PACOFLO 9000, LEVEL 1
INSTALLATION, OPERATION, AND MAINTENANCE MANUAL

S/N:
DATE:

PACOFLO 9000, LEVEL 1

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Attachments may include: Pump IOM, Sales and Service Centers Guide

INTRODUCTION

The Pacoflo 9000, Level 1 booster system is a complete, factory assembled water booster system. The system operates with multiple pumps in parallel. The booster system's U.L. panel provides controls for the system sequencing and alarm functions. The booster system takes water from a source and boosts the pressure for final use at the discharge of the unit. Pump sequencing is provided with a wide range of devices and the exact configuration of the unit will depend on how the unit was ordered. The system comes complete, ready for installation and operation, and is intended to pump clean, fresh water.

This booster system has been fabricated and preset at the factory to the required system and flow specifications. Final system adjustments may be required to place the system in operation. The booster system has been designed to operate over the range of pressures and flows as described in Paco Pumps' catalog and is built to the customer's specifications and jobsite requirements.

This system will perform as set at the factory and will continue to provide satisfactory service when properly installed and maintained. Periodic maintenance is necessary for continuous trouble free service. Service assistance in maintaining the system can be provided by Paco's factory trained service organizations. Service by unauthorized agencies should be avoided.

All PACO booster systems are identified with a system nameplate and individualized label, located on and in the control panel. A sample nameplate and label is included at the end of this IOM. In addition, the individual pumps have nameplates. **When referring to this system, please include all nameplate information.**

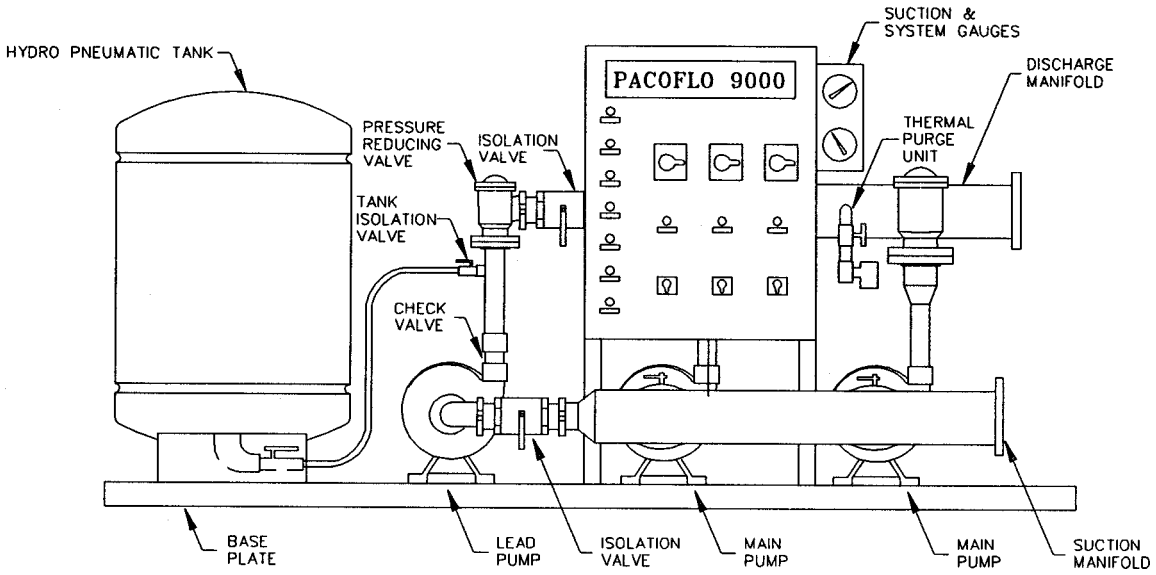
With the nameplate and label information, spare or replacement parts can be easily identified and ordered. All normally required parts are available in kit form, as shown in the replacement parts guide included in this IOM.

A form has been included near the end of the IOM for your use to fill out nameplate information that can be used when contacting our service representatives.

It is recommended that the system nameplate and label be immediately examined and information contained therein be immediately recorded on the forms in this IOM to insure proper identification in the event of future nameplate or label damage.

THE ENTIRE CONTENTS OF THIS MANUAL SHOULD BE COMPLETELY READ BEFORE ANY INSTALLATION, OPERATION, OR MAINTENANCE.

PACOFLO 9000, LEVEL 1
MAJOR SYSTEM COMPONENTS



NOTE: System is typical. End suction pumps shown.
Pump type and number will vary with system type.

SYSTEM INSTALLATION

RECEIPT OF SYSTEM

The booster system is to be inspected upon receipt for indications of possible transit damage. If there is any damage, contact the freight carrier immediately and report any damage. File a freight claim directly and immediately with the freight carrier.

Inspect the entire system for components that may have loosened in the transporting of the system. Repair or tighten the affected components. Open the electrical panel door and inspect the interior of the panel. Check all wires for tightness and all components to make sure they have not loosened nor been inadvertently disconnected.

STORAGE

The system must be stored indoors, out of the weather. Avoid any temperature extremes. Storage temperatures should range from 40 degrees F to 104 degrees F.

Whether the system is stored at the final site of the booster system or at a separate site, the system must be **loosely** covered with a plastic or canvas cover. If the system may be exposed to moisture, the cover is to be moisture proof. Allowances should be made to allow for proper ventilation and air circulation.

If the system will be exposed to dirt and dust before system startup, a plastic or canvas cover is to be used to keep the system clean.

MOVING THE SYSTEM

This packaged system can be moved with a fork lift truck. The forks of the lift truck should be placed under the side or end of the baseplate of the system. The system should be secured to the fork lift mast to prevent the system from shifting or falling from the forks.

Do not attach a sling or other type of convenience to any of the system components or move the system in any way through the system components. If a sling is used to move the system, the sling can be placed under the base. Dollies or other wheeled devices can also be used to transport the system.

MECHANICAL INSTALLATION

The site for the installation should be clean, level, and free from all debris.

Place the Pacoflo 9000, Level 1 booster system at the installation location and check for approximate alignment with suction and discharge piping. Check the clearance between the electrical panel door and any obstruction to make sure the distance is in compliance with the National Electric Code, and any local codes. Correct any discrepancies.

Mark the location of the baseplate anchor bolt holes on the floor and install anchors in the floor. Install the anchor bolts and secure the baseplate using flat washers and lock washers under the bolt heads.

Use a level to level the booster system baseplate. Shim the base plate at the anchor bolt locations until the level in various planes is satisfied at several points on the baseplate.

When the system has been leveled, apply grout to the base and completely fill in the space between the baseplate and the floor. Allow the grouting to dry before attempting any connection of the system piping. Without proper grouting, the booster system may be noisy and susceptible to vibration.

CONNECTING THE SYSTEM TO THE BUILDING PIPING

Follow any local codes when making final connections of the system.

System Isolation valves must be provided at the connection points of the booster system suction and discharge manifolds with the system piping. Flexible couplings can also be used, as specified.

Flushing of the system prior to installation is required. Check the booster system manifolds to make sure they are free of debris. Also check building piping for any obstructions or debris before connecting the booster system to the building piping. Piping to the system must be free from obstructions that will prevent proper flow to and from the system, or otherwise damage the system.

The building piping must be piped TO the manifolds of the booster system. Do not pipe from the booster system to the building piping. Tighten all piping securely and adjust the final fittings to the flanges or fitting of the system.

The booster system manifolds are not to be used as supports for the building piping. Supports for the building piping must be provided. Do not put stress on the booster system manifolds by using them to "close up" any poor fit of the building piping to the booster system.

Good piping practices and proper fittings are required to prevent any air pockets from being created in the piping from the supplied suction line.

Pipe the thermal purge valve to the floor drain or other type drain.

ELECTRICAL INSTALLATION

Electrical Safety.... Electrical circuits pose a potential danger. DO NOT attempt to connect an electrical panel to the main power supply with out proper and complete electrical training in electrical safety and proper electrical maintenance skills. The following section is written to assist an EXPERIENCED AND QUALIFIED ELECTRICIAN in connecting the panel to the main power.

Use only electrical testing devices and protection equipment that have been verified as safe and reliable. All testing devices used to indicate voltage and current must be of known reliability. Do not use a strange or untested electrical measuring device to troubleshoot or verify any electrical circuit.

The power to the panel must be connected in compliance with the National Electric Code (NEC) and any local codes. Voltage variations greater than 10% of the supply voltage or frequency variations greater than 5% will cause poor performance and damage the electrical components of the system. Correct any variations of voltage or frequency before connection to the system.

The booster system nameplate, located on the upper left hand corner of the panel front, contains the correct voltage, phase, and frequency of the panel and Pacoflo 9000, Level 1 electrical components. The supply voltage, phase and frequency must match the panel nameplate information. Double check by checking the motor nameplates to verify the required voltage. If there is a discrepancy, contact PACO Pumps for assistance. Test the voltage at the branch circuit disconnecting device to verify the correct voltage before connecting the wires to the panel.

The wires coming to the system must be copper wire and correctly sized by the electrical contractor or engineer.

Make sure the booster system electrical panel disconnecting switch(es) and all H-O-A (HAND-OFF-AUTO) switches are in the **OFF** position before applying power to the panel.

ELECTRICAL CHECK OUT

On systems equipped with self-protected starters, see the TRIP MODULE ADJUSTMENT section for additional information.

Make sure all HAND-OFF-AUTO (H-O-A) switches are in the OFF position. Open the panel door and use a voltage meter or other electrical instrument to verify that the incoming voltage matches the nameplate information. The voltage can be checked at the power distribution block or panel disconnecting switch. If Voltage is not present, check the Branch Circuit disconnecting device to see if the device is **ON.**

Inspect the panel for any abnormal conditions, loose wires, loose components, missing components, etc. Check the motor starters to see if the heaters have been installed on heater-type overload relays, or that the amp settings are correct on adjustable overload relays. Correct heater sizes, trip module adjustments and/or overload adjustment are based on the motor's nameplate FLA value.

If the motors are protected with fuses, make sure the fuses are present. If the fuses are not present, consult PACO Pumps for correct fuse sizing. If fuses are required to be installed, use an insulated fuse installation tool. If the motors are protected with circuit breakers and the panel has a main disconnect, make sure the breakers are in the "ON" position.

Make sure water is present at the suction side of the pumps and at the correct suction pressure (See page 7, Applying Water to the System). Close the panel door and turn on the panel main disconnect(s) so that power is applied to the panel. If an alarm horn sounds, press the silence reset button to silence the horn. Momentarily move the HAND-OFF-AUTO switch to the HAND position and back to OFF, and observe the rotation of each pump. Rotation is indicated by an arrow on the pump and is observed through the motor bracket opening. A chalk mark placed on the shaft end prior to energizing may prove a valuable aid in ease of observation. For vertical turbines, rotation should be verified before by coupling pump to motor.

If the rotation is incorrect on all of the system pumps, change any two incoming panel wires on three phase systems. If one motor's rotation is incorrect, change any two wires at the motor starter to correct the rotation. Single phase systems will require a change at the motor junction box, and information on these connections will be inside the junction box.

If the motor starter does not energize, check the circuit breaker or fuses and the overload reset on the starter. Also check to make sure you have control voltage at the down stream side of the control power fuse(s).

HYDROCUMULATOR TANK

CAUTION

If a Hydrocumulator tank has been included as a part of this booster system, the tank requires proper air charging before water pressure is applied. Damage to the tank bladder can occur if water under pressure is introduced into the tank with no air charge.

AIR CHARGE

The specific air charge will vary depending upon the tank manufacturer. When there are no instructions provided with the tank, the recommended setting of the air charge pressure is 20 PSI below the system pressure. If the system pressure were 100 PSI, the tank air charge will be 100 - 20 = 80 PSI.

Make sure the temperature of the tank is as close as possible to the ambient temperature before making any pressure tests or readjustments.

Check the pressurizing stem for any obstructions or debris prior to checking the tank pressure or adding air to the tank. Check the air charge with a pressure gauge. Add or release air as required. Air can be added with a hand tire pump or with an air compressor. Do not over pressurize beyond the tank nameplate maximum pressure. Damage to the tank internal bladder will result.

SYSTEM PRESSURE is defined as system boost pressure plus minimum suction pressure. Each particular system pressure value is listed in the booster system label.

After clearing all of the air from the system, and the system is working on automatic, open the tank isolation valve slowly to allow water to enter the tank. Gradually open the valve all the way.

TANK AIR CHARGE= System Pressure (PSI) minus 20 PSI.

PACOFLO 9000, LEVEL 1 STARTUP CHECK LIST

PRELIMINARY

_____ 1. Confirm nameplate information.

_____ 2. If unit has a tank, air charge tank to system pressure (PSI) minus 20 PSI before applying any water pressure to booster system.

_____ 3. Fill system with water.

_____ 4. Bleed air at top of pumps, prv's, gauges and at pressure switches.

_____ 5. Bleed air from any other high point in the system.

_____ 6. Check pressure reading on suction gauge (make sure it's at minimum).

CAUTION:
FINAL ELECTRICAL CONNECTIONS AND PANEL CHECKOUT SHOULD BE MADE BY A QUALIFIED ELECTRICIAN!

ELECTRICAL

_____ 7. Turn HOA switches to "OFF" position.

_____ 8. Check settings on trip modules inside panel.

_____ 9. Apply power to panel.

_____ 10. Check supply voltage to panel and verify correct voltage with nameplate data.

_____ 11. Close and secure panel door, (push "ALARM SILENCE" button if alarm is sounding).

_____ 12. Bump each motor and verify proper pump rotation.
(on vertical turbine systems, check rotation before coupling pump to motor).

GETTING READY TO RUN

_____ 13. When building is ready to accept water pressure, turn on pump #1 in "HAND" mode.

_____ 14. Open building fixtures to establish approximately 15-25 GPM flow.

_____ 15. Observe system pressure gauge, (check to see if pressure is as required).

_____ 16. If incorrect, readjust PRV to desired pressure reading.

_____ 17. Check remaining pumps and PRV's in same manner.

SETTING SYSTEM & SUCTION PRESSURES TO PC

_____ 18. Confirm pressure switches adjusted to correct pressure set point.

SYSTEM IS NOW READY FOR "AUTO" OPERATION

_____ 19. Put all "HOA" switches in "AUTO" mode.

_____ 20. Open and close fixtures or valves in building to check flow switch settings and verify "AUTO" operation of booster system. **IF FURTHER DETAILS ARE REQUIRED, SEE F9d.2.**

PLACING THE SYSTEM INTO OPERATION

APPLYING WATER TO THE SYSTEM

Before applying water to the booster system, close all of the isolation valves on the booster system. Slowly open the building suction shut off valve and allow water to fill the booster system suction manifold.

All air must be removed from the system. If all air is not removed from the system, improper operation of the system will result, and possible permanent damage to the system may occur.

Loosen the suction pressure gauge line at the gauge and bleed all air. Retighten the connection.

Open the suction valve to each pump, one at a time, and observe for leaks. Report any leaks immediately to Paco Pumps. Open a plug or other fittings at the top of each pump to discharge any and all air from the pumps. Replace and retighten the fittings.

Loosen the discharge pressure gauge line at the gauge and bleed all air. Retighten connection.

Check the pressure gauge and determine that the suction pressure corresponds to the Paco-flo 9000, Level 1 design settings, and falls between the minimum and maximum conditions indicated on the system label. This label is located on the interior of the electrical panel.

Check for leaks in the piping to the manifold and any leaks that may appear in the manifold. Repair any leaks in the building piping and report any leaks in the Pacoflo 9000, Level 1 immediately to Paco Pumps.

Open the discharge isolation valves at each pump. If the system has a PRV/pump, open the vent (nut) on each PRV and vent each line to remove all air. Bleed air for at least 30 minutes. Close the vent.

Open the building system valve. Check the building piping and repair all leaks.

SYSTEM CHECK OUT

For venting the system, open a valve at the top or extreme end to the piping system. Direct the valve to a drain or other sink that will take the expected water discharge. Place the lead pump motor in the HAND position and run the pump until clear water is coming from the valve. Monitor the suction pressure to make sure the pressure stays above the minimum acceptable value.

Close the valve used to vent the system and place all of the HAND-OFF-AUTO switches in the-AUTO position. Reset any alarms that may occur by pressing the ALARM-RESET button. The system should stop after a no flow condition has existed for three minutes. (Note: Systems without a no flow circuit will continue to run).

Open a valve to discharge water from the building piping. The valve should be large enough to handle total system flow. The booster system should restart when the system pressure has dropped below the set pressure. Close the valve and the system should shut down after three minutes. Open the valve again and increase the flow until the first main pump starts. (Note: On a duplex system the second pump will start.) Continue to open the valve until the third pump starts. Close the valve and each main pump will stop after a time delay. The lead pump will stop after three minutes

SETTING PRV's

If the PRV (s) have been installed at the factory, they have been set to the system pressure. If a single PRV will be added to the system at the jobsite, the PRV must be set to the required system pressure. Follow PRV instructions.

SUMMARY

When the system is completely checked out and properly adjusted, the system will be ready for use. If problems develop, check the sections in the manual that cover the problem area for solutions to the problems.

MOTOR STARTERS

The majority of Pacoflo 9000, Level 1 systems are equipped with state-of-the-art self protected starters. Check the control panel to determine whether self protected starters or separate starters/ overload protection are present.

SELF PROTECTED STARTERS / TRIP MODULES

The self protected starter has a removable module called the "TRIP MODULE". This module is adjustable for both the motor overloads and motor short circuit protection. All settings have been factory set, and adjustment is not normally required.

MODULE TRIPPING PROBLEMS

Most module tripping problems occur when the motor is drawing more amps than its nameplated FLA value. If the module continuously trips or if tripping is a problem, check the settings on the trip modules, as well as the motor amperage draw.

TRIP MODULE ADJUSTMENTS
OVER CURRENT DIAL

There are two dials on the front of the module. The left-hand dial is set for short circuit protection. The right-hand dial is set for motor overload protection.

The left-hand dial and the portion of the trip module controlled by its setting is similar to a Motor Circuit Protector (MCP). The dial is set to 13 times the motor nameplate FLA value. For example, a motor that has a FLA value of 10 amps has a correct dial setting of 130. Do not increase the dial setting to more than 13 times the motor FLA value. If the dial can not be adjusted to the correct value, then the TRIP MODULE must be changed. Please contact a PACO Service Technician.

To order a new trip module, check the motor nameplate FL amps, and from the TRIP MODULE table on page 10, determine the part number for the correct trip module.

OVERLOAD DIAL

The right-hand dial controls the motor overload part of the TRIP MODULE. On the trip module, check the setting of the dial on the right-hand side of the module and adjust the dial to the correct motor nameplate FLA value. Do not increase the setting of the dial to more than 15 percent above the motor nameplate FLA rating. If motors with a service factor other than 15% are used, do not exceed the motor nameplated FLA plus the nameplated service factors. If the range of the trip module does not correspond to the nameplate amps, select trip module from the table on page 10.

If nuisance tripping continues after the proper adjustments have been made, the switch point to bring on the next pump in the sequence needs to be checked. (If the motor is over amping at the switch point, adjustment to the switch point is required). See the appropriate sequencing section for check out and adjustment. If the trip module continues to trip after all of the preceding checks have been made, the trip module may be defective.

TRIP MODULE

SELF PROTECTED TRIP MODULE PART NUMBERS

Model	AMPS	Complete Starter & Coil (Less the Trip Module)	Replacement Coil Only
18A	18A	96035209	96035209 - Coil
32A	32A	96035210	96035210 - Coil
63A	63A	96035211	96035211 - Coil

PACO PART NUMBER	RANGE-AMPS MOTOR F.L. AMPS
96035200	2.5 TO 4
96035201	4 TO 6
96035202	6 TO 10
96035203	10 TO 16
96035204	16 TO 25
96035205	23 TO 32
96035206	28 TO 40
96035207	35 TO 50
96035208	45 TO 63

NOTE: To order a complete Self protected starter assembly, select both the "Complete Starter and Coil" and the appropriate "Trip Module".

CONTROL SYSTEM (PLC)

All booster systems require some method of control for purposes of automating the system and sequencing the pumps. The Control System typically involves three steps, as follows:

1. Data Acquisition or “Sensing” of existing system conditions
2. Processing of the input data.
3. Control Signal Output and “Sequencing”.

It is important to note that a control system has both primary and secondary functions. The primary function of a control system is to monitor, process and control pump sequencing in order to provide efficient automation of the pump system. A secondary, but equally important function is to monitor, process and control the system safety and protective operations.

PACOFLO 9000, LEVEL 1 booster systems are provided with a programmable logic controller (PLC) for purposes of controlling the booster system. A PLC is a control device which efficiently and effectively processes incoming and outgoing data.

Like a computer, the PLC contains both hardware and software. The PLC is a solid-state micro-processor with data input and output capability, used specifically for control functions. The PLC is able to “read” incoming data from the sensors, process that data according to the programming software, and provide control signal output via relay contacts on the PLC.

The PLC is preprogrammed at the factory with a standardized control program (software) written specifically for PACOFLO 9000, LEVEL 1 booster systems. All programs are thoroughly tested and debugged. The standardized programs may be tailored for specific jobs by adding/removing pre-tested programming “modules” related to the available booster system options. The program is also loaded with specific, job related set-point data. Once complete, the finalized program is “flashed” into memory. The memory is non-volatile, which means that the programming data is not lost with a loss of power. Therefore, a back-up battery power source is not required to maintain program storage.

Note that a back-up battery is not required and therefore not supplied with the booster system. A "Battery Low" LED will remain lit on the PLC as a result.

DATA ACQUISITION AND SENSING SYSTEMS

The PACOFLO 9000, LEVEL 1 booster system may use several methods of “Data Acquisition” to monitor current conditions of the booster system. These methods are the “eyes and ears” of the booster and are used to monitor and signal various conditions.

Pressure based Alarms & Functions:
Level 1 boosters use pressure switches as the standard means of monitoring for given pressure conditions such as high system pressure alarm and low suction pressure alarm. Independent pressure switches are used for each condition to be monitored. In most cases, the pressure switches provide a single, discrete “close contact” signal upon initiation of condition. That signal maintains “closed” until the condition subsides.

Flow based Alarms & Functions:
Level 1 boosters use a flow switch as the standard means of monitoring for given flow conditions such as “No Flow” condition. In most cases, flow switches provide a single, discrete “close contact” signal upon initiation of condition. That signal maintains “closed” until the condition subsides.

Sequencing Devices:
Sequencing Devices are critical part of data acquisition. These devices serve a specific function, and are discussed in detail in the following section.

SEQUENCING DEVICES

"Sequencing Device" is the term used to describe a sensing mechanism that is used specifically for monitoring and signaling the point of activation and sequencing of the pumps on the skid. This is the unit that indicates when it is appropriate to activate a pump, or if a pump is already running, to activate an additional pump.

There are many methods to determine when it is appropriate to activate a pump. Common methods include flow sensing, pressure sensing and current sensing. The PACOFLO 9000 Level 1uses a Pressure Sensing Sequencing Device.

Pressure Sensing
Pressure sensing is the standard sequencing indicator method for the PACOFLO 9000, LEVEL 1 booster. Pressure sensing is accomplished by means of a pressure switch. This pressure switch may be identical to other pressure switches used on the system to monitor the alarm conditions.

For pressure sensing, the pressure switch setting or 'set point" is equal to the System Pressure. Upon a drop in pressure below System Pressure, the switch "closes contact" to indicate the condition. This signal is then processed by the PLC, and based upon the programming, a pump may be activated. Typically, when the pump activates, pressure is restored and the switch opens. Otherwise, if demand is very large, the pressure switch may remain closed, and the PLC may call to activate an additional pump.

The sequence of pump activation may vary, and is discussed in the next section "Sequence Variations".

SEQUENCE VARIATIONS

Pumps may be sequenced in many variations in order to meet demand (flow) requirements. For a given demand, it may be possible to satisfy that demand by activating two pumps in parallel within the booster system. However, it may also be possible to satisfy that same demand by activating one large pump. Other demands may be satisfied with one small and one large pump. An effective sequence variation allows for the minimum amount of "pumping power" to be activated, to meet system requirements. For instance, if demand can be satisfied by two 5HP pump, it is not efficient to activate a third 5 HP pump to meet that demand.

Sequence variations are typically described in terms of the number of sequencing steps or more comprehensively in terms of percentage of total flow. Sequence variations are also dependent on the original capacity split design of the pumps. Typically, the greater the number of steps, the better chance of minimizing the "pumping power" for any given demand. Below is a table of capacity splits and sequencing variations.

Common Sequence Variations

Capacity Split	Sequencing Variation	Pumps activated
50/50 Duplex	50%, 100%	A, A+B
30/70 Duplex	30%, 100%	A, A+B
	30%, 70%, 100%	A, B, A+B
20/40/40 Triplex	20%, 60%, 100%	A, A+B, A+B+C
	20%, 40%, 100%	A, B, A+B+C
	20%, 40%, 60%, 80%, 100%	A, B, A+B, B+C, A+B+C

There are many adaptations of the above sequencing variations as well, especially when capacity splits are tailored for specific system demands. A 65/65 split will follow the same sequencing variation as a 50/50 split.

In addition to those listed above, there are systems where pump capacity splits and sequencing variations are designed for system redundancy, emergency back-up, or "over-capacity capability". With these systems, the total flow of all pumps exceeds the total demand requirement of the system. This is done to provide additional "back-up" pumping, should one pump become inoperable. Below is a table of capacity splits and sequencing variations for redundant systems.

Redundant Sequence Variations

Capacity Split	Sequencing Variation	Pumps Activated
50/50/50 Triplex	50%, 100%,	A, A+B (C as backup)
30/70/70 Triplex	30%,100%	A, A+B (C as backup)
	30%, 70%, 100%	A, B, A+B (C as backup)
30/70/100 Triplex	30%, 100%	A, A+B (C as backup)
	30%, 70%, 100%	A, B, A+B (C as backup)

ALARMS, OPTIONS AND OTHER FEATURES

ALARM LIGHTS (Standard)

Each alarm or shutdown condition indicated herein has an individual, labeled alarm light. Alarm lights will remain lit until the alarm condition is relieved.

AUDIBLE ALARM (Standard)

The audible alarm is a high frequency solid state horn that will sound when an alarm condition occurs. The alarm can be silenced with the ALARM SILENCE button and will clear itself when all alarm conditions are corrected.

PUMP ALTERNATOR (Standard)

The control system has two methods of alternating the main pumps. Primary alternation of the main pumps occurs at the completion of every first stage cycle. Cycle completion is determined by a first stage start and subsequent stop after the mnimum run time. If additional stages are signaled to run and stop during the same cycle, the called main pump sequence will remain.

The control system also includes a timed method of main pump alternation. The alternation time is factory set at 12 hours. Alternation time is initiated by a first stage start signal. If the alternation time is completed before the end of the run cycle, main pumps alternate positions. If the run cycle is completed before the alternation time elapses, then the alternation time is reset and the main pumps alternate based on cycle completion. Alternation will occur only if main pump H-O-A selectors are in the auto mode and no main pump failure has been sensed.

PUMP FAILURE PROTECTION AND ALARM (Standard)

When a pump is called to run, controller monitors the motor starter auxiliary contact input for the respective pump as a confirmation that pump is running. Failure to receive signal within 2 seconds after pump is called to run is interpreted as a pump failure. Controller locks out said pump from the pumping sequence and calls the next available pump to operate. Respective "Pump Failed" light is illuminated. Manual reset required before pump is re-instated into pumping sequence.

LOW SUCTION PRESSURE (Shutdown and alarm Standard)

If the suction pressure falls to preset minimum suction pressure value (as indicated on the panel label), the low suction pressure light will be lit and the alarm will sound, after a delay of 10 seconds. The system will shut down and not run in the alarm condition. The alarm is self clearing when the suction pressure returns to normal parameters.

LOW SUCTION LEVEL (Shutdown and Alarm optional)

When the level of the reservoir or tank drops below a set point (as determined by the placement of the float switch), the level switch closes and the system will shut down after a 10 second delay. The condition is indicated by a visible light and alarm horn. The system restarts when the reservoir or tank level rises above the set point and reopens the level switch. Electrical runslonger than 200 feet to the float switch may cause poor panel performance and should be avoided.

THERMAL PURGE SYSTEM

If a pump continues to operate when flow (demand) is not present, the condition is called “dead heading the pump”. Pumps which “dead head” can build up heat within the pump case. The system is equipped with a thermal purge system to prevent excessive build up of heat in the pump from damaging the pump seal and system components. The thermal purge may be a thermal-mechanical valve or a thermostat & solenoid valve combination. Thermal purge systems may be provided “one per pump” or “one per system” depending on the original ordering criteria.

TIMED SHUT-OFF (STANDARD WITH TANK)

If a booster system is provided with a hydro-cumulator tank, the system is provided with a Timed Shut-Off circuit as standard. This feature allows the booster system to shut off upon satisfying the system pressure requirements for a minimum of 10 minutes. After 10 minutes of operation, the system will shut off for energy savings, and allow pressure to be maintained by the hydro-cumulator tank. If demand (flow) remains, the system will reactivate upon reaching the Low Pressure Start set point. Systems which are supplied with a No-Flow Shut-off option, are not equipped with the Timed Shut-Off feature. This feature is not provided on systems that do not have a hydro-cumulator or hydro-pneumatic tank, as those systems have no means of maintaining pressure while pumps are de-activated.

NO-FLOW SHUT-OFF (OPTIONAL WITH TANK)

If a booster system is provided with a hydro-cumulator tank, the system may be equipped with an optional No Flow Shut-off circuit instead of the standard Timed Shut-Off feature. When flow diminishes below a set point, and system pressure is maintained, the No-Flow switch closes and a minimum run timer counts for 180 seconds before shutting off the pumps. If demand (flow) remains, the system will reactivate upon reaching the Low Pressure Start set point.

AUXILIARY ALARM CONTACTS

Auxiliary alarm contacts are relays (“dry contacts”) which are paralleled with the alarm option. When the alarm option is activated, the relay closes and provides remote alarm indication. The customer will supply the correct voltage for the remote alarm option from the remote alarm indicating station.

PHASE FAILURE - LOW VOLTAGE FAILURE

When the Phase failure/low voltage option is installed, the panel control power will be shutoff if a low voltage or phase failure condition exists. The low voltage or phase failure (or reversal) condition must be cleared before the system will restart.

HIGH SYSTEM PRESSSURE SHUTDOWN AND ALARM (OPTIONAL)

When the system pressure reaches the maximum flange design rating of the system, the system is shut down and an alarm light and horn sound. A two second delay is provided to consider momentary high pressure spikes. The system requires a manual reset to restart. The system maximum design rating is the maximum pressure the system is designed to withstand on a continuous basis. Typically, these pressures are: 175 PSI, 250 PSI and 400 PSI, depending on installation design.

OVERVIEW OF FACTORY SETTINGS

PACOFLO 9000 Booster Systems are pre-programmed at the factory. Low Pressure Start settings and Low Suction Pressure settings have been set according to specific job data supplied to PACO at time of purchase. All pressure settings are field adjustable, as required for fine tuning purposes. Pressure Setting Adjustment procedures are described in this manual under "Adjustment of Pressure Setting".

Time delay settings are programmed as necessary to protect the booster system and related components. The timer settings indicated below have been found most appropriate to ensure proper system operation. Time delay settings are stored internally on the system PLC and require servicing by a trained technician. Reprogramming and adjustment of the time delay settings is inadvisable, without direct factory assistance.

FEATURE	Std/ Opt.	SETTING	TIME DELAY	RESET
Timed Shut Off	Std.*	Upon maintained System Pressure	10 Minutes	Not Applicable
No-Flow Shut Off	Opt.*	Flow of approx. 5 GPM	Dependent**	Not Applicable
Low Pressure Start	Std.	10 PSI below System Pressure ***	2 Seconds	Not Applicable
Minimum Run Timer, lead pump	Std.	Not Applicable	180 Seconds	Not Applicable
Minimum Run Timer, main pumps	Std.	Not Applicable	30 Seconds	Not Applicable
Pump Failure Alarm	Std.	Upon Failure to start	2 Seconds	Manual
Low Suction Pressure Alarm & Shutdown	Std.	10 PSI below Minimum Suction Pressure ***	10 Seconds	Automatic
Low Suction Level Alarm & Shutdown	Opt.	Upon close of float switch contact	10 Seconds	Automatic
High System Pressure Alarm & Shutdown	Opt.	Pressure rating of System components	2 Seconds	Manual
Phase reversal & low voltage Shutdown	Opt.	Phase loss, reversal, voltage drop of 10%	Instantaneous	Upon Correction

* Timed Shut-Off and No-Flow Shut-off are provided only with systems utilizing hydro-pneumatic or hydro-cumulator tanks.
** Upon detection of No Flow condition, individual pump Minimum Run Timers define the time delay for Shut Off.
***Minimum Suction Pressure and System Pressure are values as defined by Customer at placement of Order.

ADJUSTMENT OF PRESSURE SETTINGS

The Pacoflow 9000, Level 1 booster system is equipped with pressure switches to monitor the system start setpoint as well as low suction and optional high discharge pressure conditions. The pressure switches include set point adjusting nuts. Each switch is factory set for conditions provided for the system; however, field adjustment may sometimes be necessary.

The system was tested under simulated pressure and flow conditions at the factory. If the on site pressure conditions of the discharge (building side) or the suction (supply side) are different than the settings on a label on the interior of the panel door, then follow the instructions in the next paragraphs.

To set the pressure set points of the system, place the system into service as outlined in "PLACING THE SYSTEM INTO OPERATION". Set the PRV's. Insure that the suction pressure is at its design point or higher, and the discharge pressure is at the design point. The pressure set points can now be set.

HOW TO ADJUST THE PRESSURE SWITCH SETTINGS

Each pressure switch has a setpoint actuation nut with scaled dial. Turn the self locking adjustment nut clockwise to raise and counterclockwise to lower the actuation point. All dials are calibrated for increasing settings.

Capture pressure in the suction and discharge pressure lines to the gauges and pressure switches by closing the gauge line isolation valves. Bleed excess pressure in the lines to attain the correct low suction pressure and minimum system pressure readings on the respective gauges. Open panel door open where the PLC input LEDs are visible. Apply control power to the PLC. Adjust the pressure switch actuation nut as necessary to the setting that will actuate the correct PLC input LED; see system PLC drawings for input designation. When correct LED illuminates, correct setpoint has been attained. No further adjustment is needed. Open isolation valves to resume normal operation.

SYSTEMS PERFORMANCE TROUBLESHOOTING GUIDE

The following guide covers some of the problems that you may encounter when operating the booster system. Addiditonal troubleshooting of the electrical system can be found in the electrical and programmable controller section.

Condition	Possible Cause/Question	Answer = Yes	Answer = No
Pump does not operate in Hand or Auto position.	Power: Examine panel. Is there a loss of power to the panel?	Restore power to panel.	Check list for other causes. -or- Contact PACO.
	Breaker: Examine pump breaker. If breaker has tripped, can you reset the breaker?	Motor operating at more than nameplate FLA. Reset breaker. Investigate reason for over amperage.	Refer to following section in trouble shooting guide.
	Starter: Turn HOA switch to Hand. Does pump "run light" energize but starter not "click" or energize?	Starter coil is defective or coil wire is loose. Examine and repair or replace as necessary.	Check list for other causes. -or- Contact PACO.
	Motor/Wiring: Turn HOA switch to Hand. Does breaker trip immediately?	Motor short circuit protection is open, wires from starter to motor are disconnected or motor is bad. Examine and repair accordingly.	Check list for other causes. -or- Contact PACO.
	Open Circuit: Turn HOA switch to Hand. Does pump "run light" energize, starter energizes and motor still not run?	Motor short circuit protection is open, wires from starter to motor are disconnected or motor is bad. Examine and repair accordingly.	Check list for other causes. -or- Contact PACO.
Pump does not operate in Hand or Auto position, breaker will not reset.	Breaker: Does breaker reset when main power supply is off?	Breaker is defective or undersized or the wiring is grounded. Contact PACO.	Trip module is still hot from last overload condition or breaker is defective. Contact PACO.
Pump will not operate in Auto condition, but will operate in Hand.	No Flow: Examine system for flow. Is there no flow in the system?	Pumps will shut down in the automatic mode if there is no demand in the system. Pumps will re-activate upon demand.	Check list for other causes. -or- Contact PACO.
	Adequate Suction Pressure: Examine suction pressure. Does the suction pressure meet or exceed the require system pressure indicated on the panel nameplate?	Pumps will shut down in the automatic mode if there is adequate suction pressure. Pumps will re-activate if needed to boost pressure to meet requirements.	Check list for other causes. -or- Contact PACO.
	Alarms: Examine panel for alarm conditions. Is an alarm condition indicated?	Pumps will not operate under certain alarm conditions. Refer to Alarm section of IOM. Correct the system condition indicated by alarm.	Check list for other causes. -or- Contact PACO.
	HOA & Wiring: Examine internal wiring, HOA switch and PLC. Are any wires loose or bad switch?	Repair accordingly.	Check list for other causes. -or- Contact PACO.
	PLC: Examine PLC. Is the PLC off, burned, or indicating an error code.	Repair or replace PLC or programming accordingly.	Check list for other causes. -or- Contact PACO.

Condition	Possible Cause/Question	Answer = Yes	Answer = No
Pump Does Not Run in Auto but runs in Hand.	Demand Is there a demand present?	Pumps will not activate if there is no demand.	Check list for other causes. -or- Contact PACO.
Pump starts in Hand, but trips breaker periodically.	Amperage: Check amperage of pump motor with amp meter. Does amperage exceed motor nameplate?	Motor is drawing excessive amps. Contact PACO.	The trip module is adjusted too low or is undersized. Adjust accordingly or contact PACO. Note: Amperage will fluctuate with flow.
Pumps Cycle On and Off continuously with demand.	Demand Is demand fluctuating?	Pumps will activate and deactivate to meet demand.	Check list for other causes. -or- Contact PACO.
Pumps Cycle On and Off continuously with NO demand.	Discharge leakage: Close the main system discharge valve and allow system shutdown in automatic mode. Does system stop cycling, and remain off?	A demand still exists in the system. Check for system leakage. Inspect hydrocumulator tank to maximize drawdown during low flow. (see hydro-pneumatic tank troubleshooting)	See "Suction leakage" below.
	Suction leakage: Close the main system discharge valve, allow system to charge up system pressue, close the main system suction valve and allow system to shutdown in automatic mode. Does system stop cycling, and remain off?	The check valves or checking PRVs are not sealing. Pressure is leaking back to suction side. Clean or replace check valves or checking PRVs.	System set points are out of range, or fault in programming. Contact PACO.
	Hydro-pneumatic Tank: Does your system have a hydro-pneumatic tank either on the skid or remotely located?	Refer to Tank troubleshooting section of this manual.	Check list for other causes. -or- Contact PACO.
Discharge pressure is too low.	Improper Rotation: Inspect pumps to determine direction of rotation. Are the pumps rotating in the wrong direction?	Reverse any two leads on starter of motors that have incorrect rotation. If all motors have incorrect rotation, reverse any two leads on power supply to panel.	Check list for other causes. -or- Contact PACO.
	Air Bound. Crack open bleed fittings from top of piping, manifolds and pump volutes. Is there air in the piping?	Vent pumps, manifolds, pressure regulating valves and piping.	Check list for other causes. -or- Contact PACO.
	Incorrect voltage: Use voltage meter to verify that the incoming power supply. Is the supply voltage different than that listed on the panel?	Panel voltage rating must match supply voltage. Contact PACO	Check list for other causes. -or- Contact PACO.
	Isolation Valves: Examine valves. Are the isolation valves partially closed?	Open valves.	Check list for other causes. -or- Contact PACO.

Condition	Possible Cause/Question	Answer = Yes	Answer = No
	Exceeding Capacity: If equipped with flow meter, does meter reading exceed the rated flow of the booster system?	Reduce the system demand or contact PACO for options on increasing the flow capacity of the system.	Check list for other causes. -or- Contact PACO.
	If no flow meter is present, close the main discharge valve and examine the pressure gauge. Did the pressure increase?	Reduce the system demand or contact PACO for options on increasing the flow capacity of the system.	Check list for other causes. -or- Contact PACO.
	Suction Pressure: Examine suction pressure gauge. Is the suction pressure less than the minimum suction pressure indicated on the panel?	Examine suction line for blockage, clogged strainers, partially closed valves, restrictive PRVs. Correct as able or contact PACO for options on increasing the booster pressure of the system.	Check list for other causes. -or- Contact PACO.
	Gauge: Remove gauge and examine. Does gauge appear defective?	Replace gauge.	Check list for other causes. -or- Contact PACO.
	PRV: Examine pressure upstream of the pressure reducing valves (PRV). Is upstream pressure adequate?	Refer to PRV troubleshooting section of this manual.	Check list for other causes. -or- Contact PACO.
Discharge pressure is too high.	PRV: Is your system equiped with one or more pressure reducing valves (PRV)?	Refer to PRV troubleshooting section of this manual.	Check list for other causes. -or- Contact PACO.
PRV not opening or too restrictive.	Diaphragm: Is water leaking from vent hole?	Diaphragm is ruptured. Replace.	Check list for other causes. -or- Contact PACO.
	Installation: Inspect PRV. Is valve installed with flow in the opposite direction of the arrow on the valve?	Water flow should be in the direction of the arrow. Reverse valve orientation.	Check list for other causes. -or- Contact PACO.
	Isolation valve: Inspect isolation valves in pilot tubing. Are any isolation valves closed?	PRV can not vent pressure. Open valve.	Check list for other causes. -or- Contact PACO.
	Speed control valves: Inspect speed control valves by opening fully and closing fully (return to original setting). Was the valve closed or frozen?	Clean or replace speed control valve, and reset the speed setting.	Check list for other causes. -or- Contact PACO.
	Failed pilot regulator.	Refer to PRV manual or contact PACO	Refer to PRV manual or contact PACO

	Possible Cause/Question	Answer = Yes	Answer = No
	Air Charge: Close isolation valve to hydropneumatic tank. Drain water from tank. Check pressure with gauge. See Hydropneumatic tank section for settings. Recharge to correct air pressure. Allow to set for 10 minutes. Check air pressure again. Has pressure fallen?	Bladder is ruptured and must be replaced. Contact PACO.	Open isolation valve to refill tank. Recheck system operation now that tank pressure setting has been re-established.
	Alarm Conditions: Review the systems conditions relating to the specific alarm that has activated. Does the alarm condition exist?	The system is designed to shutdown to protect system components. Restore proper operating conditions and reset alarm.	System may have entered an alarm condition earlier and now requires resetting. -Or- See other possible causes listed below.
	Alarm Setting: Review/adjust alarm settings as instructed in this manual. Are settings correct?	Check list for other causes. -or- Contact PACO.	Re-adjust switch settings accordingly.
	Defective Switch: Manually test the alarm indicator switch or transducer. Does the switch function properly?	Check list for other causes. -or- Contact PACO.	Replace the switch/ transducer.
	Defective Switch: Manually test the alarm indicator switch or transducer. Does the switch function properly?	Check list for other causes. -or- Contact PACO.	Replace the switch/ transducer.
	Alarm Setting: Review/adjust alarm settings as instructed in this manual. Are settings correct?	Check list for other causes. -or- Contact PACO.	Re-adjust switch settings accordingly.
	Time Delay: Verify time delay setting for this alarm. Has the condition existed continuously for the entire delay cycle?	Check list for other causes. -or- Contact PACO.	A time delay is utilized with this alarm to avoid inappropriate shutdown due to common pressure fluctuations. System is operating properly.
	Wiring: Examine internal wiring, and PLC. Are any wires loose or bad switch?	Repair accordingly.	Check list for other causes. -or- Contact PACO.
	Wiring. Inspect wiring. Is there a loose wiring connection?	Repair wiring accordingly.	Continue to next step
	Bulb: Remove wires to light and provide external 120VAC power source to light. Does light energize now?	Wiring or PLC contact is bad. Contact PACO.	Bulb or fixture is defective. Replace.

Condition	Possible Cause/Question	Answer = Yes	Answer = No
Horn will not sound when alarm condition exists.	Wiring. Inspect wiring. Is there a loose wiring connection?	Repair wiring accordingly.	Continue to next step
	Horn. Remove wires to horn and provide external 24VDC power source to horn. Does horn sound now?	Wiring or PLC contact is bad. Contact PACO.	Horn is defective. Replace.
Horn will not silence.	Wiring. Inspect wiring. Is there a loose wiring connection?	Repair wiring accordingly.	Continue to next step
	Button: Apply a jumper across terminals of Silence button. Does horn stop now?	Silence button is defective. Replace.	Wiring or PLC contact is bad. Contact PACO.
Remote alarm will not work.	Relay:Inspect the relay, are the contacts clear and does the coil cause the contacts to close when energized/	Check list for other causes. -or- Contact PACO.	Relay is defective, replace accordingly.
	Wiring. Inspect wiring. Is there a loose wiring connection?	Repair wiring accordingly.	Continue to next step
	Remote Power: Is power supply verified at remote location.	Check list for other causes. -or- Contact PACO.	Remote alarms often require separate power supply. Restore power at remote location.

APPENDIX A SYSTEM SETTINGS

PERMANENT RECORD OF SYSTEM SETTINGS

Data Indicated Herein Should Correspond to Panel Label Information.

SYSTEM GPM _____
PUMP #1 GPM _____
PUMP #2 GPM _____
PUMP #3 GPM _____

SYSTEM DESIGN PRESSURE 175 250 400 (Circle One)

SYSTEM PRESSURES

MAXIMUM SUCTION PRESSURE _____

MINIMUM SUCTION PRESSURE _____

SYSTEM PRESSURE _____

SYSTEM SEQUENCE

%	%	%	%	%
_____	_____	_____	_____	_____

APPENDIX B

PUMP AND PUMP NAME PLATE INFORMATION

The following panel nameplate information is obtained from the booster system nameplate on the upper left-hand corner of the front of the electrical panel.

MODEL NO. _____

SERIAL NO. _____

HP(1)_____ HP(2)_____ HP(3)_____

VOLTAGE_____ HZ_____

PANEL AMPS_____ PH_____

DRAWINGS: _____

PANEL NAMEPLATE

PACO® PUMPS
BROOKSHIRE, TX

CONTROL

MODEL:
SERIAL:
HP (1) (2) (3)
VOLTS: HZ:
MAX. AMPS: PHASE:
DRAWINGS:

PUMP NAMEPLATE

PACO® PUMPS
BROOKSHIRE, TX

SMART PUMP

CAT:
STOCK:
SER:
GPM: TDH: IMP DIA:

PACO® PUMPS

APPENDIX C SYSTEM NAMEPLATE INFORMATION

Duplex

PACOFLO 9000, LEVEL 1

System Flow ____ GPM
Suction Pressure: MIN. ____ PSI MAX. ____ PSI
System Boost ____ PSI
System Pressure ____ PSI
Capacity Split: ____ % ____ % ____ %

CONTROL PANEL NEMA PANEL ☐1 ☐3R ☐4 ☐12
☐ Low Suction Pressure ☐ Low Suction Level
☐ Fused Motor Protection ☐ Remote Alarm Contacts
☐ High Discharge Pressure

Wiring Diagram No. ____

Manifold Size ____ " X ____ "
____ " X ____ "
Suction Discharge ____ #ANSI
____ #ANSI

PRV: ☐ 1 Per Pump ☐ 1 Per System
☐ 0 Per System
☐ Tank ____ Gallons ____ PSI ☐ Remote

Constant Pressure Duplex System ____
System Serial Number ____

Pump	Model No.	GPM	TDH	Trim
1				
2				

____ Volts ____ HZ ____ Phase

Motor	HP	RPM	ENCL	Fuse	FLA	Manufacturer
1						
2						

Sequencing Device:
☐ Standard Sequencing 50% 100%
☐ Non-Standard Sequencing
____ % ____ %
☐ Pressure Sensing
Thermal Purge Option
☐ 1 Per System
☐ 1 Per Pump

Triplex

PACOFLO 9000, LEVEL 1

System Flow ____ GPM
Suction Pressure: MIN. ____ PSI MAX. ____ PSI
System Boost ____ PSI
System Pressure ____ PSI
Capacity Split: ____ % ____ % ____ %

CONTROL PANEL NEMA PANEL ☐1 ☐3R ☐4 ☐12
☐ Low Suction Pressure ☐ Remote Alarm Contacts
☐ Fused Motor Protection ☐ Low Suction Level

Wiring Diagram No. ____

Manifold Size ____ " X ____ "
____ " X ____ "
Suction Discharge ____ #ANSI
____ #ANSI

PRV: ☐ 1 Per Pump ☐ 1 Per System
☐ 0 Per System
☐ Tank ____ Gallons ____ PSI ☐ Remote

Constant Pressure Triplex System ____
System Serial Number ____

Pump	Model No.	GPM	TDH	Trim
1				
2				
3				

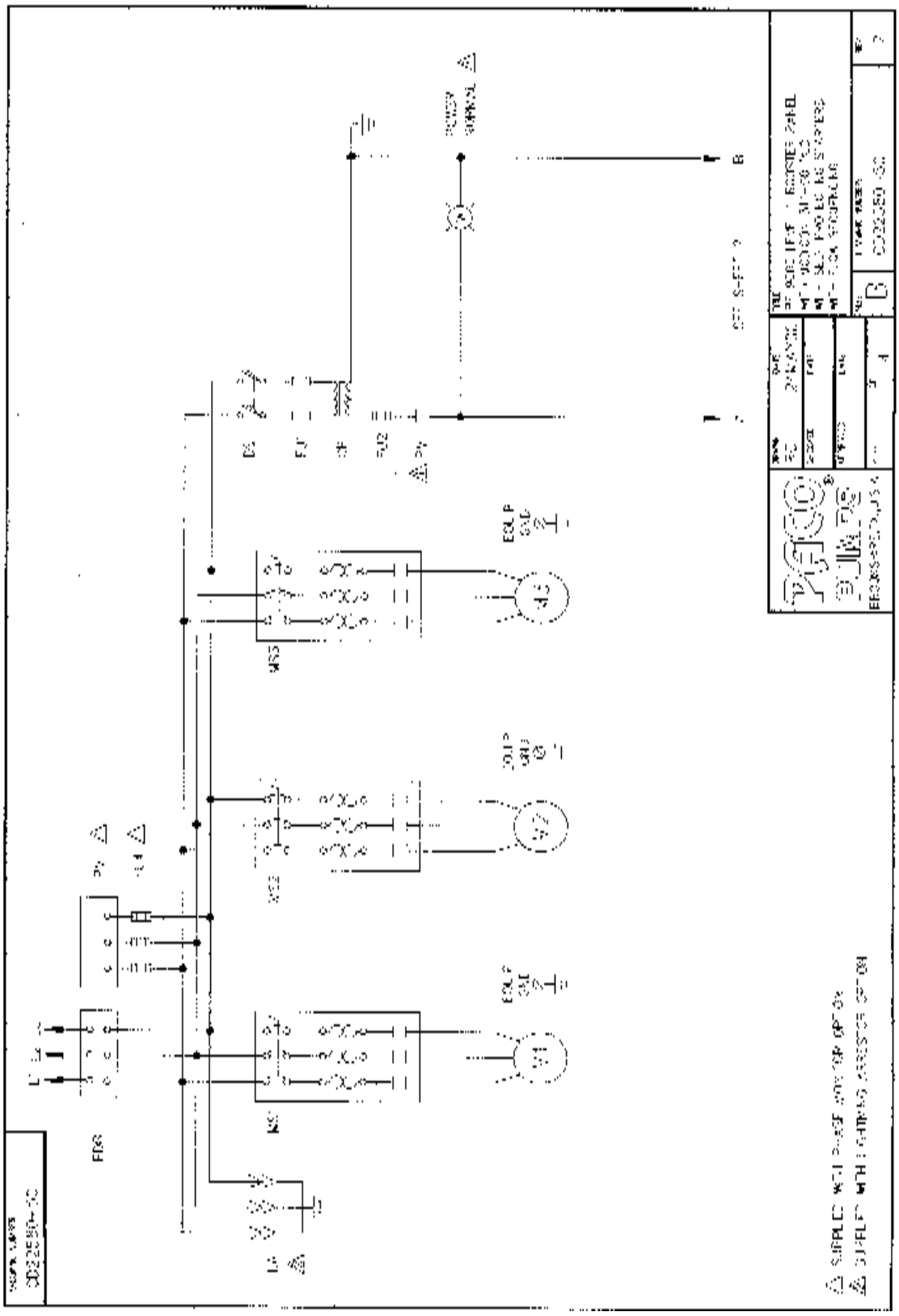
____ Volts ____ HZ ____ Phase

Motor	HP	RPM	ENCL	Fuse	FLA	Manufacturer
1						
2						
3						

Sequencing Device:
☐ Standard Sequencing 20% 60% 100%
☐ Non-Standard Sequencing
____ % ____ % ____ % ____ % ____ %
☐ Pressure Sensing
Thermal Purge Option:
☐ 1 Per System
☐ 1 Per Pump

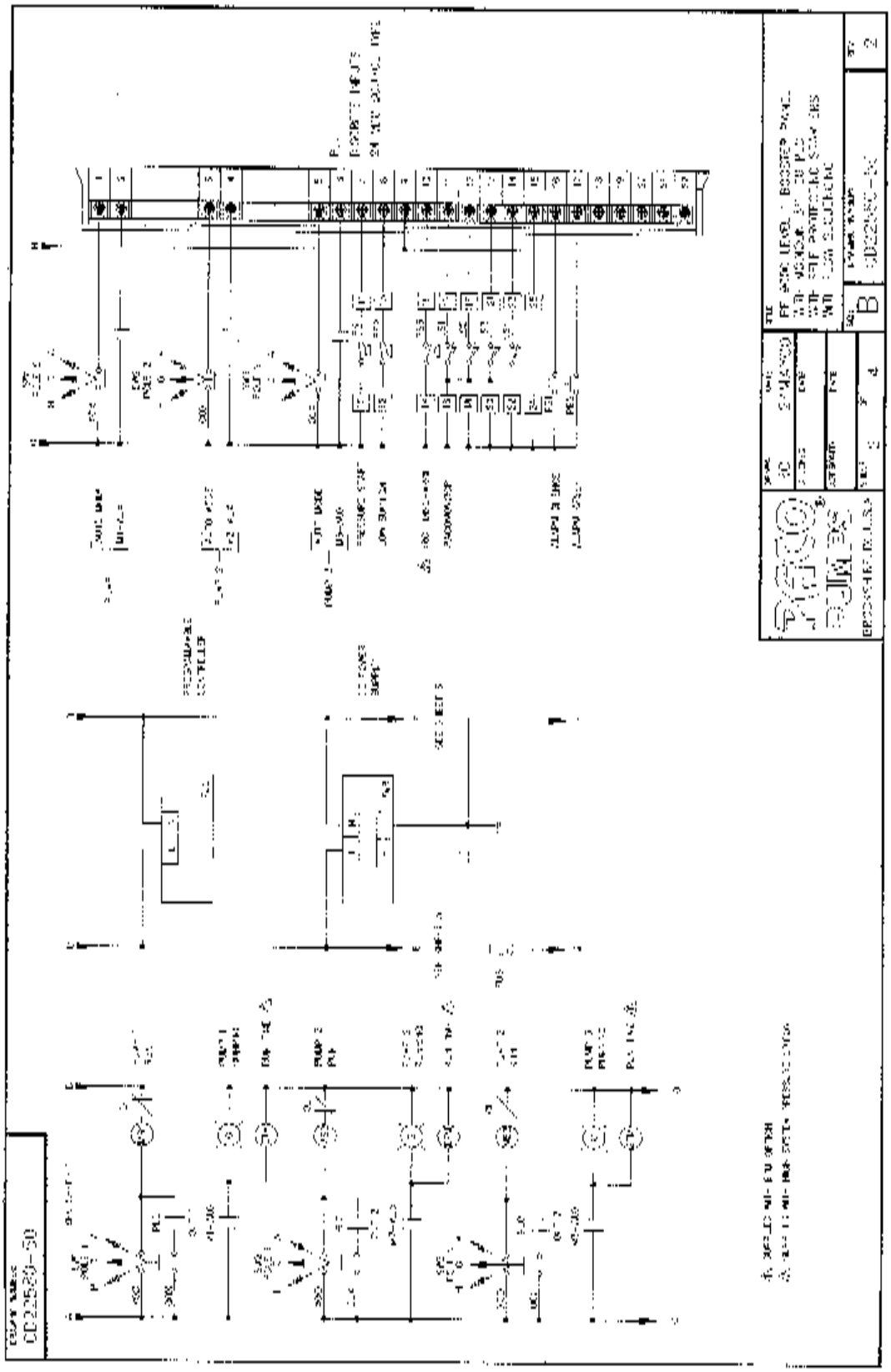
PACO® PUMPS

DUPLEX BOOSTER
WITH PRESSURE SEQUENCING



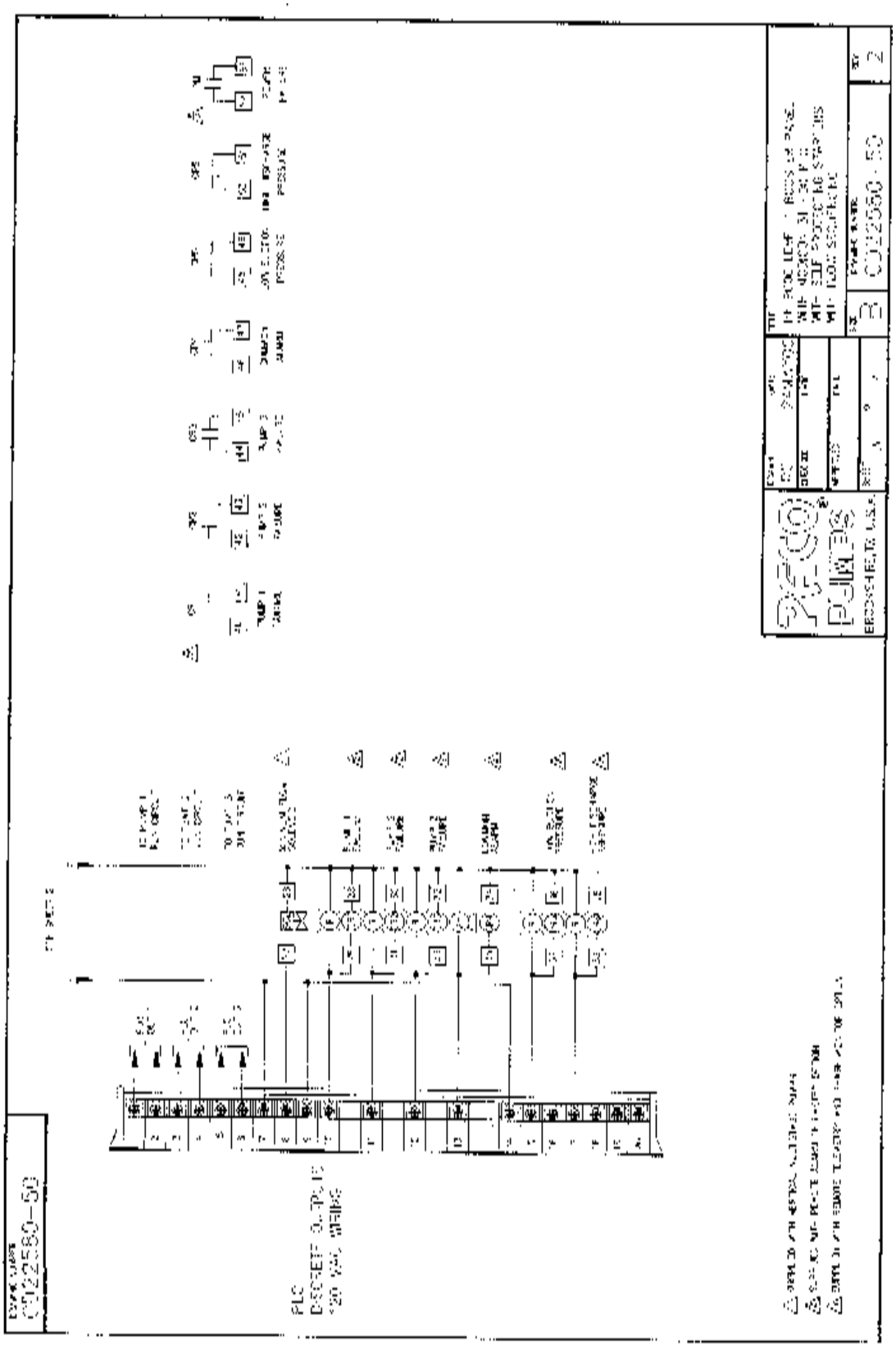
PACO® PUMPS

DUPLEX BOOSTER
WITH PRESSURE SEQUENCING



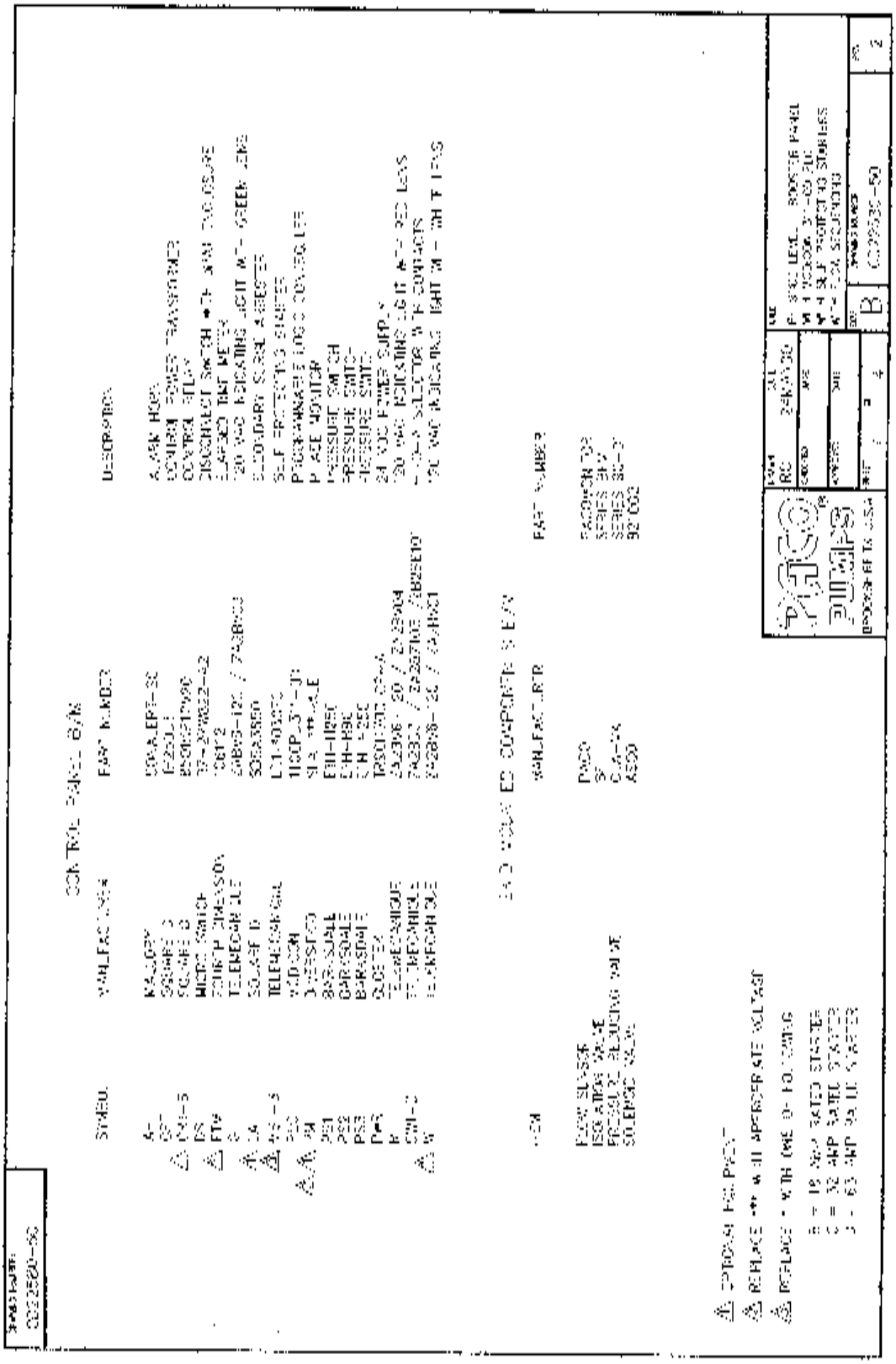
PACO® PUMPS

DUPLEX BOOSTER WITH PRESSURE SEQUENCING



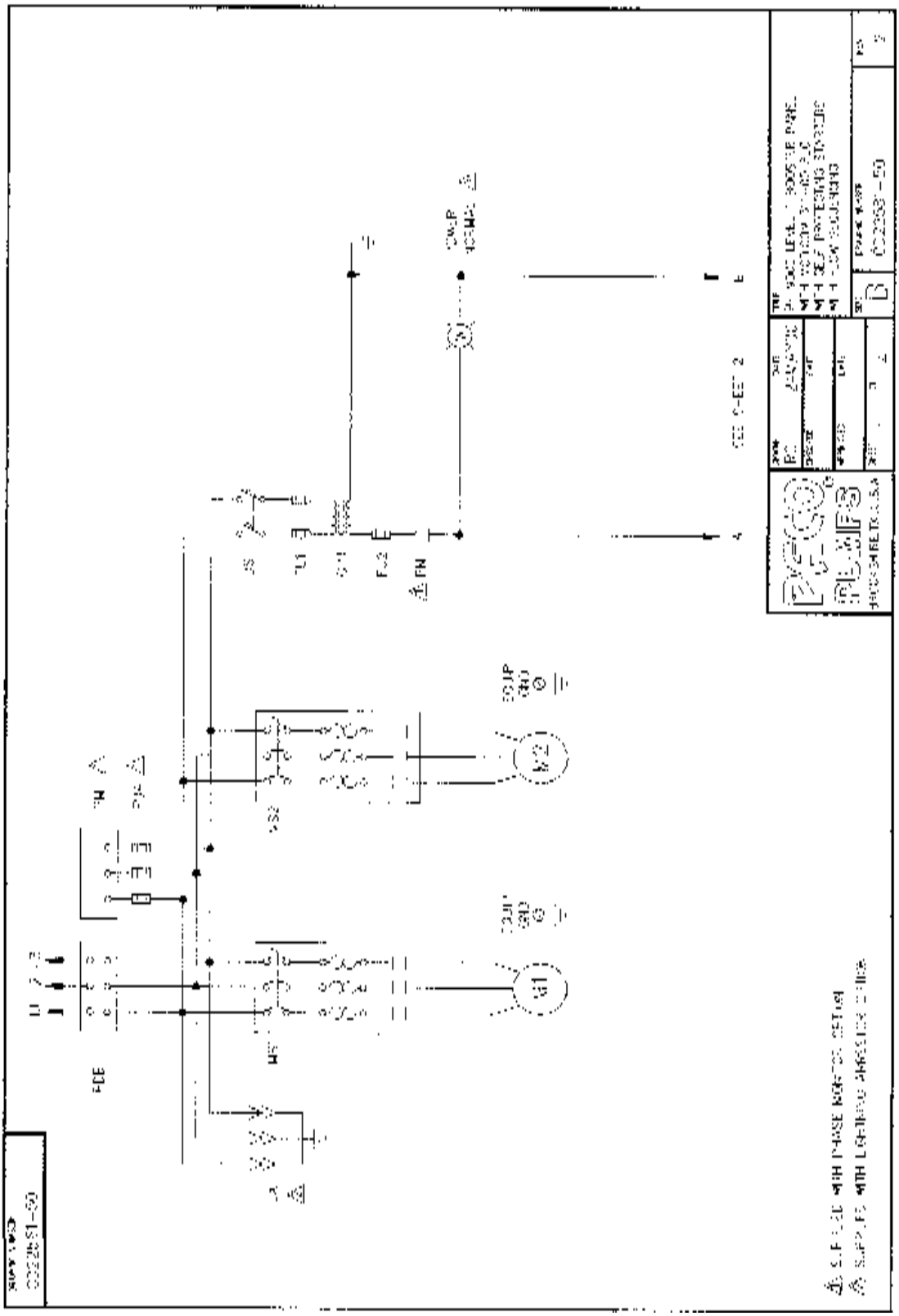
PACO® PUMPS

DUPLEX BOOSTER
WITH PRESSURE SEQUENCING



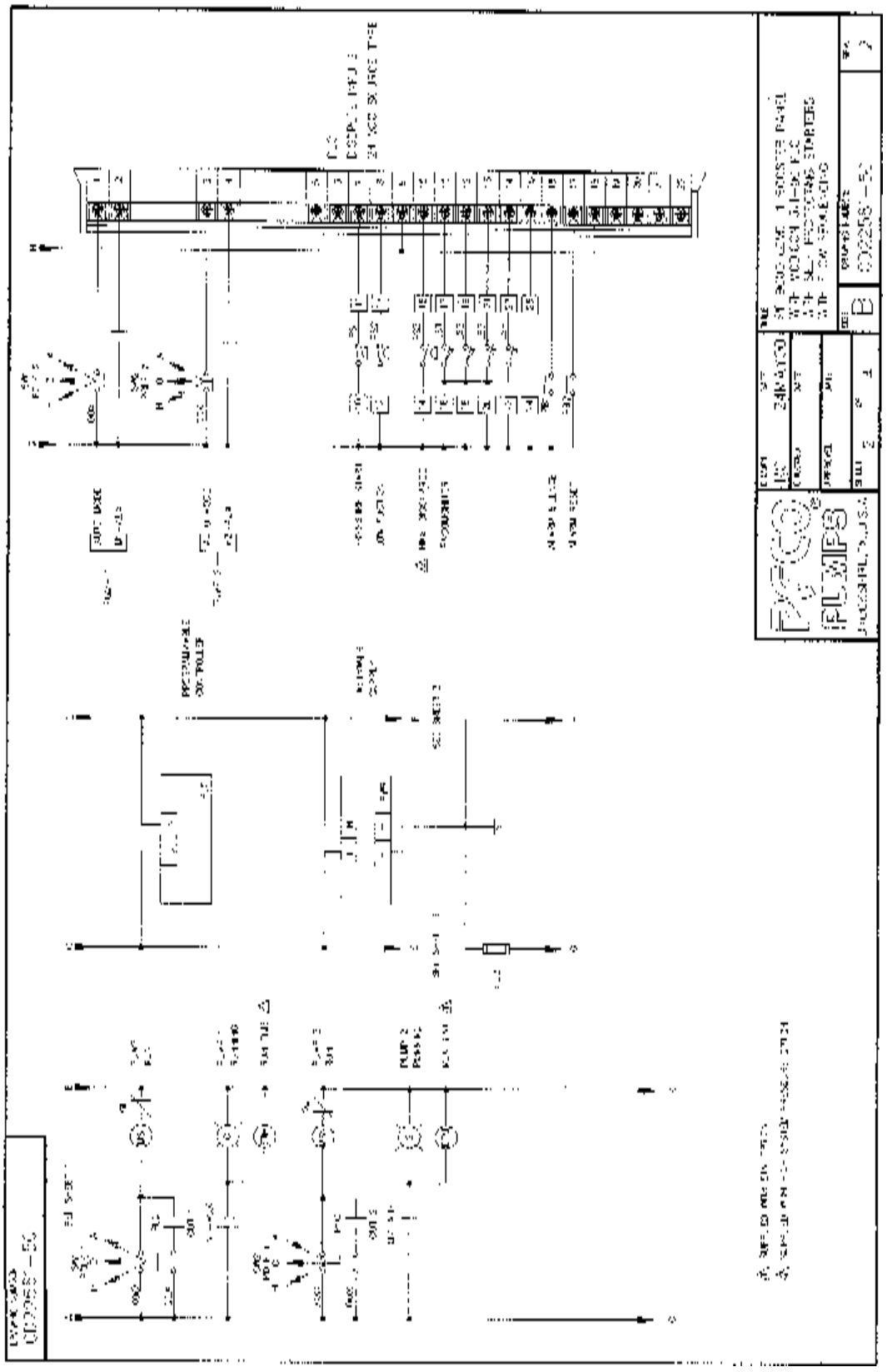
PACO® PUMPS

TRIPLEX BOOSTER
WITH PRESSURE SEQUENCING



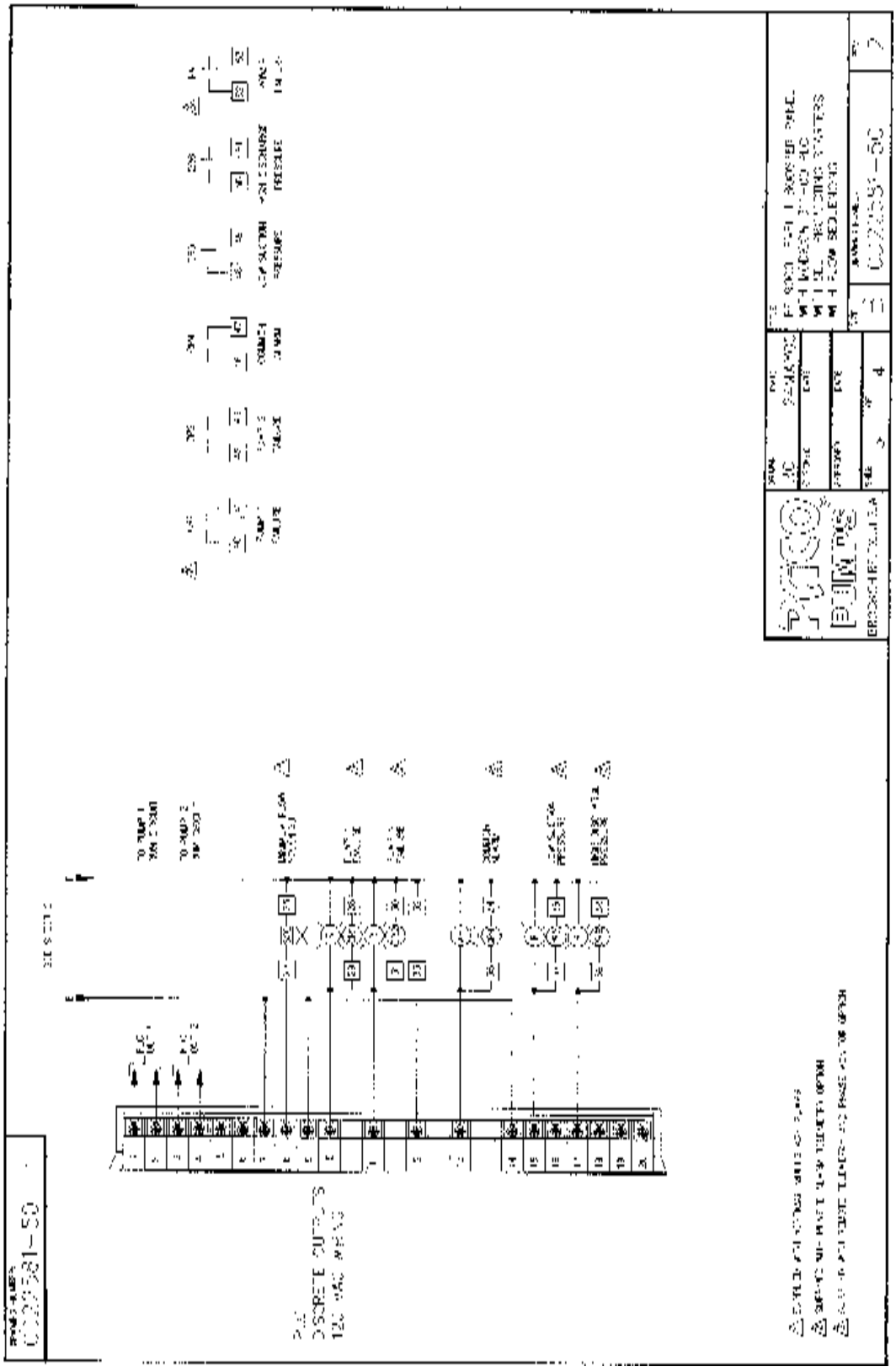
PACO® PUMPS

TRIPLEX BOOSTER
WITH PRESSURE SEQUENCING



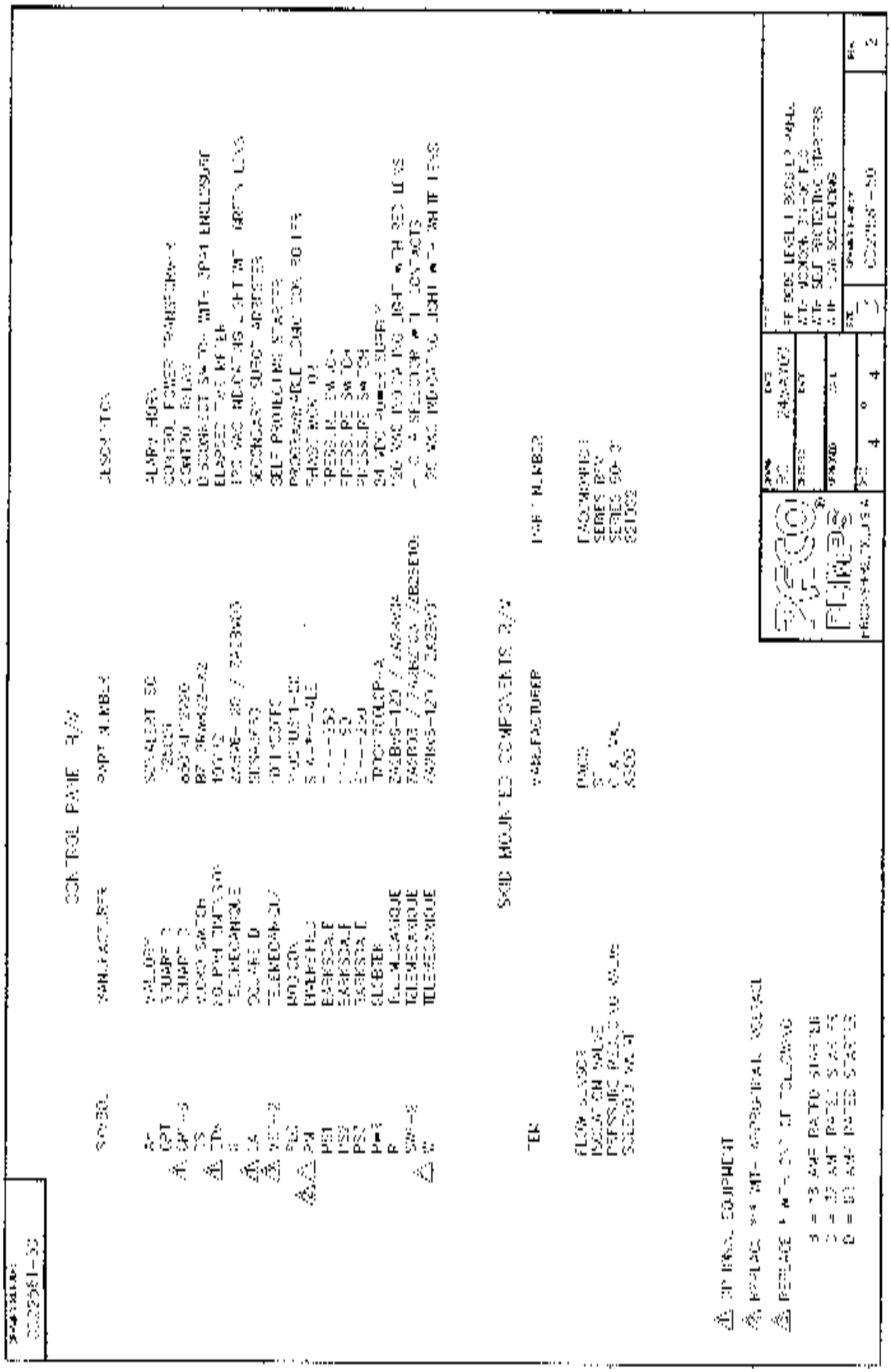
PACO® PUMPS

TRIPLEX BOOSTER
WITH PRESSURE SEQUENCING



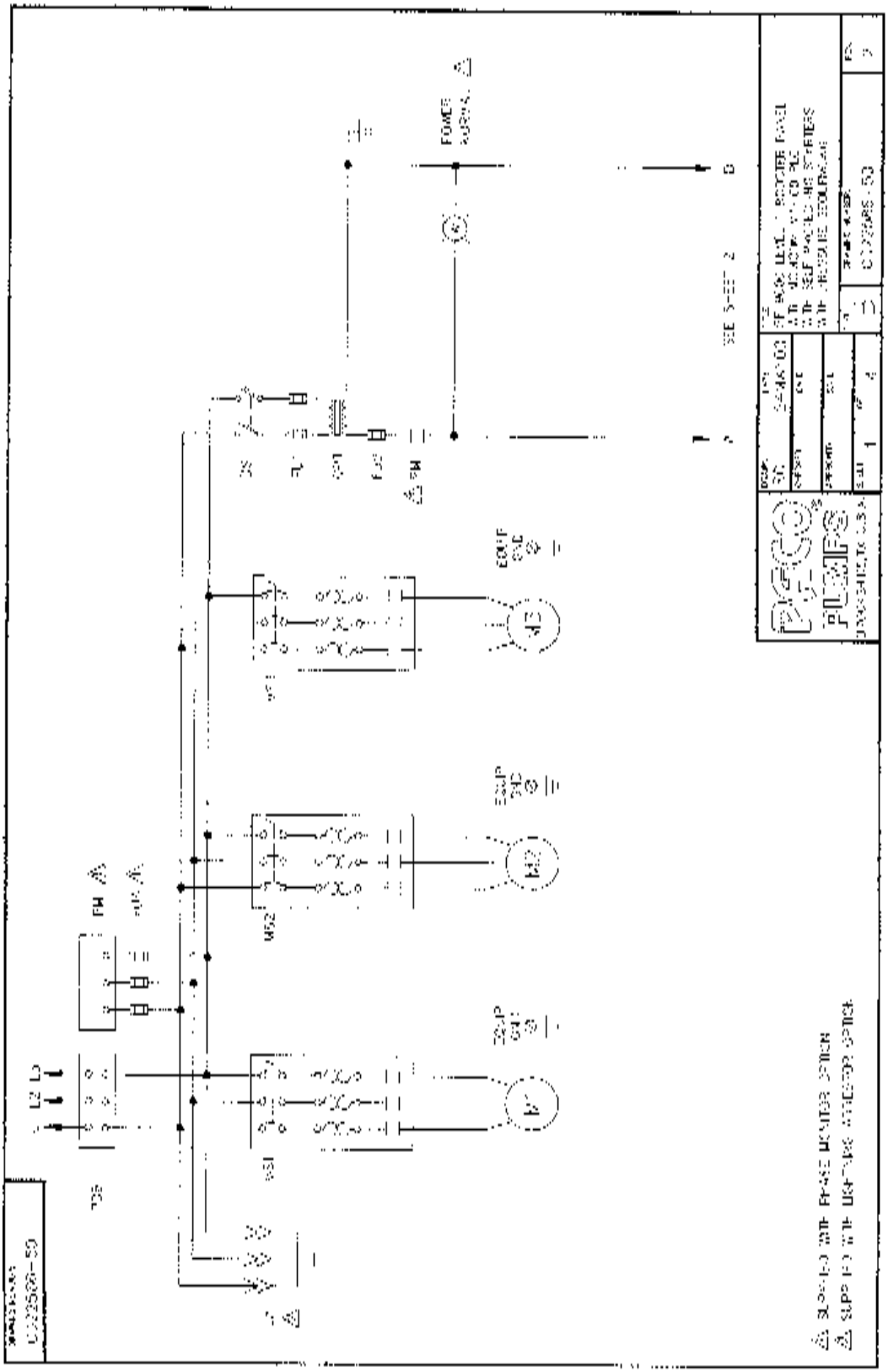
PACO® PUMPS

TRIPLEX BOOSTER
WITH PRESSURE SEQUENCING



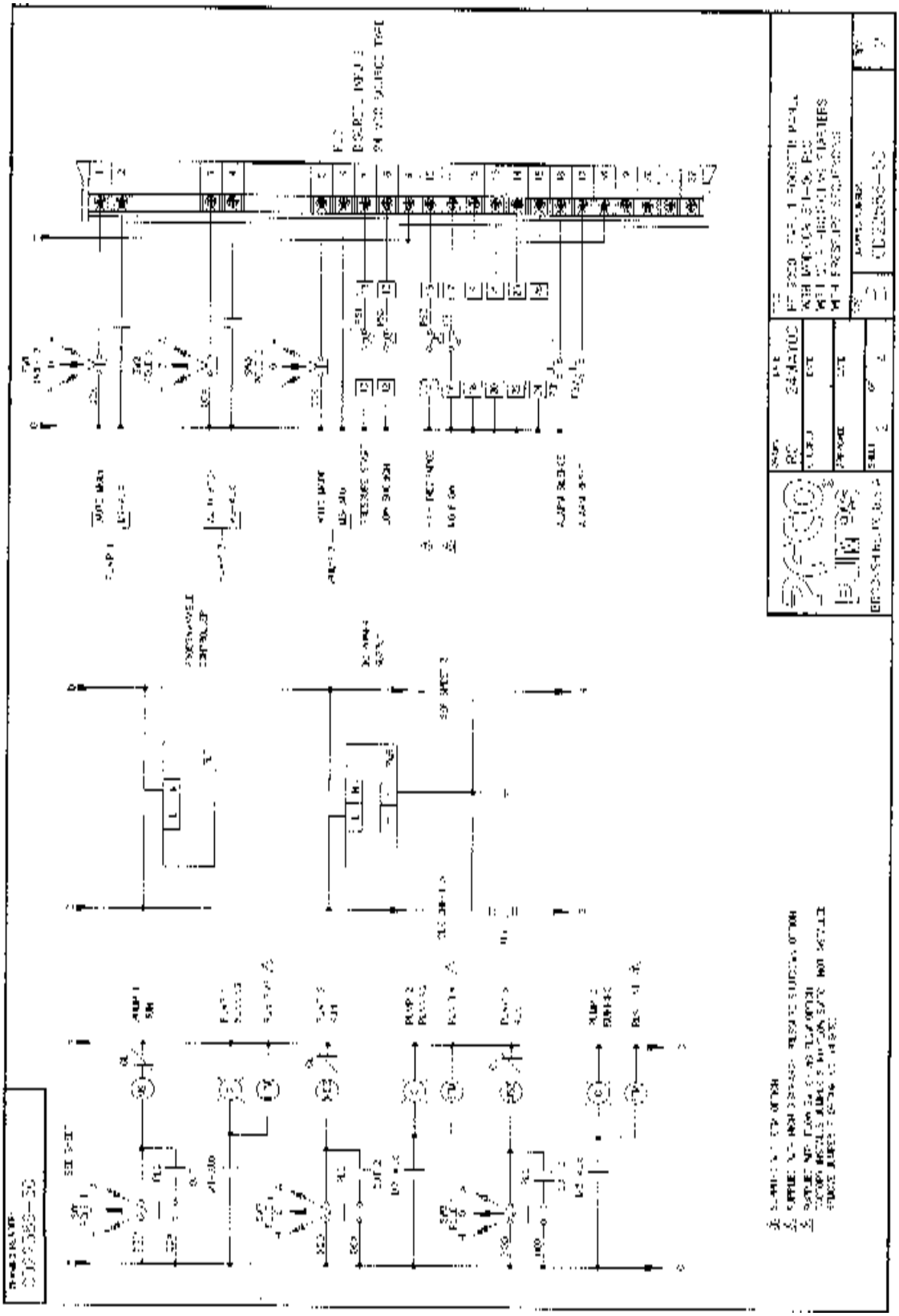
PACO® PUMPS

DUPLEX BOOSTER
WITH FLOW SEQUENCING



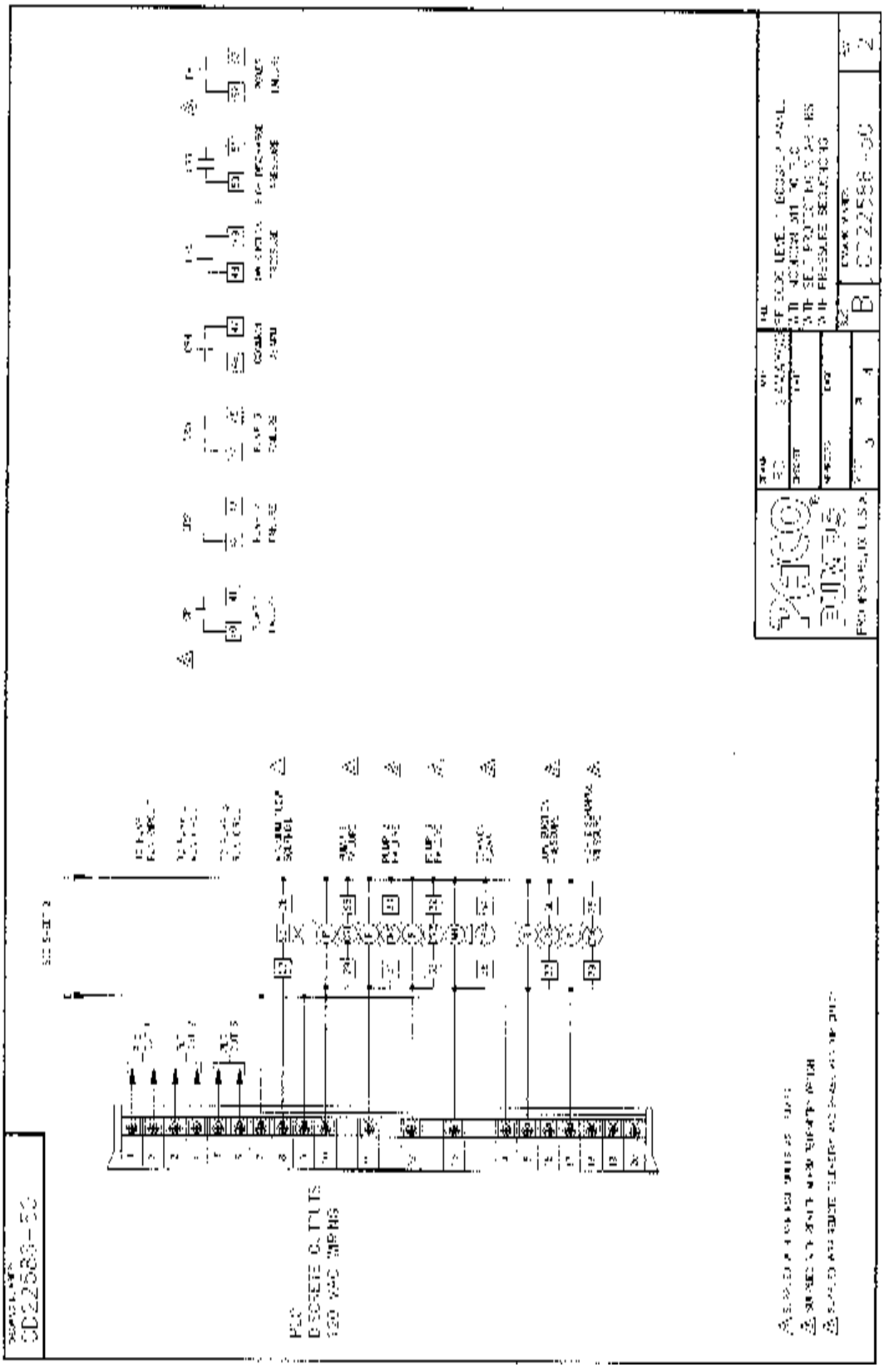
PACO® PUMPS

DUPLEX BOOSTER WITH FLOW SEQUENCING



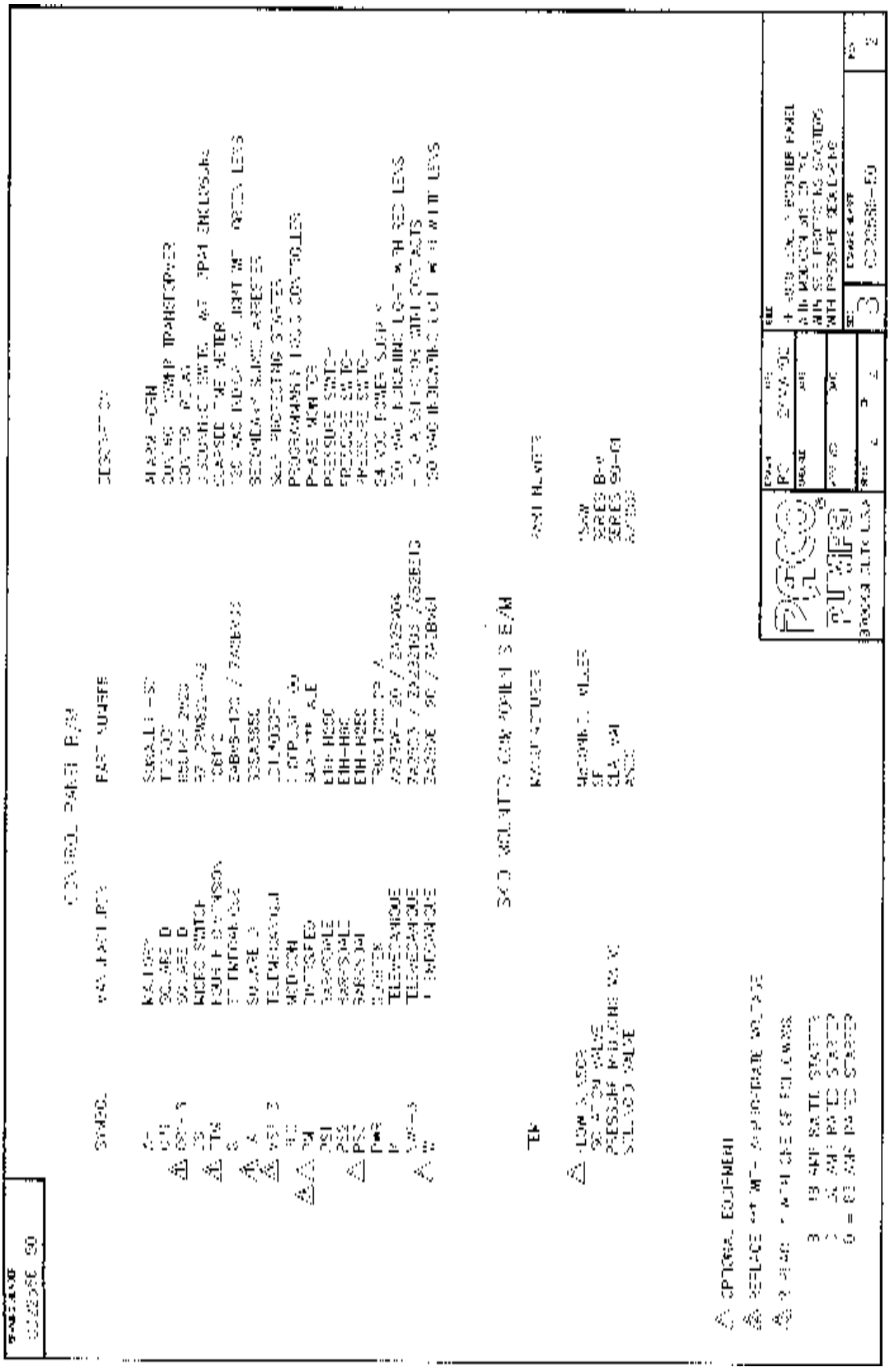
PACO® PUMPS

DUPLEX BOOSTER WITH FLOW SEQUENCING



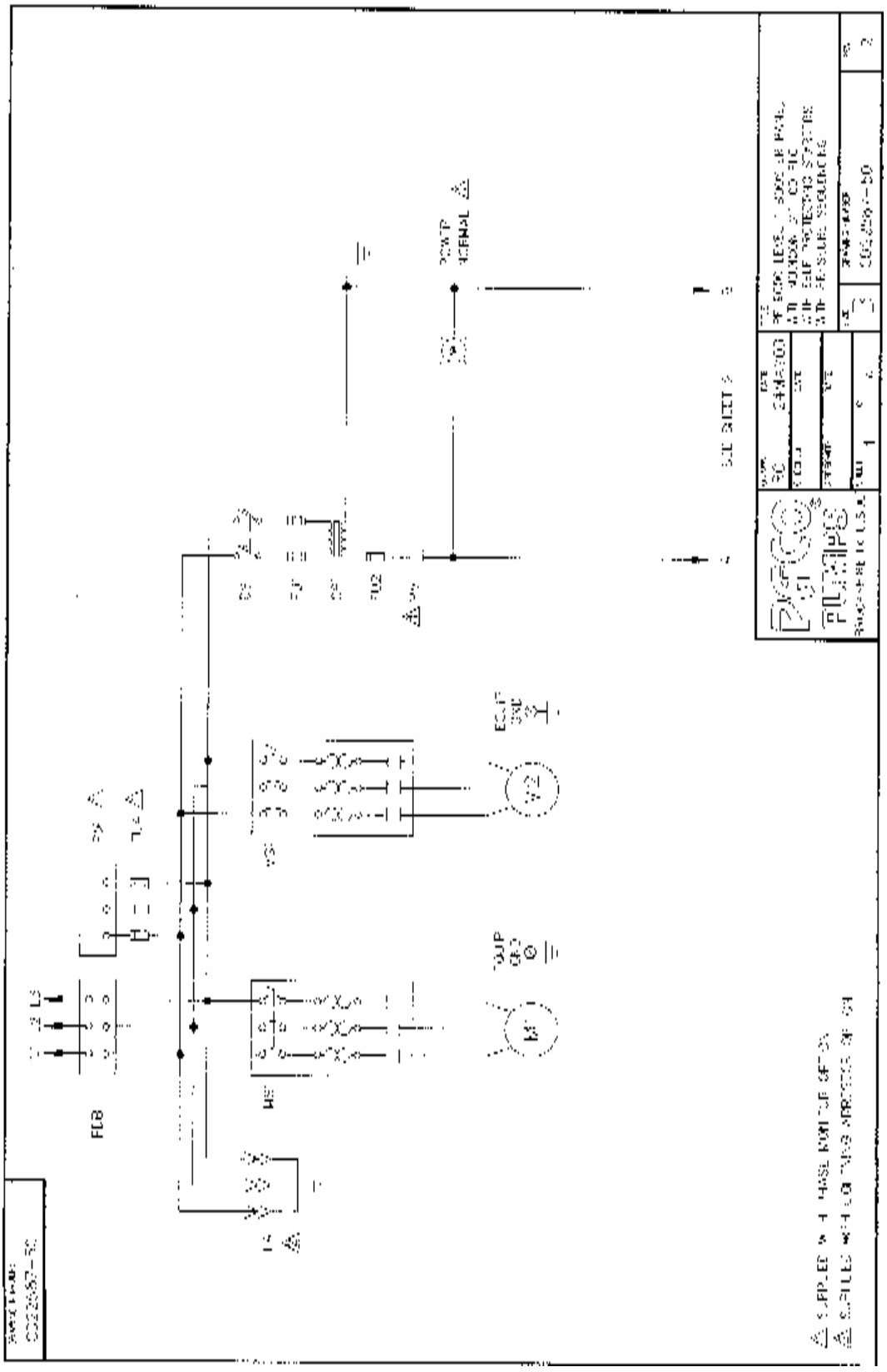
PACO® PUMPS

DUPLEX BOOSTER WITH FLOW SEQUENCING



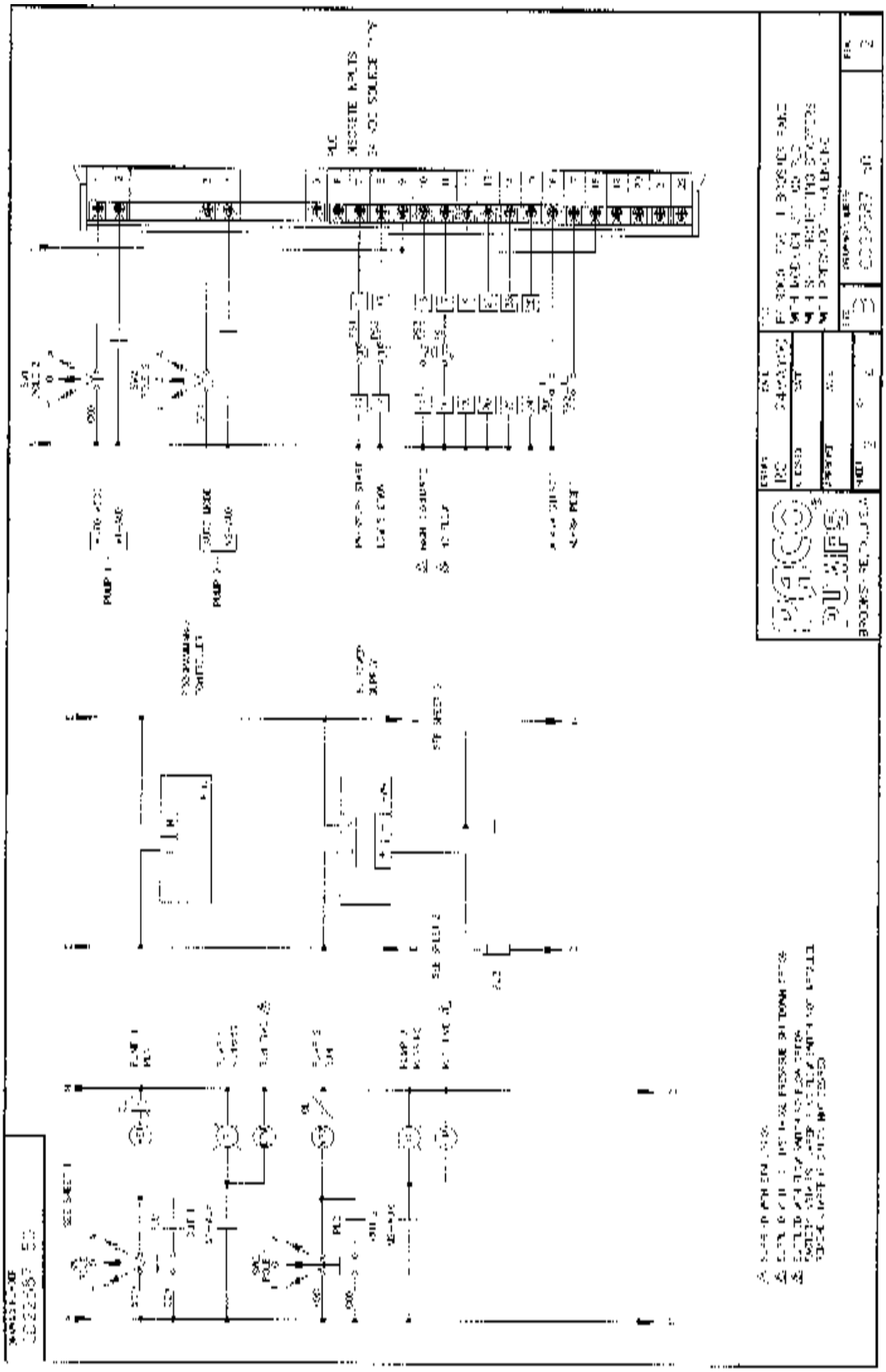
PACO® PUMPS

TRIPLEX BOOSTER
WITH FLOW SEQUENCING

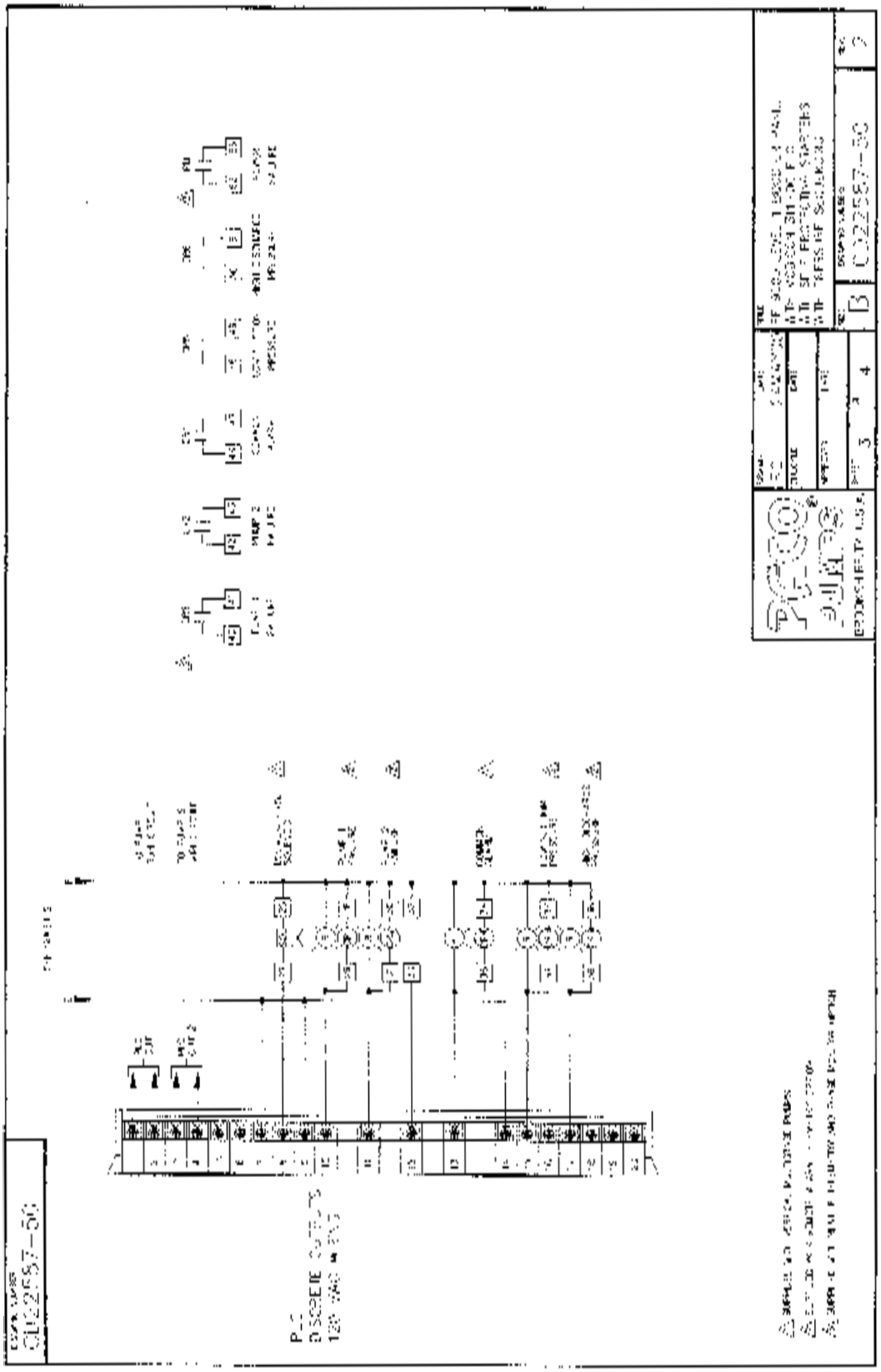


PACO® PUMPS

TRIPLEX BOOSTER
WITH FLOW SEQUENCING

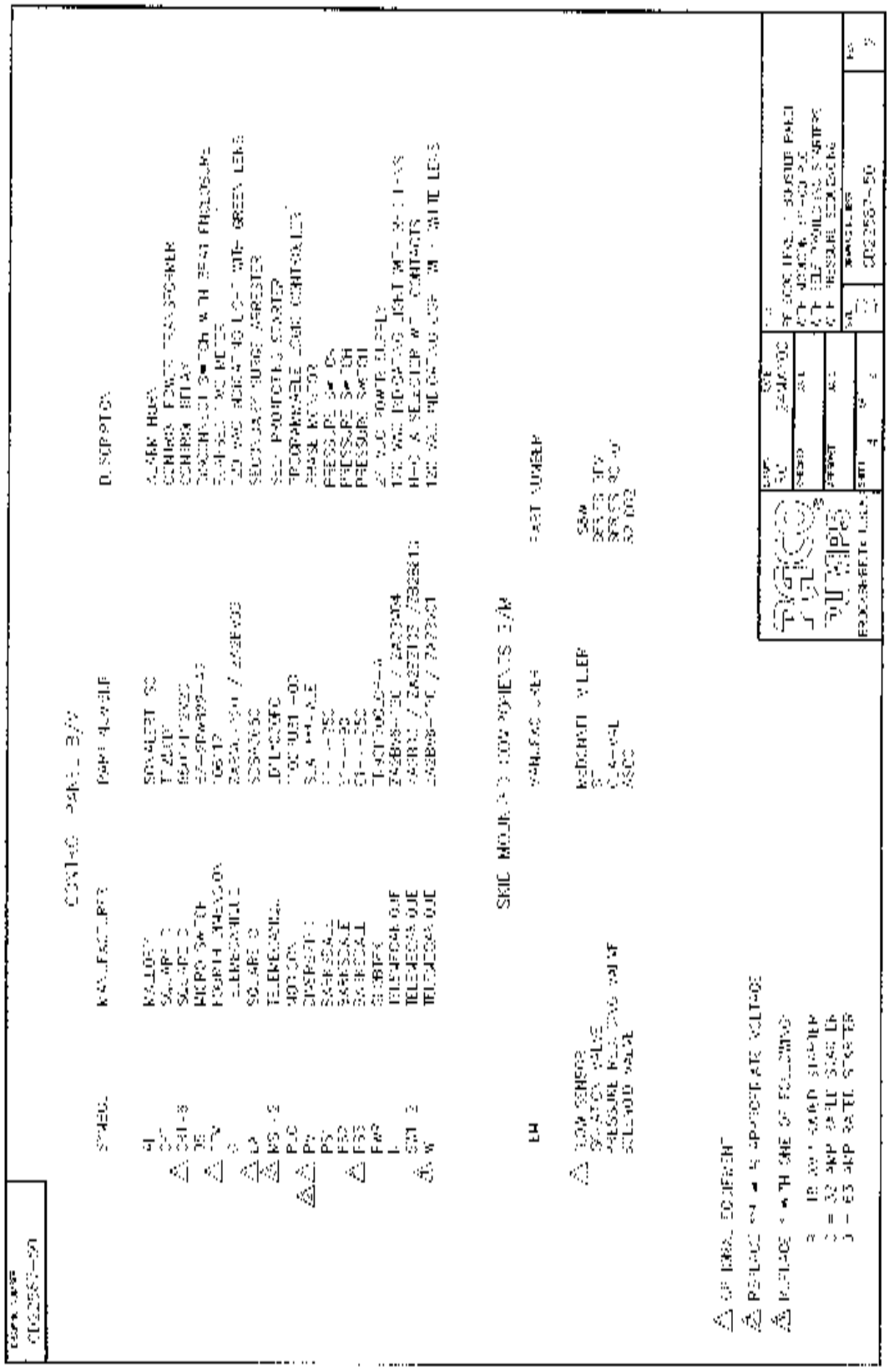


TRIPLEX BOOSTER
WITH FLOW SEQUENCING



PACO® PUMPS

TRIPLEX BOOSTER
WITH FLOW SEQUENCING



APPENDIX E1 PRESSURE REDUCING/CHECK VALVE

FUNCTION

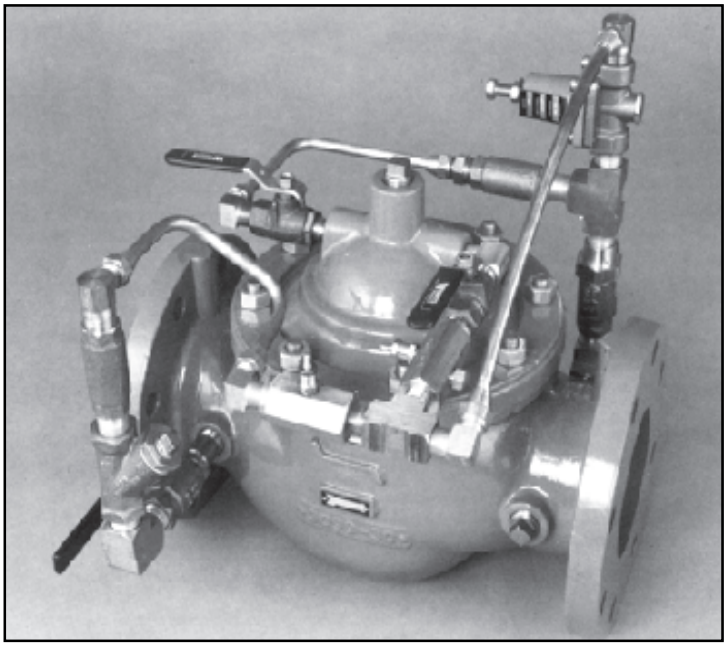
- **REDUCES A HIGHER INLET PRESSURE TO A CONSTANT, LOWER, OUTLET \PRESSURE.**
- **CLOSES WHEN OUTLET/DOWNSTREAM PRESSURE EXCEEDS INLET/UPSTREAM PRESSURE.**

OPERATION

FIGURE 115-3 PRESSURE REDUCING/CHECK VALVE is controlled by a Pressure Reducing Control. The control is normally open, held open by an adjustable spring to maintain a constant discharge pressure from the main valve.

As the downstream pressure (OUTLET) increases to the pressure reducing set-point, the Pressure Reducing Control throttles towards closed, restricting flow through the control tubing. This action increases pressure in the main valve cover chamber, modulating the main valve towards closed an appropriate amount. Closing speed is regulated by an adjustable needle valve.

As downstream pressure decreased, the Reducing control throttles towards open, increasing the flow through he control tubing. This action decreases pressure in the main valve cover chamber, modulating the main valve towards open an appropriate amount, maintaining the desired outlet pressure. Opening speed is regulated by an adjustable flow control.



An integral check feature guards against reverse flow. When downstream pressure exceeds upstream pressure, the main valve cover chamber is flooded, driving the valve closed.

WATTS/MUESO Automatic Control Valves are hydraulically operated, diaphragm actuated, pilot controlled, globe or angle valves of packless design. The stem assembly is the only moving part in the main valve and is guided top and bottom. Positive drip-tight closure is accomplished by a quad-ring or O-ring seat seal. The basic valve is available in Cast Iron., Steel, and Aluminum in a variety of sizes, end connections, and options. Consult the WATTS/MUESCO factory for further information.

PACO® PUMPS

APPENDIX E-2

OPERATION MATRIX

This matrix of the operation illustrates the cause and effect sequence for proper functioning. The diagram begins with the system status and ends with the main valve action

SYSTEM STATUS	REDUCING CONTROL	CHECK FEATURE	MAIN VALVE COVER CHAMBER	MAIN VALVE ACTION
DOWNSTREAM PRESSURE INCREASE >SET POINT	THROTTLES TOWARDS CLOSED	NO EFFECT	PRESSURE INCREASE	MORE RESTRICTIVE
DOWNSTREAM PRESSURE DECREASE <SET POINT	THROTTLES TOWARDS OPEN	NO EFFECT	PRESSURE DECREASE	LESS RESTRICTIVE

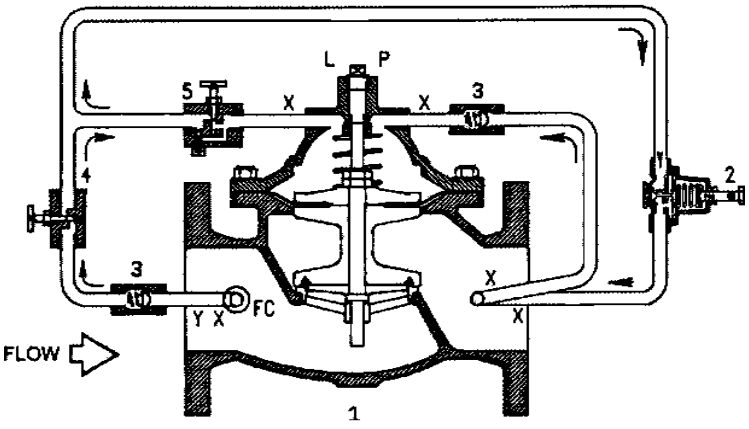
PRESSURE REDUCING FUNCTION

DOWNSTREAM PRESSURE >INLET PRESSURE	NO EFFECT	FLOODS MAIN VALVE COVER	PRESSURE INCREASED	CLOSES

< = Below
> = Above

CHECK FUNCTION

SCHEMATIC



COMPONENTS
1 Basic Valve
2 Reducing Control*
3 Check Valve
4 Needle Valve-Adjustable Restriction Closing
5 Flow Control-Adjustable Opening Speed

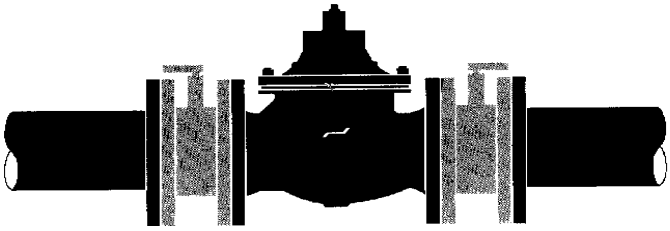
LOCATION OF ACCESSORIES
L Limit Switch
P Position Indicator
X Isolation Cocks
Y Y-Strainer
FC Flo-Clean Strainer

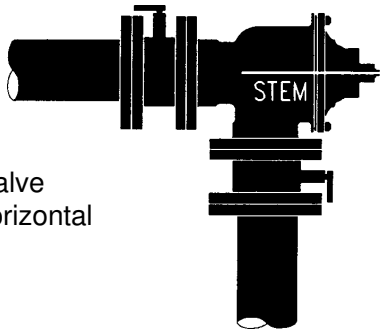
Assembled valve will vary in appearance but will conform with drawing in regard to component locations and functions.

*Model number of the actual control used is dependent upon valve size and materials.

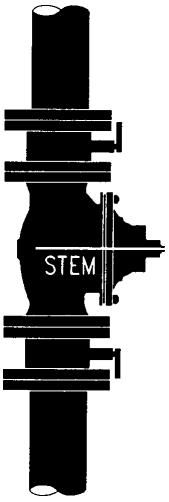
APPENDIX E-3

RECOMMENDATIONS & REQUIREMENTS





Angle Valve
Stem Horizontal



Globe Valve
Stem Horizontal

- As with all automatic control valves, isolation valves should installed in the line before and after the automatic control valve so that the valve may be isolated from pressure for inline servicing. At tempts to service the valve without isolation from pressure may prove hazardous.

  Should installation require the valve stem to be horizontal (cover pointed sideways), factory should be consulted concerning valves of 6" and larger.

SIZING

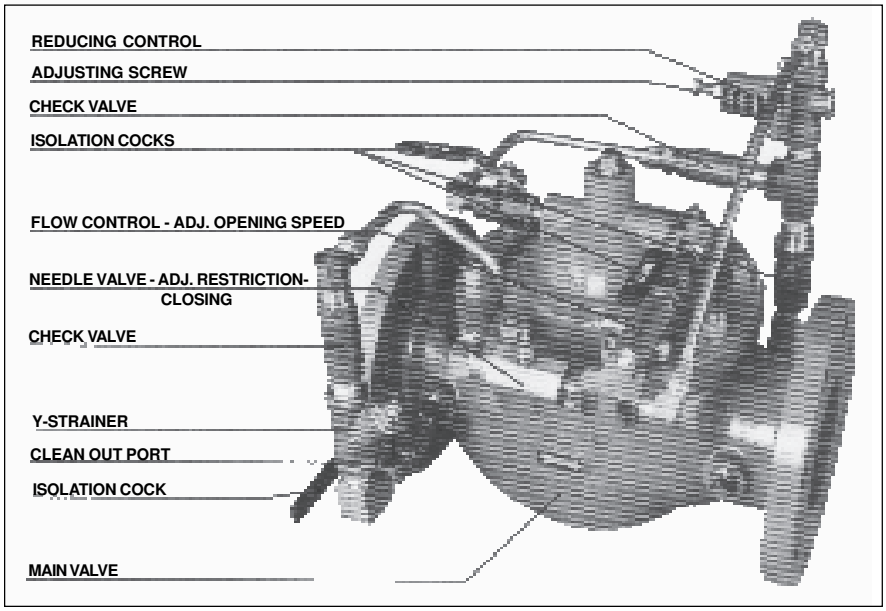
- Proper sizing of the automatic control valve to hydraulic conditions is of paramont importance. Refer to Series Brochure 115, Valve Sizing section.

INSTALLATION/STARTUP

- Clear the line of lag and other debris.
- Install the valve so that the FLOW ARROW marked on the valve body matches flow through the line.
- Close upstream and downstream isolation valves.
- Open ball valves or isolation cocks in the control tubing, if the main valve is so equipped. Failure to open these will prevent the valve from functioning properly.
- Install pressure gauge on main valve (downstream side port), or another downstream location in the system. Valves equipped with a 263 AP pilot have a 1/4" N.P.T. pressure gauge port in the pilot body.

INSTALLATION/START-UP CONTINUED

Start-up of an automatic control valve requires that proper procedures be followed. Time must be allowed for the valve to react to adjustments and the system to stabilize. The objective is to bring the valve into service in a controlled manner.



Step 1

- Turn Pressure Reducing Control adjustment screw counterclock wise (OUT), backing pressure off the spring, Prventing possible overpressuring of the system.

Step 2

- Back opening speed flow control adjustment screw out one half turn from closed. Back closing speed needle valve adjustment screw out one and a half turns from closed. Loosen a turb fitting at a valve highpoint to allow venting of air.

Step 3

- Open upstream isolation valve SLOWLY to a full open position to allow controlled filling of the valve. Air is vented through the loosened fitting. Tighten fitting when liquid begins to vent.

Step 4

- Open downstream isolation valve partially to establish flow through the valve, observing downstream pressure change. If downstream pressure is outside the desired pressure range, turn the Reducing Control adjustment screw clockwise (IN) to increase, or counterclockwise (OUT) to decrease,until pressure is near the desired setting.

Step5

- Gradually open the downstream isolation valve until full open.

Step6

- Allow the system to stabilize.

Step 7

- Fine-tune Pressure Reducing Control adjustment to the set-point, as detailed in Step 4.

Step 8

- Opening Speed Adjustment: The opening speed flow control allows free flow into the cover of the main valve.
- If recovery of pressure is slow upon increased downstream demand, turn the adjustment screw counterclockwise (OUT), increasing the rate of opening.
- If recovery of downstream pressure is too quick, as indicated by a rapid increase in pressure, possibly higher than the desired set-point, turn the adjustment screw clockwise (IN), decreasing the rate of opening.

Step 9

- Closing Speed Adjustment: The closing speed needle valve regulates the fluid pressure into the main valve cover chamber, controlling the valve closing speed. If the downstream pressure fluctuates slightly above the desired set-point turn the adjustment screw counterclockwise (OUT), increasing the rate of closing.

Step 10

- No start-up is required for the check feature.

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PACO® PUMPS

Terms And Conditions Of Sale

SECTION 1: THE CONTRACT

The Contract shall be comprised of the following terms, together with such terms and conditions as are set forth in Seller's written proposal or quotation (the "Quotation"), including any documents, drawings or specifications incorporated therein by reference, and any additional or different terms proposed in Buyer's purchase order (the "Purchase Order") that are accepted by Seller in writing, which together shall constitute the entire agreement between the parties, provided, however, that preprinted terms on Buyer's purchase order or invoice shall not apply and Seller gives notice of objection to such terms. An offer by Seller in its Quotation that does not stipulate an acceptance date is not binding. This Contract shall be deemed to have been entered into upon written acknowledgment of the Purchase Order by an officer or authorized representative of Seller, which may not be modified, supplemented, or waived except in a writing executed by an authorized representative of the party to be bound.

SECTION 2: PRICE

The price quoted in the Quotation shall be the Purchase Price unless otherwise agreed in the Purchase Order. The Purchase Price for equipment shall include packing for shipment. Field Services shall be provided at Seller's standard rates. All other costs, including packing for storage, freight, insurance, taxes, customs duties and import/export fees, or any other item not specified in the Contract, shall be paid by Buyer unless separately stated in the Quotation and included in the price quoted. Any sales, use, or other taxes and duties imposed on the transaction or the equipment supplied shall be paid or reimbursed by Buyer.

SECTION 3: PAYMENT TERMS

Payment shall be due within 30 days of the date of Seller's invoice in U.S. funds unless otherwise agreed. If Buyer does not observe the agreed dates of payment, Buyer shall pay interest to Seller on overdue amounts at a rate that is the higher of: 9% per annum or a rate 5% in excess of the rate borne from time to time by new issues of six-month United States Treasury bills. Seller shall be entitled to issue its invoice for the Purchase Price for equipment upon the earlier of shipment, or notice to Buyer that Seller is ready to ship, and for services, upon completion. If the Purchase Price exceeds $250,000 USD, Buyer shall pay the Purchase Price in Progress payments as follows: Fifteen percent (15%) upon submittal of general arrangement drawings, thirty five percent (35%) after receipt of first Bowl Casting, twenty percent (20%) after first case/bowl hydro test or bowl machining and thirty percent (30%) after notification of ready to ship.

SECTION 4: ACCEPTANCE AND INSPECTION

All equipment shall be finally inspected and accepted by Buyer within 14 days after delivery or such other period of time as is agreed in the Purchase Order. Buyer shall make all claims (including claims for shortages), excepting only those provided for under the warranty clause contained herein, in writing within such 14 day period or they are waived. Services shall be accepted upon completion. Buyer shall not revoke its acceptance. Buyer may reject the equipment only for defects that substantially impair its value, and Buyer's remedy for lesser defects shall be in accordance with Section 10, Warranty. If tests are made by Buyer to demonstrate the ability of the equipment to operate under the contract conditions and to fulfill the warranties in Section 10, Buyer is to make all preparations and incur all expenses incidental to such tests. Seller will have the right of representation at such tests at its expense, and the right to technically direct the operation of the equipment during such tests, including requiring a preliminary run for adjustments.

SECTION 5: TITLE AND RISK OF LOSS

Full risk of loss (including transportation delays and losses) shall pass to Buyer upon delivery, regardless of whether title has passed to Buyer, transport is arranged or supervised by Seller, or start-up is carried out under the direction or supervision of Seller. Delivery shall be ex works, INCOTERMS 2000. Loss or destruction of the equipment or injury or damage to the equipment that occurs while the risk of such loss or damage is borne by Buyer does not relieve Buyer of its obligation to pay Seller for the equipment.

SECTION 6: PATENT OR TRADEMARK INFORMATION

If the equipment sold hereunder is to be prepared or manufactured according to Buyer's specifications, Buyer shall indemnify Seller and hold it harmless from any claims or liability for patent or trademark infringement on account of the sale of such goods.

SECTION 7: CHANGES

Buyer may request, in writing, changes in the design, drawings, specifications, shipping instructions, and shipment schedules of the equipment. As promptly as practicable after receipt of such request, Seller will advise Buyer what amendments to the Contract, if any, may be necessitated by such requested changes, including but not limited to amendment of the Purchase Price, specifications, shipment schedule, or date of delivery. Any changes agreed upon by the parties shall be evidenced by a Change Order signed by both parties.

SECTION 8: CANCELLATION OR TERMINATION

Buyer shall have the right to cancel the Contract upon 15 days' prior written notice to Seller, and Seller shall stop its performance upon the receipt of such notice except as otherwise agreed with Buyer. If Buyer cancels the Contract, it shall pay: (a) the agreed unit price for equipment or components completed and delivered, (b) additional material and labor costs incurred, and for engineering services supplied by Seller with respect to the canceled items, which shall be charged to Buyer at Seller's rates in effect at the time of cancellation, but which shall not exceed the contract price for such items, and (c) such other costs and expenses, including cancellation charges under subcontracts, as Seller may incur in connection with such cancellation or termination.

of quotation. Seller shall not be liable for any nonperformance, loss, damage, or delay due to war, riots, fire, flood, strikes or other labor difficulty, governmental actions, acts of God, acts of the Buyer or its customer, delays in transportation, inability to obtain necessary labor or materials from usual sources, or other causes beyond the reasonable control of Seller. In the event of delay in performance due to any such cause, the date of delivery or time for completion will be extended to reflect the length of time lost by reason of such delay. Seller shall not be liable for any loss or damage to Buyer resulting from any delay in delivery.

SECTION 10: WARRANTY

Seller warrants that the equipment or services supplied will be free from defects in material, and workmanship for a period of 12 months from the date of initial operation of the equipment, or 18 months from the date of shipment, whichever shall first occur. In the case of spare or replacement parts manufactured by Seller, the warranty period shall be for a period of six months from shipment. Repairs shall be warranted for 12 months or, if the repair is performed under this warranty, for the remainder of the original warranty period, whichever is less. Buyer shall report any claimed defect in writing to Seller immediately upon discovery and in any event, within the warranty period. Seller shall, at its sole option, repair the equipment or furnish replacement equipment or parts thereof, at the original delivery point. Seller shall not be liable for costs of removal, reinstallation, or gaining access. If Buyer or others repair, replace, or adjust equipment or parts without Seller's prior written approval, Seller is relieved of any further obligation to Buyer under this section with respect to such equipment or parts. The repair or replacement of the equipment or spare or replacement parts by Seller under this section shall constitute Seller's sole obligation and Buyer's sole and exclusive remedy for all claims of defects. SELLER MAKES NO OTHER WARRANTY OR REPRESENTATION OF ANY KIND WITH RESPECT TO THE EQUIPMENT OR SERVICES OTHER THAN AS SPECIFIED IN THIS SECTION 10. ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE HEREBY DISCLAIMED.

For purposes of this Section, the equipment warranted shall not include equipment, parts, and work not manufactured or performed by Seller. With respect to such equipment, parts, or work, Seller's only obligation shall be to assign to Buyer any warranty provided to Seller by the manufacturer or supplier providing such equipment, parts or work.

No equipment furnished by Seller shall be deemed to be defective by reason of normal wear and tear, failure to resist erosive or corrosive action of any fluid or gas, Buyer's failure to properly store, install, operate or maintain the equipment in accordance with good industry practices or specific recommendations of Seller, or Buyer's failure to provide complete and accurate information to Seller concerning the operational application of the equipment.

SECTION 11: TECHNICAL DOCUMENTS

Technical documents furnished by Seller to Buyer, such as drawings, descriptions, designs and the like, shall be deemed provided to Buyer on a confidential basis, shall remain Seller's exclusive property, shall not be provided in any way to third parties, and shall only be used by Buyer for purposes of installation, operation and maintenance. Technical documents submitted in connection with a Quotation that does not result in a Purchase Order shall be returned to Seller upon request.

SECTION 12: LIMITATION OF LIABILITY

Seller shall in no event be liable for any consequential, incidental, indirect, special or punitive damages arising out of the Contract, or out of any breach of any of its obligations hereunder, or out of any defect in, or failure of, or malfunction of the equipment, including but not limited to, claims based upon loss of use, lost profits or revenue, interest, lost goodwill, work stoppage, impairment of other equipment, environmental damage, nuclear incident, loss by reason of shutdown or nonoperation, increased expenses of operation, cost of purchase of replacement power or claims of Buyer or customers of Buyer for service interruption whether or not such loss or damage is based on contract, tort (including negligence and strict liability) or otherwise.

Seller's maximum liability under this Contract shall not exceed the Purchase Order amount of the equipment or portion thereof upon which such liability is based. All such liability shall terminate upon the expiration of the warranty period, if not sooner terminated.

SECTION 13: THIS COMPANY IS AN EQUAL OPPORTUNITY EMPLOYER

This agreement incorporates by reference applicable provisions and requirements of Executive Order 11246 and FAR Section 52.222-26 (covering race, color, religion, sex and national origin); the Vietnam Era Veterans Readjustment Assistance Act of 1974 and FAR Section 52.222-35 (covering special disabled and Vietnam era veterans); and the Rehabilitation Act of 1973 and FAR Section 52.222-36 (covering handicapped individuals). By acceptance of this agreement Buyer certifies that it does not and will not maintain any facilities in a segregated manner, or permit its employees to perform their services at any location under its control where segregated facilities are maintained, and further that appropriate physical facilities are maintained for both sexes. Buyer agrees that it will obtain a similar certificate prior to award of any nonexempt lower-tier subcontracts.

SECTION 14: LAW AND ARBITRATION

The Contract shall be governed by the law of the State of Texas. Any disputes arising out of this Contract shall be resolved by informal mediation in any manner that the parties may agree within 45 days of written request for mediation by one party to the other. Any dispute that cannot be resolved through mediation shall be resolved by binding arbitration conducted in English in Portland, Oregon under the Commercial Rules of the American Arbitration Association except as otherwise provided in this Section. The arbitration shall be conducted by three arbitrators chosen in accordance with said Rules. The arbitrators are not entitled to award damages in excess of compensatory damages. Judgment upon the award may be entered in any court having jurisdiction.

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