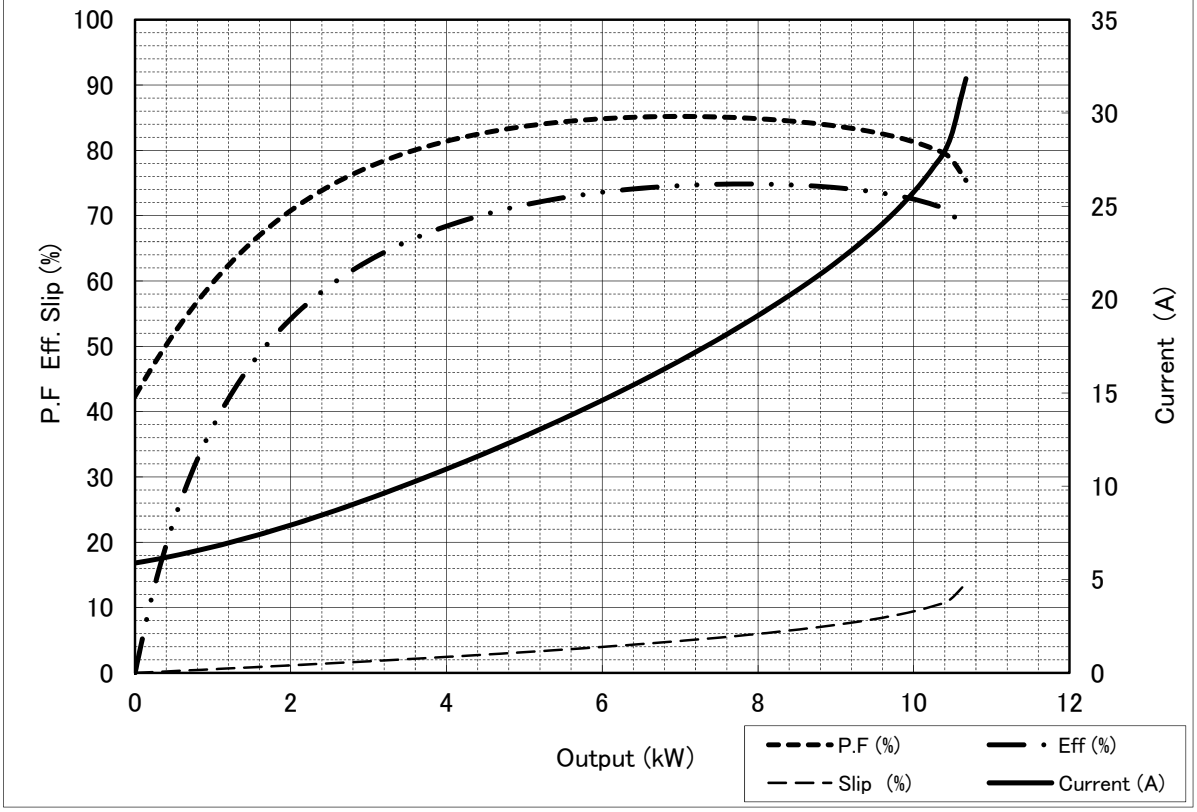
Remarks:

Rotation (view into pump suction): CCW

Data presented is for reference only and for a motor operating at 120 HZ speed

217P Motor Data is for FC-770 or AmpCool 240 inert oil fill per underwriter's requirement

Output Characteristics Curve



TEIKOKU USA INC CHEMPUMP	APPROVED BY	CHECKED BY	DRAWN BY	DWG. NO.
			CMH 10/23/2018	

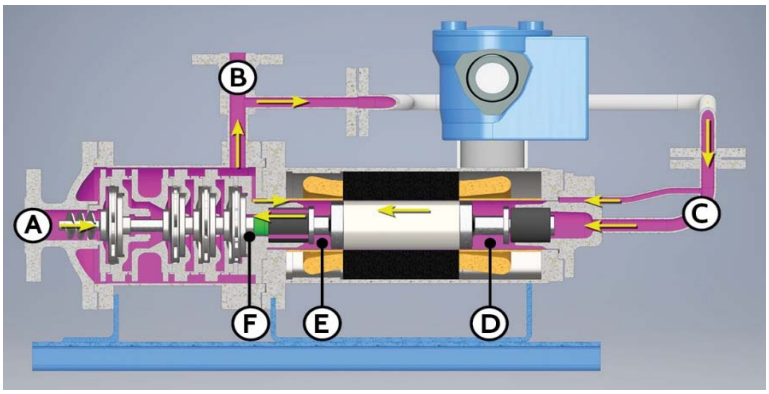
Appx. J. 1-SD Temperature/Pressure Profile

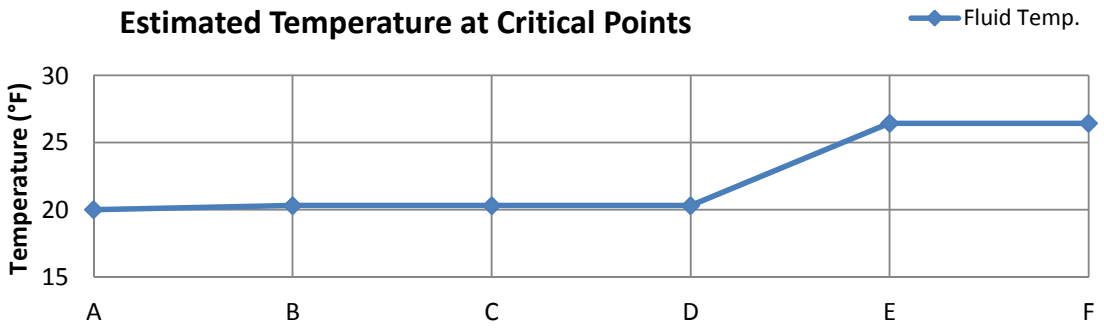
TEIKOKU USA INC.
CHEMPUMP

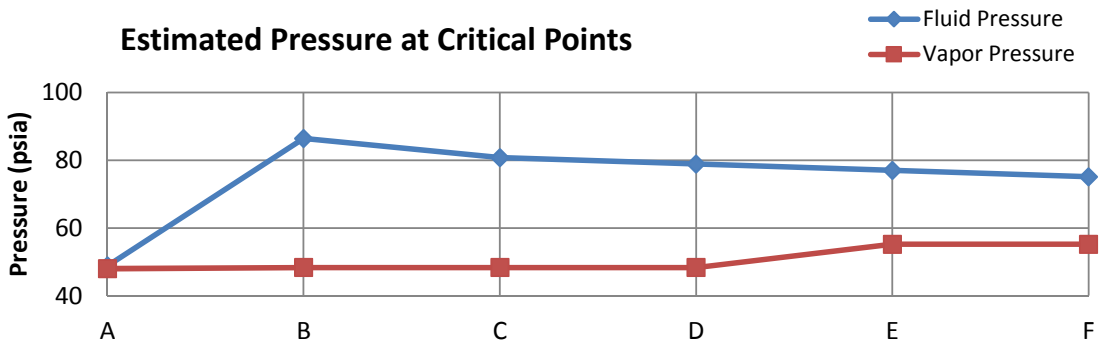
API 685 - Annex K
Circulation Pressure-Temperature Profile

API Circulation Plan: 1-SD: Pressurized
Pump Model: F42-217P4BL-0104QM4-JR

Comments: Maximum flow rate at minimum frequency for Anhydrous Ammonia: +20°F, Frequency = 60 Hz, Flow Rate = 25 GPM*



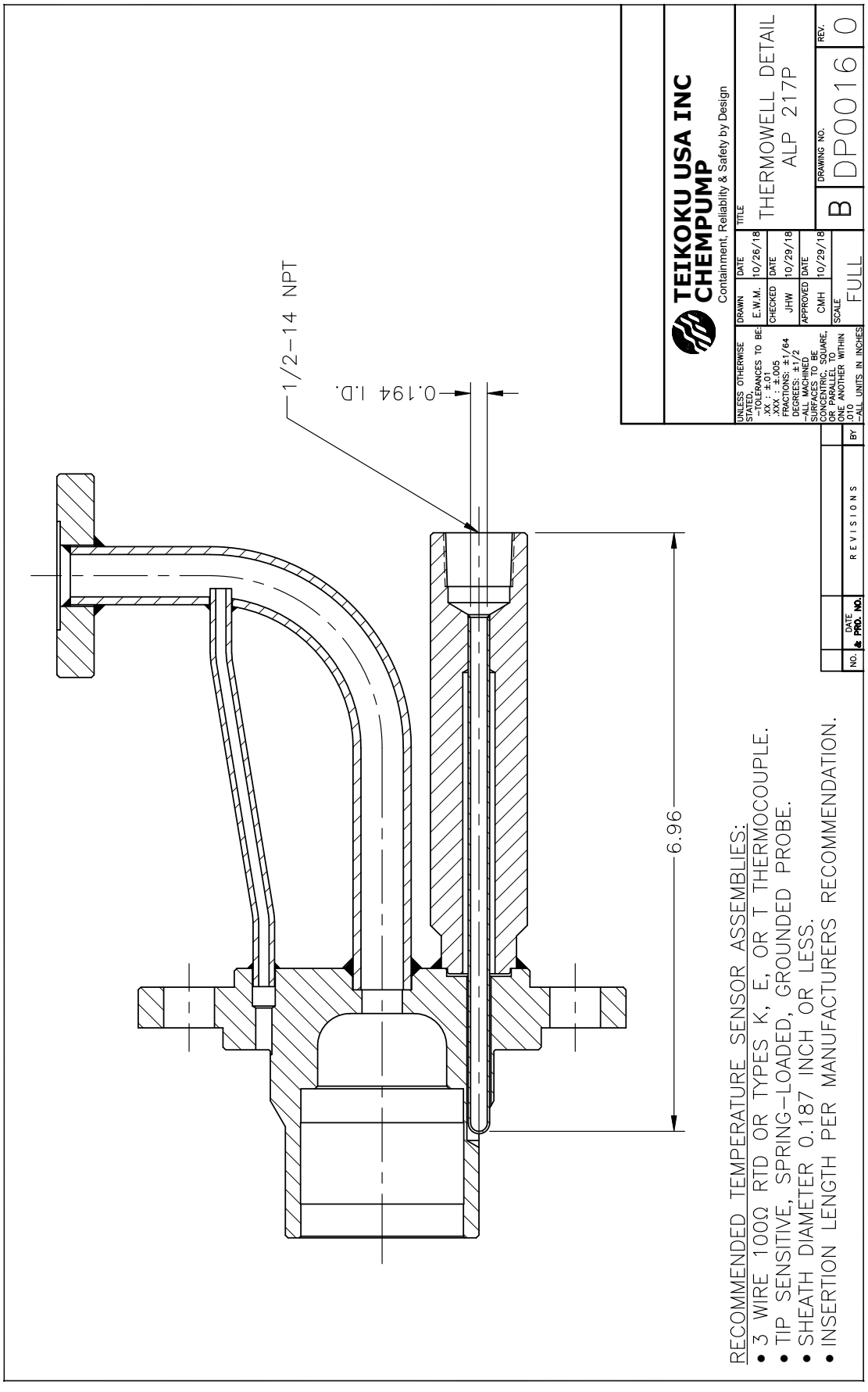




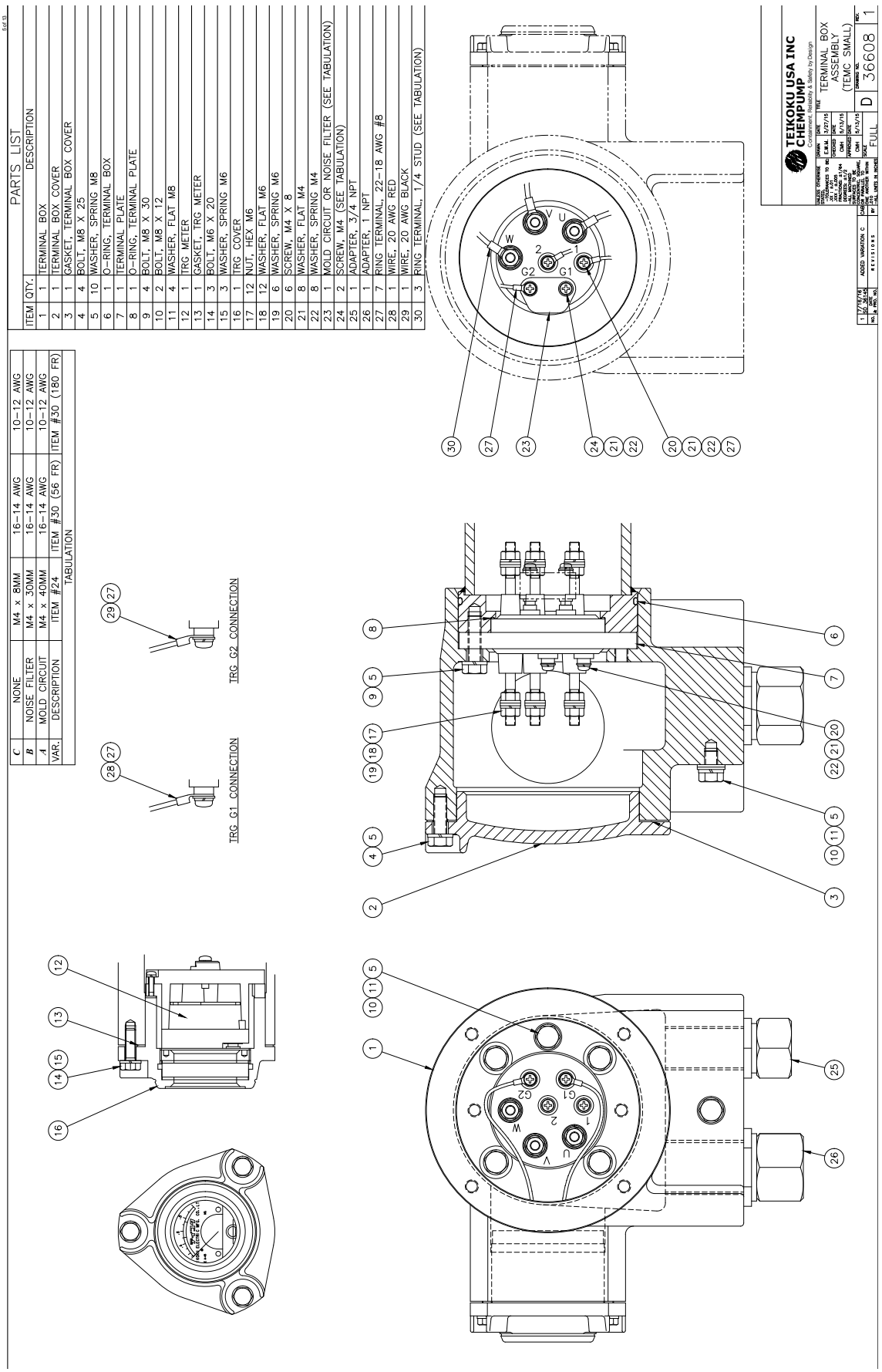
Critical Point	A	B	C	D	E	F
Pressure Margin (psi)	1	38	32	31	22	20
Judement Criteria	> 0	> 0	> 0	> 0	> 0	> 0
Judgement	Good	Good	Good	Good	Good	Good

* Higher flow and speeds and lower temperatures will increase NH_3 Pressure Margins

Appx. K. Optional Rotor Cavity Thermowell

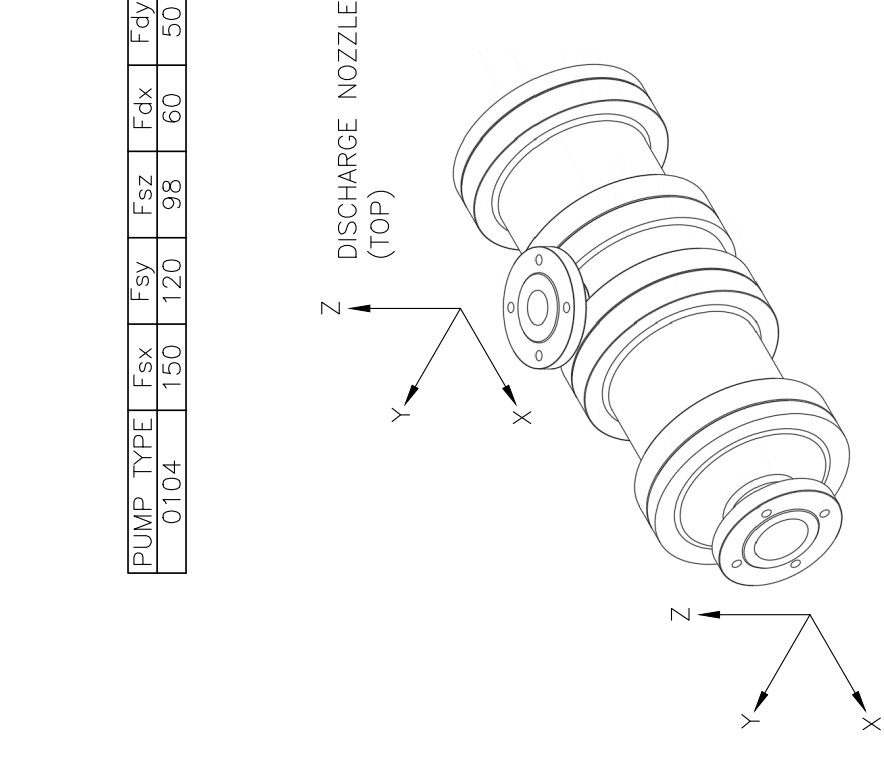


Appx. L. Terminal Box Assembly



PUMP TYPE	Fsx	Fsy	Fsz	Fdx	Fdy	Fdz	Msx	Msy	Msz	Mdx	Mdy	Mdz
0104	150	120	98	60	50	75	255	128	195	130	64	98

NOTE: F=FORCE (lb.) M=MOMENT (lb-ft)
s=SUCTION NOZZLE
d=DISCHARGE NOZZLE
SEE THE FIGURE FOR ORIENTATION OF NOZZLE LOADS (X, Y, Z)



TEIKOKU USA INC
CHEMPUMP
Containment, Reliability & Safety by Design

UNLESS OTHERWISE STATED: -TOLERANCES TO BE: .XX : ±.01 .XXX : ±.005 FRACTIONS: ±1/64 DEGREES: ±1/2 -ALL MACHINED SURFACES TO BE CONSIDERED TO BE SQUARE, OR PARALLEL TO ONE ANOTHER WITHIN .010 -ALL UNITS IN INCHES

	DRAWN	CHECKED	APPROVED
DATE	JHW 10/24/18	CMH 10/24/18	CMH 10/24/18

SCALE FULL

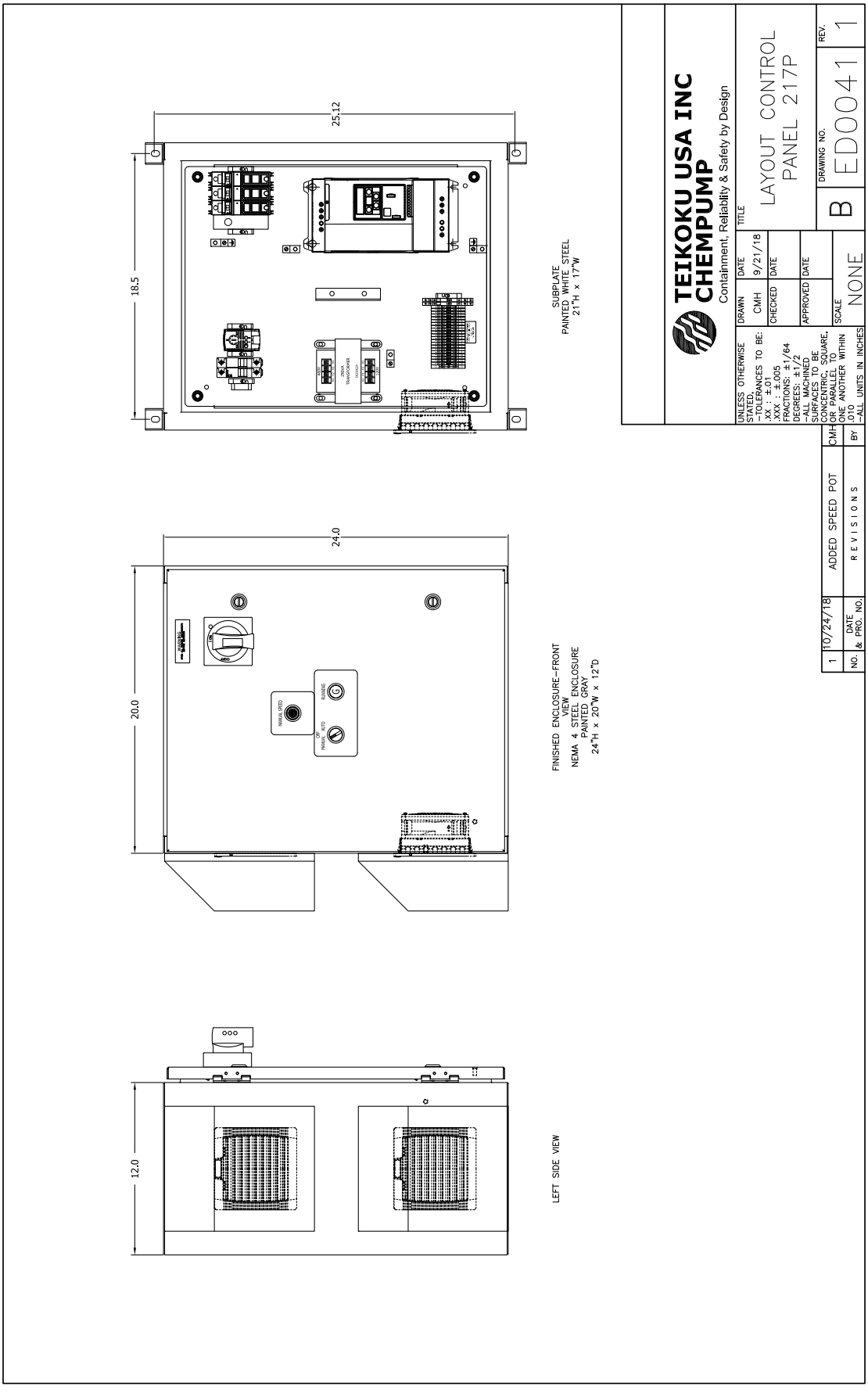
TITLE: ALLOWABLE PIPING FORCES AND MOMENTS

DRAWING NO. B DP0015

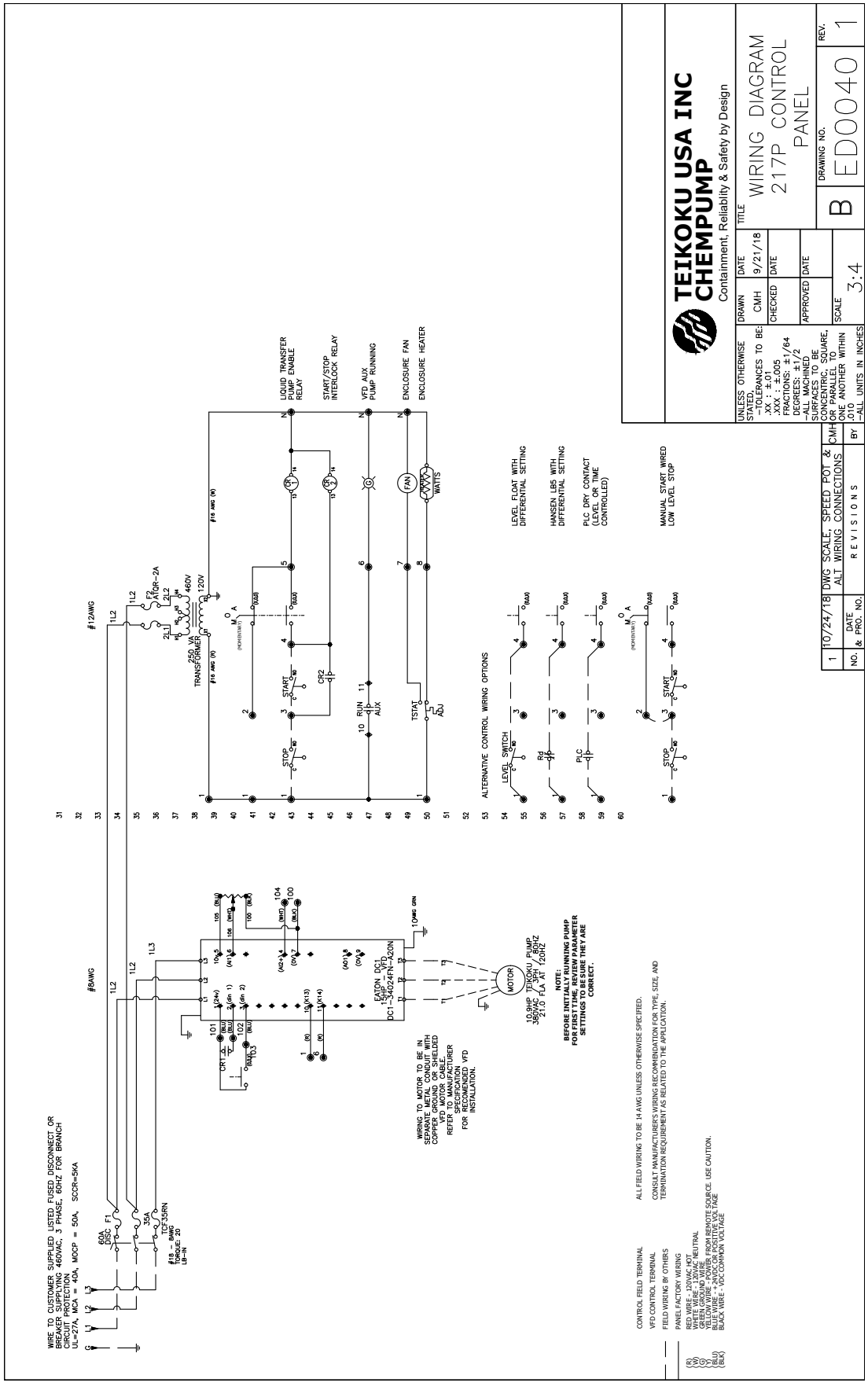
REV. 0

NO.	DATE & PRO. NO.	REVISIONS	BY

Appx. N. Optional TSG NH_3 Speed Control Panel



Appx. O. Wiring Diagram Optional TSG NH_3 Speed Control Panel



Appx. P. Decontamination Form

REV. 4-17-20

TEIKOKU USA INC
CHEMPUMP

DECONTAMINATION CERTIFICATION AND FLUSHING PROCEDURE

CUSTOMER _____
ADDRESS: _____
_____
CONTACT: _____

DATE: _____
PHONE: _____
EMAIL: _____
RMA #: _____

Please complete the items below. By providing this information, you will allow us to work as quickly and safely as possible.

PUMP MODEL: _____
PART NUMBER: _____
DATE PURCHASED: _____

SERIAL NUMBER: _____
DATE INSTALLED: _____
INDOOR / OUTDOOR: _____

REASON FOR RETURN: ☐ WARRANTY REQUEST ☐ FACTORY SERVICE

FAILURE INFORMATION:

☐ Failure To Deliver Required Capacity
☐ Loses Prime After Starting
☐ Axial Wear Due To Thrust
☐ Vibration
☐ Bearing Failure
☐ Insufficient Pressure
☐ Motor Burnout
☐ Other: _____
☐ Bearing Monitor Reading

BRIEF DESCRIPTION OF PUMP FAILURE: _____
_____
_____

DECONTAMINATION INFORMATION

All pumps/parts must be completely decontaminated and all information in this section must be completed prior to shipment to our factory or service center. Shipments received without this documentation will not be accepted and will be returned to the point of shipment.

CHECK ONE OF THE FOLLOWING:

☐ Pump is new/unused and never subjected to process fluid.

☐ The pump has been flushed by following the applicable steps in section A of the Teikoku USA Flushing Procedure on page 2 of this form. No liner rupture is suspected.

☐ Both the complete pump and the stator assembly have been flushed by following the applicable steps in section A, plus section B, C or D of the Teikoku USA Flushing Procedure on pages 2 and 3 of this form. The motor must be rewound.

FLUID PUMPED: _____ **WHAT FLUID DID YOU FLUSH WITH:** _____

Attach completed material safety data sheets (MSDS) for these fluids. *If either fluid is proprietary, please attach a description of any characteristics that will assist Teikoku USA in safe handling. Without detailed and complete information on the pumped fluid, we will not be able to process your order.*

PROTECTION EQUIPMENT RECOMMENDED FOR SAFE HANDLING OF THE PROCESS FLUID: _____
_____

DECONTAMINATION CERTIFIED BY: _____ **DATE:** _____

TITLE: _____ **PHONE:** _____

RETURN COMPLETED FORM AND PUMP/PART TO:

☐ TEIKOKU USA
Factory Service Center
959 Mearns Road
Warminster, PA 18974
Phone: (215) 343-6000
Fax: (267) 486-1037

☐ TEIKOKU USA
Midwest Service Center
27881 State Route 7
Marietta, OH 45750
Phone: (740) 538-5332
Fax: (740) 538-5015

☐ TEIKOKU USA
Sales and Service Center
5880 Bingle Road
Houston, TX 77092
Phone: (713) 983-9901
Fax: (713) 983-9919

TEIKOKU USA INC
CHEMPUMP

DECONTAMINATION CERTIFICATION
AND FLUSHING PROCEDURE

FLUSHING PROCEDURES FOR TEIKOKU
USA PRODUCTS

THE FOLLOWING FLUSHING PROCEDURES ARE REQUIRED TO ALLOW FOR MAXIMUM REMOVAL OF PROCESS FLUIDS.

A. COMPLETE PUMPS AND PARTS

Pumps and parts that are returned for service are to be thoroughly decontaminated and free of process and flushing fluids.

Some pumps handle a fluid that may solidify and cannot be removed by flushing the pump. These pumps should be fully disassembled for removal of all traces of fluids to avoid solidification of the fluids in the pump.

SUGGETIONS FOR DECONTAMINATION

1. With the suction flange down, introduce an appropriate neutralizing fluid through the discharge flange. Flush the pump in this manner for a sufficient time to allow for the removal of all process fluid.

2. Introduce an appropriate neutralizing fluid to the rear of the pump for a sufficient time to allow for the removal of all process fluid. The method of fluid insertion depends on the pump design. Access may be through a circulation line, vent, drain or flush connection. In some cases, the rear bearing housing needs to be removed to thoroughly flush the pump internals.

Remove as much of the neutralizing fluid as possible using compressed air or inert gas.

For pumps with shaft sleeves, complete disassembly will be required to remove trapped fluid.

Flush all auxiliary tubing, piping and equipment such as heat exchangers.

For any questions on decontamination, contact your Teikoku service representative.

See sections "B" through "D" for stator assembly decontamination requirements where a liner breach is suspected. Pumps with the TRG bearing wear monitor will have a wear meter visible on the pump terminal box.

B. G series without TRG and J-series stator assembly (if equipped with a relief valve).

If a stator liner rupture is suspected, follow this section to flush the stator cavity. **Caution:** if this step is followed, the motor must be rewound.

Remove the relief valve. Insert a screwdriver into the relief valve adapter and pry the Lisk filter to one side. Remove the connection box from the lead nipple and chip away the potting compound from the lead nipple.

Position the stator assembly with the lead nipple down and introduce an appropriate neutralizing fluid to the relief valve adapter. The fluid will exit through the lead nipple. Flush the stator cavity in this manner for a sufficient time to allow for the removal of all process fluid and stator oil.

Remove as much of the neutralizing fluid as possible by purging the stator cavity with compressed air or inert gas for 3 - 5 minutes.

If the connection box is to be returned, assure that all components have been decontaminated.

REV. 4-17-20

Page 2 of 3

TEIKOKU USA INC
CHEMPUMP

DECONTAMINATION CERTIFICATION
AND FLUSHING PROCEDURE

C. NC-series stator assembly without TRG

If a stator liner rupture is suspected, follow this section to flush the stator cavity. Caution: if this step is followed, the motor must be rewound.

Drill a hole through base cradle mounting hole located in rear end bell, drill this hole just deep enough to break through end bell. Drill a second hole through stator liner on the opposite end of the stator.

Position the stator assembly with rear end bell up and introduce an appropriate neutralizing fluid through drilled hole in rear end bell. The fluid will exit through the drilled hole on opposite end. Flush the stator cavity for a sufficient time to allow for the removal of all process fluid.

Remove as much of the neutralizing fluid as possible by purging the stator cavity with compressed air or inert gas for 3 - 5 minutes.

If the connection box is to be returned, assure that all components have been decontaminated.

D. For all Teikoku pumps, LE stators, G and NC stators with TRG.

If a stator liner rupture is suspected, follow this section to flush the stator cavity. Caution: if this step is followed, the motor must be rewound.

There might be a case in which pressure is released when terminal box cover or terminal plate is removed. Take the necessary precautions and follow Teikoku's terminal box removal procedure, that is available upon request. With the terminal box up, remove the cover and the terminal plate. Drill a hole through the stator liner on the opposite end of the stator.

Position the stator assembly with the rear end bell up and introduce an appropriate neutralizing fluid through the junction box port. The fluid will exit through the drilled hole in the opposite end. Flush the stator cavity for a sufficient time to allow for the removal of all process fluid. After washing is completed, drain all the fluid.

Remove as much of the neutralizing fluid as possible by purging the stator with compressed air or inert gas for 3 – 5 minutes. If the terminal box and terminal plate are to be returned, assure that all components have been decontaminated.

NOTE ON DECONTAMINATION:

TEIKOKU USA RESERVES THE OPTION TO RETURN PUMPS, AT THE CUSTOMER'S EXPENSE,
IF THEY HAVE NOT BEEN PROPERLY DECONTAMINATED.

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Appx. Q. Teikoku Pump Repair Policy

TEIKOKU USA INC
CHEMPUMP

959 Mearns Road
Warminster, PA 18974
www.TeikokuPumps.com
☎(215) 343-6000
(267) 486-1037

5880 Bingle Road
Houston, TX 77092
www.TeikokuPumps.com
☎(713) 983-9901
(713) 983-9919

27881 State Route 7
Marietta, OH 45750
www.TeikokuPumps.com
☎(740) 538-5332
(740) 538-5015

Repair Receipt Policy

Teikoku USA policy requires that an RMA be generated prior to the shipment of pumps or components to any Teikoku USA facility. With the shipment Teikoku USA also requires a copy of the RMA, a completed Teikoku USA Decontamination Form, an SDS for the process fluid to which the pumps or parts were subjected and an SDS on the decontamination flush fluid that was used to decontaminate the equipment.

THESE DOCUMENTS MUST ACCOMPANY THE SHIPMENT. IF THESE DOCUMENTS ARE NOT PROVIDED, TEIKOKU USA PERSONNEL WILL REFUSE THE SHIPMENT AND INFORM BOTH THE CARRIER AND CUSTOMER OF THE REFUSAL.

These requirements are essential to Teikoku USA's safety practices and reviews that serve to protect all of Teikoku USA's associates, visitors and customers. Teikoku USA thanks you in advance for your adherence to our policy regarding returns for evaluation and/or service. Please feel free to contact the service center personnel at the Teikoku USA facility to which the pump was sent for repair.

As part of its ongoing process improvement policy, Teikoku USA continually reviews business processes to ensure that a safe work environment is provided for all employees, associates, visitors, customers and the community. As such this policy is subject to change without prior notice. To check for any changes to this policy, please use the contact numbers for each facility as listed in the above letterhead.

TEIKOKU USA INC
CHEMPUMP

www.teikokupumps.com

Pennsylvania
959 Mearns Road
Warminster PA 18974
215-343-6000

Texas
5880 Bingle Road
Houston, TX 77092
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