Goldfinger
TECHNOLOGIES LLC
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Customer Focused Flexible Solutions

Components – Only

Single – Stack

Double – Stack

▪ SUPERCLEAN 1600-55 A/M RINSER/DRYER ▪

▪ OPERATIONS AND MAINTENANCE MANUAL ▪

Manual Part Number: 9300152.1

Goldfinger Technologies LLC
1241 E. Dyer Rd., Suite 100
Santa Ana, CA USA 92705-5611
Telephone: (714) 445-2000
www.akrion.com

References in this manual may describe optional equipment. Please contact a GFT sales representative for information about standard and optional equipment.

This document is available on cleanroom paper. Contact Goldfinger Technologies LLC to order.

Operations Manual Part Number: 9300152.1
Document Release Date: 02/07/05

PRODUCT MASTER STRUCTURE

Product Structure		Model No. and Description
Manual No.:	**9300152.1**	**SuperClean 1600-55 A/M**
Schematic Numbers:		Up to 6-inch wafers — 1600-55
Centrifuge	**1098566.1**	Automatic Door — A
FREM Single-Stack Cabinet	**1098565.1**	Manual Door — M
FREM Double-Stack Frame	**1098564.1**	
Bay and Chase Single-Stack Cabinet	**TBD**	
Bay and Chase Double-Stack Frame	**1098563.1**	
Table-Top	**1098577.1**	
Plumbing Schematic	**1067705.1**	
Electrical Schematic	**1074044.1**	
Controller Assembly	**1075227.1**	
Optical Sensor Testor	**1068949.1**	

REVISION HISTORY

Date	Section	Description
05/01/00	Entire Manual	Initial Release of a complete re-write. New sections include: Software Functional Description Improved Operating Instructions Additional Maintenance Procedures Particle Troubleshooting Flowcharts SECS II Communications Schematics and IPBs Spare Parts Lists Technical Reference
07/11/00	Schematics	Replaced all facility drawings with new
11/30/00	Schematics	Replaced all 1071233 Controller drawings with 1075227
12/04/00	Section 3	Removed AutoWash Note on Page 3-8
01/11/01	Section 6	Added Installation Procedures
05/10/01	Section 7	Corrected Spare Parts List, added Clear Lens
05/10/01	Section 8	Added Table-Top Facilily Requirements Drawing 1098577
04/03/03	Section 8	Replaced Electrical Schematics 1074044 with rev C
05/09/03	Section 4	Added Return Service Parts Instructions
05/09/03	Section 6	Improved Install and Test Procedures
09/15/03	Section 3	Updated EMO “Twist and Lock” Pushbutton Information
02/07/05	Entire Manual	Updated Title, Name, and Logo to *Goldfinger Technologies, LLC*

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PREFACE

This preface includes the following topics:

- intended use and audience
- customer support
- determining the features and options on your dryer

CAUTION	
⚠	**USING IMPROPER CONFIGURATION VALUES CAN CAUSE PRODUCT OR EQUIPMENT DAMAGE** Do not enter configuration values outside the specified range for any given item. To do so can seriously damage your product or equipment.

Intended Use Of This Dryer

This dryer is not to be used for any purpose other than for which it was designed. What product is to be produced and how the hardware and software are to be configured for the allowed processing chemicals and parameters are stated in this manual.

Intended Audience

The level of detail in this manual assumes you have previously been trained by an authorized GFT trainer to operate and maintain this system.

This document supplements the training class and addresses the comprehensive needs of Process Engineers and Maintenance personnel. After reading and understanding this information, Process Engineers are responsible for disseminating the appropriate level of information to their Equipment Operators.

Customer Support

For assistance in operating this dryer, refer first to this manual. If this manual does not address your specific question, please contact GFT Field Service: (refer to the maintenance section for customer repair support and return parts information).

Goldfinger Technologies, LLC 1241 E. Dyer Rd., Suite 100 Santa Ana, CA USA 92705-6533	Phone: (714) 445-2000 Fax: (714) 445-2204
From 8:00 a.m. to 5:00 p.m., PST, Monday through Friday	

When calling, please be at the dryer, if possible, and be prepared to give a detailed description of the problem and the dryer’s serial #.

NOTE

Review your contract warranty statements regarding specific instructions for receiving help.

Determining the Dryer's Features and Options

Your dryer can be configured with several features and options. The mix of features and options were determined at the time of sales. Since this Operations and Maintenance manual is comprehensive in content, (having all the information needed for all the features and options), the following tables will help you to determine the features and options on your dryer.

Once you are familiar with the configuration of your dryer model, you can then use the corresponding information in this manual to properly operate and maintain the dryer and ignore all other information not related to your dryer and it's features and options.

There are three major pieces of information needed to determine the features and options included at time of sales. They are:

- Software Version and Revision
- Standard Features and Options for each software version
- Additional Features and Options ordered at time of sales

The following tables may not take into account any feature or option added on after shipment of the dryer from the GFT factory.

Software Version and Revision

On the Control Panel type in the programmable code **1602**. The resulting group of numbers represent the software version and revision currently in the dryer's controller. The **1600** represents the dryer, the first set of dashed numbers represents the software version (i.e., **-005**) and the second set of dashed numbers represent the revision level (i.e., **-03**). As revisions occur, the second set of dashed number on your Control Panel may be greater in value then what is listed here but still applies.

If the Software Version number is:	Then these are the Standard Features on your dryer
1600 – 005 – 05 **(GFT Controller P/N: 1075227.755**	This is the standard baseline controller and software. There are no additional features. Ignore the information in Section 3.2.1, *Optional Features*.
1600 – 007 – 01 **(GFT Controller P/N: 1075227.775**	All standard features ***plus*** the Security Passcode option. Refer to Section 3.2.1.4 for details.
1600 – 008 – 03 **(GFT Controller P/N: 1075227.784**	All standard features ***plus*** the AutoWash option. Refer to Section 3.2.1.2 for details.

If the Software Version number is:	Then these are the Standard Features on your dryer
1600 – 009 – 01 (GFT Controller P/N: 1075227.795	All standard features ***plus*** the Security Passcode and AutoWash options. Refer to Section 3.2.1.2 and 3.2.1.4.
1600 – 0011 – 03 (GFT Controller P/N: 1075227.751	All standard features ***plus*** the CO_2 Injection Module option. Refer to Section 3.2.1.5 for details.

Additional Features and Options

The following list of options is not the complete list of all options available. Rather, this table lists the options, if ordered, that will affect the proper operations and/or maintenance of the dryer. To determine if your dryer has any of the following options, refer to the sales order for this dryer or call GFT Inside Sales, then go to the listed section in the manual for details about the option.

Options	Operations Sections:	Maintenance Sections:
Audible Alarm	**3.2, 3.2.1.5.3, 3.2.1.1, 3.2.1.2, 3.6**	
Boat Detection	**3.2.1.3**	
CO_2 Injection Module	**3.2.1.5**	**4.16**
DI H_2O Filter		
EMO Pushbutton	**1.2.3, 3.4**	
Footswitch	**3.2**	
Heater Indicator Light	**3.6**	**4.13**
Hinged Doors		**4.6, 4.9**
Manual Door Latch		**4.6, 4.9**
N_2 Filter	**3.6, 3.8**	**4.3**
Resistivity	**2.2.9, 3, 3.3**	**4.15**
Rotor Style		**4.4, 4.10**
others:		

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CONTENTS

3 Operating Procedures

4 Maintenance Frequencies and Procedures

5 SECS II Communications

1 SAFETY SYSTEMS

1.1 S2-93 Specifications

GFT recommends that persons servicing the dryer are trained, experienced technicians with a basic understanding of the concepts and procedures inherent to electronic technology and chemistry. Without such knowledge, attempted servicing may render the equipment unfit or unsafe for use.

1.1.1 Hazards and Safety Issues

Verify that all persons installing, operating, or providing service and maintenance to the dryer adhere to the following guidelines:

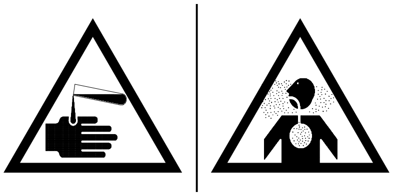
SAFETY ISSUES	
1.	Follow all procedures as outlined in this manual and comply with all WARNINGS and CAUTIONS pertaining to electrical, chemical or operating hazards. Voltages exceeding "safe" limits are present in the SRD and are identified by the WARNINGS throughout this manual. Failure to comply with these WARNINGS may result in severe electrical shock or death.
2.	DO NOT under any circumstances remove equipment covers that have warning labels prohibiting removal. These warning labels indicate safety hazards and require compliance.
3.	When handling chemicals always wear protective clothing and follow industry prescribed chemical handling techniques.
4.	All system service and maintenance must be performed by a trained, competent person. When performing service and maintenance always follow the appropriate procedure as outlined in this manual as a minimum.

Important information in the manual is distinguished by the following notations:

NOTE
Specific information is placed in a NOTE box when clear procedural understanding is essential.

CAUTION	
!	**POTENTIAL PRODUCT OR EQUIPMENT DAMAGE!** Caution notices will be used where equipment or product damage might occur if care and attention is not taken.

WARNING



HAZARDOUS CHEMICALS CAN CAUSE SEVERE INJURY OR DEATH!

Before attempting removal procedures apply your company's chemical and electrical lockout and tag procedures, which are supplemented by these procedures. Also, these procedures must be performed while wearing the appropriate level of personal protective equipment, such as, but not limited to:

- goggles
- apron
- boots
- gloves
- respirator

Your company's policies and procedures for safely operating the dryer supersede the safety considerations listed below. It is your responsibility to follow your company's safety procedures. If there are none, follow those established by these instructions, OSHA, DEQ, and/or the DOT, as a minimum.

1.1.2 Environmental Information

The following information is available from GFT's Health and Safety department for the baseline process:

- Overall Chemical Mass Balance
- Exhaust Concentration – Un-reacted Process Chemicals
- Known Environmental Restrictions – Baseline Chemistry
- Volumetric Flow
- Waste Water Contaminants

1.1.3 Ergonomics

GFT does not provide specific installation location requirements. However, the installation location should account for height, reach, load weight, and other factors to provide the operator a safe and comfortable access to the tank and the system keypad/display. To quote guidelines indicated in SEMI S2-93, the installation should account for the "5th percentile small Asian female to the 95th percentile large American male". Typical installations generally place the system so that the grasp height is approximately 35- to 38-inches above foot level, and no farther than a 7- to 18-inch reach.

WARNING

DRYER IS TOO HEAVY FOR ONE PERSON LIFT!

Due to the excessive weight of the dryer, handling (lifting) should be performed by two persons (minimum).

1.1.4 Seismic Activity Precaution

CAUTION	
⚠	**POTENTIAL PRODUCT OR EQUIPMENT DAMAGE!** The system should be secured in such a fashion as to inhibit movement in the event of any seismic activity.

Regardless of the locating and leveling means, the dryer should be secured against both vertical and horizontal movement. Securing means should take into account the weight of the dryer under normal operating conditions.

1.1.5 User Supplied Devices

“User Supplied Devices" refers to signal lights, switches and alarms, etc., that may be interfaced with the dryer but are not supplied by or purchased from GFT.

Before connecting a user supplied device to the dryer, always refer to the specifications outlined in the drawings to verify that the device can be supported and to determine which wires are used to interconnect the device to the dryer.

1.1.6 Equipment Noise Data

The end user of this equipment can expect a continuous A-weighted sound pressure level of less than 70dB(A) at the front of the dryer; and no peak C-weighted instantaneous sound pressure levels in excess of 63 Pa.

1.2 Dryer Safety Protection

GFT suggests the following protection for all dryers.

- Dryer Circuit Protection
- Electrical Disconnect and Equipment Lockout and Tag Procedures
- Emergency Shutdown (EMO / EPO)

1.2.1 Dryer Circuit Protection

The facility circuit protection device should be rated to withstand the short circuit current of no less than 10,000 rms symmetrical amperes at 208/120 volts at the incoming terminals.

Power receptacle service requirements are standard #10 AWG 20 ampere wiring, NEMA receptacle configuration type 15-20R. If the specified receptacle is not used, rigid conduit, or flexible conduit for runs of less than 20 feet, must be used. A Ground Fault Interrupter (GFI) with a trip current of less than 7 mA should be employed for personal protection.

1.2.2 Electrical Disconnect and Equipment Lockout

Follow standard procedures when working on electrical equipment. The breaker box or branch circuit feeding the equipment must be locked and tagged with the appropriate information.

GFT may not supply a lockable, safety-type electrical disconnect with some dryers. GFT therefore suggests that the end-user provide a means of disconnecting power to the dryer with a lockable-type safety disconnect. Follow all equipment safety Lockout and Tag procedures as outlined in your country’s and/or company's equipment safety manuals.

European standards require proper markings on the disconnect. If a mains plug is installed, is should conform to IEC 320. The EU end user should provide a main power cord that meets the requirements of IEC 227 or IEC 245, and is listed by a recognized European testing laboratory (i.e., HAR Cordage).

1.2.3 Emergency Shutdown

GFT and S2-93 specifications recommend the installation of an Emergency Power Off (EPO) push-button on all dryers to shut main power off should an "EMERGENCY" situation arise. The EPO pushbutton should be of the red mushroom-type and labeled "*EMERGENCY POWER OFF*".

NOTE

The EPO mounting height should not exceed 63.5 inches from the floor. If planning to install an EPO, it is important to provide a separate POWER ON button to return power after MAIN POWER has been shut off.

CAUTION

POTENTIAL PRODUCT OR EQUIPMENT DAMAGE!

If installing an EPO button, a clear PVC sleeve surrounding the EPO button is required to prevent accidental activation of the EPO.

The following diagram (Figure 1-1) is a typical Emergency Power Off or Emergency Off circuit.

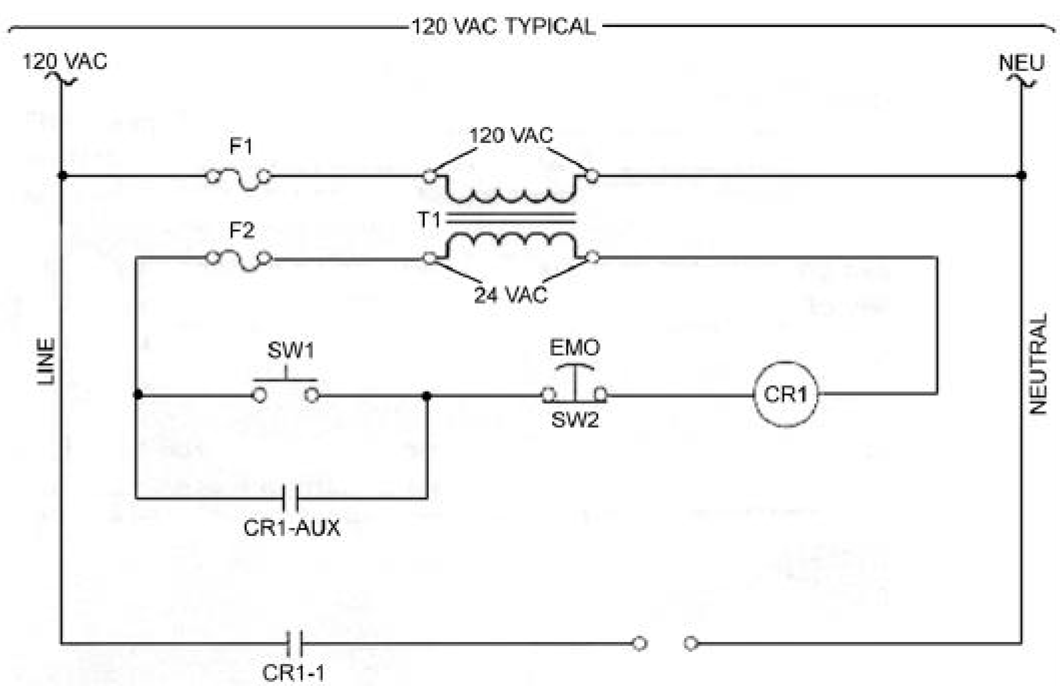


Figure 1-1. *A typical Emergency Power Off or Emergency Off circuit.*

Circuit Components	Description
F1	Primary protection for transformer T1
F2	Secondary protection for transformer T2
T1	24 VAC isolation transformer
SW1	Momentary POWER ON pushbutton (green)
SW2	EMO (EPO) pushbutton, red mushroom-type, 60 mm diameter with shroud
CR1	24VAC power contractor with N.O. auxiliary contact

If the input voltage is reduced to 24 VAC, SW1 energizes CR1 and is held using a CR1-AUX contact, also applying power to the dryer using a CR1-1 main contacts (120 VAC). Should an emergency arise, the operator presses the EMO pushbutton which will open the circuit and removing all AC input to the dryer.

1.3 Lighting in Work Areas

CAUTION

IMPROPER LIGHTING CAN CAUSE HAZARDOUS CONDITIONS

When performing maintenance in enclosed bays and cabinets, S2-93 safety requirements call for the lighting to be at or greater than 30 footcandles in power. Use additional lighting apparatuses where lighting is less than 30 footcandles in all work areas associated with GFT equipment.

2 THEORY of OPERATIONS and SPECIFICATIONS

2.1 Product Introduction

The SuperClean 1600-55 A/M is a single cassette, front-loading, programmable rinser/dryer used to rinse and dry semiconductor wafers, photomasks, and substrates up to six inches (150mm) in diameter. The Component-only model's electrical components are in separate enclosures for easy integration into wet systems. The dryer can also be configured as 'single-stack' or 'double-stack' standalone models in two different configuration cabinets (Figure 2-1).

Figure 2-1*. The SuperClean 1600-55 A/M dryer models can be configured as a 'Component-only' (left), a 'single-stack' (middle) or a 'double-stack' (right). The models shown are typical examples. Your dryer may have less or more features than the ones shown here and some of the features may be in different locations. Also refer to the foldout at the end of this section.*

The patented noncontact nitrogen labyrinth seal is key to the effectiveness of the dryer. Filtered nitrogen gas flows through the seal area forming a gaseous barrier that seals the bowl from outside contaminants and keeps N_2 and water in the bowl from escaping. Since the shaft and bowl of the dryer have no mechanical contact, particulate contamination is virtually eliminated.

Upon completion of the final rinsing step of a wet process, the wafer and cassette surfaces are primarily dried through spinning action. Liquid droplets on the bowl and other surfaces are evaporated with heated nitrogen which absorbs moisture rapidly. Ionized nitrogen neutralizes static charges in order to prevent particle attraction and reattachment. The dryer provides effective drying while minimizing particles as small as 0.15 micron from being added to the wafers. The dryer can also be used to pre-rinse wafers prior to drying.

The dryer can run two types of cycles: rinse and dry. The cycles are controlled independently, therefore, a rinse and dry, rinse only, or dry only cycle can be programmed.

The process bowl is designed to eliminate as many welds as possible and electropolished to provide a corrosion resistant surface (Figure 2-2). The interior is meticulously detailed to provide an ultrasmooth surface with excellent rinsing characteristics to prevent particle trapping. To complement the cleanliness of the bowl, the dryer features an ultrapure plumbing design with an in-line 0.03 μm nitrogen filter. A static eliminator is provided to prevent static buildup which can cause particles to reattach to product (wafer) surfaces. The dryer features multi-step, multi-recipe editing with user-programmable control over several processing options. The controller governs a full complement of safety features and has built in diagnostics to ensure that the dryer is well protected and very reliable. The dryer is designed to operate with a full or partial product load in manual or wet process systems, and in free standing cabinets. Systems used in automated environments include host communications and fully automated door control.

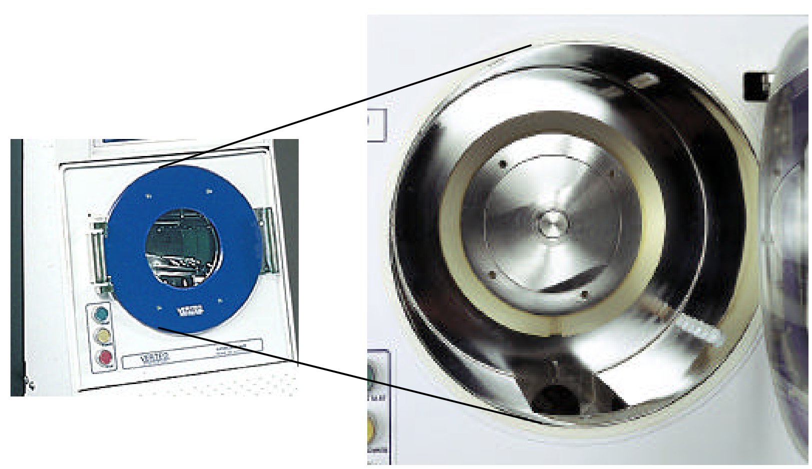


Figure 2-2*. The inside of the process bowl is designed to eliminate as many welds as possible and electropolished to provide a corrosion resistant surface.*

2.2 Theory of Operations

GFT’s SuperClean 1600-55 A/M dryer uses centrifugal force to dry the surface of the wafers. A cassette is placed inside the drying chamber, held in place by a rotor, and spun at an appropriate speed depending on the nature of the load and the process. The drying chamber (bowl) is warmed with a continuous flow of hot filtered nitrogen and surface heaters on the outside walls. The liquid on the wafer surface is spun off and drained from the bowl while liquid droplets on the drying chamber surfaces are evaporated.

The dryer can also be configured, at time of purchase, to pre-rinse the wafers prior to the drying cycle with ultra-pure DI water. The water is sprayed from a line of strategically placed nozzles to provide even rinsing of the wafer surfaces. This is done to rinse residual chemistries from the surface, or to replace existing water with fresh water prior to drying. When the dryer is used for dry-only processing, the rinse cycle can also be used for periodic cleaning of the bowl surfaces between process sessions.

2.2.1 Rinsing

A typical rinse cycle consists of DI water being sprayed into the bowl through six nozzles while the rotor (and cassette) rotates. The length of the rinse cycle is determined by either the programmed cycle duration, or by an optional resistivity monitor that measures when the resistivity of the rinse water has reached the desired setpoint.

2.2.2 Drying

A typical dry cycle consists of filtered nitrogen entering the bowl through the door blowoff nozzle, static eliminator manifold, and bowl nozzles. The nitrogen flowing into the bowl is heated if the heater has been programmed into the recipe. The nitrogen that floods the bowl is ionized if the static eliminator function has been programmed into the recipe. The duration of the dry cycle and speed of the rotor are determined by values programmed into the recipe.

2.2.3 Recipes / Steps

Recipes define the performance capabilities of the dryer. Process recipes include the cycle duration, spin speeds, and whether to include a rinse step or not. Speeds for different wafer sizes may vary as can the time required to dry the bowl and cassette surfaces. The dryer can be programmed to store up to ten recipes, with each recipe capable of containing up to ten steps. Each step of the recipe controls either a rinse cycle or a dry cycle, depending on the requirements of each unique process.

2.2.4 Cycles

The dryer runs two cycles - *rinse* and *dry*. The cycles are controlled independently, so the dryer can rinse and dry, rinse only or dry only. Cycles are initiated by recipes that have been programmed.

The dryer can store up to 10 preprogrammed recipes, each of which can contain 10 steps or *cycles*. The conditions in any particular rinse or dry cycle vary depending on the functions programmed into a recipe. Nitrogen, DI water, heater, resistivity monitor and static eliminator options function during a cycle, only if they are included in the recipe.

During a typical rinse cycle, DI water is sprayed into the bowl through six (6) nozzles as the rotor turns at the speed selected. The length of any rinse cycle is determined by a rinse timer program or by measuring the resistivity of the rinse water to determine if it equals or exceeds a programmed setpoint.

A typical dry cycle consists of filtered nitrogen entering the bowl through the door blowoff nozzle, static eliminator manifold, and the bowl nozzles. The N_2 flowing through the dryer is heated if programmed "ON". Ionized nitrogen floods the bowl if the optional static eliminator has been programmed into the recipe. The duration of the dry cycle and speed of the rotor are determined by values programmed into the recipe.

2.2.5 Bowl Seals

To keep particle contamination to an absolute minimum, the front and back of the bowl are sealed. The door is pulled shut, a recipe is selected and the dryer is started. An air cylinder system pulls the door against the door seal. The door can be unsealed and opened only when the last cycle in the recipe is complete or the cycle has been aborted. The bowl is nitrogen-purged prior to the door being sealed and when the door is opened to prevent possible contamination.

2.2.6 AutoWash

If the dryer is used for dry cycles only, it must be periodically rinsed with DI water to ensure consistently clean operation. The dryer can be programmed to illuminate a warning LED if a user-programmed number of dry-only cycles have been run or a user-specified time interval has passed with the dryer in idle mode, indicating to the operator that a rinse cycle is due. The dryer will automatically initiate a rinse cycle after the cycle or time counter has expired. The bowl is rinsed for a user-specified number of minutes as it rotates at 100 RPM.

2.2.7 Labyrinth Seal

The area between the hub and seal plate at the back of the bowl is sealed by GFT's patented labyrinth seal. Filtered nitrogen flows to the seal during a cycle, forming a gaseous barrier that seals the bowl from outside contaminants. Because this is a gaseous, non-contact seal, static charges are not produced nor do particles slough off and contaminate the wafers.

Figure 2-3 shows a cross-section of the bowl. The seal area is the gap between the hub and the seal plate. During operation, nitrogen is pumped into the gap from two sets of nozzles. One set blows filtered nitrogen through the seal area in the bowl so water can’t leak out. The second set blows nitrogen through the seal area and out the back of the bowl so contaminants can’t get in. The result is a perfectly sealed bowl without the stray charges of particle contamination of contact-type seals.

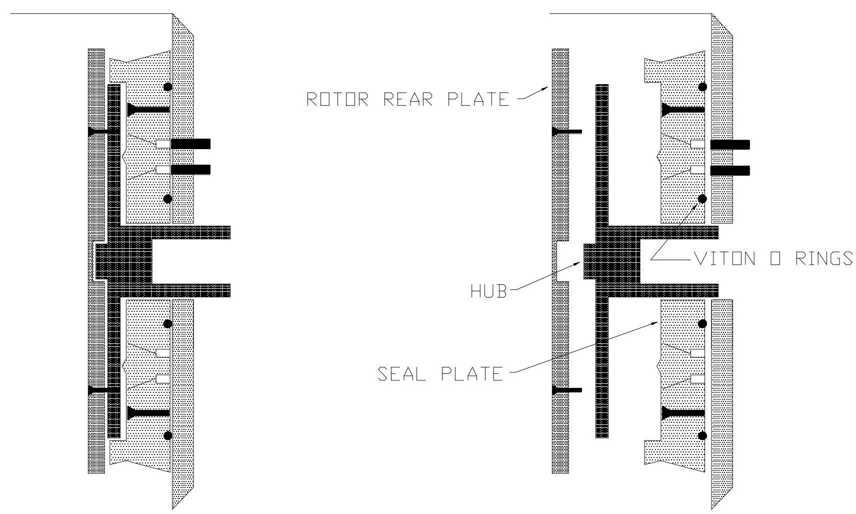


Figure 2-3. *Labyrinth Seal.*

2.2.8 Autopositioner

To further protect the wafers, the dryer uses a rotor autopositioner to automatically index (to the upright position) the rotor at the end of every cycle. The autopositioner rotates the rotor so that the carrier stops in the upright position. The door will not unseal until the rotor is properly indexed, ensuring that the wafers cannot accidentally fall out of the carrier during automatic removal by a robot or manual removal by an operator.

2.2.9 Resistivity Controller

The electronic circuitry used in the resistivity controller combines a high input impedance analog amplifier with an 8-bit microprocessor to provide accurate and stable readings.

Accuracy is not dependent on a reference voltage, but rather on the stable reference resistors and the microprocessor's crystal clock. An AC square wave current is generated at 75 Hz for resistivity and applied to the cell through a multiplexer. The resistivity is then calculated as proportional to the voltage generated across the cell electrodes. Since this resistance varies with temperature, a correction must be made to relate the resistivity to what it would be at 25°C. This calculation is accomplished in the microprocessor by DC input from the resistance temperature detector (RTD) which is internal to the cell.

The RTD increases in resistance for increasing temperature. Metering the DC resistance of the RTD gives the microprocessor accurate temperature information to calculate resistivity to 25°C. This correction factor calculation assumes the solution resistivity varies with temperature as if all the impurity ions are sodium chloride (NaCl). Although NaCl is rarely the only impurity present, it is typical of many inorganic impurities and is the usual standard for this calculation. The microprocessor must sequence through the following measurements or calculations:

- AC resistance (uncorrected) of the cell
- DC resistance of the RTD
- Calculation of corrected resistivity to 250 °C.
- Measurement of set point controls
- Comparison of corrected resistivity to setpoint
- Control output signal

2.2.9.1 Resistance-Temperature Data 18.3 megohm-cm (Pure Water)

Temperature °C	Resistivity (megohm-cm)	Resistance (± DC ohms)
0	88.2	500.0
10	44.4	520.8
20	23.8	542.3
25	18.3	553.3
30	13.7	564.5
40	8.5	587.3
50	5.6	610.8
60	3.9	634.8
70	2.9	659.3
80	2.1	684.2
90	1.7	709.5
100	1.3	735.1

2.3 Software Functional Description

The dryer’s software functions within 6 basic modes of operation. These modes are:

Mode	Refer to Section:
Power Up	2.3.2
Idle	2.3.3
Alarm	2.3.4
Open Door	2.3.5
Close Door	2.3.6
Run Recipe	2.3.7

2.3.1 Overview

The **Power Up** mode is automatically executed when the dryer is turned on. If no alarms are encountered during this mode, the dryer enters **Idle** mode. The dryer maintains **Idle** mode until it is instructed to perform a function, or until it detects an alarm condition. While in **Idle** mode, the dryer can be instructed to enter the **Close Door** or **Open Door** mode (1600-55 **A** only), or **Run Recipe** mode. After successful completion of any of these modes, the dryer returns to **Idle** mode. If at any time the dryer detects an alarm, it enters the **Alarm** mode.

The following flowcharts outline the step-by-step occurrence of the major lines of code within the software. Please keep in mind the timing (sequence) of the flowcharts may appear to act differently from the physical action of the dryer.

2.3.2 Power Up Mode

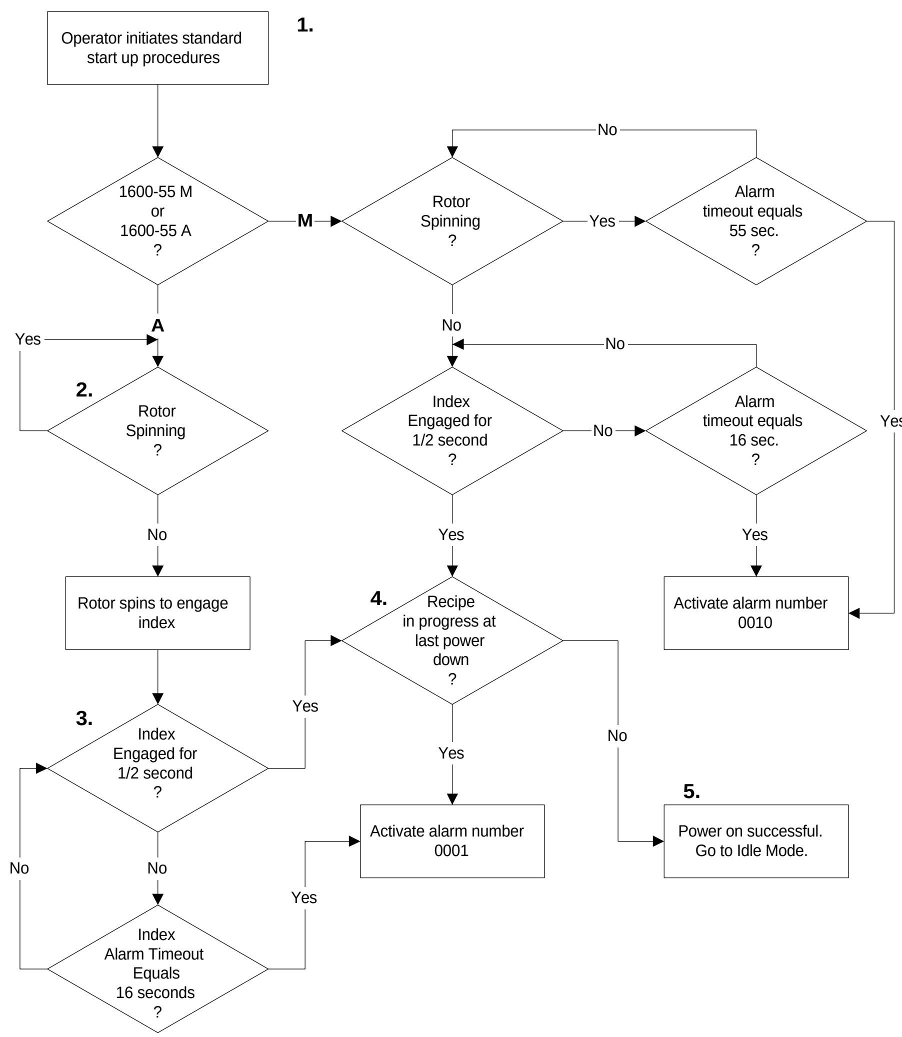
1. Operator applies power using normal start up procedures.

2. The software checks for a spinning rotor. Normally, the rotor won't be spinning at power up. If the rotor is spinning, the system waits indefinitely for the rotor to stop for the 1600-55 A, or 55 seconds for the 1600-55 M. If the rotor is not spinning, the rotor is moved to engage the index cylinder.

3. The index cylinder is engaged. A sensor reports when engagement occurs for longer than 1/2 of a second. If after 16 seconds the sensor has not reported engaged, an alarm is sent.

4. If a recipe was in progress during the last power down of the dryer, the system will activate an alarm at the next power up request.

5. If no alarms have occurred, then the dryer was successfully powered up and is in Idle mode.



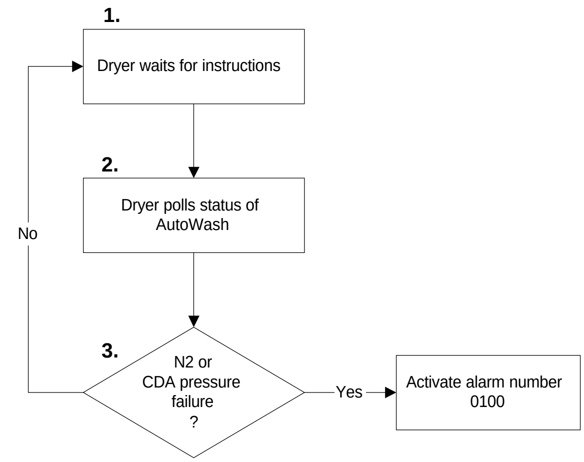
2.3.3 Idle Mode

1. The dryer is powered on and is waiting instructions from either an operator or commands from a Host operating system.

2. The dryer polls the time and cycle status of the optional AutoWash feature. If an AutoWash routine is called for, the dryer will AutoWash and return to Idle mode.

3. During Idle the dryer will activate any of two (2) alarms that may occur. These alarms are:

N_2 or CDA Pressure Failure

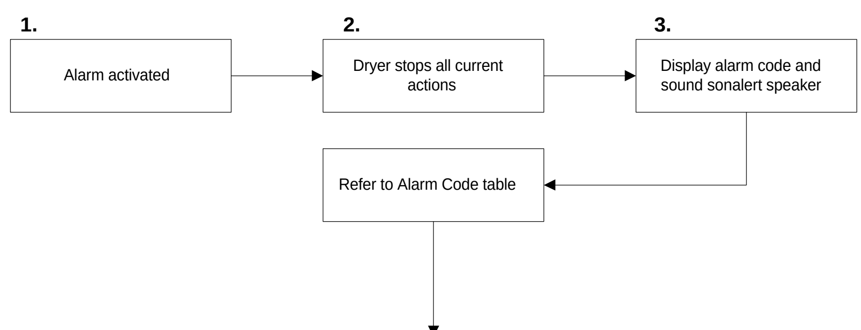


2.3.4 Alarm Mode

1. An alarm can occur during any mode.

2. The dryer halts all actions currently taking place.

3. The appropriate alarm code is sent to the control panel and the sonalert speaker is sounded. Refer to the attached Alarm code reference table.



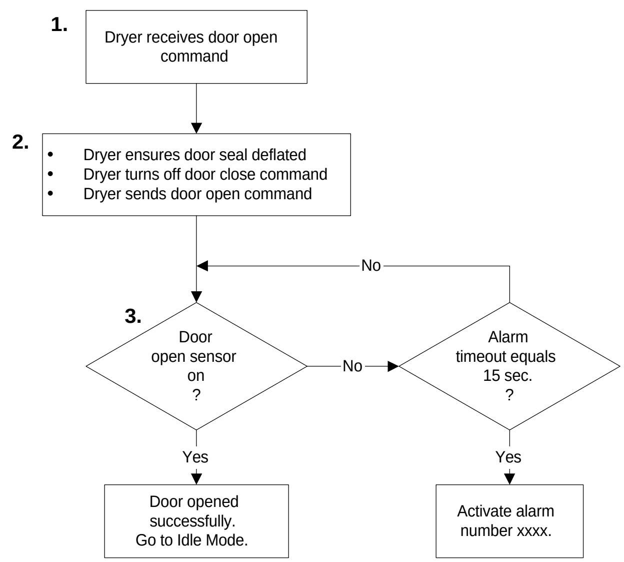
Alarm Code	Fault Description
0001	Power Failure
0002	Heater Failure
0004	DI Flow
0010	Index Failure
0020	RPM Too High
0100	N_2 Pressure Failure
1000	Door Open in Run
2000	Door Seal (bladder) Failure
4000	Door Open Error (1600-55 **A** only)
8000	Door Close Error (1600-55 **A** only)
8888	Motor Loss of Feedback or Overspeed

2.3.5 Open Door Mode (1600-55A)

1. While in Idle mode, the operator presses the optional footswitch or the dryer receives a door open command from a host computer. The footswitch is ignored if the dryer is not in Idle mode.

2. The dryer ensures the door seal (bladder) is deflated, ensures the door close command is off, and sends a door open command.

3. If the door open sensor does not report open within 15 seconds a timeout alarm is activated. If the door sensor reports open, then the dryer is placed in Idle mode.

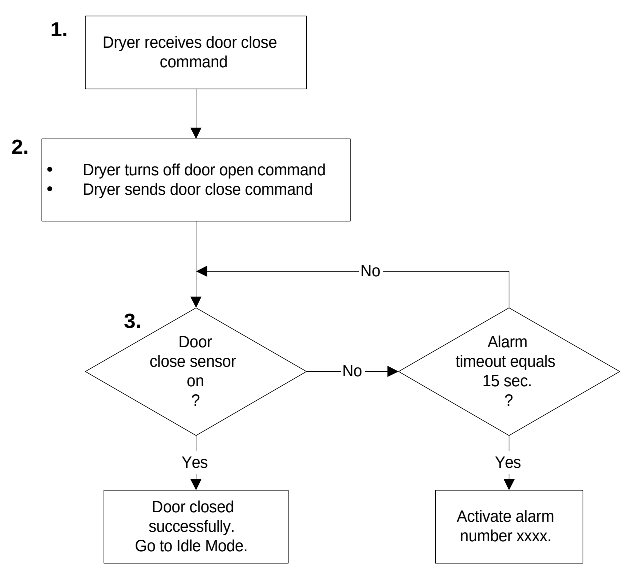


2.3.6 Close Door Mode (1600-55 A)

1. While in Idle mode, the operator presses the optional footswitch or the dryer receives a door close command from a host computer. The footswitch is ignored if the dryer is not in Idle mode.

2. The dryer ensures the door open command is off, and sends a door close command.

3. If the door close sensor does not report closed within 15 seconds a timeout alarm is activated. If the door sensor reports closed, then the dryer is placed in Idle mode.

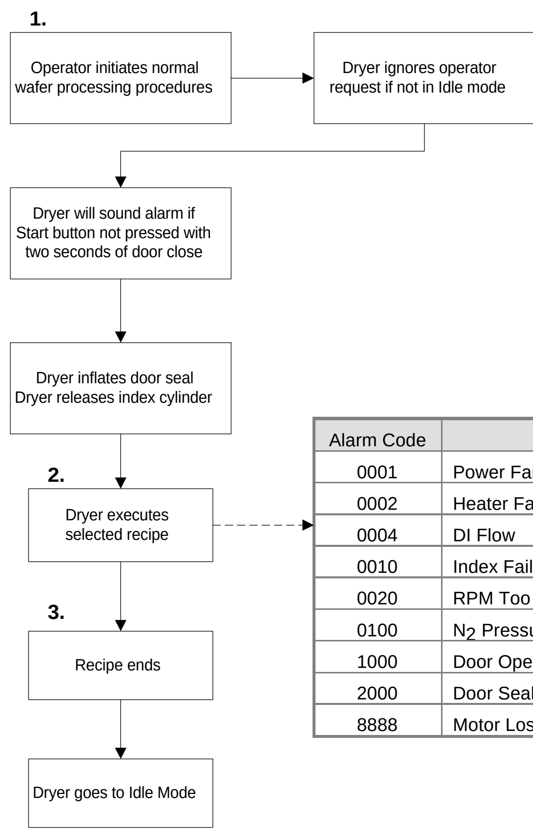


2.3.7 Run Recipe Mode

1. The operator starts a recipe run normally. If the dryer is not in Idle mode, the dryer ignores the operator request. If a optional boat sensor is installed, the dryer will sound the sonalert speaker if the operator has not pressed the Start pushbutton within two (2) seconds after the door close sensor has reported closed.

2. The dryer executes the selected recipe. While running the selected recipe, the dryer monitors for and responds to alarm conditions should they become active.

3. The recipe ends and the dryer is placed in Idle mode. The dryer also signals the operator to unload the wafers.



Alarm Code	Fault Description
0001	Power Failure
0002	Heater Failure
0004	DI Flow
0010	Index Failure
0020	RPM Too High
0100	N_2 Pressure Failure
1000	Door Open in Run
2000	Door Seal (bladder) Failure
8888	Motor Loss of Feedback or Overspeed

2.4 Specifications

The following tables outline various specification valves for all standard model configurations.

2.4.1 Standard Features

Feature	Description
Capacity (depends on carrier used)	1 carrier with 0-25 wafers up to 6”
Bowl Dimensions	11.25” inside diameter x 11” deep
DI/N_2 Nozzles	Six (fan-type)
DI H_2O	All PFA fittings, TFE valves, TFE tubing, TFE flowswitches
System N_2	PFA tubing, PFA fittings, stainless steel N2 heater, and 316 low carbon stainless steel regulators
Cycle speed	50 to 3200 RPM
Cycle Timer	0 to 9999 seconds

2.4.2 Load Capacities

The dryer can process up to twenty-five 6-inch (150mm) or smaller silicon wafers. The dryer can also process square masks.

CAUTION

POTENTIAL PRODUCT OR EQUIPMENT DAMAGE!

Using the wrong cassette in the dryer may cause damage. Ensure the serial number of the cassette matches the number on the rotor. See Section 3, Operations, for location of these numbers. Never run a cycle without the cassette installed in the process bowl. The dryer is balanced with the cassette. Damage to the labyrinth seal and rotor will occur.

2.4.3 Operating Parameters

Dryer Operating Parameters and Ranges	
Rinse Cycle Speed	0 (50) to 3200 RPM
Dry Cycle Speed	0 (50) to 3200 RPM
Rinse Timer	0 to 9999 seconds
Dry Timer	0 to 9999 seconds
Resistivity	0 to 18.2 megohms

2.4.4 Facility Requirements

Refer to Table 2-1 for a *typical* single dryer, single-stack FREM or single-stack Bay and Chase model. Refer to Table 2-2 for a *typical* double-stack FREM or Bay and Chase model. Always defer to the facilities drawing for your dryer model supplied with this manual if the values differ.

Table 2-1. *Facility requirements for all single dryer model types.*

<table>
<tr><th colspan="4">Single Dryer Facility Requirements</th></tr>
<tr><td rowspan="5">DI H_2O Input</td><td colspan="3">$^3/_8$-inch OD Teflon tubing</td></tr>
<tr><td colspan="3">1.75 gpm minimum</td></tr>
<tr><td colspan="3">25 psi dynamic minimum</td></tr>
<tr><td colspan="3">40 psi dynamic maximum for low pressure valve</td></tr>
<tr><td colspan="3">70 psi dynamic maximum for high pressure valve</td></tr>
<tr><td rowspan="2">DI H_2O Return</td><td colspan="3">$^3/_8$-inch OD Teflon tubing</td></tr>
<tr><td colspan="3">minimum 5 psi lower than input pressure valve</td></tr>
<tr><td rowspan="3">System N_2</td><td colspan="3">$^3/_8$-inch OD Teflon tubing</td></tr>
<tr><td colspan="3">6-7 scfm (gauge reading)</td></tr>
<tr><td colspan="3">60 psi dynamic minimum</td></tr>
<tr><td rowspan="3">CDA / N_2</td><td colspan="3">Operates pneumatic components</td></tr>
<tr><td colspan="3">¼-inch OD Teflon tubing</td></tr>
<tr><td colspan="3">60-90 psi dynamic</td></tr>
<tr><td rowspan="2">Drain</td><td colspan="3">1 ½-inch mnpt (drain box).</td></tr>
<tr><td colspan="3">1 ½-inch pvc pipe (drain plumbing option)</td></tr>
<tr><td>Vent</td><td colspan="3">1 ½-inch pvc pipe</td></tr>
<tr><td>Exhaust</td><td colspan="3">-0.5 max to -1.0 inches of water if not exhausted to fab</td></tr>
<tr><td rowspan="4">Power</td><td>Voltage</td><td>Hertz</td><td>Amps</td></tr>
<tr><td>120 vac</td><td>50/60</td><td>15 – Standard</td></tr>
<tr><td></td><td></td><td>18 – Step-Up Transformer</td></tr>
<tr><td></td><td></td><td>10 – Step-Down Transformer</td></tr>
</table>

NOTE

Always defer to the facilities drawing for your dryer model supplied with this manual if the values differ.

Table 2-2. *Facility requirements for all double-stack dryer model types.*

Double-Stack Dryer Facility Requirements			
DI H_2O Input	Dual $^3/_8$-inch OD Teflon tubing without single point option		
	½-inch OD Teflon tubing with single point Flaretek		
	½-inch OD Teflon tubing w/ single point compression		
	3.5 gpm minimum		
	25 psi dynamic minimum		
	40 psi dynamic maximum for low pressure valve		
	70 psi dynamic maximum for high pressure valve		
DI H_2O Return	Dual $^3/_8$-inch OD Teflon tubing without single point option		
	½-inch OD Teflon tubing with single point Flaretek		
	½-inch OD Teflon tubing w/ single point compression		
	minimum 5 psi lower than input pressure valve		
System N_2	Dual $^3/_8$-inch OD Teflon tubing without single point option		
	½-inch OD Teflon tubing with single point Flaretek		
	½-inch OD Teflon tubing w/ single point compression		
	12-14 scfm (gauge reading)		
	60 psi dynamic minimum		
CDA / N_2	Operates pneumatic components		
	Dual ¼-inch OD Teflon tubing without single point option		
	½-inch OD Teflon tubing with single point Flaretek		
	$^3/_8$-inch OD Teflon tubing w/ single point compression		
	60-90 psi dynamic		
Drain	1 ½-inch mnpt (drain box).		
	1 ½-inch pvc pipe (drain plumbing option)		
Vent	1 ½-inch pvc pipe		
Exhaust	-0.5 max to -1.0” of water if not exhausted to fab		
Power	**Voltage**	**Hertz**	**Amps**
	120 vac	50/60	15 – Standard
			18 – Step-Up Transformer
			10 – Step-Down Transformer

NOTE
Always defer to the facilities drawing for your dryer model supplied with this manual if the values differ.

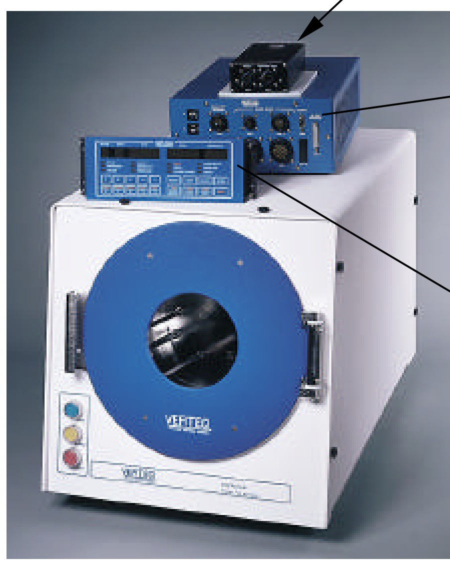
SuperClean 1600-55 A/M Rinser / Dryer

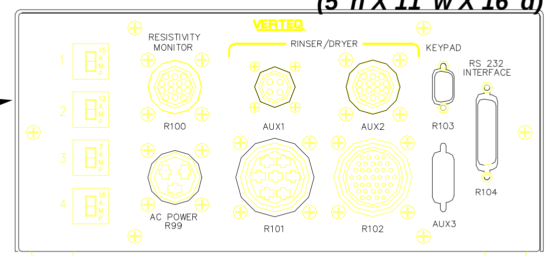
Typical GFT 1600-55 A/M rinser / dryers are shown in various standard configurations. Your dryer may not contain all of the components, features and options shown. Features on your dryer may be in different locations than those shown in these examples. Not all componets, features, options or configurations are shown. All information is for reference only.

Typical Componets

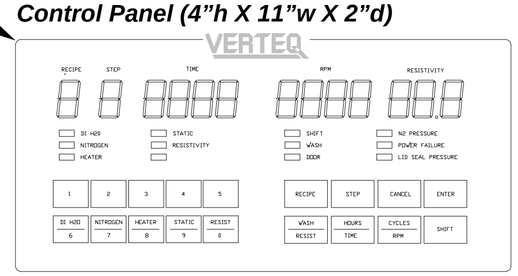
Resistivity Controller (2"h X 4"w X 8"d)

Controller (rear view) (5"h X 11"w X 16"d)



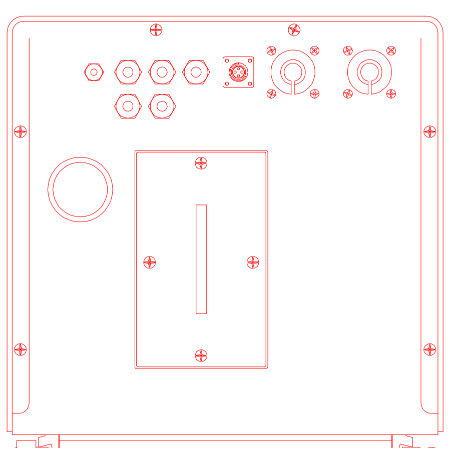


Control Panel (4"h X 11"w X 2"d)



Dryer unit also referred to as a Centrifuge
Dryer Dimensions: 19"h X 16"w X 27"d

Facilities connections



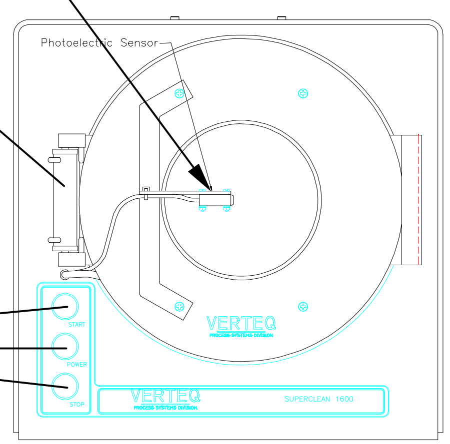
Rear view

Cassette Detect option shown

1600-55 A (Auto Door)

1600-55 M (Manual Door)

Left-hand Hinge shown



Start
Power
Stop

Right-hand opening door shown

Typical Front-Removable (FREM) Single Dryer in a Cabinet

EMO Pushbutton

Control Panel

Front Access

Footswitch

Cabinet Dimensions: 55"h X 17"w X 36"d

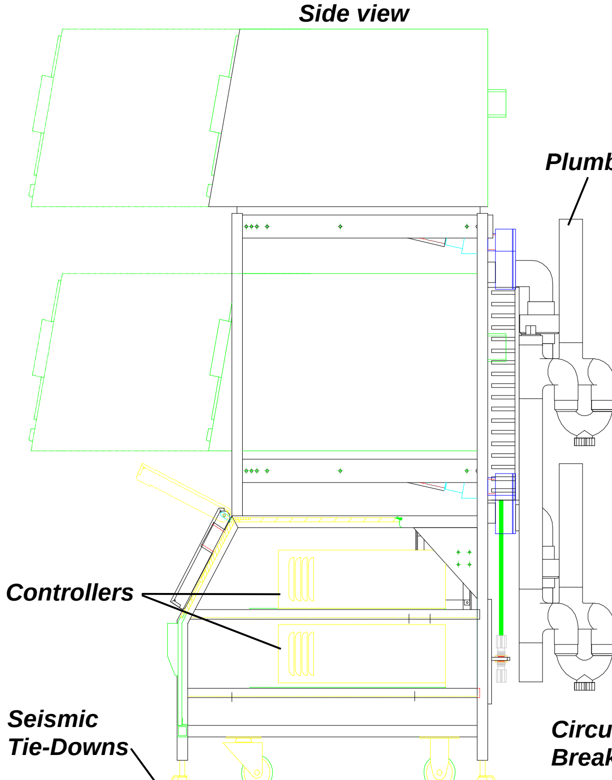
Single-Dryer Bay and Chase Cabinet 67"h X 22"w X 30"d (configuration not shown)

Typical Bay and Chase Double-Stack Frame

Frame Dimensions: 73"h X 20"w X 32"d

Typical FREM Double-Stack Frame (66"h X 19"w X 30"d)

Side view



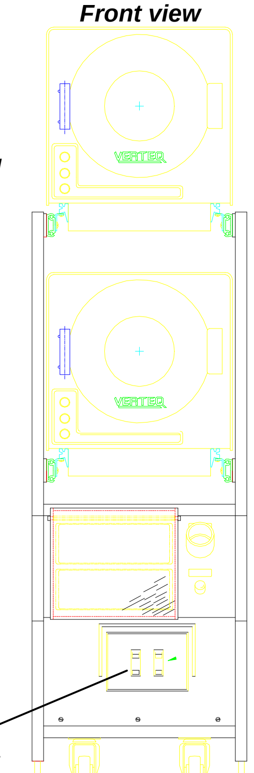
Plumbing

Controllers

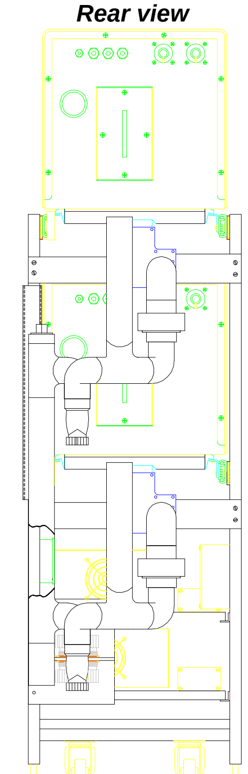
Seismic Tie-Downs

Circuit Breakers

Front view



Rear view



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Customer Focused Flexible Solutions

Typical Features and Options	
Features	**Description**
Product Capacity	1 cassette / 0-25 150mm wafers
Bowl Dimensions	11.25" I.D. X 11" deep
DI H_2O	Six (6) Fan-type. All PFA fittings, TFE valves, tubing, and flowswitches
System N_2	PFA tubing, fittings, stainless steel N_2 heater, and 316 low carbon stainless steel regulators
Cycle Speed	50 to 3200 RPM
Cycle Timer	0 to 9999 seconds
Options (contact GFT Sales for details)	
Left- or Right-hand Hinged Door	
2 Rotor Styles	
CE Marked	
Resistivity	
Flaretek Fittings on DI H_2O Lines	
RA-10 Finish Bowl	
High Pressure Teflon DI H_2O valves	
Millipore N_2 Filter Cartridge	
Heater Indicator Lights	
Audible Alarm	
N_2 Current Heater Detector	
Manual Safety Door Latch	
No Tools Drain Box	
CO_2 Injection (2 Versions)	
Cassette Detector Kit	
Housing:	
Front Removable (FREM) Single Cabinet	
Bay and Chase Single Cabinet	
FREM Doublestack Frame	
Halar Coating on FREM Doublestack Frame	
Side Panels on FREM Doublestack	
Bay and Chase Doublestack Frame	
Housing Options:	
Resistivity Monitor and Probe	
EMO for FREM or Bay and Chase	
GFI	
Footswitch	
Drain Plumbing	
Doublestack Single-point Facility Hook up	
PVDF or PFA 0.2µ DI H_2O Filter	
Step Down Transformer	
Controller Options:	
AutoWash	
Passcode	
AutoWash and Passcode	

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3 OPERATING PROCEDURES

This section includes the following topics:

- Control Panel (Section 3.1)
- Pushbutton Controls and Optional Features (Section 3.2)
- Recipe Programming (Section 3.3)
- Operating Procedures (Section 3.4)
- Programmable Codes (Section 3.5)
- Fault Codes (Section 3.6)
- Controller Card Dipswitch Settings (Section 3.7)
- Nitrogen Regulators (Section 3.8)
- Valve Bracket Assembly (Section 3.9)

3.1 Control Panel Functions

The alphanumeric displays on the control panel (Figure 3-1) have a dual purpose. In the programming, standby, and operating modes the display shows the programmed values. In a fault mode, 'HELP' will be displayed with a fault code number.

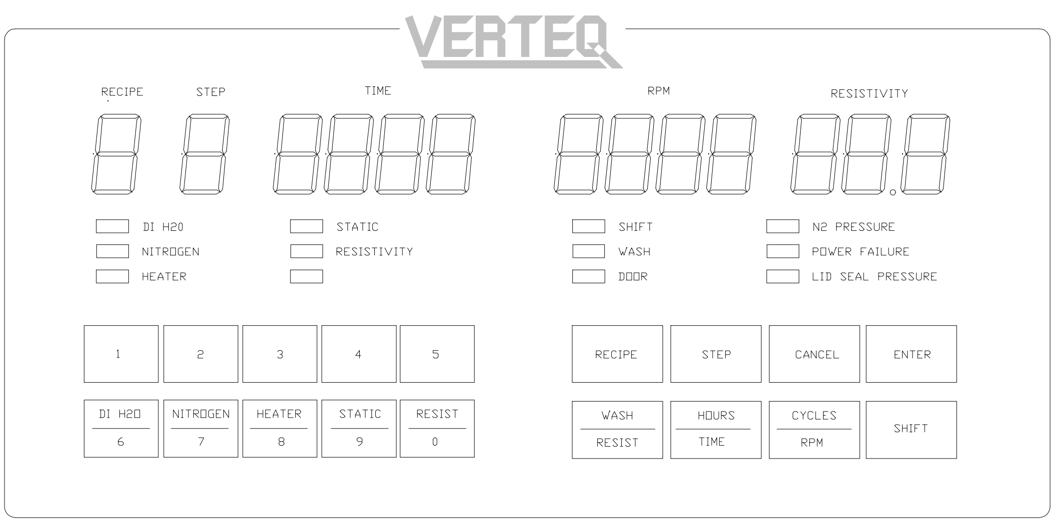


Figure 3-1. *Control Panel and Keypad layout.*

3.1.1 Numeric Read-Out on the Control Panel

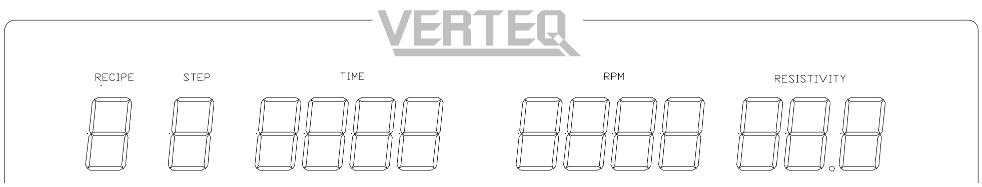


***Figure 3-2**. Numeric read out on the Control Panel.*

RECIPE shows the recipe number from 0-9, with 0 designated as the first recipe.

STEP shows the step (cycle) number from 0-9, with 0 designated as the first step.

TIME shows the time programmed in seconds for each specific step. The time will count down during the cycle. When a system fault occurs, '**HELP**' will be displayed, Figure 3-3.

RPM indicates the programmed rpm. During a cycle, the actual rpm will be displayed. When a system fault occurs, the fault (**HELP**) code number will be displayed.

RESISTIVITY indicates the programmed resistivity setpoint of the drained DI water.

3.1.2 Fault (HELP) Display Mode

When a fault has occurred, the word '**HELP**' will be displayed under the TIME display and the fault or HELP code number will be displayed under the RPM display. For a list of HELP codes refer to Section 3.6.

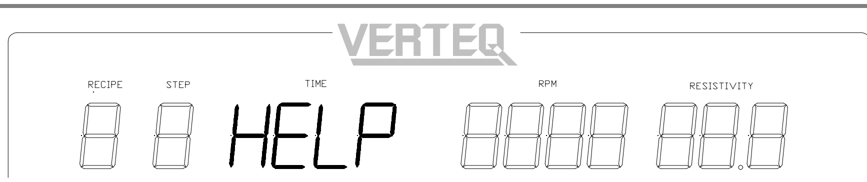


***Figure 3-3**. HELP Display Mode.*

3.1.3 LEDs

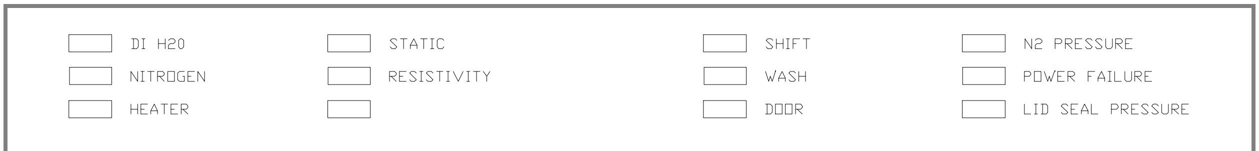


Figure 3-4. *LED functions of the Control Panel.*

DI H_2O, **NITROGEN**, **HEATER**, **STATIC**, **RESISTIVITY** indicate the functions that have been programmed into the current step (cycle).

SHIFT indicator is actuated by the SHIFT key and is illuminated during the programming mode. SHIFT is used to program only the keys in orange (i.e., DI H_2O, NITROGEN, HEATER, STATIC, RESIST, WASH, HOURS, and CYCLES).

NOTE

SHIFT must be off to exit the programming mode.

WASH illuminates when a rinse cycle is necessary to clean the inside of the dryer. See Section 3.2.1.1, *Wash Warning*, and Section 3.2.1.2, *AutoWash*.

POWER FAILURE illuminates at the next power up event after the AC supply voltage has been interrupted during processing.

N_2 PRESSURE indicates that the Nitrogen and CDA supply pressures are adequate.

DOOR illuminates when the door is not properly closed and sealed.

LID SEAL PRESSURE illuminates when the N_2 supply pressure is not adequate.

3.1.4 Control Panel Keys

The keys on the Control Panel are used to program or view recipes and steps. The numerical keys are used to program the recipe, step, cycle duration, rpm, and resistivity level. Several keys have dual functions that are controlled by the SHIFT key. With the SHIFT LED illuminated, the upper functions (displayed in orange) can be programmed. With the SHIFT LED **not** illuminated, the lower functions can be programmed.

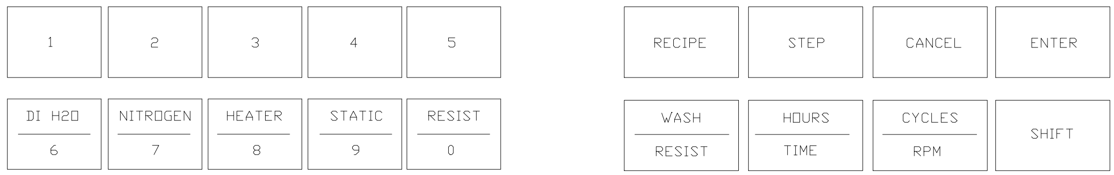


Figure 3-5*. Control Panel Keys functions.*

Numeric Keys are used to program the recipe, step, time, rpm, and resistivity values as well as Wash Warning values.

DI H_2O, **NITROGEN**, **HEATER**, **STATIC**, **RESIST**, **WASH**, **HOURS**, **CYCLES** are displayed in orange on the keypad are used to program the process selections of each cycle. To access these functions, press **SHIFT**.

RECIPE is used to select a recipe number from 0-9; up to ten recipes can be programmed.

STEP is used to select a step (cycle) number from 0-9; up to ten steps can be programmed.

CANCEL will erase any programming changes made while in the programming mode. Pressing ***CANCEL***, ***ENTER***, ***ENTER*** will revert to the recipe (if any) that had existed before any changes were programmed. The CANCEL key will silence the audible alarm, and will also put the dryer in standby mode when system faults (HELP codes) have been cleared.

ENTER is used to exit the programming mode by pressing it twice.

WASH is not used.

HOURS is used to program the Wash Warning parameters. Ensure all four numbers are keyed in. See Section 3.2.1.1, *Wash Warning Feature*.

CYCLES is used to program the Wash Warning. Ensure all four numbers are keyed in. See Section 3.2.1.1, *Wash Warning Feature*.

RESIST is used to program the resistivity setpoint. Ensure all three numbers are keyed in.

TIME is used to program the cycle duration and is shown in the TIME display. The time is programmed in seconds (e.g., a two minute cycle is programmed as 0120). Ensure all four numbers are keyed in.

RPM is used to program the speed of the rotor and cassette. The minimum and maximum RPM values are determined by the software version.

SHIFT will illuminate when in shift mode and is used to access the following (orange) keys:

- DI H_2O
- NITROGEN
- HEATER
- STATIC
- RESIST
- WASH
- HOURS
- CYCLES

NOTE

SHIFT must be off to exit the programming mode.

3.2 Pushbutton Controls

Figure 3-6 is for all dryer configurations. Some features are optional and may not be installed on your dryer. Also, the individual feature may be in a different location then what is shown. Refer to the numbered paragraphs for functional descriptions of the various pushbuttons.

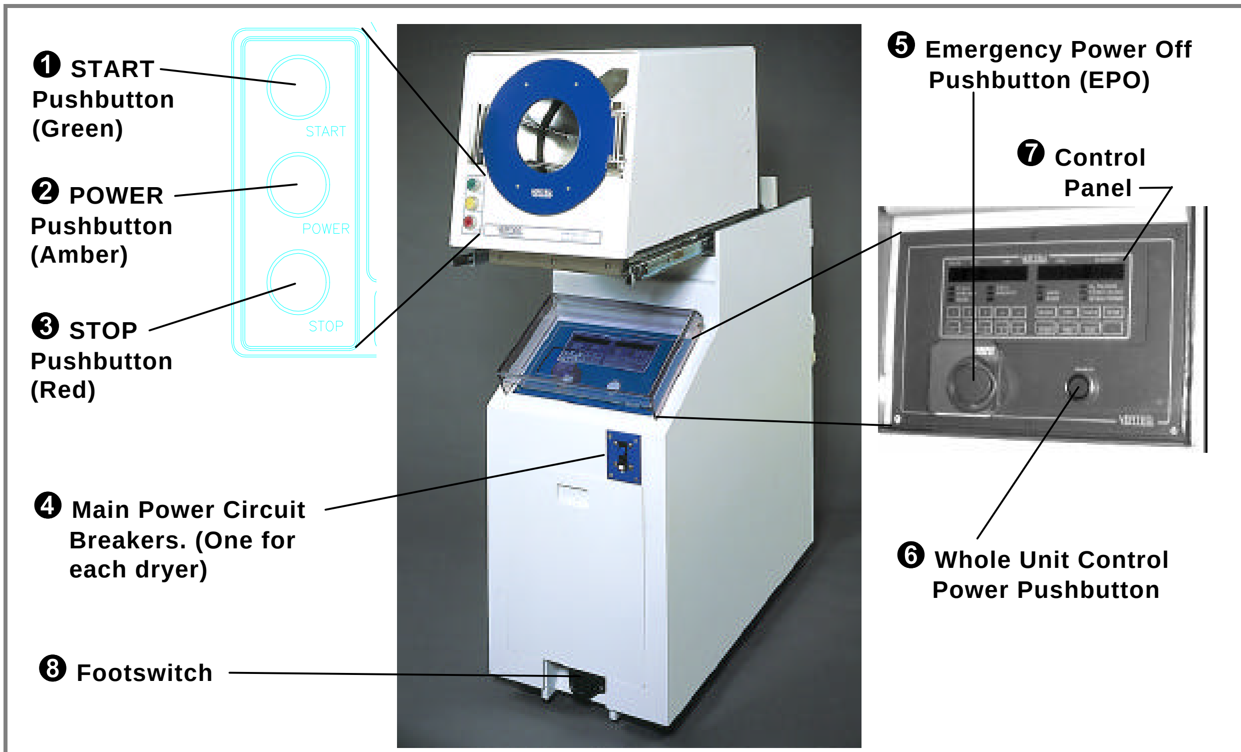


***Figure 3-6**. Typical Single dryer in a cabinet. Pushbutton availability and location will vary on other configurations.*

1. **START** is green and will start a cycle. When a cycle has been interrupted, pressing START will restart the run from the beginning of a recipe and not from the point of interruption.

2. **POWER** is amber and must be toggled ON to allow the dryer to function. The Control Panel lights will be illuminated when this button is toggled on. There is one pushbutton for each dryer within a stacked configuration.

3. **STOP** is red and is used for non-emergency process interruptions. If the dryer is in process, pressing this button will interrupt the process. Processing cannot be restarted for that lot from where it was interrupted. The wafers should be considered under-processed.

NOTE
Buttons 1, 2, and 3 are standard for all dryer configuration types.

4. **Main Power** circuit breakers are used for Lockout and tagging procedures. There is one for each dryer in cabinet and frame configurations. Component-Only dryers do not have this feature as a standard. Main power from the facility of each dryer is disconnected when the breaker is in the full down and off position.

5. **EMO** is the Emergency Power Off pushbutton. This is optional feature. Power is removed from all dryers downstream of each Main Power circuit breaker. When pushed, this button remains locked in the off position. To restart after an EMO, twist the button while pulling out.

6. **Control Power** pushbutton supplies power to all dryers downstream of the EMO pushbutton. This feature is not standard on the Component-Only dryer models.

7. **Control Panel** displays all programming, standby, fault and operating mode values. This is standard on all model types.

8. **Footswitch** is an optional feature which allows operators to toggle the door open or closed with their foot.

3.2.1 Optional Features

The following optional features and equipment may require programming or affect recipes. Refer to the Preface section of this manual and your sales order to determine if your dryer configuration has any of the following features.

3.2.1.1 Wash Warning Feature (Standard)

Your processing requirements may dictate the use of dry cycles only. In this circumstance, the bowl must be rinsed periodically with DI water to ensure a consistently clean operation. The dryer can be programmed to illuminate the WASH LED as a reminder that a rinse cycle is due. The WASH LED can be set to illuminate after a specific number of hours without a rinse cycle or after a specific number of consecutive dry cycles.

If values are set for both hours and cycles, the first to occur will illuminate the warning light. Once a DI water (rinse) cycle is run, the light goes off and the countdown starts over.

NOTE
For HOURS and CYCLES to function, both must be programmed with non-zero values. To set for Cycles only, set Hours to 0000. To set for Hours only, set Cycles to 0000.

To set Wash Warning time and cycle parameters:

1. Enter 1601.

2. Enter the Passcode. (See Section 3.2.1.4)

3. Press HOURS to clear the TIME display, then enter the desired time up to a maximum of 9999 hours.

4. Press CYCLES to clear the RPM display, then enter the desired number up to a maximum of 9999 cycles.

5. Press ENTER ENTER to save the settings and exit Wash Warning programming mode.

3.2.1.2 AutoWash Feature

An automatic AutoWash feature will run both a rinse and dry cycle. The rinse cycle duration can be programmed to run for up to 9999 seconds. The dry cycle is pre-programmed to run for 600 seconds (10 minutes). Both cycles are pre-programmed to run at 100 rpm.

To program for AutoWash: (Wash Warning also must be enabled)

1. Enter 1604.
2. Enter the Passcode. This step only applies if the Security Passcode Option is installed. Otherwise bypass this step. (See Section 3.2.1.4).
3. Press **HOURS** to clear the TIME display, then enter the desired time up to a maximum of 9999 seconds.
4. Press **ENTER ENTER** to save the settings and exit AutoWash programming mode.

If the dryer is in Idle mode with the door closed and then the WASH LED illuminates, the AutoWash recipe will automatically start. If the WASH LED illuminates during a recipe run, the system waits until the recipe stops and the door is opened and closed before commencing the AutoWash.

3.2.1.3 Boat Detect Feature

The boat detect feature ensures the dryer starts a cycle immediately after a cassette is placed in the rotor. The photoelectric sensor detects if a cassette has been loaded. An alarm sounds if a cycle is not started within two seconds after the cassette is detected in the rotor and the door is closed. See Figure 3-7.

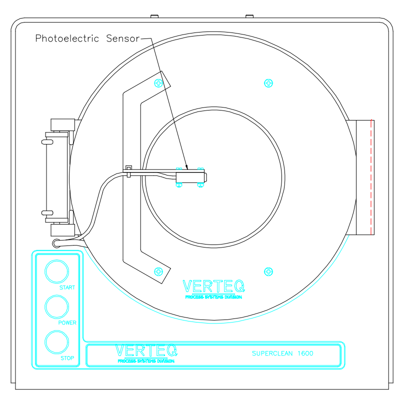


Figure 3-7. *Boat Detect option includes a Photoelectric sensor.*

3.2.1.4 Program Security Passcode Feature

The security passcode feature restricts access to the following functions:

- Programming a recipe
- Setting Wash Warning parameters
- Programming a AutoWash recipe
- Resetting the passcode

This feature requires the operator to know the security passcode to change the above functions. This feature also allows the user to change the passcode.

When the dryer (or this feature) is first installed, the default passcode is **4861**. This default passcode should be change to a different one. Once your new passcode has been entered, the factory default passcode is overwritten.

NOTE
If the current passcode is forgotten, the battery-backed up RAM chip will need to returned to GFT for reprogramming.

To change the Passcode:

1. Place the dryer in Idle mode.

2. On the Control Panel type **1605**, then type in the current passcode. If this is the initial change, you will type in **4861**.

3. If the current passcode typed in is not correct, the dryer will exit this program and return to Idle mode. Restart at step 1 above.

4. If the passcode is correct, the Control Panel will show **1111** in the RPM field. The dryer is now ready to accept a new passcode.

5. On the Control Panel, type in four new numbers representing the desired new passcode. When the last (fourth) digit is typed in, the Control Panel will display **2222**.

6. Type in the desired new passcode again which verifies this new passcode. If the second new passcode does not match the first new passcode, the dryer will exit this program and return to Idle mode. Restart at step 1 above.

7. If the second new passcode matches the first new passcode, the Control Panel will display **3333**. This signals success. Press any key to return to Idle mode.

3.2.1.5 CO_2 Injection Options

There are two versions (or applications) of CO_2 injection. The simplified version requires no programming or recipe writing. Refer to the Maintenance section for the CO_2 filter change out procedure. The second version is called the CO_2 Injection Module and it requires a one time adjustment of CO_2 pressure and flow. Refer to the Preface section of this manual and your sales order to determine which CO_2 injection application your dryer configuration has, if any.

3.2.1.5.1 CO2 Injection Module Introduction

This is an optional device that mixes DI water and CO_2. Mixing DI water and CO_2 helps prevent corrosion on wafers during rinse steps of a recipe. See Figure 3-8.

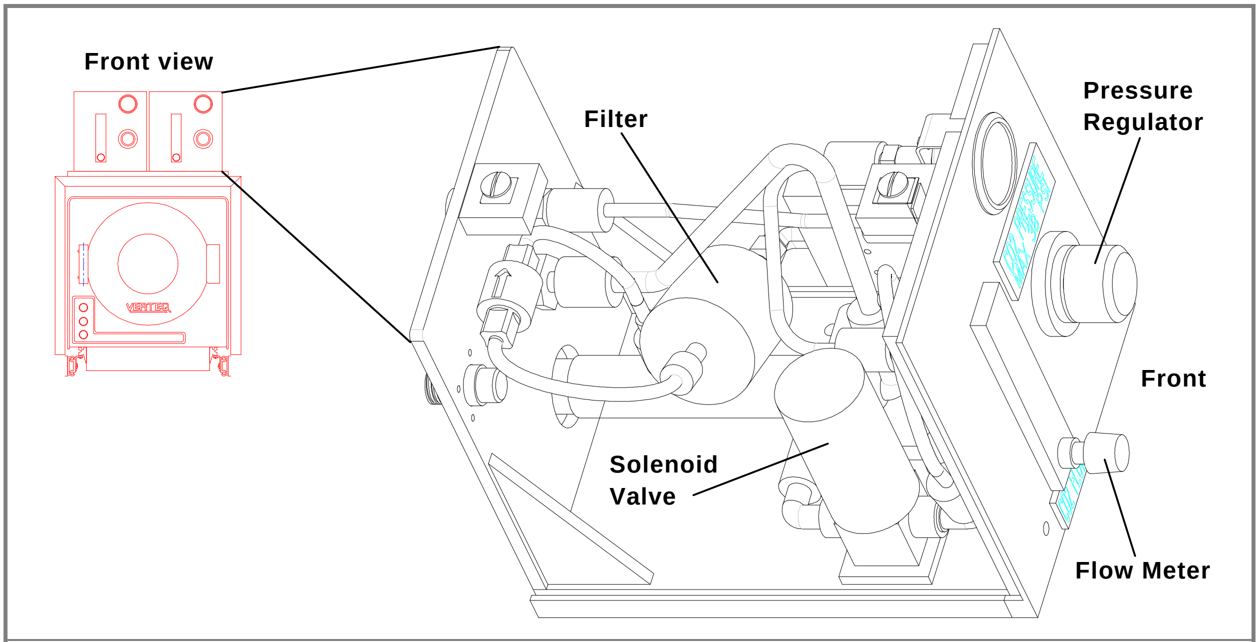


Figure 3-8. *The CO2 Injection Module usually will sit on top of a double stack configuration (left). A simplified layout is shown (right).*

3.2.1.5.2 Theory of Operation

The CO_2 Injection Module mixes CO_2 and DI water which is sprayed onto wafers in the process chamber during a rinse cycle. This solution helps remove fluorine and chlorine residues from the surface of the wafer. A wafer may have these residues after a conductor plasma etch process is completed.

3.2.1.5.3 Operations

DI water will not enter the process chamber unless CO_2 is detected. If CO_2 is not detected, the alarm light will flash and an audible alarm will sound. See Figure 3-9. The recipe is **not** interrupted.

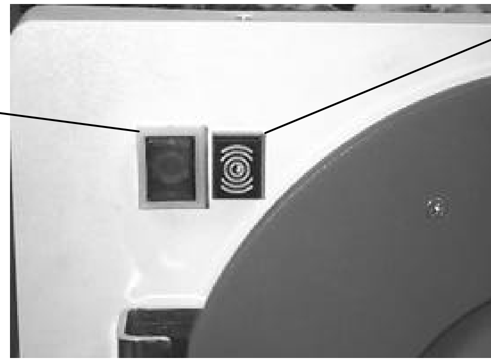


***Figure 3-9**. Silencing the audible alarm.*

Press the alarm light / button on the front of dryer to silence the audible alarm and stop the alarm light from flashing. The alarm light will remain on steady until the end of the recipe. The Control Panel will display a HELP 0004 message when the recipe ends. Clear the fault code by pressing the **CANCEL** key.

3.2.1.5.4 Adjusting Pressure and Flow

In Idle mode, adjust the pressure as required, to a maximum of 38 psi. See Figure 3-10. Once the dryer begins a rinse cycle, adjust the flowmeter as required, up to a maximum of 40 cfh.

***Figure 3-10**. Adjusting CO_2 Pressure and Flow.*

3.3 Recipe Programming

3.3.1 Recipe Options Descriptions

When programming a recipe, the following standard selectable items will function according to their descriptions when selected during the programming procedures. See Section 3.3.2 for programming a recipe.

DI H_2O. DI valves will open and DI water will flow into the bowl and rinse the wafers. DI H_2O is only selected in rinse cycles.

NITROGEN. The nitrogen valve will open and nitrogen will flood the bowl. NITROGEN is selected for every rinse and dry cycle.

HEATER. Allows the heaters to function when called upon within the recipe. This function can be used for both rinse and dry cycles. The nitrogen heater will not function unless NITROGEN has also been selected.

STATIC. Nitrogen will flow continually through the static eliminator during both rinse and dry cycles. Nitrogen is ionized when passing through the static eliminator before entering the bowl to neutralize any static charges. Operating the static eliminator is available for dry cycles only and will not function if selected with **DI H_2O**.

RESISTIVITY. Enables the resistivity monitor to measure the cleanliness of the outgoing DI water in megohms as it is drained during rinsing cycles. The rinse cycle will end when both the programmed time and resistivity setpoint have been reached. However, if the time expires prior to satisfying resistivity, the rinse cycle will run indefinitely until it is reached. If resistivity is not reached in the programmed time, the resistivity measurement can be bypassed by pressing **SHIFT 0** (zero) and the next step will begin.

NOTE
The Resistivity feature will function only when the DI H_2O feature is also selected.

3.3.1.1 Viewing an Existing Recipe

Recipes may be viewed before programming or processing wafers. To view a particular recipe, press the **RECIPE** key followed by the number key corresponding to the recipe number you want to view.

3.3.2 Programming a Recipe

GFT recommends the following settings for optimum rinse and dry performance:

- **Step 1 Rinse**: 50 RPM; with DI H_2O, N_2, and Resistivity enabled for 45 seconds.
- **Step 2 Rinse**: 300 RPM; with DI H_2O, N_2, Heaters and Resistivity enabled for 60 seconds.
- **Step 3 Dry**: 2000 RPM; with N_2, Heaters and Static enabled for 240 seconds.
- **Step 4 Dry**: 500 RPM; with N_2, Heaters and Static enabled for 240 seconds.

NOTE

The following common rules must be followed for optimum dryer performance:

- Nitrogen should be selected for every recipe step, rinse or dry.
- The static eliminator will not function if STATIC is selected with DI H_2O.
- The RESISTIVITY feature functions only when selected with DI H_2O.
- ***Before exiting programming mode, ensure that you are at the last step of the recipe or the following steps of that recipe will be erased. You do not need to be in the last recipe to safely exit.***
- SHIFT must be off to exit programming mode.

To program a new recipe or change an existing recipe:

1. Before entering programming mode, ensure that the dryer is in Idle mode (i.e., no ‘HELP’ codes are displayed).

2. To enter Programming mode, use the keypad to enter **1600**. The panel will perform a lamp test, then the parameters of step 0 of the current recipe will be displayed.

3. You may have to enter your Passcode if this feature is installed. Ignore this step if the Passcode feature is not installed. See Section 3.2.1.4 for detailed information.

4. Enter the recipe number by pressing **RECIPE** and then the recipe number desired (0-9). For example, to program recipe 0 press **RECIPE**, then **0**. Step 0 of recipe 0 will be displayed.

5. To program step 0 of recipe 0 enter **STEP**, then **0**.

6. To enter a resistivity setpoint, press **RESIST** (SHIFT must be off). The current setpoint flashes, indicating the panel is ready to accept a three digit number. The optimal resistivity range is from 00.0 to 18.2 megohms. For example, to enter a value of 10.0, type **100**.

> **NOTE**
>
> Technically, you can enter a megohm value up to 20.0. GFT does not recommend a value greater than 18.2.

7. To enter the time value, press **TIME** (SHIFT must be off). The panel will go blank to indicate it is ready to accept a four digit number (0000 to 9999 seconds). For example, to program a time of 120 seconds, type **0120**.

8. To enter the rotor (cassette) speed, press **RPM** (SHIFT must be off). The panel will go blank to indicate it is ready to accept a four digit number (minimum and maximum RPM speeds are determined by the dryer's software). For example, to program a speed of 600 RPM, enter **0600**.

9. To select the process options, press **SHIFT** to access the upper function of the dual-function keys.

10. Select the process options desired: DI H_2O, NITROGEN, HEATER, STATIC, or RESIST. Ensure each green LED is illuminated on the panel.

11. Press **SHIFT** to exit SHIFT mode.

12. To program the next step (or cycle) of the recipe, press **STEP** followed by the number. For example, to program step 1 of recipe 0 press **STEP** then **1**.

13. Follow the above procedure to program further steps and recipes.

> **NOTE**
>
> ***Before exiting programming mode, ensure that you are at the last step of the recipe or the following steps of that recipe will be erased. You do not need to be in the last recipe to safely exit.***

14. When every recipe and step has been programmed, press **ENTER**, **ENTER** to exit the programming mode. The recipes and steps entered will be saved and will remain in the RAM memory until manually changed.

3.3.2.1 Rinse-*and*-Dry Recipe Programming Example

The following is a step-by-step routine for programming a typical rinse-*and*-dry recipe. See Section 3.3.2.2 for a typical dry-*only* recipe.

1. Enter 1600 to enter the programming mode.

2. You may have to enter your Passcode if this feature is installed. Ignore this step if the Passcode feature is not installed. See Section 3.2.1.4 for detailed information.

Rinse Cycle:

3. Press RECIPE, then 0 to program recipe 0.

4. Press STEP, then 0 to program step 0 of recipe 0.

5. Press RESIST, then enter 100 for a resistivity setpoint of 10.0.

6. Press TIME, then enter 0120 for a rinse cycle time of 120 seconds.

7. Press RPM, then enter 0600 for a speed of 600 rpm.

8. Press SHIFT to access the keys in orange.

9. Press DI H2O to select DI water.

10. Press NITROGEN to select nitrogen.

11. Press HEATER to select heaters.

12. Press RESIST to select resistivity monitoring.

13. Press SHIFT.

Dry Cycle:

14. Press STEP, then 1 to program step 1 of recipe 0.

15. Press RESIST, then enter 000 as resistivity is not monitored during a dry cycle. (000 needs to be entered for the RAM address to function properly.)

16. Press TIME, then enter 0240 for a dry cycle time of 240 seconds.

17. Press RPM, then enter 1200 for a speed of 1200 rpm.

18. Press SHIFT to access the keys in orange.

19. Press NITROGEN to select nitrogen.

20. Press HEATER to select heaters.

21. Press STATIC to select the static eliminator.

22. Press SHIFT.

NOTE
Before exiting programming mode, ensure that you are at the last step of the recipe or the following steps of that recipe will be erased. You do not need to be in the last recipe to safely exit.

23. Press ENTER ENTER to save the settings and exit programming.

3.3.2.2 Dry-*only* Recipe Programming Example

The following is a step-by-step routine for programming a typical dry-*only* recipe.

1. Enter 1600 to enter the programming mode.

2. You may have to enter your Passcode if this feature is installed. Ignore this step if the Passcode feature is not installed. See Section 3.2.1.4 for detailed information.

3. Press RECIPE, then 0 to program recipe 0.

4. Press STEP, then 1 to program step 1 of recipe 0.

5. Press RESIST, then enter 000 as resistivity is not monitored during a dry cycle.
(000 needs to be entered for the RAM address to function.)

6. Press TIME, then enter 0240 for a dry cycle time of 240 seconds.

7. Press RPM, then enter 1200 for a speed of 1200 rpm.

8. Press SHIFT to access the keys in orange.

9. Press NITROGEN to select nitrogen.

10. Press HEATER to select heaters.

11. Press STATIC to select the static eliminator.

12. Press SHIFT.

NOTE

Before exiting programming mode, ensure that you are at the last step of the recipe or the following steps of that recipe will be erased. You do not need to be in the last recipe to safely exit.

13. Press ENTER ENTER to save the settings and exit programming.

This ends Recipe Programming instructions.

3.4 Operating Procedures

The following procedures are GFT standard operating procedures to rinse and dry wafers including safe start up procedures, processing wafers and safe shut down procedures. Your procedures may vary depending on process needs and configured options.

3.4.1 Safe Start Up Procedures (Component Only)

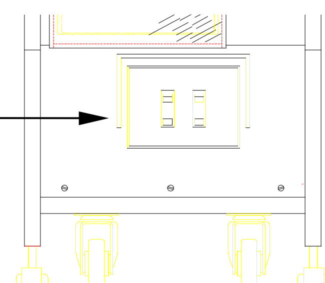
With the power cord, at the back of the controller, connected to the main power source:

1. Ensure that the dryer door is closed.

2. Press the Power pushbutton on the front of the dryer.

3.4.2 Safe Start Up Procedures (Frame or Cabinet)

1. Ensure that the Main Power circuit breaker, for each dryer, is in the full up and on position.

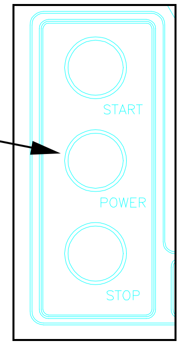


2. Press the control Power pushbutton. The rotor will index into the upright position.

Use the EMO to stop the dryer under emergency conditions.

3. If the rotor does not index or the Control Panel does not illuminate, press the Power ON/OFF pushbutton, then press the control Power pushbutton again.

The dryer is now powered on. If there appears to be no power to the dryer, call for maintenance help.



3.4.3 Wafer Processing Procedures

CAUTION

LACK OF CASSETTE DURING DRYER OPERATION WILL CAUSE PERMANENT ROTOR VIBRATION, IMBALANCE AND DAMAGE!

During any type of rotor movement, at speeds greater than 100 RPM, requires at least an empty cassette present in the rotor.

1. Ensure that the dryer is powered on, the rotor is indexed correctly, the Control Panel is illuminated.

2. Open the door, place the cassette of wafers correctly into the dryer. See Figure 3-11.

NOTE

Ensure that the cassette model number matches the stamped number on the dryer rotor.

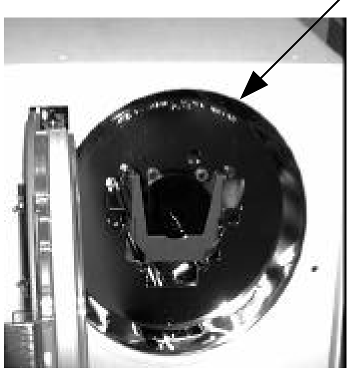
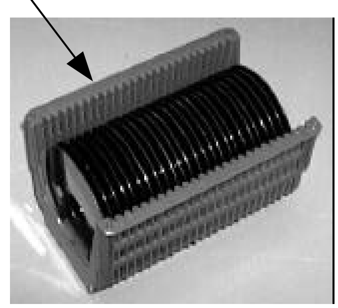
Rotor-stamped cassette model number	**Cassette-stamped model number**
	

***Figure 3-11**. Correct placement of cassette in rotor.*

3. Select a recipe from the stored recipes. To do this, press the RECIPE key on the Control Panel, then press the appropriate numeric key (representing the desired recipe) on the Control Panel. See Section 3.1.4 for key descriptions.

4. Press the START pushbutton on the dryer. The dryer performs a series of checks, inflates the door bladder to lock the door, and will spin, rinse, and dry according to the recipe selected.

5. When the recipe is done, the rotor will index to the upright position, open the door and remove the cassette.

6. To process other cassette of wafers, start at step 1 of this procedure.

This ends the standard wafer processing procedures.

3.4.4 Emergency Shutdown Procedure

CAUTION

POTENTIAL PRODUCT OR EQUIPMENT DAMAGE!

The following GFT standard emergency shut down procedure may not apply to your dryer. Contact your supervisor or system maintenance personnel for instructions on shutting down your dryer.

1. Press the red EMO “twist and lock” (Emergency Power Off) pushbutton to disconnect the main power supply to the dryer downstream of the main power circuit breaker.

2. To restore power to the dryer: twist the EMO pushbutton while pulling out, then press the POWER ON pushbutton.

3.4.4.1 Emergency Wafer Retrieval Procedure

As a safety feature to protect the operator from possible injury and the wafers from accidental contamination, the door cannot be opened once a process cycle has started. The door can only be opened when the final step of the recipe has been completed or the recipe has been interrupted and the rotor indexed.

In the event the dryer loses power during a cycle and there is a need to remove the wafers before power is restored, the door can be manually unsealed and opened by performing the following:

1. Turn off the facility CDA pressure to the dryer.

2. Press the relief valve located adjacent to the static eliminator power supply on the right side of the dryer.

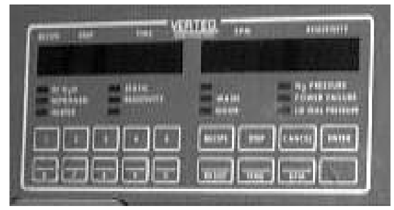
3. Manually rotate the cassette to the upright position to avoid spilling the wafers during cassette removal.

4. Remove the cassette.

3.4.5 Safe Shut Down Procedures

Refer to Figure 3-12 for the shut down procedure when the SRD will not be operated for an extended period of time or when power needs to be removed for maintenance purposes.

1. Ensure that the dryer is in Idle mode.



2. Remove the cassette from the dryer.

3. Move the main power circuit breaker switch to the full down and off position for each dryer.

For Component-only models, disconnect the controller from the main power source.

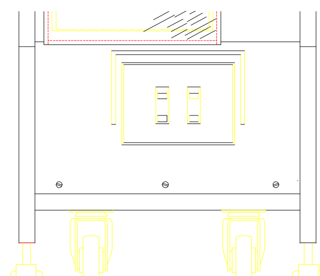


Figure 3-12*. Procedure for removing power from the dryer.*

3.5 Programmable Codes

These codes are entered onto the Control Panel as the first step in programming certain features. If the optional feature Passcodes are installed on your dryer, enter the passcode after you've entered the programmable code.

***Table 3-1**. Codes used to program the dryer.*

Code	Function / Description
1600	Program Recipe - Used to program rinse and dry parameters for recipes.
1601	Wash Warning - Used to set the timer and counter in order to illuminate the WASH indicator on the keypad, warning the operator to wash the bowl. The WASH indicator is extinguished when DI water is used in a recipe. Pressing <SHIFT>, then <TIME> and enter the number of hours (0-9999), the machine can remain idle before the WASH light is illuminated. Pressing <SHIFT>, then <RPM> and enter the number of cycles (0-9999) the machine can run without DI water before the WASH light is illuminated. **Note:** Setting both hours and cycles to “0” disables Wash Warning.
1602	Display Software Revision - Information is displayed on the keypad in the following format: 16 VVV RR, where 16 is the type of software, VVV is the version, and RR is the revision number. The display clears after a few seconds. Refer to the Preface section to interpret these values.
1603	Display status of input sensors - Using the keypad readouts, displays the status of the following input sensors: 0 = Sensor Off 1 = Sensor On Recipe = Not Used Step = Footswitch Time (1000) = Not used Time (100) = Door open Time (10) = Door closed Time (1) = Bladder pressure RPM (1000) = N_2 Pressure RPM (100) = Start pushbutton RPM (10) = Stop pushbutton (Normally closed) RPM (1) = Not used Press CANCEL to exit this feature
123	Cycle stop indication - When entered, (after the problem that caused the interruption is corrected), process information is displayed indicating when the machine last stopped. This options displays recipe number ,step, time remaining, RPM and recipe options (DI, N_2, static, heaters, and resistivity). Press CANCEL to exit this feature.

3.6 Fault (HELP) Codes

When an alarm occurs, the dryer will sound the Sonalert speaker and post a Fault code on the Control Panel. The word ‘**HELP**’ will be displayed under the **TIME** display and the fault or HELP code number will be displayed under the **RPM** display. Table 3-2 outlines the alarm type, the device affecting the alarm, and any applicable operator recovery procedures. Alarm types will only occur on your system if the affected option is installed or the dipswitch of a specific option is configured wrong.

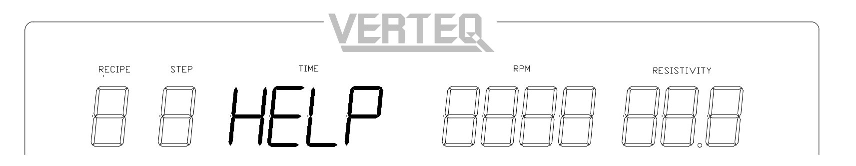


Figure 3-13. *HELP Display Mode.*

NOTE

More than one fault can occur at a time. If this occurs HELP codes will be added together. For instance, if Index Failure ***and*** RPM Too High alarms occur at the same time, the HELP code will be 0030. GFT recommends that these alarms be resolved in order of lowest digit first. This means that the operator should attempt to recover from the Index Failure alarm first. Refer to Table 3-2 for the HELP codes and recovery procedures.

Table 3-2. *Fault (HELP) Codes.*

HELP Code	Fault Description	Operator Response
0001	Power Failure	• Correct the problem • Press **START** to clear the Control Panel.
0002	Heater Failure	• Correct the problem • Press **CANCEL** to clear the Control Panel
0004	DI Flow	• Correct the problem • Press **CANCEL** to clear the Control Panel
0010	Index Failure	• Correct the problem • Press **START** to clear the Control Panel.
0020	RPM Too High	• Correct the problem • Press **CANCEL** to clear the Control Panel.
0100	N_2 Pressure Failure	• Correct the problem • Press **CANCEL** to clear the Control Panel.
1000	Door Open in Run (During Processing)	• Correct the problem • Press **CANCEL** to clear the Control Panel.
2000	Bladder Pressure Fail	• Correct the problem • Press **CANCEL** to clear the Control Panel.

HELP Code	Fault Description	Operator Response
4000	Door Open Error (While ***not*** in Process Mode) (1600-55 **A** only)	• Correct the problem • Press **CANCEL** to clear the Control Panel.
8000	Door Close Error (While ***not*** in Process Mode) (1600-55 **A** only)	• Correct the problem • Press **CANCEL** to clear the Control Panel.
8888	Loss of Speed Feedback While Running	• Correct the problem • Cycle power (Off then On).

3.6.1 Faults with No Codes

Problem	Possible Cause	Suggested Solution
Wafers wet and/or with water spots when removed	Faulty heaters	Call for Maintenance
Keypad flashing or recipe information disappearing	Bad RAM battery	Call for Maintenance
TIME display flashes between zeros and dashes, and the RESISTIVITY display flashes between the actual and programmed resistivity levels	Resistivity level has not been reached in the programmed time	Call for Maintenance
Door opens/closes slow	Low CDA supply pressure	See Section 4.6, *Door Position Adjustment Procedure*
Door water leak	Door seal insufficient	See Door Adjustment Procedure – Maintenance section
High particle count	Various	See Section 4.17, *Particle Troubleshooting Procedure*

3.7 Controller Card Dipswitch Settings

Dipswitches are mounted on the edge of the controller card, Figure 3-14, and are accessible through an opening in the controller enclosure. They are used to set several system parameters and enable installed optional features. The dipswitches are factory set and should not be changed without assistance from a GFT Field Service Representative.

Figure 3-14. *Dipswitch location.*

To reset dipswitch settings, disconnect power before altering dipswitch settings. Remove the black plug in the side of the controller enclosure to access the dipswitches (Figure 3-14). The switches are numbered 1 through 8 on the switch body. Tables 3-3 and 3-4 provide information on the correct settings for each software version and revision. Refer to the Preface section for instructions in finding your dryer's software version.

Table 3-3. *Dipswitch settings for the following software versions.*

For Software Types:		
Dryer	**Version No.**	**Revision No.**
1600	**– 005**	**– – 05**
1600	**– 007**	**– – 01**
1600	**– 008**	**– – 01**
1600	**– 009**	**– – 01**
1600	**– 010**	**– – 01**
1600	**– 011**	**– – 01**

Dipswitch No.	Position	Function
1	Up Down	50Hz 60Hz
2	Up Down	Auto Door Manual Door
3 *	Up Down	End of Process Alarm Enabled End of Process Alarm Disabled
4	Up Down	Clean Coil Sensor Enabled Clean Coil Sensor Disabled

5	Up Down	N_2 Blow until Door Close N_2 Blow for 30 seconds
6	Up Down	Warning Boat Sensor Enabled Warning Boat Sensor Disabled
7	Up Down	4800 Baud 9600 Baud
8	Up Down	Idle 10 minutes, then go to Recipe 0 Stay at last recipe ran
*** No.3**: If optional board installed, additional audible Sonalert notification to the operator.		

***Table 3-4**. Dipswitch settings for the following software versions.*

For Software Types:		
Dryer	**Version No.**	**Revision No.**
1600	**– 004**	**– – 01**
1600	**– 005**	**– – 03**

Dipswitch No.	**Position**	**Function**	
1	Up Down	50Hz 60Hz	
2	Up Down	Auto Door Manual Door	
3 *	Up Down	End of Process Alarm Enabled End of Process Alarm Disabled	
4	Up Down	Clean Coil Sensor Enabled Clean Coil Sensor Disabled	
5	Up Down	DI H_2O Flow Sensor Enabled DI Flow H_2O Sensor Disabled	
6	Up Down	SECS II Enabled SECS II Disabled	
7 & 8 **SECS II Communication**	**Switch 7**	**Switch 8**	**Baud Rate**
	Down	Down	9600
	Down	Up	4800
	Up	Down	2400
	Up	Up	1200
*** No.3**: If optional board installed, additional audible Sonalert notification to the operator.			

3.7.1 Controller Card LEDs

Fourteen LEDs each are mounted on the controller I/O and CPU boards for diagnostic purposes. See Table 3-5.

***Table 3-5**. I/O and CPU Board Controller LED Functions.*

I/O Board Controller LED Functions		CPU Board Controller LED Functions.	
CR# = LED	**Function**	**D#= LED**	**Function**
CR1		D4	Index
CR2		D5	Speed
CR3	Index	D6	
CR4	Power Fail OK	D7	Stop N/C
CR5	Nitrogen	D8	Start N/O
CR6	DI Water	D9	N_2 Pressure OK
CR7	Door Bladder	D10	Bladder OK
CR8	Motor Run	D11	Door Open
CR9	Heater	D12	Door Closed
CR10	Close Door	D13	Foot Switch N/O
CR11	Open Door	D14	
CR12	Alarm	D15	Heater
CR13		D16	
CR14	Static Eliminator	D17	

3.8 Nitrogen Regulators

The dryer has two independently plumbed nitrogen lines: one for bowl nitrogen and one for secondary nitrogen or CDA (clean dry air). The secondary line delivers nitrogen to the rotor positioner cylinder and the auto-door cylinder.

The system nitrogen line consists of two separate circuits: the bowl circuit and the bladder circuit. The bowl circuit delivers nitrogen to the bowl, labyrinth seal, and the static eliminator. Nitrogen enters the circuit through regulator RG1. Flow to the clean coil and throughout the rest of the circuit is monitored by pressure switch PSW1.

The bladder circuit controls the flow of nitrogen to the bladder that seals the door. Nitrogen enters this circuit through RG2. Flow to the bladder is monitored by pressure switch PSW2. Both of these lines are designed to operate at specific pressures and are set at the factory. Do not adjust the regulators except to return them to specification.

NOTE
CDA may be used in place of nitrogen for the rotor positioner cylinder and auto-door cylinder. The secondary line delivers CDA or nitrogen to the auto-door only on the 1600-55A.

WARNING	
⚠	**REGULATORS SET INCORRECTLY CAN CAUSE INJURY!** Regulator RG2 (door bladder) must be operated at a dynamic pressure of 21 psi. The bladder could be damaged if the regulator is set too high, and the bladder will not inflate if the regulator is set too low. Either circumstance could lead to operator injury.

3.9 Valve Bracket Assembly

The normal condition of the valve refers to the de-energized state when power is OFF.

Label	Description
V1	2-way manual relief valve, used to deflate the door bladder if the unit lost power during a cycle.
V2	A 2-way Teflon check valve, used to purge the DI manifold of excess water during a dry cycle.
V3	A 2-way Teflon flow control valve, used to control water flow during a rinse cycle.
V101	A 2-way NC solenoid valve, used to control the flow of system N_2 to the clean coil, labyrinth seal, and static eliminator.
V102	A 3-way NC solenoid valve, used to control system water flow. The standard valve will deliver 1.75 gpm under a dynamic pressure of 25 psi minimum @40 psi maximum. The optional high pressure valve will deliver 1.75 gpm under a dynamic pressure of 25 psi minimum @70 psi maximum.
V103	A 2-way NC solenoid valve, used to ensure that the bladder remains inflated during a power failure. With the power on the solenoid is open, allowing N_2 to flow to the bladder. If power is off the solenoid closes, keeping the existing pressure on the bladder.
V104	A 3-way NC solenoid valve, used to control the flow of N_2 to the door seal.
V105	A 3-way NC solenoid valve, used to control the flow from RG3 to the auto-positioner cylinder.

4 MAINTENANCE FREQUENCIES and PROCEDURES

This section includes the following maintenance procedures relating to all hardware types. Not all hardware types will be on any one dryer. Procedures in this section pertaining to hardware that is not on your dryer are to be ignored.

- PM Frequency (Section 4.1)
- Static Eliminator Verification (Section 4.2)
- Nitrogen Filter Replacement (Section 4.3)
- Bowl and Motor Change (Section 4.4)
- Resetting the Clean Coil Thermostat (Sec. 4.5)
- Door Position Adjustment (Section 4.6)
- Labyrinth Seal Cleaning (Section 4.7)
- Hub Installation (Section 4.8)
- Door Bladder Replacement (Section 4.9)
- Rotor Removal and Installation (Section 4.10)
- Retaining Bar Tube Replacement (Sec. 4.11)
- PFA Rod Maintenance (Section 4.12)
- Bowl Heater Verification (Section 4.13)
- Cleaning the Rinse/Dryer (Section 4.14)
- Resistivity Probe and Monitor Test (Sec. 4.15)
- CO_2 Injection Procedures (Section 4.16)
- Particle Troubleshooting (Section 4.17)

How to Reach GFT Customer Support

GFT is committed to assisting you in your goal of achieving self-sufficiency with all of your GFT batch process systems. Your system's Customer Documentation Package is provided to support you in assessing and resolving operation and maintenance questions. If the documentation does not address your specific questions involving Hardware, Software, or Process related questions, please contact your local GFT representative.

If you have no local GFT representative in your area, please contact the Batch Customer Support Team at:

Goldfinger Technologies, LLC
1241 E. Dyer Rd., Suite 100
Santa Ana, CA USA 92705-6533

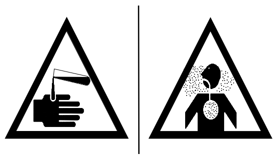
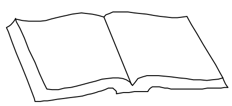
Phone: (714) 445-2000
Fax: (714) 445-2204

From 8:00 a.m. to 5:00 p.m., PST, Monday through Friday

Please be at the equipment, if possible, and be prepared to give a detailed description of the problem.

How To Return Service Parts for Repair

For efficient processing and quick turnaround, it is highly important when returning service parts for repair that the following three cautionary items be adhered to or timely disposition of the failed part may be delayed.

CAUTION	
	**Safety standards must be followed. The part must be safely and correctly decontaminated (if applicable)**
	**The part must be correctly packaged for damage-free shipment to the factory**
	**All appropriate documentation must accompany the returned part**

This procedure is a guideline to follow when resolving failed parts:

1. Determine if the part to be repaired is under warranty. If the part is under warranty call your local GFT Service Representative. If the part is not under warranty, call the GFT Sales department.

2. If GFT determines that the failed part does not need to be returned, go to step 4 of this procedure. If GFT determines that the failed part is to be returned for repair, you will be given a Return Authorization Number (RA#). A packet of information will also be electronically mail to you. This packet of information includes:

- Instructions to safely decontaminate the part
- Instructions to correctly package the part for shipment
- Required documentation to be filled out by you, including:
  - The part's **Chemical History** – a form declaring the type of process chemicals the part has been exposed to.
  - **Discrepancy and Corrective Action Report** (D–CAR) – instructions and form that captures information about the part and how it failed and what you and GFT want corrected.

3. Ensure the part is decontaminated and packaged correctly. Include the Chemical History form and a copy of the D–CAR with the part. Also electronically forward a copy of the D–CAR to the Batch Customer Support Team for quick disposition of a replacement part.

4. **Parts Not Returned for Repair**. Information about the failed part needs to be collected even though the part is not to be returned. A Discrepancy and Corrective Action Report (D–CAR) needs to be filled out and returned (by e-mail) to the Batch Customer Support Team for quick disposition of a replacement part.

4.1 Preventive Maintenance Frequency

4.1.1 Daily Maintenance

1. Clean the door seal with DI water and a lint-free cloth once per shift. Ensure cloth particles do not transfer onto the seal, do not use excessive pressure when wiping.

2. Inspect the door bladder seal for nicks, wear, and proper positioning. Replace the door bladder if necessary. See Section 4.9, *Door Bladder Replacement Procedure*.

CAUTION

POTENTIAL PRODUCT OR EQUIPMENT DAMAGE!

Do not use isopropyl alcohol (IPA) inside the bowl because it can damage the door bladder.

3. Clean the front shroud, door and hinge with IPA and a lint-free cloth once per shift. See Section 4.14, Cleaning the dryer Procedure.

4. Check that the correct carrier is being used in the dryer.

5. Verify the resistivity level reaches the recommended level.

6. Check for excessive vibration during the first cycle of a shift.

7. At the end of a dry cycle, verify that the wafers are completely dry.

8. Verify that the door is properly aligned. Verify that the bladder does not touch the bowl and that the door is centered with respect to the bowl. See Section 4.16, Door Position Adjustment Procedure.

9. Verify that the correct recipe is programmed.

4.1.2 Weekly Maintenance

1. Check the Teflon sheath on the rotor's retaining bar. If the sheath has severe ridges or indentations, rotate the sheath 1/4 turn so an unmarred portion of the sheath faces the wafers. The sheath can be rotated three times before it must be replaced. Perform this service after running a dry cycle so the sheath will be warm and easily manipulated. See Section 4.11, Retaining Bar Tube Replacement Procedure.

NOTE

The rotor will have Teflon sheaths or PFA rods depending upon the rotor type. Refer to the table in the Retaining Bar Tube Replacement Procedure.

2. Check that all rotor mounting screws are secure.

3. Run a complete cycle to check the operation of the dryer.

4. Check the dynamic pressures of all the facilities. Read the pressures on the gauges at the back of the dryer while running a dry cycle.

5. Check all plumbing hardware for leaks.

6. Verify that the N_2 heater is heating.

4.1.3 Monthly Maintenance

1. Rotate the PFA rods. If necessary, perform the 1600-55 *PFA Rod Maintenance Procedure*, Section 4.12.

> **NOTE**
>
> The rotor will have Teflon sheaths or PFA rods depending upon the rotor type. Refer to the table in Section 4.11, *Retaining Bar Tube Replacement Procedure*.

2. Check all electrical wiring and connectors for wear and proper connections.

3. Inspect the process bowl and rotor for stains. If necessary, clean with a solution of DI water, 30% H_2O_2, and a small amount of IPA.

4. Check the index-sprocket set screws and location of the optical sensor board. The sprocket should be in the middle of the sensor. Loosen the sensor mounting screws and adjust the sensor if necessary.

5. Check the drain box and resistivity probe for contamination.

6. Read the secondary voltage of the N_2 transformer. Connect the leads of a digital multimeter (DMM) to the two large terminal connectors on the left side of the rinser/dryer. Run a dry cycle. The DMM reading should be 3.2 VAC to 5 VAC.

7. Check the DI valve. During a dry cycle, look for signs of DI water in the line that supplies the DI manifold. If there is flow during the dry cycle, turn the power off. Power on the unit. Watch the DI nozzles while the N2 purge is on. If water comes from the nozzles, the DI valve may need replacement.

8. Check the clean coil thermostat interlock. During a rinse or dry cycle remove the spade connector on the white wire on the KA relay. This should disable the dryer and prohibit further operation. There should be an N_2 pressure failure error message on the keypad.

> **CAUTION**
>
> **POTENTIAL PRODUCT OR EQUIPMENT DAMAGE!**
>
> Do not use isopropyl alcohol (IPA) inside the bowl because it can damage the door bladder.

4.1.4 Semi-Annual Maintenance:

1. Remove and clean the labyrinth seal plate. See Section 4.7, Labyrinth Seal Cleaning Procedure.

2. Replace the rotor mounting screws.

3. Check the static eliminator with a hand-held digital multimeter. See Section 4.2, Static Eliminator Verification Procedure.

4. Tighten the hub screws, shock mounts, and bowl mounts.

5. Verify the dryer rinses within 2 megohms of the resistivity of the incoming DI water. If it does not, see Section 4.15, Resistivity Probe and Monitor Test Procedure.

6. Check the bowl heaters. Verify they are securely fastened to the bowl. Use a digital temperature meter to measure the temperature of both patch heaters. See Section 4.13, Bowl Heater Verification Procedure.

7. Check the voltage on the system terminal block (113 - 120 volts). Check the voltage drop when the system is turned on. The voltage should never drop below 109 volts.

8. Check all assemblies and subassemblies for general wear.

9. Ensure the connections on the clean coil transformer and clean coil assembly are tight.

10. Remove and replace the N_2 and DI water filters. Wipe the inside of the filter housing with IPA before installing the new filter. See Section 4.3, Nitrogen Filter Replacement Procedure.

11. Check the hub spacing with the supplied spacing tool. If your rotors are 1" to 5", the spacing should be .050 inch. If you have a 6" rotor the spacing should be .080 inch. (Refer to the Hub Installation Procedure)

12. Check the door bladder. Remove and replace it if signs of corrosion or stretching are apparent. Clean the groove in the door with DI water and a lint-free wipe before installing the new bladder. See Section 4.9, Door Bladder Replacement Procedure.

13. Check all the HELP code interlocks.

14. Verify that the door bladder relief valve is functioning properly. While the unit is in the middle of a cycle, press the POWER button and allow the rotor to come to a halt. Pull on the door handle. The door should not open. Press the POWER button to turn the unit back on and press the STOP button to clear the power failure message.

15. Clean the motor commutator and inspect the brushes for excessive wear.

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4.2 Static Eliminator Verification Procedure

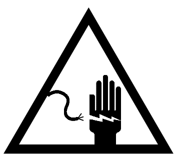
The following procedure guides a technician to verify a good operating static eliminator.

4.2.1 Tools Required

- Digital Multimeter
- Phillips screwdriver

4.2.2 Procedure

WARNING



DANGEROUS VOLTAGE IS PRESENT!

Hazardous voltages exist. Use caution around exposed circuits.

Check area for exposed contacts prior to reaching into the dryer to take measurements.

To ensure operator, equipment, and product safety, follow the instructions and use care when operating this equipment.

1. Remove the cover of the dryer.
2. Select a recipe that includes a dry cycle step with the static eliminator.
3. During the dry cycle step, place the red positive lead of the digital multimeter just below the static eliminator cable. The positive lead should touch the transducer plate.
4. Connect the black negative lead to the frame or a ground.
5. When the static eliminator is on, the digital multimeter will indicate a voltage of 5 to 15 VAC. When the static eliminator is off, there will not be any measurable voltage.

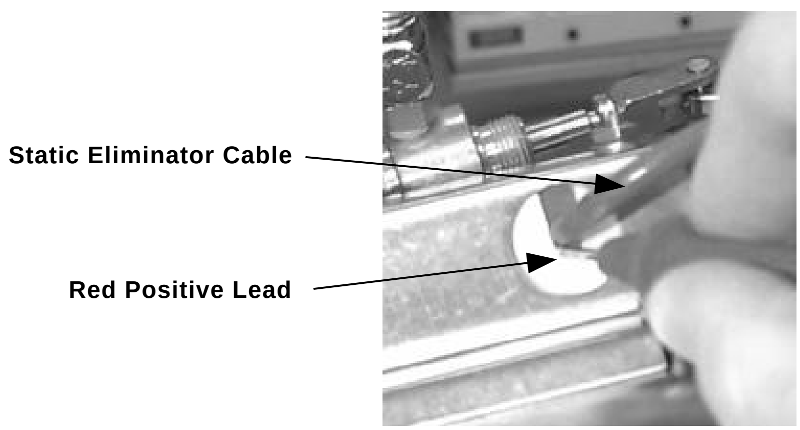


***Figure 4-1**. Multimeter probe position.*

6. If the static eliminator does not read correctly, change out the static eliminator power supply (GFT P/N 4114388).
7. Reinstall the cover of the dryer.

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4.3 Nitrogen Filter Replacement Procedure

CAUTION	
⚠	**POTENTIAL PRODUCT OR EQUIPMENT DAMAGE!** Always wear clean gloves when handling the nitrogen filter to avoid contamination.

4.3.1 Tools Required

- Phillips screwdriver
- Clean gloves

4.3.2 Procedure

1. Follow Section 3.4.5, *Safe Shut Down Procedures*.

2. Turn off the CDA and N_2 supply to the dryer.

3. Remove the cover from the dryer.

4. Unscrew the filter cover clamp. See Figure 4-2.

5. Remove the filter cover.

6. Remove and discard the filter.

7. Install the new filter onto the male fitting.

8. Ensure that the O-ring is properly seated.

9. Reinstall the filter cover and filter cover clamp.

10. Finger tighten the clamp.

11. Reinstall the cover onto the dryer.

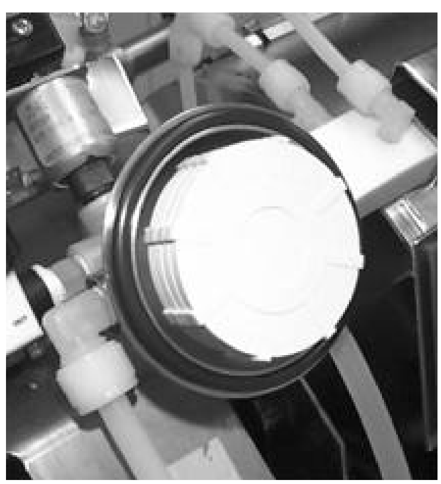

***Figure 4-2**. Nitrogen Filter location.*

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4.4 Bowl and Motor Change Procedure

4.4.1 Tools Required

- #2 Phillips Screwdriver
- 3/16" Flat Blade Screwdriver
- 10-Inch Adjustable Wrench
- Pliers
- Hex Wrench Set
- 3/8" Ratchet Set With Sockets
- 7/16" Combination Wrench (Long “T” Handle)
- 5/16" Combination Wrench (Long “T” Handle)
- RTB 10 (14302003) 5/16" T-Handle Ratchet (SNAP-ON)
- RTB 14 (14302003)7/16" T-Handle Ratchet (SNAP-ON)
- Rotor Tool (GFT P/N 4118693) See Figure 4-3
- Dial Indicator (GFT P/N 4120610) See Figure 4-3
- Hub Stand-Off (GFT P/N 1074975.1) See Figure 4-3
- Motor / Bowl Alignment Tool (GFT P/N 1076677.1) See Figure 4-3
- Hub Spacing Tool (GFT P/N 1066322.1)

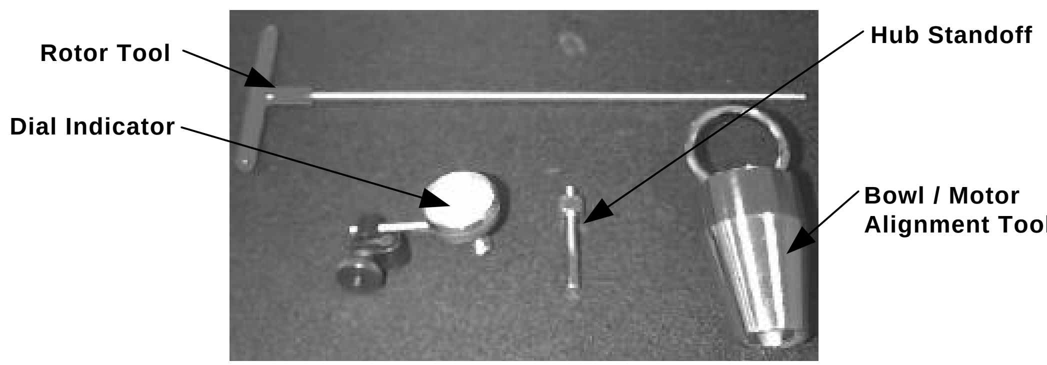

***Figure 4-3**. Non-standard tools.*

4.4.2 Recommended Spare Parts List

PART DESCRIPTION	GFT P/N	QUANTITY
SRD 1600 Series Bowl With Heater Pads	1074599.1	1
Static Eliminator Assembly	1069254.501	1
Gasket, Static Eliminator Assembly	1059696.1	1
N_2 Manifold	1065682.1	1
Gasket, N_2 Manifold	1065681.1	1
DI Manifold	1062537.1	1
Gasket, DI Manifold	1062531.1	1
Bracket, DI Manifold	1062552.1	1
DI Nozzles (Fan)	4117876	6
DI Nozzles (Cone)	4116484	6
N_2 Labyrinth Seal Plate	1062546.1	1
Front Cover w/Gasket (LH)	1071667.3	1
Front Cover w/Gasket (RH)	1071667.1	1
Front Cover w/Gasket (Universal)	1075470.1	1
Door (LH / RH)	1067661.3	1
Hub	1062563.1	1
Rotor (SRD Dependent)	SRD Dependent	1
N_2 Filter (Millipore, Wafergaurd)	4118199	1
Door Seal (Bladder)	1064788.1	1
Front Motor (Shock) Mount(s)	4116634	2
Rear Motor (Shock) Mount(s)	4116635	6

The above recommended list of parts will be inspected at each bowl/motor change and a decision will be made by maintenance personnel as to the part's replacement or re-use, considering silicon contamination. The final decision as to the disposition of each part will be made by the customer.

4.4.3 Procedure

1. Follow Section 3.4.5, *Safe Shut Down Procedures*.

2. Turn off all facilities: DI, nitrogen, and CDA to the system.

3. Remove the cover from the dryer.

4. Disconnect all facility lines from the rear panel.

5. Remove all Teflon lines between the rear panel, valve bracket assembly, and the index cylinder.

6. Remove electrical plug (J19) from ground neutral block at the left-rear of system.

7. Disconnect white (neutral) and green (ground) wires from the ground neutral block.

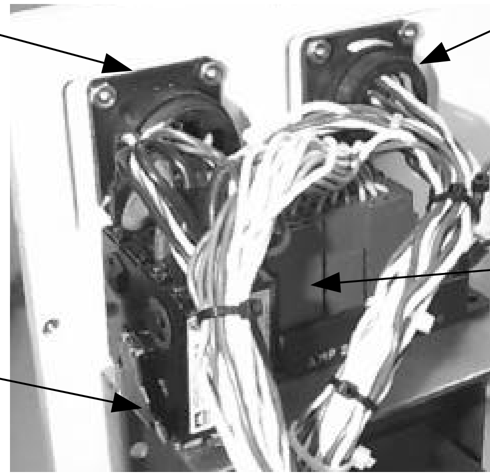

Figure 4-4*. Ground Neutral Block Components.*

8. Record the position of each wire.

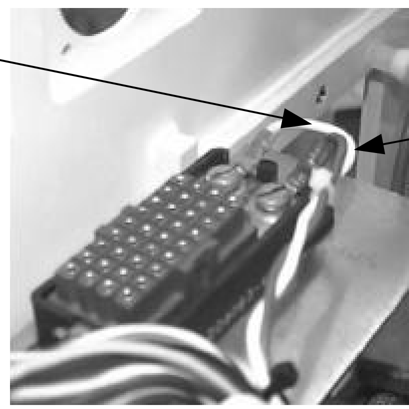

Figure 4-5*. Ground and Neutral Wire Positions.*

9. Remove the "KA" relay from the mounting bracket by carefully prying open the left and right clamps.

NOTE

Do not disconnect wires from the "KA" relay.

10. Disconnect controller cables from rear panel of the dryer.

11. Disconnect all facilities lines from the rear panel.

12. Remove the screws (4) from the (P105) and (P106) connectors.

13. Remove the lower (3) and upper Phillips screws (2) securing the rear panel to the base mounting assembly.

14. Remove the rear panel and set it off to the side.

15. Disconnect the door bladder tubing from the bladder relief valve.

16. Disconnect tubing from the DI water spray manifold located on the bottom right of the bowl.

17. Disconnect the N_2 tubing from the labyrinth seal plate.

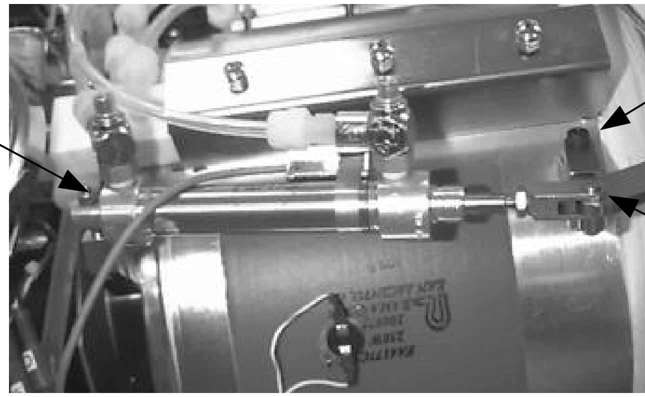

***Figure 4-6**. Door Cylinder Assembly (1600-55A only).*

18. Remove the pivot pin connecting the door hinge to the air cylinder (1600-55A only).

19. Remove the 10-24 socket head screw that connects the door cylinder assembly to the bowl (1600-55A only).

20. Remove the nut on the rear pivot and remove the door air cylinder assembly from the bowl (1600-55A only).

21. Disconnect bullet connectors labeled “C” and “P16” (1600-55A only).

22. Disconnect the clean coil N_2 tubes (2).

23. Disconnect bowl heater pad thermal switches (J12) and snap switch (J18).

24. Disconnect the electrical plug (J5).

25. Remove and label switches (power, start, and stop).

26. Disconnect the wires from the door microswitch.

27. Disconnect wires (6 awg) from the nitrogen clean coil assembly.

28. Remove the clean coil cover by removing the thumb screws (2) located at the top and bottom of the clean coil assembly and remove the clean coil assembly and bracket.

29. Remove the alarm board (if applicable).

30. Remove the number 12, 13, and 14 wires from the alarm board (if applicable).

31. Remove the 7/16" hex head bolts (3) that secure the valve bracket assembly to the motor housing.

32. Relocate the valve bracket assembly to the right side of the dryer without removing wires.

NOTE

The valve bracket assembly is moved to the right side of the unit temporarily so the pressure meter does not interfere with removal of the nitrogen manifold assembly.

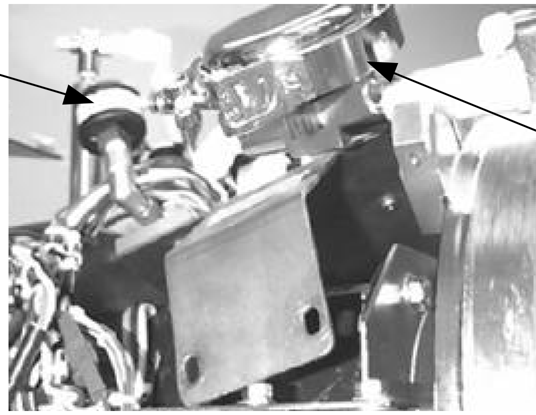

***Figure 4-7**. Valve Bracket Assembly Prior to Nitrogen Manifold Removal.*

33. Disconnect the N_2 tubes (3) from the N_2 manifold.

34. Loosen retaining hardware and remove N_2 manifold and filter.

35. Move the valve bracket assembly to the left side without removing any wires.

36. Use a large tie-wrap to support the weight of the valve bracket assembly to alleviate any stress on the wires.

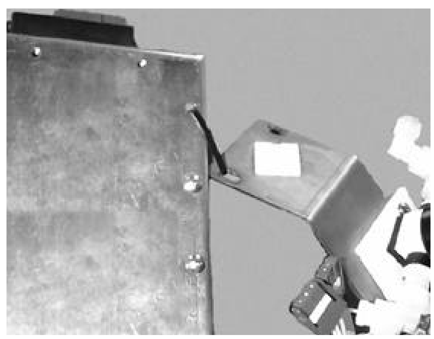

***Figure 4-8**. Valve Bracket Assembly.*

37. Remove the rotor from the process bowl. See Section 4.10, *Rotor Removal and Installation Procedure*.

38. Remove the hub from the motor axle by loosening the 1/8” hex screws (2).

39. Remove the labyrinth seal plate by removing the screws (8).

40. Disconnect the optical sensor board cable (J20).

41. Disconnect the motor power supply plug (J15).

42. Remove the 7/16" hex head nuts (6) and 7/16" hex head bolts (2) (top side) securing the motor bracket to the motor housing.

43. Disconnect the static eliminator high voltage cable (red) from the static eliminator power supply.

44. Carefully lift out the motor bracket assembly.

45. If installed, record the number and location of spacers used between the motor bracket assembly and the shock mounts. This will aid in the alignment of the new bowl and motor.

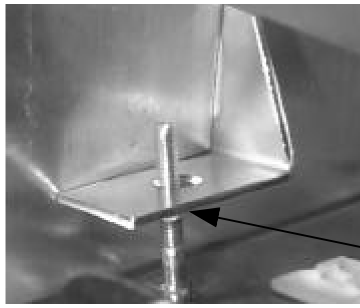

***Figure 4-9**. Bowl Assembly on Base Mount Bolts.*

46. Remove the upper bowl mounting nuts (2) (1 on each side of bowl) located behind the front panel.

47. Do not move the position of the lower jamb nuts on the mounting brackets. Maintaining original positions of the jamb nuts ensures accurate re-alignment of the bowl.

48. Cut the wires off the bowl heater pads at the thermostat switches, keeping the leads as long as possible, and install bullet connectors if not already done.

49. Remove the 5/16" hex head bolts (5) securing the rear bowl to the motor housing.

50. Remove the 1 3/4" vinyl tubing from the drain box.

51. Remove the bowl assembly from the base mount assembly.

52. Remove and replace all eight shock mounts, regardless of their condition. Six of the shock mounts have threads on both sides and two of them have threads on only one side.

53. Remove all manifolds, tubing and hardware from the bowl assembly.

54. Remove the hinge and door panel assembly from the bowl assembly.

55. Save all tubing, plumbing fittings, and hardware that are re-usable.

56. Inspect the DI, N_2, and static eliminator manifolds for contamination or damage.

57. Replace any components that show signs of wear or silicon impregnation.

4.4.4 Bowl / Motor Installation

1. Install all manifolds on new bowl assembly prior to installation. When installing new manifolds, the gaskets must be aligned and tightened down properly to prevent the gaskets from protruding into the process chamber.

2. Install the 1 3/4" vinyl tubing onto the bowl.

3. Set the bowl into place on the base assembly and install 5/16" hex head bolts (5) into the rear of motor housing and bowl.

4. Connect the drain tubing to drain box.

5. Install the top nuts on the base mount bolts but do not tighten.

6. Tighten the 5/16" hex head bolts (5) until the bowl and motor mount are flush.

7. Install the motor assembly onto the motor mount.

8. Center the motor assembly with respect to the bowl.

9. Install the rear 7/16" nuts (2) and the front 7/16” bolts (2).

NOTE
The remaining nuts (4) are not installed at this time so that the shock mount threaded posts are visible with respect to the motor bracket.

10. Verify that the motor bracket assembly does not touch the threaded posts of the motor shock mounts.

11. Ensure that the labyrinth seal plate O-rings (2) are in place.

12. Carefully install the labyrinth seal plate into the rotor.

NOTE
Verify that the groove in the seal plate is pointed down.

13. Center the labyrinth seal plate with respect to the bowl and tighten the screws.

4.4.5 Initial Bowl and Motor Alignment

1. Install the motor/bowl alignment tool, pushing it in as far as possible to center the bowl and labyrinth seal plate to the motor shaft.

2. With the motor/bowl alignment tool in place, inspect the front and rear shock mounts to determine if there is space between the motor bracket and the shock mounts.

3. If necessary, add shims to the front or rear shock mounts to achieve proper vertical alignment of the bowl and motor. Install the shims between the motor bracket and the top of the shock mount.

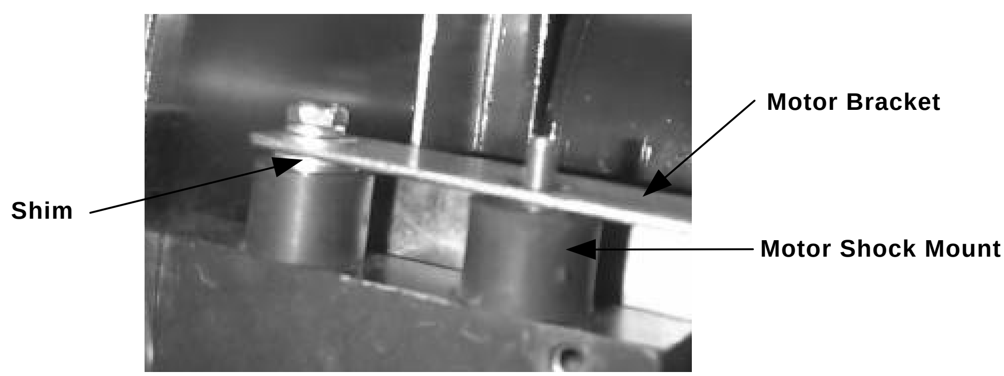

***Figure 4-10**. Shims between Motor Bracket and Shock Mounts.*

4. With the motor/bowl alignment tool in place, center the motor bracket assembly on the motor mount with respect to the bowl to achieve a gross horizontal alignment.

5. Verify the motor bracket assembly is not touching the threaded posts of the shock mounts.

NOTE
The motor bracket assembly does not need to be centered with respect to the threaded posts of the shock mounts. The motor bracket assembly may be moved along the motor axis to keep the bracket from touching the shock mount threads.

6. Tighten the rear 7/16” nuts (2) when the shims are in place, the motor bracket assembly is centered along the horizontal axis, and the shock mount threads are not in contact with the motor bracket.

7. Remove the bowl/motor alignment tool.

8. Install the hub key into the slot on the motor axle.

9. Install the hub so that it is close to but not touching the labyrinth seal plate.

10. Tighten the set screw that is located over the hub key to hold the hub in place.

NOTE
Verify that the key is flush with the hub.

11. Install the hub stand-off onto any of the hub mounting holes.

12. Install the dial indicator onto the hub stand-off.

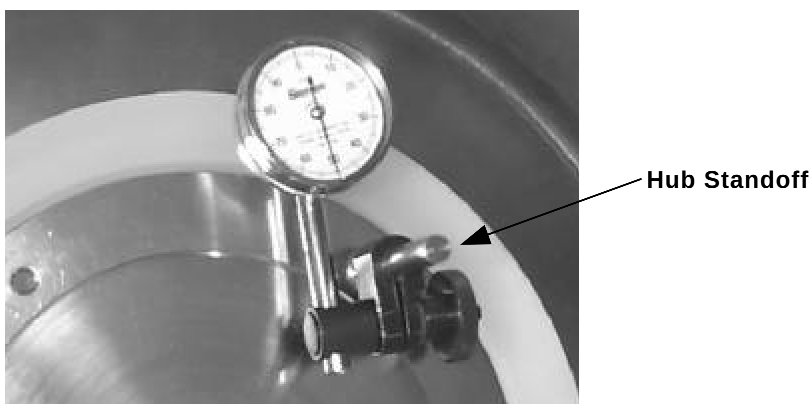

***Figure 4-11**. Dial Indicator on Hub.*

13. Tighten the dial indicator to the hub standoff when the dial indicator is in the middle of it’s range.

4.4.6 Horizontal Bowl/Motor Alignment

1. Set dial indicator to "0" at the left side of the hub / seal plate.

2. Check the clearance at the right side of the hub / seal plate.

3. The variance between left and right must be no more than +/- 0.010".

4. If right side is more positive than +0.010", push the right side of the motor toward the front of the dryer.

5. If right side is more negative than -0.010", push the right side of the motor toward the rear of the dryer.

> **NOTE**
>
> It may be necessary to perform the horizontal alignment section of the procedure several times to ensure proper alignment. Move the motor assembly a little at a time in one direction so that the opposite side does not get out of alignment.

6. Install the remaining 7/16" nuts (4) onto the motor mount.

7. Torque motor shock mounts to 14 inch-lbs., see Figure 4-12. Verify that the horizontal alignment is maintained after the nuts on the motor shock mounts are torqued.

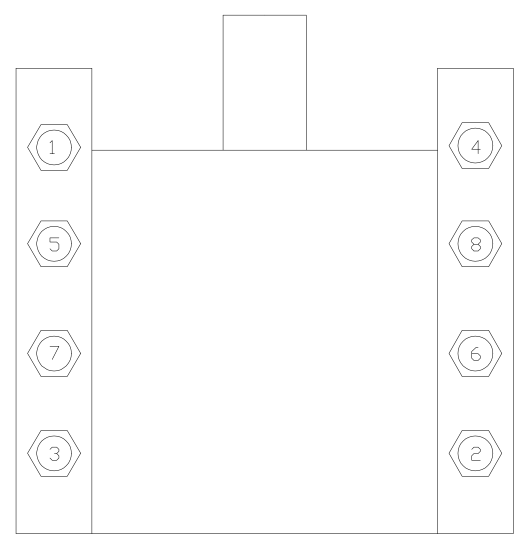

***Figure 4-12**. Bolt Torque Pattern for Motor Bracket.*

4.4.7 Vertical Bowl/Motor Alignment

1. Set the dial indicator to "0" at the top of the of the hub/seal plate.

2. Check the clearance at the bottom of the hub / seal plate.

3. Variance must be no more than +/- 0.010".

4. If bottom is more positive than +0.010" but less positive than +0.020", screw the front upper nuts down until the dial indicator shows a variance less than + 0.010".

5. If bottom is more than +0.020", add a shim to the rear threaded posts on the motor bracket. The alignment procedure will need to be performed again if shims are added to the rear threaded post on the motor bracket at this point in the procedure.

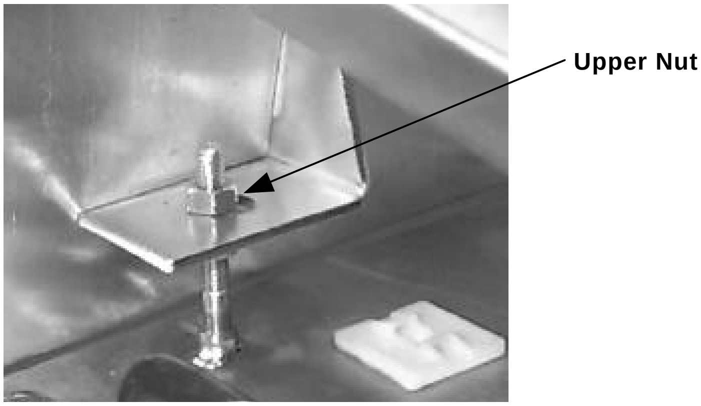

Figure 4-13. *Base Mount Nuts in Tightened Position.*

6. If bottom is more negative than -0.010", screw the front lower nuts up until the dial indicator shows a variance less than -0.010”.

7. Once the vertical axis alignment of the bowl and motor is achieved, cinch the lower or upper nuts on the front bowl mount bracket to hold the bowl in place.

8. Remove the dial indicator from the hub standoff.

9. Remove the hub standoff from the hub.

10. Loosen the set screw and remove the hub.

11. Loosen the eight screws in the seal plate.

12. Install the hub so that it is close to the labyrinth seal plate but does not touch it.

13. Center the seal plate with respect to the hub.

NOTE

If the seal plate does not have enough play in it to achieve alignment with the hub, loosen the motor assembly and shift it to the left or right as required. Perform the horizontal alignment portion of the procedure again.

14. Remove the hub and key from motor axle.

15. Torque the seal plate screws to 24 inch-lbs.

4.4.8 Re-assembly

1. Install the hub onto the motor axle. See Section 4.8, *Hub Installation Procedure*.

2. Install the door assembly to the front panel of the dryer.

3. Install the Allen head screws (2) into the door hinge.

4. Center the door assembly so that the door bladder does not rub against the bowl.

NOTE
It may be necessary to align the door with the bowl. See Section 4.6, *Door Position Adjustment Procedure*.

5. Remove the nut and ferrules from the Tygon tubing and insert the tubing into the hole in the front panel.

6. Reassemble the nut and ferrules.

7. Connect the static eliminator high voltage cable (red) to the static eliminator power supply.

NOTE
The static eliminator cable may be installed in either receptacle in the power supply.

8. Cut the tie wrap holding the valve bracket assembly and move the assembly to the right side of the unit.

9. Install the N_2 filter and manifold assembly onto the bowl.

10. Tighten the three screws to hold the N_2 filter and manifold assembly in place.

11. Move the valve bracket assembly into place and install the three 7/16” hex head bolts.

12. Install the alarm board. (if applicable)

13. Attach wires #12, #13, #14 to the alarm board.

14. Connect the bowl heater pad thermal switch (J12).

15. Attach the clean coil bracket to the bowl using the nuts and spacers.

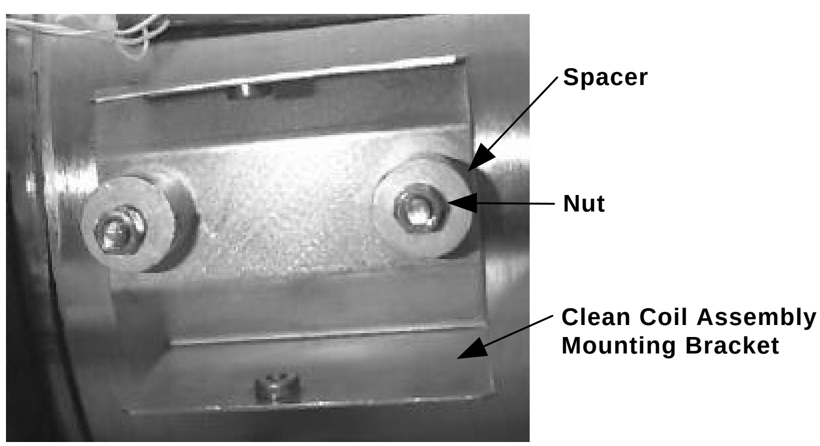

***Figure 4-14**. Clean Coil Assembly Mounting Bracket.*

16. Install the clean coil assembly to the bowl.
17. Fasten the cover to the clean coil assembly with thumb screws (2).
18. Connect the transformer cables (2) (6 awg) to the clean coil assembly.
19. Connect the motor power supply plug (J15).
20. Connect the optical speed sensor cable to the sensor board.
21. Connect the wires to the door microswitch.
22. Assemble the switches to the front panel (Start, Stop, Power).
23. Connect the wire leads to the switches (Start, Stop, Power).
24. Connect the clean coil assembly snap switch (J18).
25. Connect bullet connectors (2) (J21, J22).
26. Connect all the plumbing to the valve bracket assembly: (door bladder lines, DI water lines, nitrogen clean coil lines).
27. Attach the rear panel to the base mounting assembly and tighten the upper (3) and lower Phillips screws (2).
28. Install the electrical plug (J5).
29. Connect the white (neutral) and green (ground) wires to the ground neutral block.
30. Install connectors (P105) and (P106) to the rear panel.
31. Install the “KA” relay on the mounting bracket.
32. Install the electrical plug (J19) to the ground neutral block.
33. Connect all Teflon lines between the rear panel, the valve bracket assembly, and the index cylinder.
34. Connect the controller cables to the rear panel.
35. Connect the facility lines to the rear panel.
36. Install the dryer cover.
37. Install the rotor into the process bowl. See Section 4.10, *Rotor Removal and Installation Procedure*.

4.5 Resetting the Clean Coil Thermostat

A high temperature thermostat is mounted on the Clean Coil enclosure to protect the Clean Coil assembly from overheating. This thermostat is reset manually.

If the outer temperature of the Clean Coil assembly reaches 125 ºC, the Clean Coil is disabled by the thermostat. It must be manually reset when the temperature is 40 ºC or less by depressing a reset button mounted on the Clean Coil enclosure.

4.5.1 Tools Required

- Philips Screwdriver

4.5.2 Procedure

WARNING	
	**EQUIPMENT SURFACE IS HOT AND CAN CAUSE SEVERE INJURY!** Before attempting removal procedures allow the surface of the Clean coil enclosure to cool to below 40 ºC.

1. Remove the cover from the dryer.

2. Use the Philips screwdriver to press the reset button mounted on the Clean Coil enclosure. See Figure 4-15.

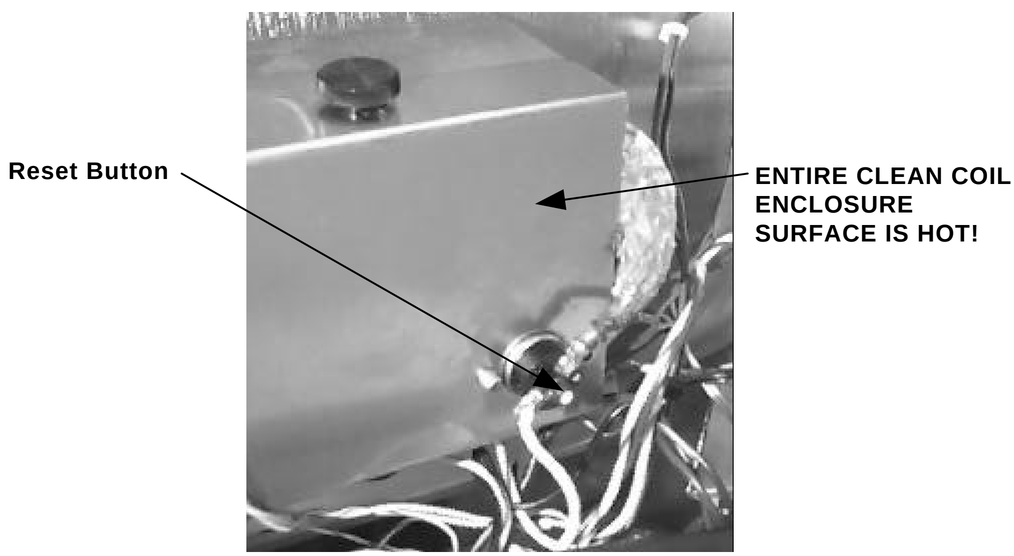

Figure 4-15*. Thermostat Reset Button.*

3. Install the dryer cover.

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4.6 Door Position Adjustment Procedure

4.6.1 Tools Required

- Philips Screwdriver

4.6.2 Procedure

1. Remove the door cover.

2. Inspect the position of the door in relation to the perimeter of the bowl. The door should be centered with respect to the bowl and the bladder should not touch the bowl when deflated.

3. Loosen the three retaining screws that fasten the door to the hinge so that the door moves freely.

4. Reposition the door so that it is centered with respect to the bowl, then tighten the retaining screws.

5. Verify that the door handle is properly aligned with the door sensor.

6. Reinstall the door cover without pinching the Tygon tubing.

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4.7 Labyrinth Seal Cleaning Procedure

4.7.1 Tools Required

- 1/8” Allen wrench
- Flat Head Screwdriver
- Cleanroom Wipes

4.7.2 Procedure

1. Remove the rotor from the bowl. See Section 4.10, *Rotor Removal and Installation Procedure*.

2. The hub is secured to the motor's output shaft by set screws (2). Loosen the set screws with a 1/8" Allen wrench.

3. Manually rotate the hub until the key-way in the motor shaft is straight up.

4. Place a clean room wipe in the drain area of the bowl.

5. Slowly pull the hub out of the bowl, being careful not to drop the key.

6. Unscrew the eight screws on the labyrinth seal and remove it from the bowl.

7. Remove the Viton O-rings from the seal plate.

8. Clean the Viton O-rings with DI water.

9. The seal plate is made of polypropylene. The seal plate should be cleaned with either hydrogen peroxide or IPA and then rinsed with DI water.

CAUTION	
⚠	**POTENTIAL PRODUCT OR EQUIPMENT DAMAGE!** Do not scratch, nick or damage the seal plate. Do not use any tools or abrasives when cleaning the seal plate. Remove the plate from the bowl if IPA is used to clean the seal plate.

10. Install the O-rings onto the seal plate.

11. Align the seal plate with the bowl, with the slot in the plate in the six o’clock position.

12. Fasten the screws (8) in the seal plate, ensuring that the seal plate is lined up with the motor axle.

13. Reinstall the hub. See Section 4.8, *Hub Installation Procedure*.

14. Reinstall the cover onto the dryer.

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4.8 Hub Installation Procedure

4.8.1 Tools Required

- 1/8” Allen wrench
- Clearance Gauge (0.080-inch clearance gauge for 6-inch rotors)

4.8.2 Procedure

1. Bolt the clearance gauge into any of the mounting holes in the hub.

2. Insert the key into the key slot on the motor axle.

3. Carefully install the hub onto the motor axle.

4. Move the key towards the hub so that the key end is flush with the end of the hub.

NOTE
Verify the step in the gauge extends beyond the edge of the hub and faces the seal plate.

CAUTION	
⚠	**POTENTIAL PRODUCT OR EQUIPMENT DAMAGE!** 0.080-inch for 6-inch rotors is a critical dimension. Failure to hold these dimensions could damage the seal and lead to contamination of the bowl.

5. Push the hub until the gauge just barely touches the seal plate.

6. Secure the hub to the shaft of the motor with the two set screws.

7. Rotate hub 360° to ensure the clearance is consistent around the perimeter of the hub.

CAUTION	
⚠	**POTENTIAL PRODUCT OR EQUIPMENT DAMAGE!** Ensure the key is inserted all the way into the hub. Do not allow the key to come in contact with the motor housing bracket.

NOTE
When properly adjusted, the hub should rotate freely and the gauge should just barely contact the seal plate at the point of adjustment. There should be no other contact between the gauge and the seal plate.

8. Remove the gauge.

9. Install the rotor into the bowl. See Section 4.10, *Rotor Removal and Installation Procedure*.

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4.9 Door Bladder Replacement Procedure

4.9.1 Tools Required

- Phillips screwdriver

4.9.2 Parts Lists

- Door bladder seal
- O - ring 0.208 id x 0.07
- Bladder stem insert

4.9.3 Procedure

1. Follow Section 3.4.5, *Safe Shut Down Procedures*.

2. Turn off all facilities: DI, nitrogen, and CDA to the system.

3. Remove the screws (4) in the blue door cover.

4. Loosen the nut that connects the union to the Tygon supply tubing so that the tubing is disconnected from the union.

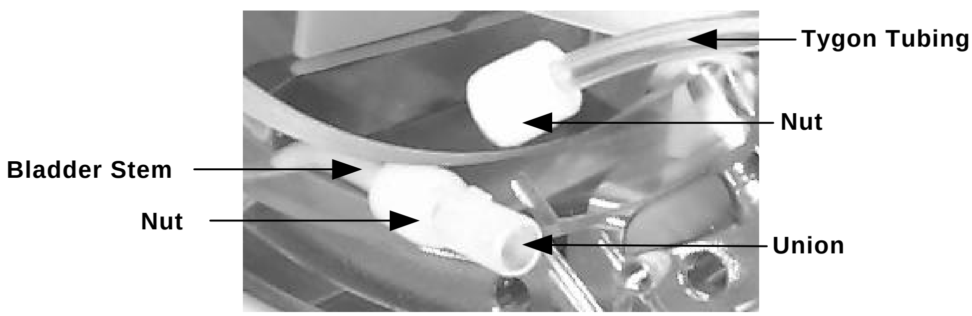

Figure 4-16. *Tygon Tube to Bladder Stem Union.*

5. Unscrew the union from the end of the bladder stem.

6. Remove the flow restrictor from the bladder stem.

7. Pull the bladder stem out of the nut.

8. Starting at the top, pull the bladder out and away from the door groove.

9. Pull the bladder stem out of the fitting channel.

10. Clean the door groove with DI water and a lint-free towel.

11. Discard the old bladder.

4.9.4 Re-assembly

CAUTION	
⚠	**POTENTIAL EQUIPMENT DAMAGE!** Bladder damage might occur if care and attention is not taken. Do not stretch the new bladder when cleaning or installing. The new bladder is shipped with a coating of powder and this powder must be cleaned off prior to assembly.

1. Gently clean the new bladder with DI water and wipe dry with the appropriate cleanroom towel. Ensure the shipping powder has been removed from the bladder before installation.

2. Place the O-ring on the bladder stem. Leave the O-ring approximately an 1/8" from the bladder.

3. Slide the bladder stem through the hole into the fitting channel. It may be necessary to cut the tip of the bladder stem to a point to get it through the hole.

4. Position O-ring on the door bladder stem so that the O-ring is against the channel orifice.

5. Ensure that the O-ring is positioned on the door bladder stem so that the O-ring is properly seated in the channel.

***Figure 4-17**. Bladder Stem in Fitting Channel.*

6. Seat the bladder in the door groove and ensure that the bladder is flat around the perimeter of the lid.

7. Insert the bladder stem into the nut. The other nut should be connected to the Tygon tubing.

8. Add the ferrules to the bladder stem and slide them down, leaving enough length to reconnect to the union.

9. Cut off any excess bladder tubing so that the union rests in the center of the door cutout.

***Figure 4-18**. Bladder Stem with Ferrules.*

10. Insert the flow restrictor into the bladder stem.

11. Screw the union into the nut.

12. Connect the nut attached to the Tygon tubing to the union.

13. Clean with DI water the sealing surface of the bowl and clean the bladder again.

14. Re-install the door cover, being careful not to pinch the supply tubing while tightening the screws. The tubing fits into a groove on the lid.

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4.10 Rotor Removal and Installation Procedure

4.10.1 Tools Required

- Rotor Tool
- Torque Wrench with a 10” extension and 5/32” hex head
- Cleanroom wipes

4.10.2 Procedure

1. Place a cleanroom wipe in the drain area of the bowl.

2. Carefully unscrew screws (3) on the rotor using the rotor tool.

3. Prevent the rotor from hitting the bowl as the fourth screw is removed.

4. Carefully remove the rotor from the bowl.

5. Mount the rotor on the hub.

6. Align the holes in the rotor with the holes in the hub.

7. Torque the four screws to 60 in-lbs.

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4.11 Retaining Bar Tube Replacement Procedure

There are three types of rotor available for the 1600-55 dryer.

Type	Rotor Description
A	Rotor has wafer support tubing that slides on from the rear of the rotor.
B	Rotor has wafer support tubing that slides on from the front of the rotor.
C	Rotor uses a solid PFA rod that slides from the front of the rotor into a stainless steel tube.

NOTE
The Retaining Bar Tube Replacement Procedure or the PFA Rod Maintenance Procedure is used for rotor maintenance depending upon the type of rotor in the dryer. Rotor types “A” and “B” have Teflon tubes that shall be replaced following the steps prescribed in the Retaining Bar Tube Replacement Procedure. Rotor type “C” has PFA rods inserted in the rotor and shall be maintained according to the PFA Rod Maintenance Procedure.

The Teflon tube on the retaining bar must be replaced according to the Preventive Maintenance Schedule. The replacement tubing must be FEP Teflon, 5/16" OD, 1/4" ID.

4.11.1 Procedure

1. Run a Dry-Only recipe to heat the rotor.

2. Remove the rotor from the bowl. See Section 4.10, *Rotor Removal and Installation Procedure*.

3. Use a heat gun to expand the tubing. Slide the expanded tube off the bar and out the hole in the back or front of the rotor and discard the tube.

4. Use a small amount of IPA to lubricate the bar. Slide the new tube onto the bar.

5. Reinstall the rotor in the bowl. See Section 4.10, *Rotor Removal and Installation Procedure*.

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4.12 PFA Rod Maintenance Procedure

There are three types of rotor available for the 1600-55 dryer.

Type	Rotor Description
A	Rotor has wafer support tubing that slides on from the rear of the rotor.
B	Rotor has wafer support tubing that slides on from the front of the rotor.
C	Rotor uses a solid PFA rod that slides from the front of the rotor into a stainless steel tube.

NOTE

The Retaining Bar Tube Replacement Procedure or the PFA Rod Maintenance Procedure is used for rotor maintenance depending upon the type of rotor in the dryer. Rotor types "A" and "B" have Teflon tubes that shall be replaced following the steps prescribed in the Retaining Bar Tube Replacement Procedure. Rotor type "C" has PFA rods inserted in the rotor and shall be maintained according to the PFA Rod Maintenance Procedure.

Perform this procedure when rotating or replacing the 8-inch long PFA rods. The rods should be removed and rotated ¼turn every month and replaced after 4 months of use.

4.12.1 Tools Required

- Phillips screwdriver
- Modified vise grip-type crimping tool (PN 1075752.1)
- Stainless steel mandril (PN 1074862.1)
- Wagner force gauge "push-pull" model FDK40 with tapered extension
- Rotor screw tool
- Single-edge razor blade or x-acto knife
- Cleanroom wipes
- IPA lubricant or equivalent

4.12.2 Parts List

- PFA Rod kit (PN 1075200.3)

4.12.3 Rod Removal Procedure

1. Move the main power circuit breaker to the full down and off position.
2. Disconnect the power cord from the power source.
3. Insert a cleanroom wipe into the bowl drain hole.
4. Remove the rotor (remove 4 mounting screws).
5. Remove the rod from the channel by pushing from the front end of the rotor.

4.12.4 Rod Installation Procedure

CAUTION	
⚠	**POTENTIAL PRODUCT OR EQUIPMENT DAMAGE!** The crimping tool should never be used without the mandril in position.

1. Insert the mandril into the front of the vacated rod channel. Leave ½inch of the mandril protruding from the rotor.

2. Fold a cleanroom wipe in half and wrap around the tube where the crimping tool will be placed.

3. Adjust the crimping tool so that the jaws meet, then crimp the tube 1 inch from the front of the rotor. If the crimping tool closes too easily, adjust the tool 1/2 turn clockwise and perform the crimp again. See Figure 4-19.

Typical Mandril

Figure 4-19*. Correct positioning of the crimping tool.*

4. Remove the mandril.

NOTE
Rotate all existing PFA rods 90° prior to installation.

5. Wipe down the new or existing PFA rod and rod channel with lubricant.

6. Insert the rod into the channel from the front of the rotor. Trim any excess length.

NOTE
Use only the force gauge when performing the push test - never use your hands.

7. At ambient temperature, perform a “push test” on the PFA rod with the force gauge. Push squarely on the rod while avoiding contact with the steel channel. If the rod moves with less than 10lb of force, remove it and perform another crimping.

8. Perform the replacement procedure for each rod.

9. Install the rotor (4 screws).

10. Connect the power cord.

11. Power the dryer on.

12. Run a recipe to ensure correct operation of the system.

13. Install the dryer cover.

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4.13 Bowl Heater Verification Procedure

Two types of bowl heaters are installed on the dryer. Two blanket heaters are installed on the left and right sides of the bowl. They are supplied with 120 VAC through J12. A strip heater is installed on the front of the bowl. The 120 VAC power is supplied through J12.

4.13.1 Tools Required

- Thermocouple
- Temperature Meter

4.13.2 Procedure

1. Position the probe of the Fluke 30 clamp meter around any wire on the blanket heater. The heater should draw at least 9 amps.

2. Position the probe of the Fluke 30 clamp meter around the N_2 heater supply wire. The N_2 heater should draw at least 1.2 amps.

3. Place the thermocouple against the blanket heaters during a dry cycle and observe the reading on the temperature meter.

4. Verify that the blanket heaters cycle on and off.

NOTE
The operating temperature of the pad heaters is approximately 120 ºC. The blanket heaters cycle on and off automatically.

5. Place the thermocouple against the strip heater during a dry cycle and observe the reading on the temperature meter. The strip heater is installed on the rim of the bowl behind the front panel. It should operate at approximately 65ºC.

6. Ensure that this heater is cycling on and off.

NOTE
The strip heater has two connectors so it can be disconnected for special applications. The heater temperatures may vary ±15 ºC, depending on the type of thermostats installed.

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4.14 Cleaning the Rinser/Dryer

4.14.1 Procedure

CAUTION	
⚠	**POTENTIAL PRODUCT OR EQUIPMENT DAMAGE!** Do not use any solution that contains hydrocarbons when cleaning the window on the outside of the door. It is made of Lexan and will be harmed by hydrocarbons.

1. Remove the rotor. See Section 4.10, Rotor Removal and Installation Procedure.

2. Thoroughly clean the bowl and rotor with hydrogen peroxide and rinse with DI water.

3. Inspect the nozzles for damage and signs of abrasion and replace them if necessary.

4. Inspect the door bladder for nicks and wear.

5. Clean the door bladder with DI water only, as other solutions could harm the bladder.

6. Check the drain box for wafer chips or other foreign matter. If it is dirty, remove the foreign matter and flush the drain box with DI water.

7. Reinstall the rotor and carrier. See Section 4.10, Rotor Removal and Installation Procedure.

8. The final step in the bowl cleaning process is an extended rinse/dry cycle. The duration of this rinse cycle should be at least six minutes. The dry cycle should run long enough to completely dry the bowl.

9. Use a mild soap solution to clean the outside of the unit. Be careful that this solution does not flow inside and contaminate the bowl.

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4.15 Resistivity Probe and Monitor Test Procedure

This procedure uses a known-good resistivity input signal (dummy-load test probe) to isolate the failing device in resistivity monitoring (Figure 4-20). The major devices to troubleshoot are:

- the resistivity monitor
- the resistivity probe (clean and/or replace)
- facility DI water

Figure 4-20*. Resistivity monitoring devices.*

4.15.1 Tools Required

- Test, Resistivity Probe Tester (P/N 1079159.1) (10 MÙ Dummy-Load)
- a small container of 10:1 solution of HCl

4.15.2 Resistivity Specification

The resistivity should read **10** megohms **± 0.2** megohms on the control panel during a rinse step.

4.15.3 Test Set-Up

1. Move the dryer’s main power circuit breaker to the full down and off position.

2. Disconnect the existing resistivity probe from the resistivity monitor (Figure 4-20).

3. Assemble the dummy-load test probe and connect it to the existing resistivity monitor (Figure 4-21).

- connect the 10MÙ dummy-load test probe (**1**) to the test cable end (**A**)
- connect the test cable end (**B**) to input of the resistivity monitor (Figure 4-20)

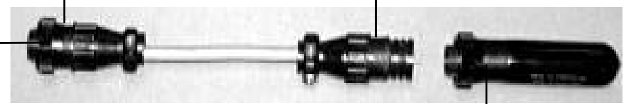

***Figure 4-21**. 10MÙ Dummy-Load Test Probe assembly instructions.*

4.15.4 Troubleshooting Procedure

4.15.4.1 Testing the Existing Resistivity Monitor

1. Move the dryer's main power circuit breaker to the full up and on position.

2. Ensure that Resistivity is enabled ON during the rinse cycle.

3. Perform a Rinse-only process in the dryer.

4. View the control panel and record the resistivity value.

5. Interrupt or stop the process.

6. If the resistivity value is outside the stated specification (10 megohms, ± 0.2 megohms), then replace the existing resistivity monitor with a new one. (Send the failed resistivity monitor to GFT for repair).

7. Start at Section 4.15.4.1 and test the new resistivity monitor using the 10MÙ dummy-load. This will ensure a 'known-good' resistivity monitor. If the resistivity value is correct, then go to Section 4.15.4.2.

4.15.4.2 Testing the Existing Resistivity Probe

1. Move the dryer's main power circuit breaker to the full down and off position.

2. Ensure that the 10MÙ dummy-load test probe is disconnected.

3. Reconnect the existing resistivity probe to the new resistivity monitor.

4. Move the dryer's main power circuit breaker to the full up and on position.

5. Ensure that Resistivity is enabled ON during the rinse cycle.

6. Perform a Rinse-only process in the dryer.

7. View the control panel and record the resistivity value.

8. Interrupt or stop the process.

9. If the resistivity valve is within the specification then **end**.

10. If the resistivity value is out of the specification, then remove the resistivity probe and dip the metal tip into a 10:1 solution of HCl for 30 seconds. Rinse the probe in DI water for three minutes.

11. If this is the first pass through this procedure, go to Section 4.15.4.2 and retest. If this is the second or third pass through this procedure, go to step #12 below.

12. If the resistivity value is out of specification after cleaning the metal tip and re-testing, then replace the resistivity probe and retest at Section 4.15.4.2. If the resistivity value is still out of specification, then check the facility DI water source.

13. Other areas to check if the resistivity value is still out specification is the dryer bowl for contamination.

14. Call the GFT Technical Assistance Group (TAG) if the above procedure does not isolate the resistivity problems.

This ends the Resistivity Probe and Monitor Troubleshooting Procedure.

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4.16 CO2 Injection Module Maintenance Procedures

CO_2 and DI water enter the dryer through separate inlets. Both the pressure and flow of the CO_2 are regulated by the CO_2 Injection Module. The CO_2 is filtered and then mixed with DI water. The mixture is then introduced into the process chamber of the dryer.

4.16.1 Annual PM Procedure

1. Remove and replace the CO_2 filter. Refer to the Section 4.16.4, *Carbon Dioxide Filter Replacement Procedure*.

4.16.2 Functional Description

The following devices are the hardware components of the CO_2 Injection Module.

VENTURE MIXER. The Venturi Mixer is used to inject one fluid into another by creating a pressure difference between the inlet and outlet of the injector.

CO_2 REGULATOR. The CO_2 regulator controls pressure of the CO_2 from the facility. The operating range of the regulator is 7-100 psi.

FLOWMETER. The flowmeter regulates the flow rate of the CO_2. The operating range is 5 to 50 scfh.

CAUTION

POTENTIAL PRODUCT OR EQUIPMENT DAMAGE!

Do not exceed forty (40) cfh when setting the flow rate on the CO_2 Injection Module.

CO_2 PRESSURE GAUGE. The pressure gage measures the pressure of the CO_2.

CO_2 SOLENOID VALVE. The solenoid valve controls the flow of CO_2 and DI water. The solenoid valve allows CO_2 and DI water to flow if DI water is requested in a recipe and the flowswitch detects CO_2.

CO_2 FILTER. The CO_2 filter is a directional filter that removes particles up to .003µm.

CHECK VALVE. The check valve prevents filtered CO_2 and DI water from re-entering the filter.

4.16.2.1 CO_2 and DI Water Path

1. CO_2 is supplied at the facility.

2. CO_2 enters the back of the CO_2 injection module through the port labeled **CO_2 In**.

3. The CO_2 is regulated by a pressure regulator. The maximum pressure of the CO_2 is 38 psi.

4. The flowmeter regulates the CO_2 flow.

5. The pressure of the CO_2 is measured by a pressure gauge.

6. DI water will be turned on and mixed with CO_2 when water is requested in a recipe. DI water will only flow if CO_2 is detected by the flowswitch. Wire four is connected to ground. Wire three is connected directly to the solenoid valve. Wire two is connected to the solenoid valve and to the adjustable flow switch.

7. The CO_2 gas is filtered.

8. The CO_2 passes through the check valve. The check valve allows flow in one direction. It ensures that the mixture will not backup through the CO_2 filter.

NOTE
Ensure that the CO_2 pressure exceeds the DI water pressure by approximately five (5) psi.

9. The CO_2 is injected into the middle of the venturi mixer. DI water enters through one end of the mixer. A pressure difference between the inlet and outlet of the injector creates a vacuum inside the body, which results in a suction through the CO_2 port.

10. The mixture leaves the CO_2 Injection Module and returns to the dryer's rear panel.

11. The mixture goes to the DI water manifold and into the process chamber.

4.16.3 Troubleshooting System Faults and HELP Codes

HELP Code	Cause	Solution
0004 CO_2/DI Failure	Faulty Solenoid Valve	Test CO_2 Solenoid Valve
		Check facility pressure
		Check pressure regulator
		Verify voltage is nominal ± 10 volts
	Faulty Flow Switch	Check electrical connections
		Check flow switch operation

4.16.4 Carbon Dioxide Filter Replacement Procedure

CAUTION

POTENTIAL PRODUCT OR EQUIPMENT DAMAGE!

Always wear clean gloves when handling the carbon dioxide filter to avoid contaminating the filter.

4.16.4.1 Supplies Required

- Teflon Tape

4.16.4.2 Parts Required

- CO_2 Filter

4.16.4.3 Removing the Filter

1. Follow Section 3.4.5, *Safe Shut Down Procedures*.

2. Disconnect the power cord from the power source.

3. Turn off the CO_2 supply to the dryer.

4. Remove the cover from the CO_2 Injection Module.

5. Disconnect the CO_2 line from the CO_2 filter. See Figure 4-22.

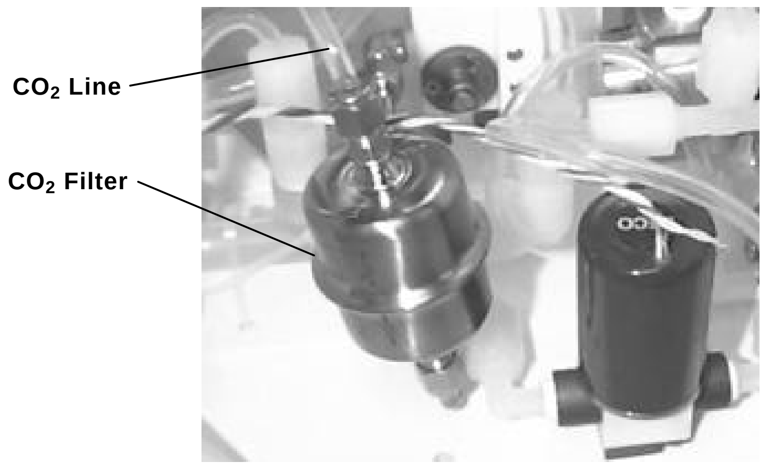


***Figure 4-22**. CO_2 filter location.*

6. Unscrew the filter from the CO_2 line.

7. Remove the Teflon tape from the nipple and from the CO_2 line elbow.

8. Discard the filter.

4.16.4.4 Installing a New Filter

1. Wrap Teflon tape around the threads on the nipple and the threads on the CO_2 line elbow.

2. Fasten the outlet side of the filter to the nipple on the CO_2 piping.

3. Reinstall the dryer cover.

4. Go to Section 3.4, *Operating Procedures*.

4.16.5 Solenoid Valve Replacement Procedure

4.16.5.1 Tools Required

- Philips screwdriver

4.16.5.2 Parts Required

- Solenoid Valve Assembly

4.16.5.3 Removing the Solenoid Valve

1. Follow Section 3.4.5, *Safe Shut Down Procedures*.

2. Disconnect the power cord from the power source.

3. Turn off the CO_2 supply to the dryer.

4. Remove the cover from the CO_2 Injection Module.

5. Disconnect the tubing from either side of the solenoid valve. See Figure 4-

6. Disconnect the wires from the connector at the back of the module.

7. Unscrew the solenoid valve from the bottom plate of the module.

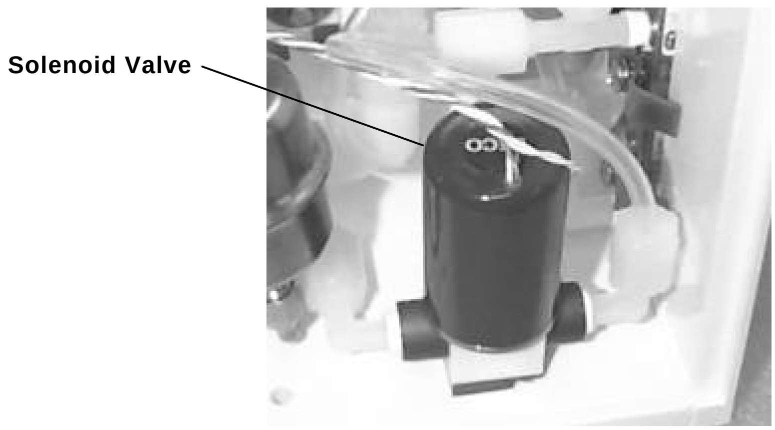


Figure 4-23. *Solenoid valve location.*

4.16.5.4 Installing a New Solenoid Valve

1. Fasten the solenoid valve to the bottom plate of the module.

2. Attach the wires to the connector at the back of the module.

3. Connect the tubing to both sides of the solenoid valve.

4. Reinstall the dryer cover.

5. Turn on the CO_2 supply to the dryer.

6. Connect the power cord to the power source.

7. Go to Section 3.4, *Operating Procedures*.

4.17 Particle Troubleshooting Procedures

4.17.1 Overview

In order to prove or eliminate the dryer as the device that is causing high particle count in the process, the following tests must be performed. After each test is run, decisions are made based on particle count.

1. **Initial Test Setup:** These procedures establish a known good set of parameters and conditions for the device under test that must be met before troubleshooting can begin.

2. **Troubleshooting Procedures:** After the 'Initial Test Setup' has been verified, specific procedures are implemented. Depending on where on the wafers high particle count is found, a decision can be made as to the cause. Each test is run an average of five (5) times. A brief discussion follows on the types of procedures used:

   a) **Pre-cleaning Routine**. As part of the initial test setup, this will ensure a clean cassette and 'Hydrophilic' test wafers.

   b) **Handling Test**. This will account for any particle count added due to the handling of the wafers outside of processing and is subtracted from the total add-ons to obtain the final particle count added by the dryer.

   c) A **'Dry in–Dry Only'** recipe is run and particle count is taken and averaged over five tests and the amount of particles added due to *Handling* is subtracted from this total.

   d) A **'Wet in– Dry Only'** recipe is run and particle count is taken and averaged over five tests and the amount of particles added due to *Handling* is subtracted from this total.

   e) A **'Wet in–Rinse** and **Dry'** recipe is run and particle count is taken and averaged over five tests and the amount of particles added due to *Handling* is subtracted from this total.

If there is an increase of particles greater than acceptable levels after each troubleshooting step, then by measuring where on the wafers the particles are collecting a decision can be made as to the area or device that is most likely adding the particles.

4.17.2 Prerequisites

The following prerequisite helps declare that the dryer ***is*** or ***is not*** the device that is adding high particle count to the wafers:

NOTE
'Particle count is based on the amount of excursion from the original sales contract specification'.

4.17.3 Initial Test Setup #1 (Getting the Dryer Ready)

The following checks and conditions must occur prior to performing particle count troubleshooting procedures on the dryer.

Precautions:

- *For dryer's with manual operating doors, do not slam door when opening or closing.*
- *Minimize contact with the cassette.*
- *Use known good clean gloves.*
- *When loading and unloading cassette, do not touch the inside of the dryer's bowl or door with any part of your clothing.*

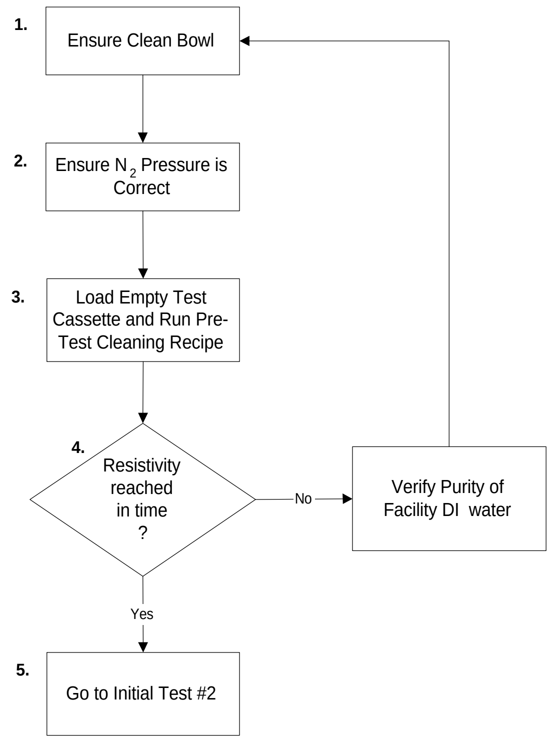
1. Ensure that the dryer bowl is clean. This may entail performing correct bowl cleaning procedures.

2. Ensure that facility N_2 pressure is at the correct level.

3. Load a known good, clean, and empty cassette (that will later hold the test wafers) into the dryer. Run the Pre-Test Cleaning Recipe with Resistivity set ON. See below.

4. If the resistivity is not reached within the allotted time, check the purity of the facility DI water, then start at step #1 of this procedure again.

5. If resistivity is reached, go to Initial Test Setup #2.



Pre-Test Cleaning Recipe (for cassette and dryer):

Rinse STEP	TIME	RPM	DI H_2O	N_2	STATIC	HEATER	RES.
1	60	50	ON	ON	OFF	ON	15 MegΩ
2	45	300	ON	ON	OFF	ON	15 MegΩ
Dry STEP							
1	240	2000	OFF	ON	ON	ON	OFF
2	240	500	OFF	ON	ON	ON	OFF

4.17.4 Initial Test Setup #2 (Getting the Test Wafers Ready)

The following checks and conditions must occur prior to performing particle count troubleshooting procedures on the dryer.

1. Ensure that the Metrology tool is functioning properly. Handle the test wafers properly, use vacuum wands (not tweezers).

2. GFT recommends pre-cleaning the test wafers (usually three) in a solution of ammonia peroxide mixture (APM). The pre-cleaning process is as follow:

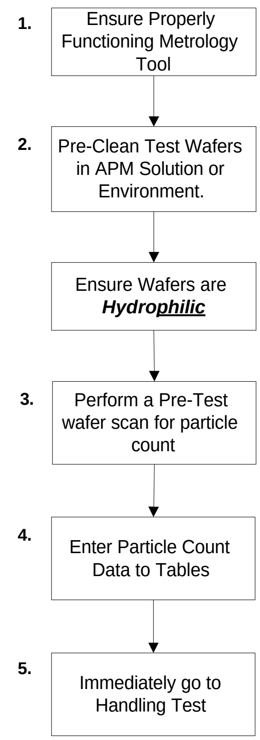
- **a.)** 10-minute dip in a,
- **b.)** APM concentration mix of H_2O:H_2O_2:NH_4OH at 5:1:1 (SCI)
- **c.)** Megasonic clean
- **d.)** Rinse and dry in a qualified dryer.

Ensure all three test wafers surfaces are hydrophilic. To do this, look at the test wafers during the rinse step of the above pre-cleaning process to ensure that the water is ***not*** sheeting off of the wafers.

3. Use the Data Collection Tables supplied in Section 4.17.9 for finding and keeping track of the particle count averages used in troubleshooting. Perform a Pre-Test particle count of the test wafers. Do not use wafers with particle counts >50 particles at ≥0.2 µm in size.

4. Enter the pre-scan particle count data to the collection table (See Table 4-1).

5. Immediately go to the Handling Test (Section 4.17.5) and start collecting particle count data using the collection tables at the end of this section.



This ends the Initial Test Setup.

4.17.5 Handling Test

This test establishes the amount of particles added to the wafers from operator handling, the cleanroom and metrology tool. The results of this test will be subtracted from the results of actual recipe testing in the dryer.

Precautions:

- *For dryer's with manual operating doors, do not slam door when opening or closing.*
- *Minimize contact with the cassette.*
- *Use known good clean gloves.*
- *When loading and unloading cassette, do not touch the inside of the dryer's bowl or door with any part of your clothing.*

To perform this test:

1. Open the door of the dryer under test. Load the cassette with the three pre-scanned test wafers into the dryer. ***Do not run the dryer.*** Close the door.

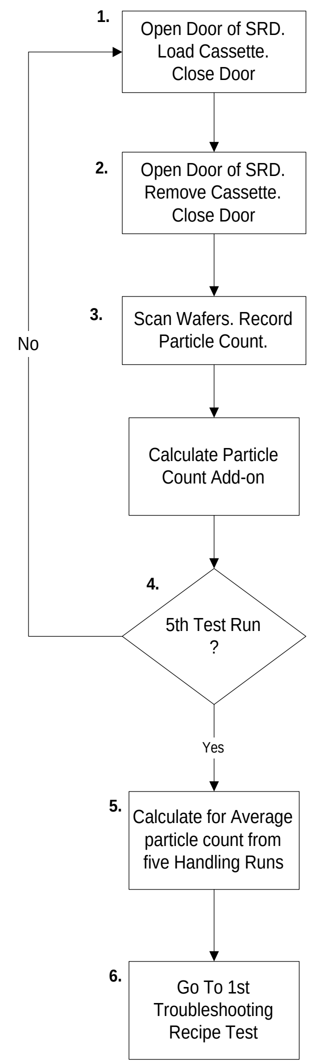
2. Open the door of the dryer and take out the cassette.

3. Scan the wafers and add this data to the Data Collection Table under the column *Handling Test Run*. See Section 4.17.9.1, Table 4-2. Calculate the particle count add-on (subtract the post-scanned number from the pre-scanned number).

4. Perform steps **1.** through **3.** four more times. After each Handling Run add and calculate the particle count data to Table 4-3.

5. Calculate for the average total particle count for the five Handling Runs. This total will be subtracted from the final particle count total of all troubleshooting recipe tests.

6. Go to the 'Dry-In, Dry Only' Troubleshooting Recipe Test.



This ends the Handling Test.

4.17.6 Troubleshooting Recipe Tests

Now that the average Handling particle count adder has been calculated, run the following recipe five times using the test wafers and the Data Collection Tables.

4.17.6.1 Dry-In, Dry Only Troubleshooting Recipe Test

Each time (5) this recipe is run, perform wafer scans and use the data collection tables to capture and calculate particle counts add-ons.

Precautions:

- *For dryer's with manual operating doors, do not slam door when opening or closing.*
- *Minimize contact with the cassette.*
- *Use known good clean gloves.*
- *When loading and unloading cassette, do not touch the inside of the dryer's bowl or door with any part of your clothing.*

To perform this test:

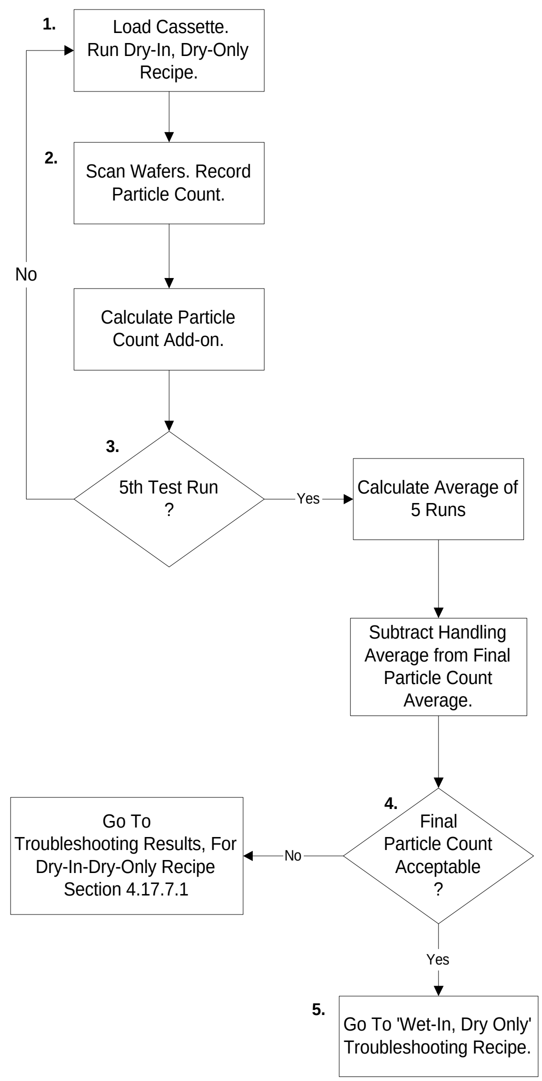
1. With wafers in the dryer, run a Dry-In, Dry-Only recipe as configured in the table below.

2. After the first run, scan the test wafers and enter the data in the collection table, see Section 4.17.9.3. Calculate the particle count add-on (subtract the post-scanned number from the Handling Test final number).

3. After all five runs have been performed, calculate the average and subtract the Handling average from the final results (see Section 4.17.9.2).

4. If the total particle count is unacceptable*, go to Section 4.17.7.1 for Dry-In, Dry-Only Troubleshooting Results.

5. If the total particle count is acceptable*, go to the second recipe test, 'Wet-in, Dry Only'.



Dry-in, Dry-Only Recipe:

STEP	TIME	RPM	DI H_2O	N_2	STATIC	HEATER	RES.
1	240	2000	OFF	ON	ON	ON	OFF
2	240	500	OFF	ON	ON	ON	OFF

*** *'Particle count is based on the amount of excursion from the original sales contract specification'.***

4.17.6.2 Wet-In, Dry-Only Troubleshooting Recipe Test

Each time (5) this recipe is run, perform wafer scans and use the data collection tables to capture the particle counts.

Precautions:

- *For dryer's with manual operating doors, do not slam door when opening or closing.*
- *Minimize contact with the cassette.*
- *Use known good clean gloves.*
- *When loading and unloading cassette, do not touch the inside of the dryer's bowl or door with any part of your clothing.*

To perform this test:

1. Pre-wet the test wafers in a known good, clean source of overflowing DI water for 30 seconds. Do not use spray bars.

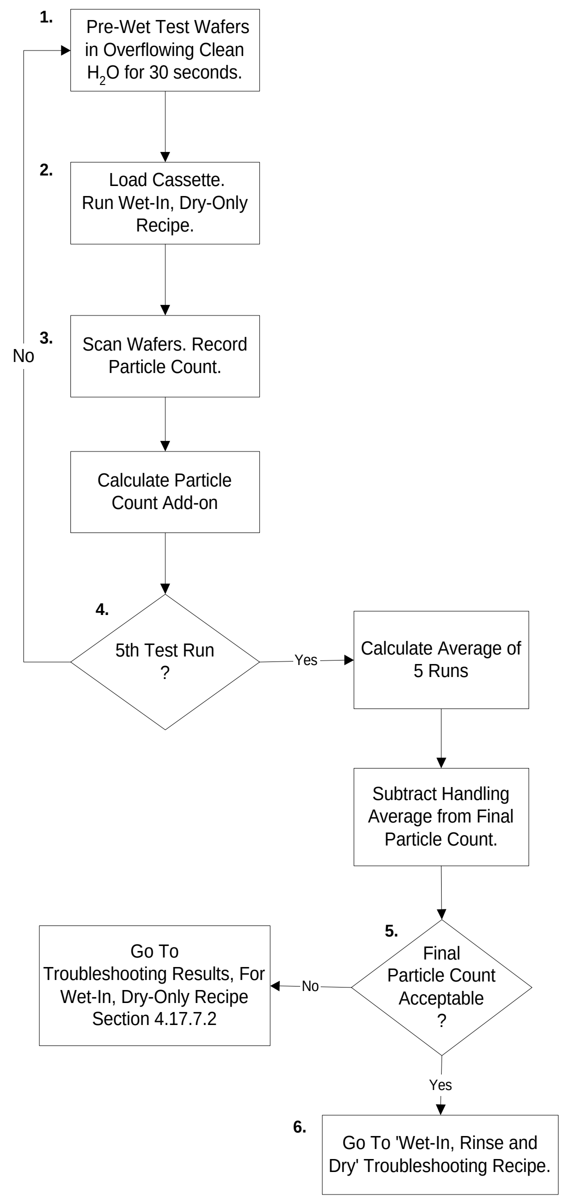
2. Place the test wafers in the dryer and run the 'Wet-In, Dry-Only' recipe as configured in the table below.

3. After the first run, scan the test wafers and enter the data in the collection table, see Section 4.17.9.4. Calculate the particle count add-on (subtract the post-scanned number from the 'Dry-In, Dry-Only' final number).

4. After all five runs have been performed, calculate the average of all runs and subtract the Handling Average from the final results (See Section 4.17.9.2).

5. If the total particle count is unacceptable*, go to Section 4.17.7.2 for 'Wet-In, Dry-Only' Troubleshooting Results.

6. If the total particle count is acceptable*, go to the third recipe test, Section 4.17.6.3, 'Wet-in, Rinse and Dry'.



Wet-in, Dry-Only Recipe:

Dry STEP	TIME	RPM	DI H_2O	N_2	STATIC	HEATER	RES.
1	240	2000	OFF	ON	ON	ON	OFF
2	240	500	OFF	ON	ON	ON	OFF

* ***'Particle count is based on the amount of excursion from the sales contract specification'.***

4.17.6.3 Wet-In, Rinse and Dry Troubleshooting Recipe Test

Each time (5) this recipe is run, perform wafer scans and use the data collection tables to capture the particle counts.

Precautions:

- *For dryer's with manual operating doors, do not slam door when opening or closing.*
- *Minimize contact with the cassette.*
- *Use known good clean gloves.*
- *When loading and unloading cassette, do not touch the inside of the dryer's bowl or door with any part of your clothing.*

To perform this test:

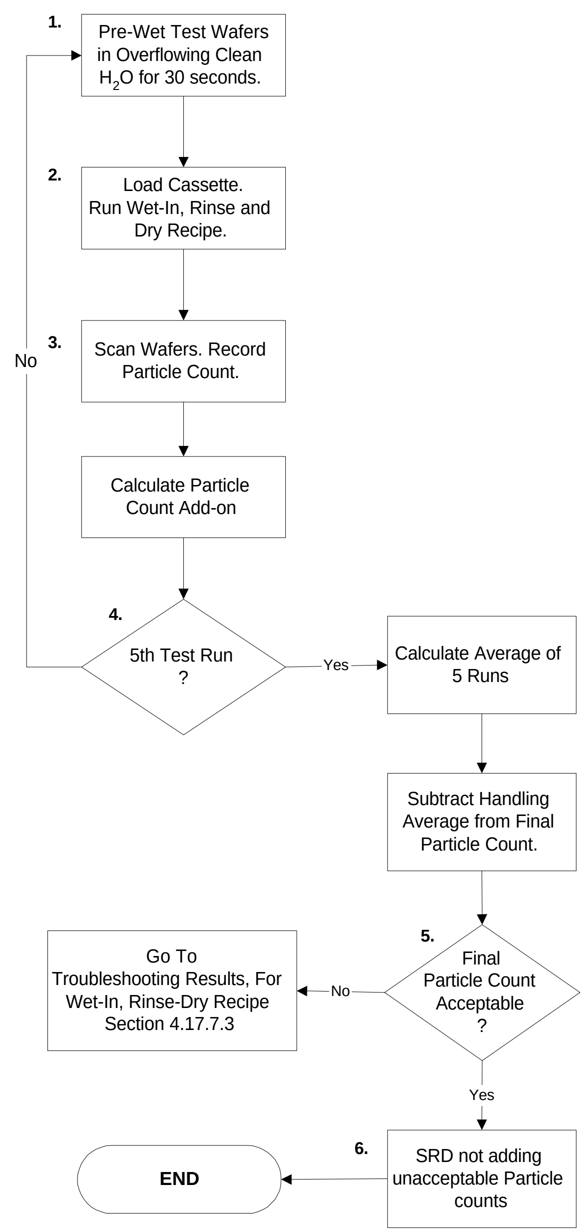
1. Pre-wet test wafers in a known good, clean source of overflowing DI water for 30 seconds. Do not use any spray bars.

2. Place the test wafers in the dryer and run the 'Wet-In, Rinse and Dry' recipe as configured in the table below.

3. After the first run, scan test wafers and enter data in the collection table, see Section 4.17.9.5. Calculate the particle count add-on (subtract the post-scanned number from the 'Wet-In, Dry-Only' final number).

4. After all five runs have been performed, calculate the average of all runs and subtract the Handling Average from the final results (See Section 4.17.9.2).

5. If the total particle count is unacceptable*, go to Section 4.17.7.3 for 'Wet-In, Rinse and Dry' Troubleshooting Results. If total particle count is acceptable*, then the dryer is not adding unacceptable particle count.



Wet-in, Rinse and Dry Recipe:

Rinse STEP	TIME	RPM	DI H_2O	N_2	STATIC	HEATER	RES.
1	60	50	ON	ON	OFF	ON	15 MegΩ
2	45	300	ON	ON	OFF	ON	15 MegΩ
Dry STEP							
1	240	2000	OFF	ON	ON	ON	OFF
2	240	500	OFF	ON	ON	ON	OFF

* ***'Particle count is based on the amount of excursion from the sales contract specification'.***

4.17.7 Troubleshooting Results

4.17.7.1 Dry-In, Dry-Only High Particle Count Results

Depending upon which test wafer has high particle count determines which components of the dryer to check. Follow the table below for the suggested solutions.

If Problem Wafer Is:	Component	Check:
Front	Door Seal	• RG2 Setting • Bladder Seal Integrity • Bladder Seal Lines
Rear	N_2 Labyrinth Seal	• Hub Spacing
All	N_2 Filter N_2 Valve	• N_2 Filter • RG1 Setting • N_2 Lines for Contamination • Vibrations

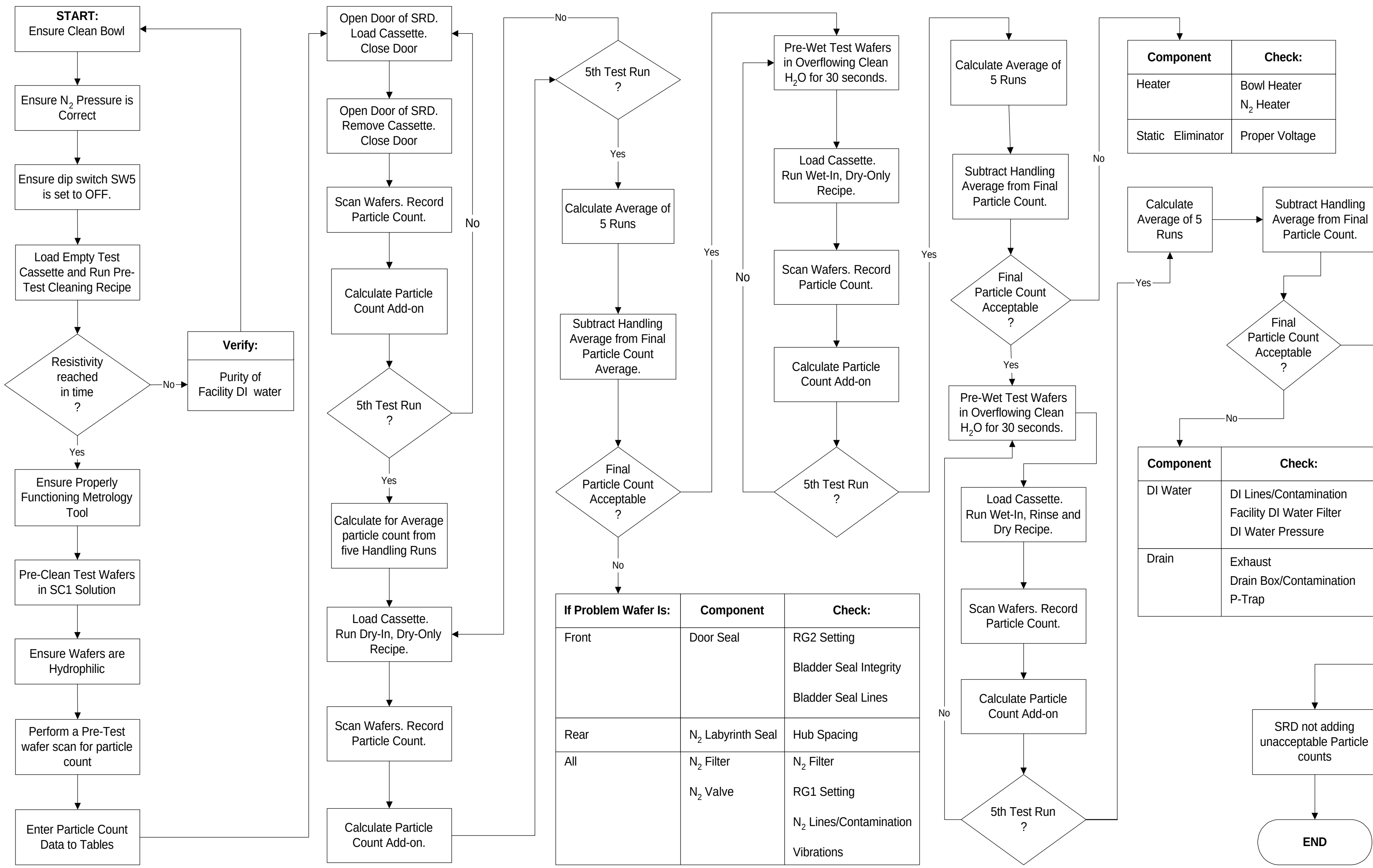
4.17.7.2 Wet-In, Dry-Only High Particle Count Results

Component	Check:
Heater	• Bowl Heater • N_2 Heater
Static Eliminator	• Proper Output

4.17.7.3 Wet-In, Rinse and Dry High Particle Count Results

Component	Check:
DI Water	• DI Lines for Contamination • Facility DI Water Filter • DI Water Pressure
Drain	• Exhaust • Drain Box for Contamination • P-Trap

4.17.8 Comprehensive Flowchart



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4.17.9 Data Collection Tables

The following tables will help in accumulating, organizing and analyzing particle count scans. Known-good (clean) wafers are essential for troubleshooting. A pre-test scan for particles on the Known-good (clean) wafers is needed before troubleshooting can begin. Three to six wafers can be used for testing.

The averaged results of these pre-test scans will be deducted from the Handling Test (see Section 4.17.5). Do not use wafers with particle counts >50 particles (Light Point Defect) at ≥0.2 µm in size.

The table below (broken into sections for clearer understanding) will help organize the collection of data. Attached to the rear of this section are blank tables for use during actual data collection. The values entered in the following tables are for demonstration purposes only, your values will be different.

4.17.9.1 Collecting Data from Handling Test

Table 4-1*. Sample Table. Pre-Test Scan results of wafers that will be used for troubleshooting.*

Wafer Slot Position	Pre-Test Scan Results
25	18
13	13
1	52

The three bolded totals will be subtracted from the first Handling Test results. See Table 4-2.

Note: The technician performing the pre-test scans may elect to clean or replace wafer number 1 as it has a particle count >50.

Table 4-2*. The results of Handling Test No. 1 subtracted from the Pre-Test Scan results .*

		Handling Test Run No. 1	
Wafer Slot Position	**Pre-Test Scan Results**	**Results**	**Delta**
25	18	21	3
13	13	9	(-4)
1	52	50	(-2)

Note: It is normal for the particle count to decrease after a test. This is an indication that the dryer is functioning properly.

***Table 4-3**. Total results after all five Handling Tests are run.*

		Handling Test Run No. 1		Handling Test Run No. 2		Handling Test Run No. 3		Handling Test Run No.4		Handling Test Run No. 5		
Wafer Slot Position	**Pre-Test Scan Results**	**Results**	**Delta**	**Results**	**Delta**	**Results**	**Delta**	**Results**	**Delta**	**Results**	**Delta**	**Ave. Delta**
25	**18**	**21**	**3**	**20**	**(-1)**	**25**	**5**	**27**	**2**	**29**	**2**	**2.2**
13	**13**	**9**	**(-4)**	**10**	**1**	**11**	**1**	**17**	**6**	**19**	**2**	**1.2**
1	**52**	**50**	**(-2)**	**49**	**(-1)**	**45**	**-4**	**46**	**1**	**43**	**(-3)**	**(-9)**
											Overall Average:	**0.53**

4.17.9.2 Calculating for Overall Average Handling Test Add-on

The average particle count added to the wafers before troubleshooting due to handling is calculated in the following manner:

Wafer Position	**Total Delta**	**Average Delta per Run**	**Overall Average per Wafer**
25	11	2.2	
13	6	1.2	
1	(-9)	(-1.8)	
	Total: 8	Total: 1.6	**Total: 0.53**

The **0.53** particle count value is the average amount that is present on all three wafers due to handling. This total will be subtracted from the Troubleshooting Recipe Test particle count results. This will give a more precise count of added particles from the dryer.

4.17.9.3 Collecting Data from the 1st Troubleshooting Recipe Test

To start capturing data for troubleshooting record the values from the 5th Handling Test Results column to the table below. Run all five ‘Dry-In, Dry-Only’ Troubleshooting Tests and add the particle count data of each run. Calculate for each Delta and calculate for the overall average ‘Dry-In, Dry-Only’ addition. Subtract the Handling Test overall average from the ‘Dry-In, Dry-Only’ recipe overall average.

Table 4-4. *Final Handling Test Run Results added to the table to start Troubleshooting Recipe Tests.*

		Dry-In, Dry-Only Run No. 1		Dry-In, Dry-Only Run No. 2		Dry-In, Dry-Only Run No. 3		Dry-In, Dry-Only Run No. 4		Dry-In, Dry-Only Run No. 5		
Wafer Slot Position	**5th Handling Test Results**	**Results**	**Delta**	**Results**	**Delta**	**Results**	**Delta**	**Results**	**Delta**	**Results**	**Delta**	**Ave. Delta**
25	**29**	**47**	**18**	**20**	**(-27)**	**27**	**7**	**19**	**(-8)**	**22**	**3**	**(-1.4)**
13	**19**	**20**	**1**	**12**	**(-8)**	**22**	**10**	**15**	**(-7)**	**16**	**1**	**(-0.6)**
1	**43**	**13**	**(-30)**	**7**	**(-6)**	**18**	**11**	**28**	**10**	**19**	**(-9)**	**(-4.8)**
											Overall Average:	**(-2.27)**

4.17.9.4 Calculating for Average ‘Dry-In, Dry-Only Add-on

The average particle count added to the wafers after the first troubleshooting recipe can now be calculated:

Wafer Position	**Total Delta**	**Average Delta per Run**	**Overall Average per Wafer**	**Minus Handling Test Overall Average**	**Overall Average per Wafer by dryer**
25	(-7)	(-1.4)			
13	(-3)	(-0.6)			
1	(-24)	(-4.8)			
	Total: (-34)	Total: (-6.8)	**Total: (-2.27)**	**0.53**	**(-2.8)**

The overall average per wafer particle count of **(-2.27)** is the amount that is present on the wafers after the first troubleshooting recipe test. The **(-2.8)** particle count value is the amount that is added to the wafers that was due to the dryer, or in this case the dryer cleaned away an additional 2.8 particles. If this value is unacceptable, go to Section 4.17.7.1 for troubleshooting results. If this value is acceptable, go to the 2nd troubleshooting recipe, Section 4.17.6.2.

4.17.9.5 Collecting Data from the 2nd Troubleshooting Recipe Test

Record the values from the 5th 'Dry-In, Dry-Only' Results column into the table below. Run all five 'Wet-In, Dry-Only' Troubleshooting Tests and add the particle count data of each run. Calculate for each Delta and calculate for the overall average 'Wet-In, Dry-Only' add-on. Subtract the Handling Test overall average from the 'Wet-In, Dry-Only' recipe overall average.

***Table 4-5**. 'Wet-In, Dry-Only' Troubleshooting Recipe Data Collection Table.*

		Wet-In, Dry-Only Run No. 1		Wet-In, Dry-Only Run No. 2		Wet-In, Dry-Only Run No. 3		Wet-In, Dry-Only Run No. 4		Wet-In, Dry-Only Run No. 5		
Wafer Slot Position	**5th Dry-In, Dry-Only Results**	**Results**	**Delta**	**Results**	**Delta**	**Results**	**Delta**	**Results**	**Delta**	**Results**	**Delta**	**Ave. Delta**
25	22	27	5	45	18	46	1	46	0	52	8	6.4
13	16	22	6	25	3	27	2	38	11	39	1	4.6
1	19	30	11	35	5	40	5	45	5	49	4	6.0
											Overall Average:	**17.0**

4.17.9.6 Calculating for Average 'Wet-In, Dry-Only Add-on

The average particle count added to the wafers after the first troubleshooting recipe can now be calculated:

Wafer Position	Total Delta	Average Delta per Run	Overall Average per Wafer	Minus Handling Test Overall Average	Overall Average per Wafer by dryer
25	32	6.4			
13	23	4.6			
1	30	6.0			
	Total: 85	Total: 17.0	**Total: 5.67**	**0.53**	**5.14**

The overall average per wafer particle count of **5.67** is the amount that is present on the wafers after the second troubleshooting recipe test. The **5.14** particle count value is the amount that is added to the wafers that was due to the dryer. If this value is unacceptable, go to Section 4.17.7.2 for troubleshooting results. If this value is acceptable, go to the 3rd troubleshooting recipe, Section 4.17.6.3.

4.17.9.7 Collecting Data from the 3rd Troubleshooting Recipe Test

Record the values from the 5th 'Wet-In, Dry-Only' Results column into the table below. Run all five 'Wet-In, Rinse and Dry' Troubleshooting Tests and add the particle count data of each run. Calculate for each Delta and calculate for the overall average 'Wet-In, Rinse and Dry' add-on. Subtract the Handling Test overall average from the 'Wet-In, Rinse and Dry' recipe overall average.

***Table 4-6**. 'Wet-In, Rinse and Dry' Troubleshooting Recipe Data Collection Table.*

		Wet-In, Rinse, Dry Run No. 1		Wet-In, Rinse, Dry Run No. 2		Wet-In, Rinse, Dry Run No. 3		Wet-In, Rinse, Dry Run No. 4		Wet-In, Rinse, Dry Run No. 5		
Wafer Slot Position	**5th Wet-In, Rinse-Dry Results**	**Results**	**Delta**	**Results**	**Delta**	**Results**	**Delta**	**Results**	**Delta**	**Results**	**Delta**	**Ave. Delta**
25	**52**	**60**	**8**	**65**	**5**	**66**	**1**	**67**	**1**	**69**	**2**	**3.4**
13	**39**	**45**	**6**	**52**	**7**	**68**	**16**	**72**	**4**	**75**	**3**	**7.2**
1	**49**	**64**	**15**	**66**	**2**	**70**	**4**	**76**	**6**	**80**	**4**	**6.2**
										Overall Average:		**5.60**

4.17.9.8 Calculating for Average 'Wet-In, Rinse and Dry Add-on

The average particle count added to the wafers after the first troubleshooting recipe can now be calculated:

Wafer Position	**Total Delta**	**Average Delta per Run**	**Overall Average per Wafer**	**Minus Handling Test Overall Average**	**Overall Average per Wafer by dryer**
25	17	3.4			
13	36	7.2			
1	31	6.2			
	Total: 84	Total: 16.8	**Total: 5.60**	**0.53**	**5.07**

The overall average per wafer particle count of **5.60** is the amount that is present on the wafers after the third troubleshooting recipe test. The **5.07** particle count value is the amount that is added to the wafers that was due to the dryer. If this value is unacceptable, go to Section 4.17.7.3 for troubleshooting results. If this value is acceptable, then the dryer is not adding unacceptable particle count to the wafers. This may point to other devices within the processing tool set (i.e., rinse bath, chemical tank, handling, cleanroom, facility fed chemicals, DI water and others).

TEST PERFORMED BY:________________________

DATE: ________________________

Dryer ID:________________________

		Handling Test Run No. 1		Handling Test Run No. 2		Handling Test Run No. 3		Handling Test Run No.4		Handling Test Run No. 5		
Wafer Slot Position	**Pre-Test Scan Results**	**Results**	**Delta**	**Results**	**Delta**	**Results**	**Delta**	**Results**	**Delta**	**Results**	**Delta**	**Ave. Delta**
25												
13												
1												
									Overall Average:			

		Dry-In, Dry-Only Run No. 1		Dry-In, Dry-Only Run No. 2		Dry-In, Dry-Only Run No. 3		Dry-In, Dry-Only Run No. 4		Dry-In, Dry-Only Run No. 5		
Wafer Slot Position	**5th Handling Test Results**	**Results**	**Delta**	**Results**	**Delta**	**Results**	**Delta**	**Results**	**Delta**	**Results**	**Delta**	**Ave. Delta**
25												
13												
1												
									Overall Average:			

		Wet-In, Dry-Only Run No. 1		Wet-In, Dry-Only Run No. 2		Wet-In, Dry-Only Run No. 3		Wet-In, Dry-Only Run No. 4		Wet-In, Dry-Only Run No. 5		
Wafer Slot Position	**5th Dry-In, Dry-Only Results**	**Results**	**Delta**	**Results**	**Delta**	**Results**	**Delta**	**Results**	**Delta**	**Results**	**Delta**	**Ave. Delta**
25												
13												
1												
									Overall Average:			

		Wet-In, Rinse-Dry Run No. 1		Wet-In, Rinse-Dry Run No. 2		Wet-In, Rinse-Dry Run No. 3		Wet-In, Rinse-Dry Run No. 4		Wet-In, Rinse-Dry Run No. 5		
Wafer Slot Position	**5th Wet-In, Rinse-Dry Results**	**Results**	**Delta**	**Results**	**Delta**	**Results**	**Delta**	**Results**	**Delta**	**Results**	**Delta**	**Ave. Delta**
25												
13												
1												
									Overall Average:			

TEST PERFORMED BY:____________________________

DATE: ____

Dryer ID:____

		Run No. 1		Run No. 2		Run No. 3		Run No. 4		Run No. 5		
Wafer Slot Position	Results	Results	Delta	Results	Delta	Results	Delta	Results	Delta	Results	Delta	Ave. Delta
25												
20												
15												
10												
5												
1												
									Overall Average:			

		Run No. 1		Run No. 2		Run No. 3		Run No. 4		Run No. 5		
Wafer Slot Position	Results	Results	Delta	Results	Delta	Results	Delta	Results	Delta	Results	Delta	Ave. Delta
25												
20												
15												
10												
5												
1												
									Overall Average:			

5 SECS II COMMUNICATIONS

5.1 Programming the Host Computer

The SuperClean 1600-55 comes standard with GFT's SECS-Interface. The SECS-II interface supports external process control by a host computer. The link between the dryer and a host computer is over an RS-232-C channel. GFT's SECS-II interface supports:

- Remote verification of dryer status, error condition and current recipe number.
- Remote recipe selection
- Remote review of recipe parameters
- Remote reprogramming of recipe parameters
- Remote dryer reset and cycle start/stop. Remote rotor index and door open/close.
- Manual override of host control at any time

GFT's implementation of the SECS-II protocol conforms to the SEMI (Semiconductor Equipment and Materials Institute, Inc.) SEC (Semi Equipment Communications) specification, versions E4-80 and E5-84. The electrical interface is made in accordance with EIA standard RS-232-C for interface type E, duplex communication. Stardard transmission speed is 9600 bps. Other speeds may be available depending on the specific configuration.

The dryer will not initiate a session with the host, it will only respond to host commands. Recipe parameters cannot be modified by the host while cycles are in progress. Recipe selection is accepted by the rinser/dryer only when the machine is in standby mode.

5.2 System Components and Specifications

Access to the communications port is made using a standard female Bell Modem 25-pin connector mounted on the controller. The pertinent signal lines are summarized in the following table.

Pin	Description
1	Shield
2	Transmitted Data
3	Received Data
7	Signal Ground

5.3 Supported Functions

The host may request the dryer to perform the following functions:

- Provide current machine status or error condition as outlined below:

Bit Definitions-Machine Status								
7	6	5	4	3	2	1	0	
I	I	I	I	I	I	I	1	Error
I	I	I	I	I	I	1		Stand-by
I	I	I	I	I	1			Cycle
I	I	I	I	1				Stop
I	I	I	1					Program
I	I	1						Index
I	1							Door Control
1								Wait

Bit Definitions-Error Condition								
7	6	5	4	3	2	1	0	
I	I	I	I	I	I	I	1	Power Failure
I	I	I	I	I	I	1		Index Error
I	I	I	I	I	1			Max Speed Reached
I	I	I	I	1				Low N_2 Pressure
I	I	I	1					Low Bladder Pressure
I	I	1						Door Open
I	1							Door Close Failure
1								Door Open Failure

- Remote Commands
  - ◊ Start or stop cycle
  - ◊ Index the rotor
  - ◊ Resistivity bypass
  - ◊ Open or close the door
  - ◊ Reset error condition
- View Recipe Parameters
  - ◊ Rinse time
  - ◊ Rinse speed
  - ◊ Dry time
  - ◊ Dry speed
  - ◊ Output options on/off
  - ◊ Resistivity setpoint (in meg-ohms)
- Change recipe parameters
  - ◊ Rinse time
  - ◊ Rinse speed
  - ◊ Dry time
  - ◊ Dry speed
  - ◊ Output options on/off
  - ◊ Resistivity setpoint (in meg-ohms)
- Output options
  - ◊ DI water valve
  - ◊ Nitrogen valve
  - ◊ Heater
  - ◊ Static eliminator
  - ◊ Resistivity bypass

5.4 Streams and Functions

GFT's Secs II implementation conforms to the SEMI specification. Information is conveyed between the dryer and the host computer by means of categories (**Streams**) and detailed messages (**Functions**). Message content is structured as Items and Lists.

The dryer will respond to the messages listed below when received from the host:

S1, F1	Presence check
S1, F5	Status or error check
S2, F19	Remote error reset
S2, F21	Commands
S7, F1	Select Recipe
S7, F3	Change Recipe
S7, F5	Read Recipe

Dryer responses include:

S1, F2	Response to presence check inquiry
S1, F6	Response to status or error check
S2, F20	Response to remote error reset
S2, F22	Response to remote command
S7, F2	Response to recipe selection request
S7, F4	Response to recipe change request
S7, F6	Response to recipe read request
S9, F1	Unrecognized device ID
S9, F5	Unrecognized function type

All transactions are initiated by the host by sending an <ENQ> character and awaiting an <EOT> character from the dryer. When the <EOT> has been received, the host will send the appropriate stream and function in SECS-II format (one byte block length, 10 bytes header, x bytes message, and two bytes checksum. Correct reception is acknowledged by an <ACK>; incorrect reception by a <NAK>.

The dryer will respond to the message received from the host and will wait for an <ACK> or <NAK>.

Details for each transaction supported by the Rinser/Dryer are given in Section 5.5, *Transaction Detail*.

5.5 Transaction Detail

5.5.1 Presence Checking

Message			Response		
S1, F1 H ➜ E			**S1, F2 E ➜ H**		
0A	Block Length		1A	Block Length	
0A	ID	Header	8A	ID	Header
28			28		
81	S1, F1		01	S1, F2	
01			02		
80	Blk. #		80	Blk. #	
01			01		
XX	System		XX	System	
XX			XX		
XX			XX		
XX			XX		
H	Checksum		01	List of 2 items	
L			02		
X = Don't care			41	4 ASCII bytes	Item 1
H = Checksum (Hi-byte)			04	Item 1	
L = Checksum (Lo-byte)			31	MDLN #1600	
			36		
			30		
			30		
			41	6 ASCII bytes	Item 2
			06	Item 2	
			XX	REV = X	
			XX	X	
			XX	X	
			XX	X	
			XX	X	
			XX	X	
			H	Checksum	
			L		
			Presence check will produce the proper EPROM ID value for revision		

5.5.2 Status or Error Check

Message			Response		
S1, F5 H ➜ E			**S1, F6 E ➜ H**		
0D	Block Length		2A	Block Length	
0A	ID		8A	ID	
28			28		
81	S1, F5		01	S1, F6	
05			06		
80	Blk. #	Header	80	Blk. #	Header
01			01		
XX	System		XX	System	
XX			XX		
XX			XX		
XX			XX		
21	1 binary item		01	List of 7 items	
01			07		
00	Status 0		21	2 binary bytes	
			02	Item 1	
H	Checksum				Item 1
L			XX	Status	
			XX	Error	
			41	1 ASCII bytes	
			01		
					Item 2
			XX	Recipe number (00-09)	
			41	1 ASCII byte	
			01		Item 3
			XX	Step #	
			41	4 ASCII bytes	
			04		
			XX	1's current rpm	Item 4
			XX	10's current rpm	
			XX	100's current rpm	
			XX	1000's current rpm	
			• • •		

Status or Error Check (*continued*)

Response

S1, F6 E ➜ H

41	4 ASCII bytes	
04		
XX	1's current time	Item 5
XX	10's current time	
XX	100's current time	
XX	1000's current time	
41	3 ASCII bytes	
03		Item 6
XX	.1's resistivity	
XX	1's resistivity	
XX	10's resistivity	
21	1 binary byte	
01		Item 7
XX	IOS	
H	Checksum	
L		

See below for Status, Error, and IOS details

5.5.2.1 Status/Error Check Detail

Status is a single binary byte.

B0 = 1	In error mode
B1 = 1	In standby mode
B2 = 1	In cycle (run) mode
B3 = 1	In motor deceleration mode
B4 = 1	In local programming mode
B5 = 1	In indexing mode
B6 = 1	In door open/close mode
B7 = 1	Waiting for resistivity to reach setpoint

Error is a single binary byte. This byte is checked if B0 of the status byte is set.

B0 = 1	Power failure (power failed while the machine was in the cycle or deceleration mode.)
B1 = 1	Index failure
B2 = 1	Rotor speed beyond 3200 RPM
B3 = 1	Low nitrogen pressure
B4 = 1	Low bladder pressure
B5 = 1	Door opened while machine was in run mode
B6 = 1	Door close failure
B7 = 1	Door open failure

IOS (output status) is a single binary byte.

B0 = 1	DI water valve is open
B1 = 1	Nitrogen valve is open
B2 = 1	Heater is on
B3 = 1	Static eliminator is on
B4 = 1	Resistivity selected (rinse cycle ends when timer expires and rinse water reaches resistivity setpoint)
B5 = 1	Door Open
B6 = 1	Door Closed
B7 = 1	Heater Failure. (Detected Off. Should be On)

5.5.3 Remote Error Reset

Message			Response		
S2, F19 H ➜ E			**S2, F20 E ➜ H**		
0D	Block Length		0D	Block Length	
0A	ID	Header	8A	ID	Header
28			28		
82	S2, F19		02	S2, F20	
13			14		
80	Blk. #		80	Blk. #	
01			01		
XX	System		XX	System	
XX			XX		
XX			XX		
XX			XX		
A5	1 integer		21	unsigned byte	
01	unsigned byte		01		
XX	RIC		XX	RIA	
H	Checksum		H	Checksum	
L			L		
RIC is a single unsigned integer that instructs the dryer to reset the error flags.			RIA is a single unsigned integer that notifies the host if reset is done or not		
RIC = 00h Reset error flags			RIA = 01h Reset denied		
			RIA = 00h Reset to be done		
			Reset denied will be sent to the host when the source of the error has not been corrected		

5.5.4 Commands

Message			Response		
S2, F21 H ➜ E			**S2, F22 E ➜ H**		
0D	Block Length		0D	Block Length	
0A	ID	Header	8A	ID	Header
28			28		
82	S2, F21		02	S2, F22	
15			16		
80	Blk. #		80	Blk. #	
01			01		
XX	System		XX	System	
XX			XX		
XX			XX		
XX			XX		
21	1 integer		21	1 integer	
01	unsigned byte		01	unsigned byte	
X	RCMD		X	CMDA	
H	Checksum		H	Checksum	
L			L		
RCMD is a single binary remote command code.			CMDA is a single binary command acknowledge code.		
RCMD = 0	Stop the cycle		CMDA = 0	Command accepted	
RCMD = 1	Start the cycle		CMDA = 1	Command does not exist	
RCMD = 2	Index and system reset		CMDA = 2	Cannot perform now	
RCMD = 3	Bypass resistivity				
RCMD = 4	Door open				
RCMD = 5	Door close				

5.5.5 Select Recipe

Message			Response		
S7, F1 H ➜ E			**S7, F2 E ➜ H**		
12	Block Length		0D	Block Length	
0A	ID	Header	8A	ID	Header
28			28		
87	S7, F1		07	S7, F2	
01			02		
80	Blk. #		80	Blk. #	
01			01		
XX	System		XX	System	
XX			XX		
XX			XX		
XX			XX		
01	List of 2 items		21	1 binary byte	
02			01		
41	1 ASCII byte	Item 1	XX	PPGNT	
01					
XX	PPID (Recipe #)				
A5	1 integer	Item 2	H	Checksum	
0	unsigned byte		L		
XX	Length				
H	Checksum				
L					
PPID is a single ASCII byte that contains the process program recipe number. Valid PPIDs are 30h through 39h (recipes 0 through 9). Anything else is invalid			PPGNT is a single binary byte that notifies the host if the recipe selection is granted or if there is an error		
Length is not used, and could be anything			PPGNT = 00h Selection accepted PPGNT = 03h Invalid PPID PPGNT = 04h Cannot perform now		
			Recipe selection is accepted only if the machine is in standby mode		

5.5.6 Change Recipe

Message			Response		
S7, F3 H ➜ E			**S7, F4 E ➜ H**		
XX	Block Length		0D	Block Length	
0A	ID		8A	ID	
28			28		
87	S7, F3		07	S7, F4	
03			02		
80	Blk. #	Header	80	Blk. #	Header
01			01		
XX	System		XX	System	
XX			XX		
XX			XX		
XX			XX		
01	List of 2 items		21	1 binary byte	
02			01		
41	1 ASCII byte		XX	ACK	
01		Item 1			
XX	PPID (Recipe #)		H	Checksum	
			L		
01	Item #2 (includes Steps 0-9)		ACK is a single binary byte		
XX	NOSPR (Number of recipe steps)		ACK = 00h Changes accepted		
A9	Item contains four 2 byte integers		ACK = 04h PPID not found		
08	unsigned integers		ACK = 05h Mode unsupported (NOSPR > 10)		
MS BYTE	Speed		ACK = 40h Programmed speed > 3200 RPM		
LS BYTE	(RPM)		ACK = 41h Programmed time > 9999 seconds		
MS BYTE	Time		ACK = 42h Programmed resistivity>19.9 meg-ohm		
LS BYTE	(sec)	Step #0	ACK = 43h Static eliminator & DI on at same time.		
MS BYTE	Resistivity				
LS BYTE	(meg-ohm)				
00000000	Output				
LS BYTE	Options				
•					
•					
•					

Message	
	Change Recipe (*continued*)

S7, F3 H → E		
A9	Item contains four 2 byte integers	
08	unsigned integers	
MS BYTE	Speed	Step #1
LS BYTE	(RPM)	
MS BYTE	Time	
LS BYTE	(sec)	
MS BYTE	Resistivity	
LS BYTE	(meg-ohm)	
00000000	Output	
LS BYTE	Options	
A9	Item contains four 2 byte integers	
08	unsigned integers	
MS BYTE	Speed	Step #8
LS BYTE	(RPM)	
MS BYTE	Time	
LS BYTE	(sec)	
MS BYTE	Resistivity	
LS BYTE	(meg-ohm)	
00000000	Output	
LS BYTE	Options	
A9	Item contains four 2 byte integers	
08	unsigned integers	
MS BYTE	Speed	Step #9
LS BYTE	(RPM)	
MS BYTE	Time	
LS BYTE	(sec)	
MS BYTE	Resistivity	
LS BYTE	(meg-ohm)	
00000000	Output	
LS BYTE	Options	
H	Checksum	
L		

Message

Change Recipe (*continued*)

S7, F3 H ➜ E	
PPID is the recipe number. NOSPR is the number of steps per recipe It is not necessary to have all ten possible steps programmed in each recipe: a recipe can consist of only one step Output option assignments:	
B0 = 1	DI water valve is open
B1 = 1	Nitrogen valve is open
B2 = 1	Heater is on
B3 = 1	Static eliminator is on
B4 = 1	Resistivity is selected (rinse cycle ends when timer expires and rinse water meets or exceeds resistivity setpoint).
B5	Not used
B6	Not used
B7	Not used

5.5.6.1 Change Recipe Example

Assume you are to program recipe #5 with three steps, as outlined below:

Recipe Parameters	Step 0 Rinse Cycle	Step 1 Dry Cycle	Step 2 Dry Cycle
Speed	300 RPM	3000 RPM	600 RPM
Time	120 Sec	180 Sec	60 Sec
Resistivity Setpoint	17.8 Meg-ohm	N/A	N/A
DI valve	On	Off	Off
N2 valve	Off	On	On
Heater	On	On	On
Anti-static	N/A	On	On
Resistivity	On	N/A	N/A

NOTE

When the Resistivity option is "on", the rinse timer must expire before the resistivity set point will be checked.

A sample host message setting the above parameters is listed on the following page.

5.5.6.2 Sample Host Message

Message			Response		
S7, F3 H ➜ E			**S7, F4 E ➜ H**		
2F	Block Length		0D	Block Length	
70A 28	ID	Header	8A 28	ID	Header
87 03	S7, F3		07 02	S7, F4	
80 01	Blk. #		80 01	Blk. #	
00 00 00 00	System		00 00 00 00	System	
01 02	List of 2 items		21 01	1 binary byte	
41 01	1 ASCII byte	Item 1	00	ACK	
05	PPID		H L	Checksum	
01	Item #2 (includes Steps 0-9)		ACK is a single binary byte		
03	NOSPR (Number of recipe steps)		ACK = 00h Changes accepted ACK = 04h PPID not found ACK = 05h Mode unsupported (NOSPR > 10) ACK = 40h Programmed speed > 3200 RPM ACK = 41h Programmed time > 9999 seconds ACK = 42h Programmed resistivity>19.9 meg-ohm ACK = 43h Static eliminator & DI on at same time.		
A9 08	Item contains four 2 byte integers unsigned integers				
01 2C	Speed (RPM)	Step #0			
00 78	Time (sec)				
00 B2	Resistivity (meg-ohm)				
00 15	Output Options				

Message
S7, F3 H ➜ E

Sample Host Message (*continued*)

A9	Item contains four 2 byte integers	
08	unsigned integers	
0B	Speed	Step 1
B8	(RPM)	
00	Time	
B4	(Sec)	
00	Resistivity	
00	(Meg-ohm)	
00	Output	
0E	Options	
A9	Item contains four 2 byte integers	
08	unsigned integers	
02	Speed	Step 2
58	(RPM)	
00	Time	
3C	(Sec)	
00	Resistivity	
00	(Meg-ohms)	
00	Output	
0E	Options	
H	Checksum	
L		

5.5.7 Read Recipe

Message			Response		
S7, F5 H ➜ E			**S7, F6 E ➜ H**		
0F	Block Length		XX	Message Length	
0A	ID		8A	ID	
28			28		
87	S7, F5		07	S7, F6	
03			06		
80	Blk. #	Header	80	Blk. #	Header
01			01		
XX	System		XX	System	
XX			XX		
XX			XX		
XX			XX		
01	List of 1 item		01	List of 2 items	
01			02		
41	1 ASCII byte		41	1 ASCII byte	
01			01	Item #1	Item 1
XX	PPID		XX	PPID	
H	Checksum		01	Item #2	
L			XX	NOSPR	
X = Don't care			A9	Item contains four 2 byte integers	
H = Checksum (Hi-byte)			08	unsigned integers	
L = Checksum (Lo-byte)			MS BYTE	Speed	
			LS BYTE	(RPM)	
			MS BYTE	Time	
			LS BYTE	(Sec)	Step 0
			MS BYTE	Resistivity	
			LS BYTE	(Meg-ohms)	
			00000000	Output	
			LS BYTE	Options	
			• • •		

Read Recipe (*continued*)

Response

S7, F6 E ➜ H

A9 08	Item contains four 2 byte integers unsigned integers	
MS BYTE LS BYTE	Speed (RPM)	Step 1
MS BYTE LS BYTE	Time (Sec)	
MS BYTE LS BYTE	Resistivity (Meg-ohms)	
00000000 LS BYTE	Output Options	
A9 08	Item contains four 2 byte integers unsigned integers	
MS BYTE LS BYTE	Speed (RPM)	Step 8
MS BYTE LS BYTE	Time (Sec)	
MS BYTE LS BYTE	Resistivity (Meg-ohms)	
00000000 LS BYTE	Output Options	
• • •		

Read Recipe (*continued*)

Response

S7, F6 E ➜ H

A9	Item contains four 2 byte integers
08	unsigned integers

MS BYTE	Speed	Step 9
LS BYTE	(RPM)	
MS BYTE	Time	
LS BYTE	(Sec)	
MS BYTE	Resistivity	
LS BYTE	(Meg-ohms)	
00000000	Output	
LS BYTE	Options	

H	Checksum
L	

PPID is the recipe number

NOSPR is the number of steps per recipe

It is not necessary to have all ten possible steps programmed in each recipe: a recipe can consist of only one step

Output option assignment:

B0 = 1	DI water valve is open
B1 = 1	Nitrogen valve is open
B2 = 1	Heater is on
B3 = 1	Static eliminator is on
B4 = 1	Resistivity is selected (rinse cycle ends when timer expires and rinse water meets or exceeds resistivity setpoint)
B5	Not used
B6	Not used
B7	Not used

5.5.8 Stream 9 System Errors

Response	Response
S9, F1 E ➜ H	**S9, F5 E ➜ H**
0A Block Length	0A Block Length
8A ID 28 09 S9, F1 01 80 Blk. # Header 01 XX System XX XX XX	8A ID 28 09 S9, F5 05 80 Blk. # Header 01 XX System XX XX XX
H Checksum L	H Checksum L
X = Don't care H = Checksum (Hi-byte) L = Checksum (Lo-byte)	X = Don't care H = Checksum (Hi-byte) L = Checksum (Lo-byte)
Response is sent from an unrecognized I. D.	Response is sent from an unrecognized function

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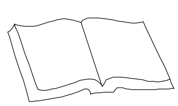
6 INSTALL and TEST PROCEDURES

6.1 Installation Summary Instructions

NOTE
Although installation information is presented throughout this manual, installation and test procedures are summarized here.

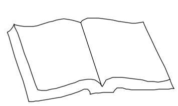
6.1.1 Facility Requirements – Single Dryer

DI H_2O Input	$^3/_8$-inch OD Teflon tubing		
	1.75 gpm minimum		
	25 psi dynamic minimum		
	40 psi dynamic maximum for low pressure valve		
	70 psi dynamic maximum for high pressure valve		
DI H_2O Return	$^3/_8$-inch OD Teflon tubing		
	minimum 5 psi lower than input pressure valve		
System N_2	$^3/_8$-inch OD Teflon tubing		
	6-7 scfm (gauge reading)		
	60 psi dynamic minimum		
CDA / N_2	Operates pneumatic components		
	¼-inch OD Teflon tubing		
	60-90 psi dynamic		
Drain	1 ½-inch mnpt (drain box).		
	1 ½-inch pvc pipe (drain plumbing option)		
Vent	1 ½-inch pvc pipe		
Exhaust	-0.5 max to -1.0 inches of water if not exhausted to fab		
Power	**Voltage**	**Hertz**	**Amps**
	120 vac	50/60	15 – Standard
			18 – Step-Up Transformer
			10 – Step-Down Transformer

DOCUMENT	
	Depending on Single Dryer configuration, refer to drawings: 1098565, or, 1098566

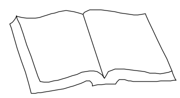
6.1.2 Facility Requirements – Double-Stack Dryers

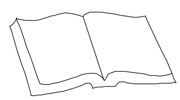
DI H_2O Input	Dual $^3/_8$-inch OD Teflon tubing without single point option		
	½-inch OD Teflon tubing with single point Flaretek		
	½-inch OD Teflon tubing w/ single point compression		
	3.5 gpm minimum		
	25 psi dynamic minimum		
	40 psi dynamic maximum for low pressure valve		
	70 psi dynamic maximum for high pressure valve		
DI H_2O Return	Dual $^3/_8$-inch OD Teflon tubing without single point option		
	½-inch OD Teflon tubing with single point Flaretek		
	½-inch OD Teflon tubing w/ single point compression		
	minimum 5 psi lower than input pressure valve		
System N_2	Dual $^3/_8$-inch OD Teflon tubing without single point option		
	½-inch OD Teflon tubing with single point Flaretek		
	½-inch OD Teflon tubing w/ single point compression		
	12-14 scfm (gauge reading)		
	60 psi dynamic minimum		
CDA / N_2	Operates pneumatic components		
	Dual ¼-inch OD Teflon tubing without single point option		
	½-inch OD Teflon tubing with single point Flaretek		
	$^3/_8$-inch OD Teflon tubing w/ single point compression		
	60-90 psi dynamic		
Drain	1 ½-inch mnpt (drain box).		
	1 ½-inch pvc pipe (drain plumbing option)		
Vent	1 ½-inch pvc pipe		
Exhaust	-0.5 max to -1.0” of water if not exhausted to fab		
Power	**Voltage**	**Hertz**	**Amps**
	120 vac	50/60	15 – Standard
			18 – Step-Up Transformer
			10 – Step-Down Transformer

DOCUMENT	
	Depending on Double-Stack Dryer configuration, refer to drawings: 1098563, or, 1098564

6.1.3 Physical Requirements for Wet System Mounting

The following dimensions indicate the minimum space needed to mount a dryer in a typical wet system. GFT suggests mounting a dryer no less than 24 inches and no more than 27 inches above the fab floor, as measured from the bottom of the dryer. GFT suggests mounting the Keypad no less than 42 inches and no more than 66 inches above the fab floor, as measured from the bottom of the Keypad.

DOCUMENT	
	Depending on Single Dryer configuration, refer to the following drawings for dryer measurements: 1098565, or, 1098566

DOCUMENT	
	Depending on Double-Stack Dryer configuration, refer to the following drawings for dryer measurements: 1098563, or, 1098564

6.1.4 Pre-Installation Safety Information

6.1.4.1 Ergonomics

GFT does not provide specific installation location requirements. However, the installation location should account for height, reach, load weight, and other factors to provide the operator a safe and comfortable access to the dryer and the keypad. To quote guidelines indicated in SEMI S2-93, the installation should account for the "5th percentile small Asian female to the 95th percentile large American male". Typical installations generally place the system so that the grasp height is approximately 35- to 38-inches above foot level, and no farther than a 7- to 18-inch reach.

WARNING	
	**DRYER IS TOO HEAVY FOR ONE PERSON LIFT!** Due to the excessive weight of the dryer, handling (lifting) should be performed by two persons (minimum).

6.1.4.2 Seismic Activity Precaution

CAUTION	
⚠	**POTENTIAL PRODUCT OR EQUIPMENT DAMAGE!** The system should be secured to in such a fashion as to inhibit movement in the event of any seismic activity.

Regardless of the locating and leveling means, the dryer should be secured against both vertical and horizontal movement. Securing means should take into account the weight of the dryer under normal operating conditions.

6.1.4.3 User Supplied Devices

“User Supplied Devices" refers to signal lights, switches and alarms, etc., that may be interfaced with the dryer but are not supplied by or purchased from GFT.

Before connecting a user supplied device to the dryer, always refer to the specifications outlined in the drawings to verify that the device can be supported and to determine which wires are used to interconnect the device to the dryer.

6.1.4.4 Equipment Noise Data

The end user of this equipment can expect a continuous A-weighted sound pressure level of less than 70dB(A) at the front of the dryer; and no peak C-weighted instantaneous sound pressure levels in excess of 63 Pa.

6.1.4.5 Dryer Safety Protection

GFT suggests the following protection for all dryers.

- Dryer Circuit Protection
- Electrical Lockout and Tag Procedures
- Emergency Shutdown (EMO / EPO)

6.1.4.6 Dryer Circuit Protection

The facility circuit protection device should be rated to withstand the short circuit current of no less than 10,000 rms symmetrical amperes at 208/120 volts at the incoming terminals.

Power receptacle service requirements are standard #10 AWG 20 ampere wiring, NEMA receptacle configuration type 15-20R. If the specified receptacle is not used, rigid conduit, or flexible conduit for runs of less than 20 feet, must be used. A Ground Fault Interrupter (GFI) with a trip current of less than 7 mA should be employed for personal protection.

6.1.4.7 Electrical Disconnect and Equipment Lockout

Follow standard procedures when working on electrical equipment. The breaker box or branch circuit feeding the equipment must be locked and tagged with the appropriate information.

GFT may not supply a lockable, safety-type electrical disconnect with some dryers. GFT therefore suggests that the end-user provide a means of disconnecting power to the dryer with a lockable-type safety disconnect. Follow all equipment safety Lockout and Tag procedures as outlined in your country’s and/or company's equipment safety manuals.

European standards require proper markings on the disconnect. If a mains plug is installed, is should conform to IEC 320. The EU end user should provide a main power cord that meets the requirements of IEC 227 or IEC 245, and is listed by a recognized European testing laboratory (i.e., HAR Cordage).

6.1.4.8 Emergency Shutdown

GFT and S2-93 specifications recommend the installation of an Emergency Power Off (EPO) push-button on all dryers to shut main power off should an "EMERGENCY" situation arise. The EPO pushbutton should be of the red mushroom-type and labeled "*EMERGENCY POWER OFF*".

NOTE

The EPO mounting height should not exceed 63.5 inches from the floor. If planning to install an EPO, it is important to provide a separate POWER ON button to return power after MAIN POWER has been shut off.

CAUTION

POTENTIAL PRODUCT OR EQUIPMENT DAMAGE!

If installing an EPO button, a clear PVC sleeve surrounding the EPO button is required to prevent accidental activation of the EPO.

The following diagram (Figure 6-1) is a typical Emergency Power Off or Emergency Off circuit.

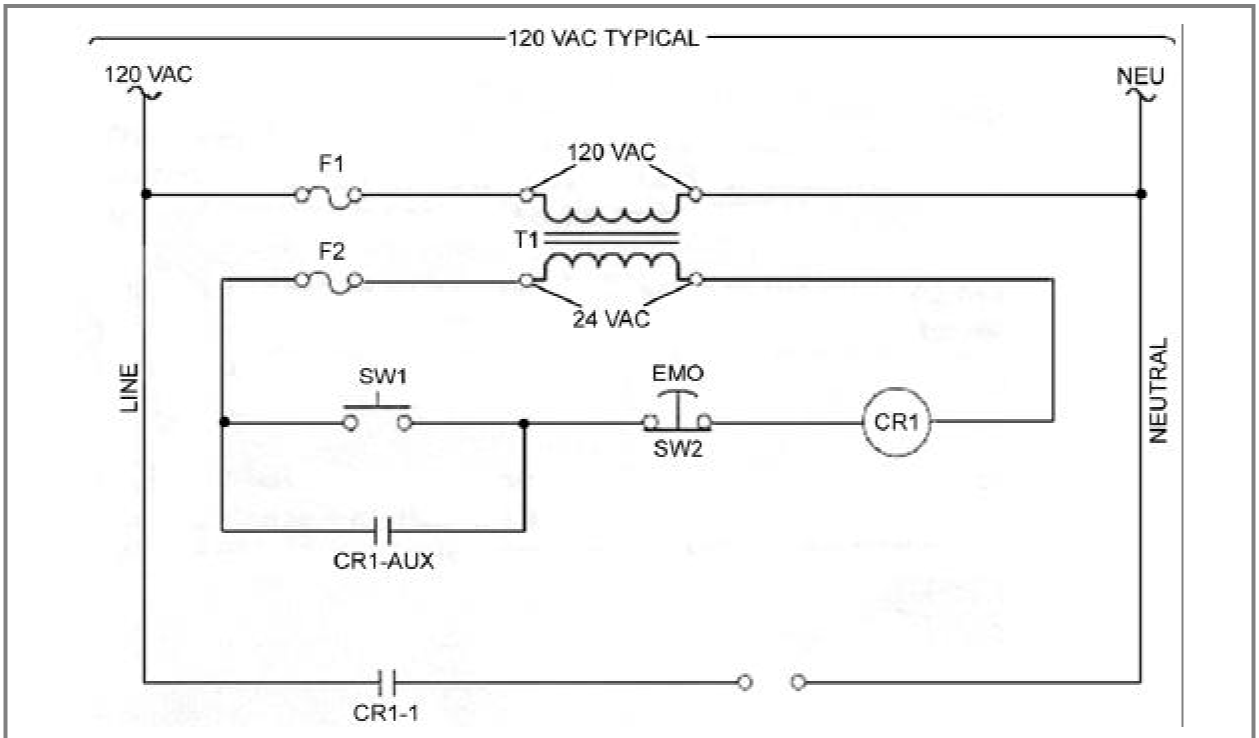


Figure 6-1*. A typical Emergency Power Off or Emergency Off circuit.*

Circuit Components	Description
F1	Primary protection for transformer T1
F2	Secondary protection for transformer T2
T1	24 VAC isolation transformer
SW1	Momentary POWER ON pushbutton (green)
SW2	EMO (EPO) pushbutton, red mushroom-type, 60 mm diameter with shroud
CR1	24VAC power contractor with N.O. auxiliary contact

If the input voltage is reduced to 24 VAC, SW1 energizes CR1 and is held using a CR1-AUX contact, also applying power to the dryer using a CR1-1 main contacts (120 VAC). Should an emergency arise, the operator presses the EMO pushbutton which will open the circuit and removing all AC input to the dryer.

6.1.4.9 Lighting in Work Areas

CAUTION

IMPROPER LIGHTING CAN CAUSE HAZARDOUS CONDITIONS

When performing maintenance in enclosed bays and cabinets, S2-93 safety requirements call for the lighting to be at or greater than 30 footcandles in power. Use additional lighting apparatuses where lighting is less than 30 footcandles in all work areas associated with GFT equipment.

6.1.4.10 Cassette Requirements

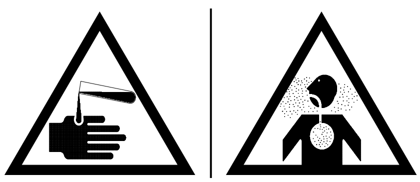
CAUTION

POTENTIAL PRODUCT OR EQUIPMENT DAMAGE!

Using the wrong cassette in the dryer may cause damage to the labyrinth seal and rotor. Ensure the serial number of the cassette matches the number on the rotor. See Section 3, Operations, for location of these numbers. The dryer is balanced with the cassette, thus, never run a cycle without the cassette installed in the process bowl.

6.1.4.11 Chemical Compatibility

CAUTION



TYPICAL CHEMICAL USAGE

These dryers are designed to operate with the following industry standard chemistries:

- DI Water
- SC1 = DI Water, H_2O_2, NH_4OH
- SC2 = DI Water, H_2O_2, HCl

6.1.5 Installation Procedures – Single Dryer

The following instructions are for a typical single-dryer installation. Your requirements may vary from these instructions.

1. Ensure all facilities are off before install procedures are performed.

2. Remove the dryer from the shipping carton and plastic wrapping. Remove the screws from the bottom of the shroud, then slide the shroud backwards off the dryer. Visually inspect the dryer, verifying that all fasteners are tight.

3. Set the dryer over the cutout of the wet system. Secure the dryer to the wet system with screws through the holes on the right and left sides of the dryer's base plate at the rear.

4. While standing behind the basemount assembly, use the handles on either side of the dryer to slide the it into place in the basemount assembly.

Ensure the polypropylene stop is against the front of the basemount and the gasket is properly seated on the side rails.

5. Reinstall the cover and shroud screws. At the dryer's rear, slide the cover forward in the slides until the locator brackets on the cover engage the front panel.

6. If not already install, locate the 2-inch flex hose at the bottom of the dryer. Connect this hose to the drain inlet on the drain box with the supplied clamp.

7. Install the controller, panel and any optional components in their designated locations.

8. Connect the DI water bypass line (3/16-inch Tygon tubing) to the hose barb on top of the drain box.

9. Connect the drain outlet on the bottom of the drain box to the facilities drain. Use Teflon tape when making this connection.

10. Connect both nitrogen fittings on the dryer to the facilities nitrogen supply.

NOTE
The dryer requires two independently plumbed nitrogen lines. The system nitrogen line connects to the 3/8-inch fitting; the secondary nitrogen line connects to the ¼inch fitting.

11. Connect the DI IN fitting to the facilities DI water supply. Connect the DI RETURN fitting to the facilities recirculation system. Use 3/8-inch OD Teflon tubing for both connections.

12. Connect the female end of the power cable and the female end of the data cable to the two electrical connectors on the back of the dryer. The power cable (P106) connects to R106; the data cable (P105) connects to R105.

13. Route these two cables to the controller. The power cable male end (P101) connects to R101; the male end of the data cable (P102) connects to R102.

14. Route the resistivity probe cable from the drain box to the resistivity monitor. Connect the female end of the cable (P107) to the connector labeled PROBE (R107) on the resistivity monitor.

15. Connect the female end of the resistivity cable (P108) to the connector on the resistivity monitor labeled CONTROL BOX (R108). Route the resistivity cable to the control box and connect the male fitting (P100) to the connector labeled RESISTIVITY MONITOR (R100).

16. Connect the male end of the control panel cable (P103) to the connector on the controller labeled KEYPAD (R103). Route the cable to the control panel and connect the female end to the connector on the back of the control panel. Use two machine crews to secure each end of the control panel cable to its respective connector.

17. Plug the power cable into the receptacle on the controller labeled R99. Plug the AC power cord on the controller into the facilities electrical supply. Power on the dryer. The LEDs on the Keypad will illuminate. The RPM LED will display zeros briefly. After to rotor has automatically indexed, the parameters for the last recipe used will be display and the dryer is ready of testing. Go to Section 6.2, *After-Install Test Procedures*.

6.1.6 Installation Procedures – Double-Stack Dryer

The following instructions are for a typical double-stack dryer installation. Your requirements may vary from these instructions.

1. Be certain all facilities are off before installation procedures are performed.

2. Remove the dryers from the pallet, shipping carton and plastic wrapping. Remove the screws from the bottom of the shrouds, then slide the shrouds backwards off the dryers. Visually inspect each dryer, verifying that all fasteners are tight.

3. Roll the stack into the fab area. Level the dryers using the leveling pads.

4. Connect the drain outlet on the frame to the facilities drain.

5. Use ½-inch Teflon tubing to connect the facilities DI water and N_2 facilities to the connectors on the facility panel located on the bottom left of the frame as you face the dryers. Use ½-inch tubing to connect the DI Return outlet to the facilities recirculation system. Use ¼-inch tubing to connect the facilities CDA supply to the CDA inlet.

6. If required, use a customer-supplied RS-232-C cable with a male 25-pin D connector and connect the host computer to the RS-232-C female interface connector on the control box.
7. Connect the two AC power lines to the facilities electrical supply.
8. Turn the facilities ON. Verify the RG1 (N_2 In) is set to 45 psi on each dryer. Go to Section 6.2, *After-Install Test Procedures-1600-55 Automatic Door*, or Section 6.3, *After-Install Test Procedures-1600-55 Manual Door*.

NOTE

If the optional EPO feature was ordered, verify that the AC power cord is connected to the receptacle(s) on the EPO rather than directly to the facilities supply. Also verify that the EPO receptacle on the contactor box is connected to the EPO switch on the dryer's cabinet.

6.2 After-Install Test Procedures 1600-55 - Automatic Door

The following procedure is written for the trained technician.

Serial Number:	______________	**Location:**	______________
Customer:	______________	**Voltage:**	________ **Hz:** ________
Rotor P/N:	______________	**Carrier Type:**	______________
Rotor S/N:	______________	**Bal Std:**	______________
Hinge Direction:	***Left // Right***	**Software #:**	______________
Inspected By:	______________	**Date:**	______________
Customer Signature:	______________	**Date:**	______________

NOTE

Do not power up the dryer prior to visual/hardware checks.

☐ **1.** Verify that all equipment and options according to the sales order are installed on the dryer.

☐ **2.** Check for GFT labels on Keypad, Resistivity Monitor, Controller & Centrifuge.

☐ **3.** Visually inspect dryer for:

- ☐ Bowl for scratches and dents.
- ☐ Cables / connectors for cuts/general condition.

NOTE

If cables were modified, check for crimps and spliced wires by removing backshells.

- ☐ Verify all cables are connected properly.
- ☐ N_2 and DI connections are correct and tight.
- ☐ All hardware is tight.
- ☐ Panels and covers for damage.

☐ **4.** Open control dryer and verify the following:

- ☐ Resistivity PCB location (if applicable)
- ☐ SECS II S/W installed (if applicable)
- ☐ Check for loose screws, wires, all hardware.

☐ **5.** Check fuse sizes and labels:

- ☐ Main 15A, Heater 15A, Motor 15A, Controller 3A.

☐ **6.** Check door alignment to bowl.

☐ **7.** Check bladder for cleanliness and cuts.

☐ **8.** Remove the rotor.

☐ **9.** Verify hub set screws are tight:

- ☐ Verify that the seal plate is centered with the hub.
- ☐ Ensure that the hub space is:
  - ☐ 2-5 Inch rotors .050 inches
  - ☐ 6 inch rotors .080 inches

☐ **10.** Install rotor. Tighten down screws in proper sequence. (12, 6, 9, 3 O'clock position)

NOTE
Do not operate the dryer without a carrier.

☐ **11.** Install proper carrier with correct load requirements.

NOTE
Prior to connecting facility DI to SRD, run DI into drain for 5-10 minutes to discard particles in line.

☐ **12.** Plug in dryer. Remove shroud Cover & Turn on facility DI and N_2 and check for leaks.

☐ **13.** Power up dryer. Check all valves, switches and regulators.

- [ ] **14.** Start dryer. Check for DI leaks in the manifold, connections, drain box and tubing.
- [ ] **15.** Verify DI / N_2 check valve. (no DI in N_2 line during rinse).
- [ ] **16.** Verify that there are no N_2 leaks at connectors, manifold, static eliminator, clean coil, fittings, regulators, switches, gauges.
- [ ] **17.** Verify maximum speed programming limitations. (3200 RPM)
- [ ] **18.** Verify resistivity functions:
  - [ ] Resistivity override
  - [ ] Timed resistivity
- [ ] **19.** Verify all L.E.D. functions on keypad.
- [ ] **20.** Verify no excessive vibration.
- [ ] **21.** At end of cycle, verify index position is exactly at the 12 O'clock position. If not, adjust CAM mechanism and optical sensor.
- [ ] **22.** Verify that bladder switch PSW-2 is set to 16 PSI. If not, adjust. Verify loss of lid seal pressure operation and display on the keypad controller.
- [ ] **23.** Adjust bladder N_2 regulator RG2 to 21 PSI.
- [ ] **24.** Adjust N_2 switch PSW-1 to 13 PSI dynamic. Verify loss of N_2 pressure operation and display on the key pad controller.
- [ ] **25.** Adjust N_2 regulator RG1 to 23 PSI dynamic.
- [ ] **26.** Adjust index switch PSW-3 to 35 PSI static.
- [ ] **27.** Adjust index regulator RG3 to 40 PSI static.
- [ ] **28.** Verify static eliminator is not arcing.
- [ ] **29.** Check thermostats. (Reconnect rim heater if applicable).
- [ ] **30.** Verify the clean coil protection circuit by disconnecting the white wire on the relay coil. Push the start button, the "N_2 pressure" lamp should display on the keypad.

31. Verify “Dead Man” function and no bladder leaks:

- Start dryer then turn off power.
- Wait 5 minutes to verify no leaks.
- Exercise bladder relief valve and verify bladder deflates.
- Turn power on and verify power failure display on the keypad controller.

32. Verify that the N_2 purge shuts off 30 seconds after completion of a cycle.

NOTE

SECS II S/W is required on all automatic rinser/dryers. Host SECS II S/W is required for remaining tests.

NOTE

Exercise these functions throughout the remainder of the tests with the customer.

33. Connect the host computer to the dryer and boot up the host test S/W.

34. Power up the dryer to the standby condition and clear the error register from the host.

35. From the host give the “Door Open” command and verify a smooth opening within 5 to 6 seconds. Adjust needle valve if necessary.

36. From the host give the “Door Close” command and verify a smooth closing operation within 5 to 6 seconds. Adjust needle valve if necessary.

37. From the host give the “Index Initialize” command and verify smooth operation and indexing at exactly 12 O’clock. Adjust air cylinder if necessary. Re-adjust mechanism if necessary.

38. Exercise the start and stop functions throughout the test from the host.

- Verify from the host:
- Resistivity bypass command.

- Recipe editing function.
- Recipe select function.
- Changing recipe parameters function.
- Looking at recipes.
- Reading machine status.

39. Check the following error conditions using the host S/W:

NOTE

After every test, reset the error register.

- Power failure (ER = 1): while dryer is running turn power off.
- Index failure (ER = 2): turn down RG3 below 35 PSI while dryer is running.
- Stop dryer, it should not index.
- Low N_2 pressure (ER = 8) : Turn RG2 below 13 PSI while dryer is running.
- Low bladder pressure (ER = 16) :Turn down RG1 below 17 PSI while dryer is running.
- Door open while in running mode (ER = 32) : Push bladder relief valve and open door.
- Door open failure (ER = 128) :Give door open command, hold door shut.
- Door close failure (ER = 64): Give door close command, hold door open.

40. During hose interface test re-verify the following:

- Resistivity bypass.
- Recipe and step functions.
- Max speed 3200 RPM.
- All heater thermostats.

- ☐ Static eliminator.
- ☐ All valves, switches, connections.
- ☐ Direction of rotation of rotor.
- ☐ Door switch and verify door failure display on the keypad controller.
- ☐ Verify acceleration rates for:

Rinse: 0-300 RPM, 7-10 seconds.
Dry: 300-3000 RPM, 60-70 seconds

☐ **41.** Assist particle test required? Y/N

☐ **42.** Wipe down dryer and verify cleanliness.

☐ **43.** Re-torque seal and lock tight all accessible hardware.

☐ **44.** Replace covers and tighten all screws.

☐ **45.** Program and record the desired process parameters.

Rinse Time:	____________________	seconds
Rinse Speed:	____________________	RPM
Dry Time:	____________________	seconds
Dry Speed:	____________________	RPM

COMMENTS:

6.3 After-Install Test Procedures 1600-55 - Manual Door

The following procedure is written for the trained technician.

Serial Number:	____________	**Location:**	____________
Customer:	____________	**Voltage:**	______ **Hz:** ______
Rotor P/N:	____________	**Carrier Type:**	____________
Rotor S/N:	____________	**Bal Std:**	____________
Hinge Direction:	***Left // Right***	**Software #:**	____________
Inspected By:	____________	**Date:**	____________
Customer Signature:	____________	**Date:**	____________

NOTE

Do not power up the dryer prior to all visual and hardware checks being verified.

☐ **1.** Verify that all equipment and options according to the sales order are installed on the dryer.

☐ **2.** Check for GFT labels on Keypad, Resistivity Monitor, Controller & Centrifuge.

☐ **3.** Visually inspect dryer for:

- ☐ Bowl for scratches and dents.
- ☐ Cables / connectors for cuts/general condition.

NOTE

If cables were modified, check for crimps and spliced wires by removing backshells.

- ☐ Verify all cables are connected properly.
- ☐ N_2 and DI connections are correct and tight.
- ☐ All hardware is tight.

- [ ] • Check brake cylinder retainer bolt for tightness and verify dimension between brake pad and sprocket is between 1/8” and 3/16”.
- [ ] • Panels and covers for damage.

- [ ] **4.** Open control dryer and verify the following:
  - [ ] • Resistivity PCB location (if applicable)
  - [ ] • SECS II S/W installed (if applicable)
  - [ ] • Check for loose screws, wires, all hardware.
- [ ] **5.** Check fuse sizes and labels:
  - [ ] • Main 15A, Heater 15A, Motor 15A, Controller 3A.
- [ ] **6.** Check door alignment to bowl.
- [ ] **7.** Check door micro switch for alignment.
- [ ] **8.** Check bladder for cleanliness and cuts.
- [ ] **9.** Remove the rotor.
- [ ] **10.** Verify hub set screws are tight:
  - [ ] • Verify that the seal plate is centered with the hub.
  - [ ] • Ensure that the hub space is:
    - [ ] • 2-5 inch rotors .050 inches
    - [ ] • 6 inch rotors .080 inches
- [ ] **11.** Install rotor. Tighten down screws in proper sequence. (12, 6, 9, 3 O’clock position)

NOTE
Do not operate the dryer without a carrier.

- [ ] **12.** Install proper carrier with correct load requirements.

NOTE
Prior to connecting facility DI, run DI into drain for 5-10 minutes to discard particles in line.

- [ ] **13.** Plug in dryer. Remove the shroud covers and turn on facility DI and N_2 and check for leaks.
- [ ] **14.** Power up dryer. Check all valves, switches and regulators.
- [ ] **15.** Start dryer. Check for DI leaks in the manifold, connections, drain box and tubing.
- [ ] **16.** Verify DI / N_2 check valve. (No DI in N_2 line during rinse).
- [ ] **17.** Verify that there are no N_2 leaks at connectors, manifold, static eliminator, clean coil, fittings, regulators, switches, gauges.
- [ ] **18.** Verify maximum speed programming limitations. (3200 RPM)
- [ ] **19.** Verify resistivity functions:
  - [ ] Resistivity override
  - [ ] Timed resistivity
- [ ] **20.** Verify all L.E.D. functions on keypad.
- [ ] **21.** Verify no excessive vibration.
- [ ] **22.** At end of cycle, verify dryer indexes properly and indexes at approximately 12 O’clock.
- [ ] **23.** Verify that bladder switch PSW-2 is set to 16 PSI. If not, adjust. Verify loss of lid seal pressure operation and display on the keypad controller.
- [ ] **24.** Adjust bladder N_2 regulator RG2 to 21 PSI.
- [ ] **25.** Adjust N_2 switch PSW-1 to 13 PSI dynamic. Verify loss of N_2 pressure operation and display on the key pad controller.
- [ ] **26.** Adjust N_2 regulator RG1 to 23 PSI dynamic.
- [ ] **27.** Adjust index switch PSW-3 to 35 PSI static.
- [ ] **28.** Adjust index regulator RG3 to 40 PSI static.
- [ ] **29.** Verify static eliminator is not arcing.
- [ ] **30.** Check thermostats. (Reconnect rim heater if applicable)

☐ **31.** Verify the clean coil protection circuit by disconnecting the white wire on the relay coil, push the start button, the “N_2 Pressure” lamp should light.

☐ **32.** Verify “Dead Man” function and no bladder leaks:

- ☐ Start dryer then turn off power.
- ☐ Wait 5 minutes to verify no leaks.
- ☐ Exercise bladder relief valve and verify bladder deflates.
- ☐ Turn power on and verify power failure display on the keypad controller.

☐ **33.** Verify that the N_2 purge shuts off 30 seconds after completion of a cycle.

☐ **34.** Is SECS II operation required? Y/N

☐ **35.** Verify acceleration rates for:

Rinse: 0-300 RPM, 7-10 seconds
Dry: 300-3000 RPM, 60-70 seconds

☐ **36.** Assist with particle check required? Y/N

☐ **37.** Wipe down dryer and verify cleanliness.

☐ **38.** Re-torque seal and locktite all accessible hardware.

☐ **39.** Replace covers and tighten all screws.

☐ **40.** Program customer process parameters and record.

Rinse Time:	______________________	seconds
Rinse Speed:	______________________	RPM
Dry Time:	______________________	seconds
Dry Speed:	______________________	RPM

COMMENTS:

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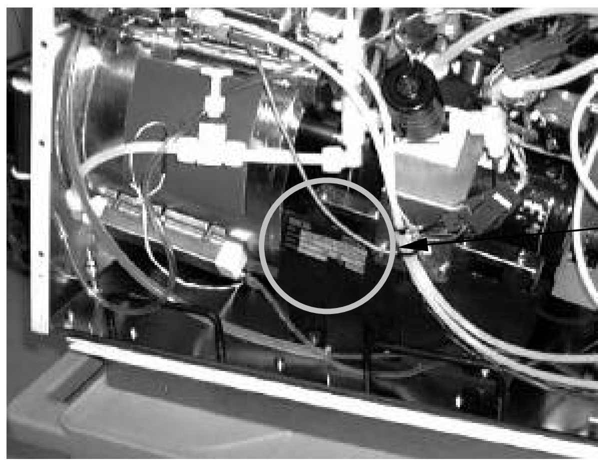
7 STANDARD SPARE PARTS LISTS

7.1 How to Order

When ordering please have your dryer's serial number ready for reference. This number can be found on the back panel of the dryer. If this label has been damaged or removed, the next best area to look for the dryer's serial number is to remove the cover to the dryer and look on the inside as shown below.

To contact GFT to order spare parts, please call GFT's main phone line at: (714) 445-2000. Ask for the Inside Sales department.



For the serial number:

Either look on the outside rear panel, or on the inside on the right.

7.2 Combined List

The following list of spare parts is for both the 1600-55 A and 1600-55 M. Also see the additional separate lists unique to each model type. If the part is called out in a preventive maintenance procedure, the frequency and procedure number is also listed.

For CE Marked parts:

- if a part is listed with a "**Yes**", then that part can be used for non-CE Marked dryers as well as CE Marked dryers
- if a part is listed with "***Only***", then that part is for CE Marked dryers only. CE Marked dryers should use this part only
- if a part is listed with a "**Non**", then that part can be used only on non-CE Marked dryers. Do not order this part for CE Marked dryers

Spare Parts List for the 1600-55 A and M					
Description	**Part No.**	**CE Marked**	**Qty.**	**PM Frequency**	**Procedure No.**
Actuator, sleeve maintained	4115778	Yes	1		
Actuator, switch, sleeve, mom	4115777	Yes	1		
Controller, 1600-55 Standard with 1020046.005, with 1073952.7 Label	1075227.755	Yes	1		
Encl assy resist monitor hard	1067786.5	Yes	1		
Filter, inline gas (1/4-inch npt)	4118199	Yes	1	Semi-Annual	4.3, 4.4
Gasket, drain box	1067878.1	Yes	1		
Gasket, N2	1065681.1	Yes	1		
Gasket, static eliminator	1059696.1	Yes	1		4.4
Heater, blanket 5.00 X 5.00	1064827.1	Yes	2		4.13
Heater, strip 1 X 36	1064832.3	Yes	1		4.13
Key, Motor	1062608.1	Yes	1		
Keypad Assy, Hardened, 1600	1083301.1	***Only***	1		
Keypad Assy, S/C1600-5	1067601.1	Non	1		
Motor, ½Shaft X 2 Output	4115758	Yes	1		
Nozzle, TFE Spray Veejet	4117876	Yes	6		4.4
Probe, resistivity CE Marked	1067803.5	***Only***	1		
Probe, resistivity & cable assy	1067803.1	Non	1		
Relay, 2 pole, 20 amp	4115243	Yes	1		
Ring, o viton .208idx.07w	4120866	Yes	1	Semi-Annual	4.9
Ring, o, epdm	4114316	Yes	1	Semi-Annual	4.7
Ring-o, epdm, viton	4115771	Yes	1	Semi-Annual	4.7
Ring-o, Viton	4115770	Yes	1	Semi-Annual	4.7
Screw, allen socket, f-hd, w/coat	1069144.3	Yes	4		
Seal, gasket DI	1062531.1	Yes	1		4.4
Seal, Labyrinth Plate	1062546.1	Yes	1	Semi-Annual	4.7
Seal, Rect, Door, 1600	1064788.1	Yes	1	Semi-Annual	4.9, 4.4
Shock	4116634	Yes	2		4.4
Shock	4116635	Yes	6		4.4
Snubber, RC, 1000HM, .1UF600V	4118741	Yes	1		
Static Eliminator Assy	1069254.501	Yes	1	Semi-Annual	4.2, 4.4
Switch, boot, 4897	4116783	Yes	1		
Switch, contact blk	4115782	Yes	1		
Switch, contact block	4115781	Yes	1		
Switch, lens, 4898	4114320	Yes	1		
Switch, lens, clear	4116897	Yes	1		
Switch, lens, green 4899	4114218	Yes	1		
Switch, lens, red	4114217	Non	1		
Switch, lens, yellow	4114219	Yes	1		
Switch, mtg, flange	4115779	Yes	1		

Spare Parts List for the 1600-55 A and M					
Description	**Part No.**	**CE Marked**	**Qty.**	**PM Frequency**	**Procedure No.**
Switch, pressure	4114327	Yes	1		
Thermostat	4118312	Yes			
Thermostat 4131	4116362	Yes	1		
Thermostat, setpoint 70d	4117376	Yes	1		
Valve Assy Spares DI HP	1070206.11	Yes	1		
Valve Assy Spares DI LP	1070206.5	Yes	1		
Varistor, 150 vac	4117725	Yes	1		

7.3 Additional Lists

Additional Spare Parts List for the 1600-55 M Only					
Description	**Part No.**	**CE Marked**	**Qty.**	**PM Frequency**	**Procedure No.**
Sensor, optical assy	1065747.1	Yes	1		

Additional Spare Parts List for the 1600-55 A Only					
Description	**Part No.**	**CE Marked**	**Qty.**	**PM Frequency**	**Procedure No.**
PCB Assy, optical sensor	1067811.1	Yes	1		
Switch, door cylinder	4119822	Yes	1		
Switch, mini per 10 63084-1	4115848	Yes	1		

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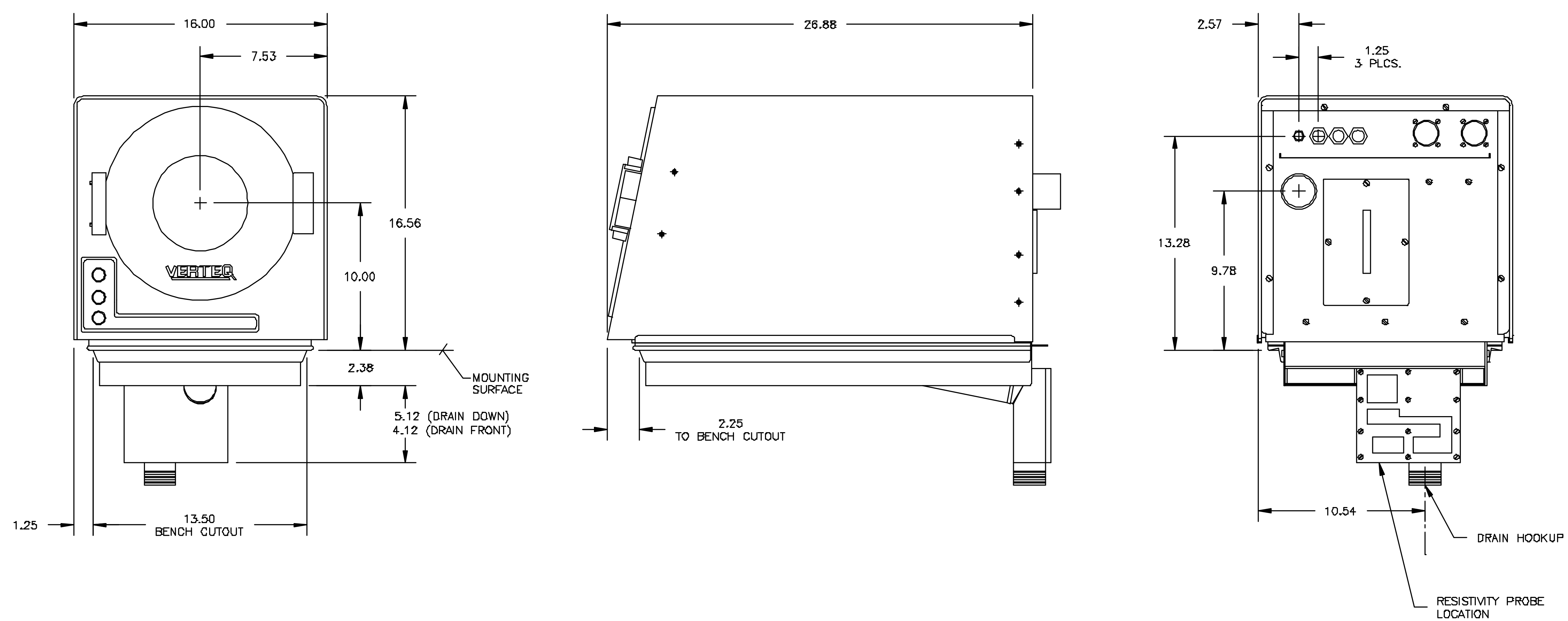
SIZE B DWG NO: 1098566 SH: 1

REVISIONS



NOTES

1.) SLOPE ON FRONT FACE IS 11°30' ±30' FROM VERTICLE. BOWL SLOPES DOWN 11°30' FROM HORIZ. SURFACE.

2.) FACILITY HOOKUPS WILL NOT CHANGE FROM RH TO LH CONFIGURATIONS.

DI WATER INPUT

3/8" O.D. TEFLON TUBING.

1.) 1.75 GPM MINIMUM.
2.) 25 PSI DYNAMIC MINIMUM.
3.) 40 PSI DYNAMIC MAXIMUM FOR STANDARD LOW PRESSURE VALVE.
4.) 70 PSI DYNAMIC MAXIMUM FOR OPTIONAL HIGH PRESSURE VALVE.

DI WATER RETURN

3/8" O.D. TEFLON TUBING.

1.) UNDER PRESSURE OF AT LEAST 5 PSI LOWER THAN D.I. WATER INPUT PRESSURE.

SYSTEM N2

3/8" O.D. TEFLON TUBING.

1.) 6 – 7 SCFM (GAUGE READING)
2.) 60 PSI DYNAMIC MINIMUM.

CDA/OFA/N2
(OPERATES PNEUMATIC COMPONENTS)

1/4" O.D. TEFLON TUBING.

1.) 60 – 80 PSI DYNAMIC.

DRAIN

1.) 1 1/2" MNPT (DRAIN BOX) 1 1/2" PVC PIPE (DRAIN PLUMBING OPTIONS)

VENT

1.) 1 1/2" PIPE (-0.5 TO -1.0 INCHES OF WATER IF NOT VENTED TO FAB)

POWER:

1.) 120VAC, 15 AMPS, 50/60 HZ.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES ON:

.XX DECIMALS ± .03	X° ± 1°
.XXX DECIMALS ± .010	X/X ± 1/32
FINISH 32	

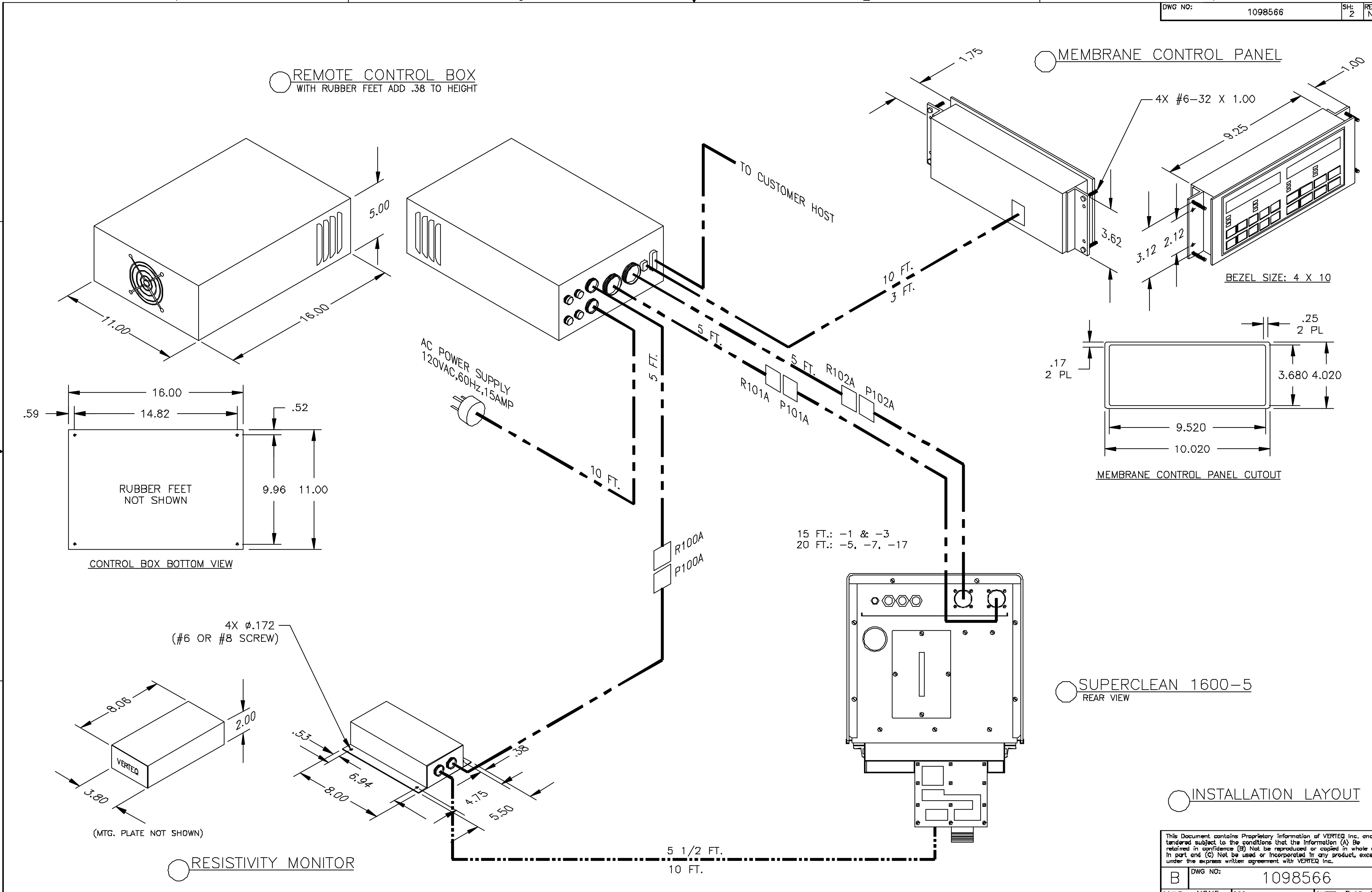
SIGNATURES		DATE
DRAWN:	W. GODWIN	7/5/00
ENGR:		
CHECKED:		
MFGE:		
APPROVED:	M. MANRIQUEZ	7/5/00

VERTEQ SANTA ANA, CA

FACILITY REQUIREMENTS STD. CENTRIFUGE BASE 1600-55 A & M

SIZE B FSCM: DWG NO: 1098566
SCALE: NONE SH: 1 OF 2

APPROVED FOR CONSTRUCTION - 7/11/00



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B	DWG NO: 1098566		
SCALE: NONE	PRO:		SHEET 2 OF 2

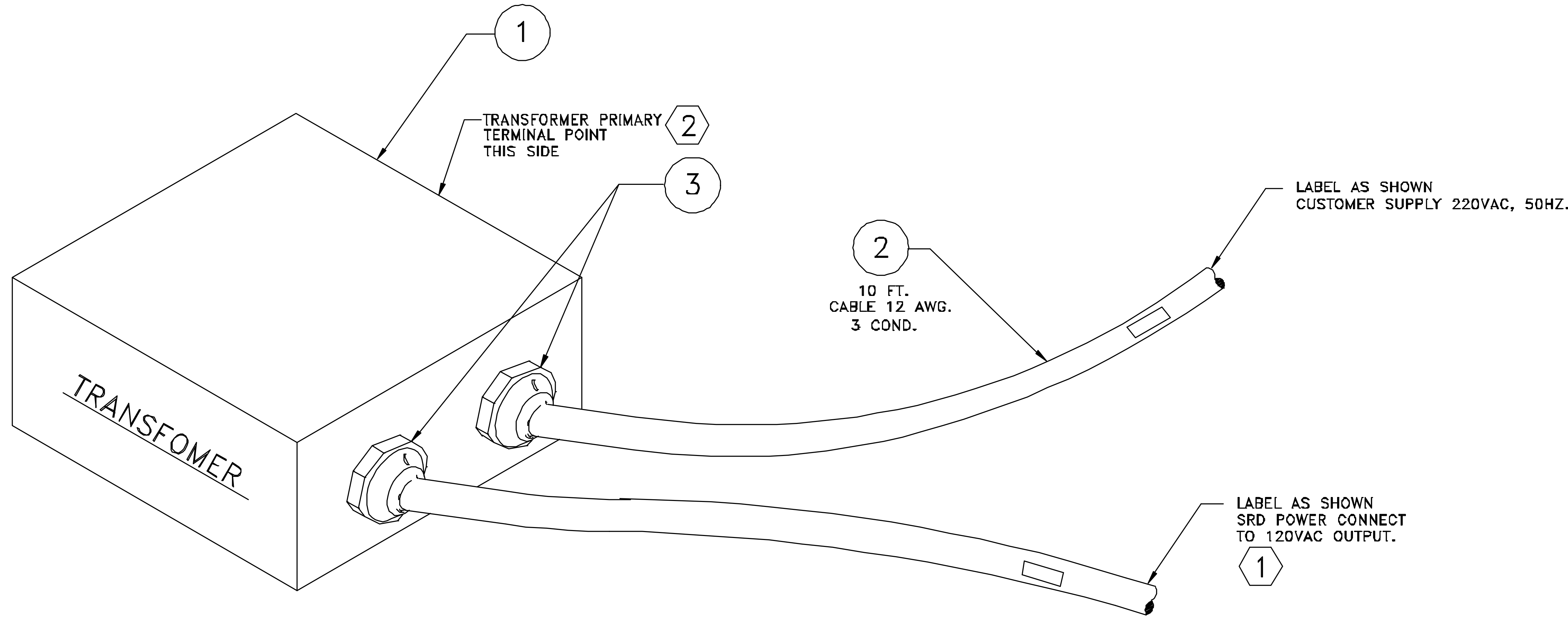
10.13.95.NC

APPROVED FOR CONSTRUCTION - 7/11/00

DWG NO: 1087359	SH: 1	REV: D

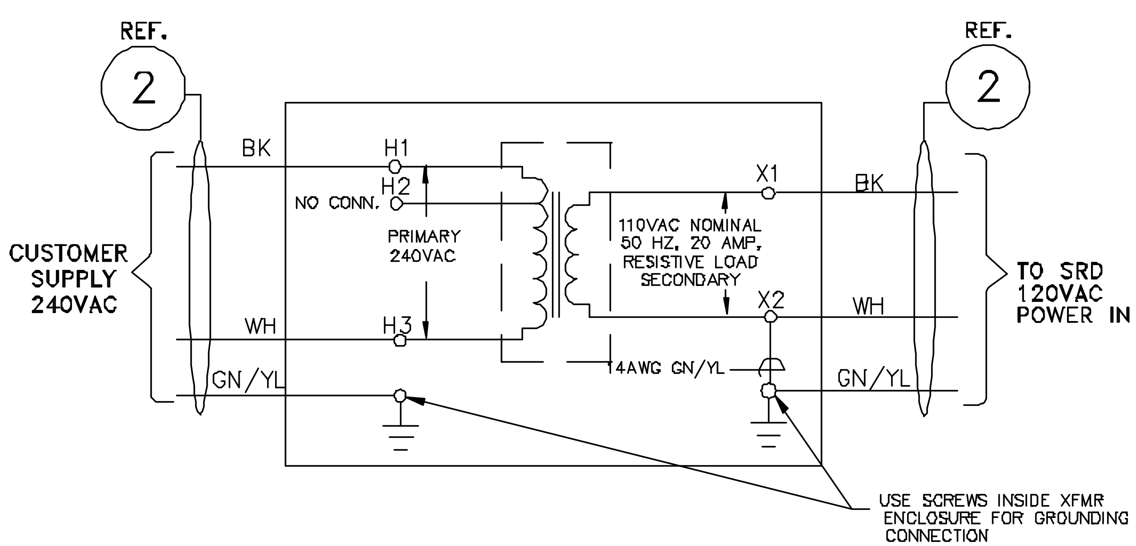
REVISIONS

REV	DESCRIPTION	DATE	APPD
NC	INITIAL RELEASE	8-4-97	R.W.W
A	SEE E.O., ADD -3 CONFIG.	2-12-98	KJQ
B	ADDED LABELS	3-25-98	MJL
C	ADDED LABEL	11/09/99	MM
D	REMOVED LABEL	11/13/00	KJQ
E	ADD -5,-7, XFMR SCHEM.	12/13/00	B.B.

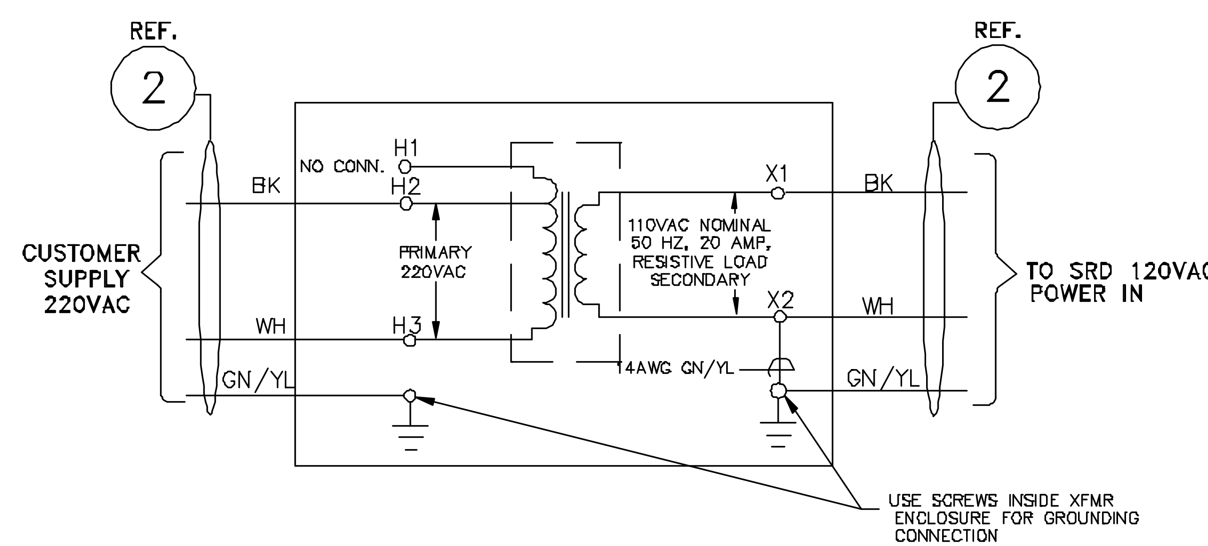


NOTES

1. FOR SRD 1600-3, REMOVE THE POWER CONNECTOR, BEFORE CONNECTING TO THE TRANSFORMER.
2. TRANSFORMER TO BE ORIENTED INSIDE OF ENCLOSURE AS NOTED.



-5 AND -7 CONFIGURATION ONLY



-1 AND -3 CONFIGURATION ONLY

CONFIG	DESCRIPTION
-7	XFMR, 240/120VAC "CE" DS
-5	XFMR, 240/120VAC "CE" DS
-3	XFMR, 220/120VAC "CE" DS
-1	XFMR, 220/120VAC "CE" SINGLE

MATERIAL SPEC	FINISH SPEC

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
.XX DECIMALS ± X° ±
.XXX DECIMALS ± X/X ±

SIGNATURES		DATE
DRAWN:	THANH NGUYEN	AUG 01, 1997.
ENGR:		

VERTEQ

NEXT ASSY	USED ON

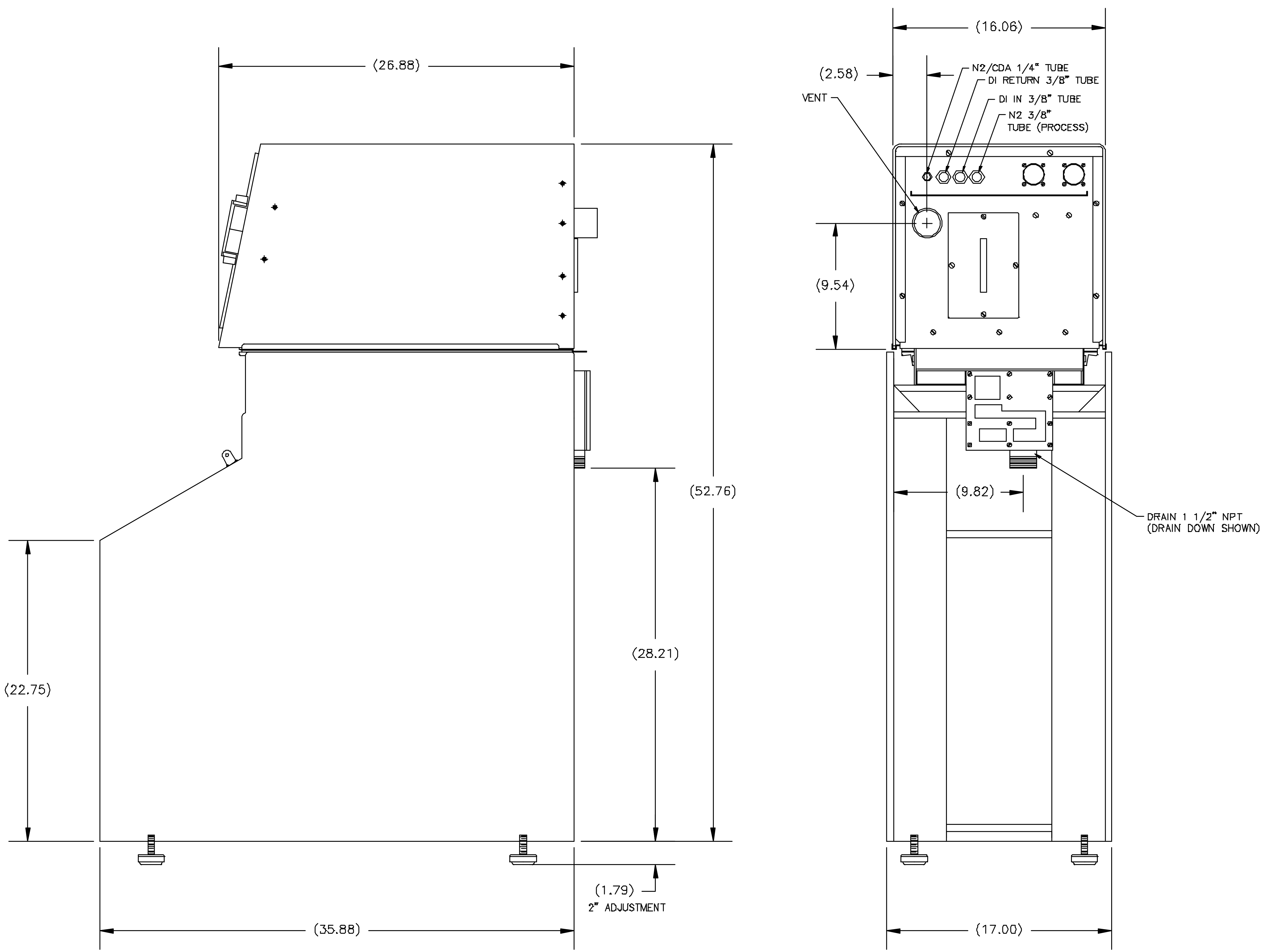
TRANSFOMER
240-220 TO 120V
ASSEMBLY

B DWG NO: 1087359

SCALE: NONE PRD: R/D SHEET 1 OF 1

10.13.95.NC

APPROVED FOR CONSTRUCTION - 12/21/00



MODEL 1600–55 FR/REM
CABINET ASSEMBLY

SIZE B DWG NO: 1098565 SH: 1

REVISIONS

NOTES

DI WATER INPUT

3/8" O.D. TEFLON TUBING.

1.) 1.75 GPM MINIMUM.
2.) 25 PSI DYNAMIC MINIMUM.
3.) 40 PSI DYNAMIC MAXIMUM FOR STANDARD LOW PRESSURE VALVE.
4.) 70 PSI DYNAMIC MAXIMUM FOR OPTIONAL HIGH PRESSURE VALVE.

DI WATER RETURN

3/8" O.D. TEFLON TUBING.

1.) UNDER PRESSURE OF AT LEAST 5 PSI LOWER THAN D.I. WATER INPUT PRESSURE.

SYSTEM N2

3/8" O.D. TEFLON TUBING.

1.) 6 – 7 SCFM (GAUGE READING)
2.) 80 PSI DYNAMIC MINIMUM.

CDA/OFA/N2
(OPERATES PNEUMATIC COMPONENTS)

1/4" O.D. TEFLON TUBING.

1.) 60 – 80 PSI DYNAMIC.

DRAIN

1.) 1 1/2" MNPT (DRAIN BOX) 1 1/2" PVC PIPE (DRAIN PLUMBING OPTIONS)

VENT

1.) 1 1/2" PIPE (–0.5 TO –1.0 INCHES OF WATER IF NOT VENTED TO FAB)

POWER:

1.) 120VAC, 15 AMPS, 50/60 HZ.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES ON:

.XX DECIMALS ± .03	X° ± 1°
.XXX DECIMALS ± .010	X/X ± 1/32
FINISH 32	

SIGNATURES		DATE
DRAWN:	W. GODWIN	7/5/00
ENGR:		
CHECKED:		
MFGE:		
APPROVED:	M. MANRIQUEZ	7/5/00

VERTEQ SANTA ANA, CA

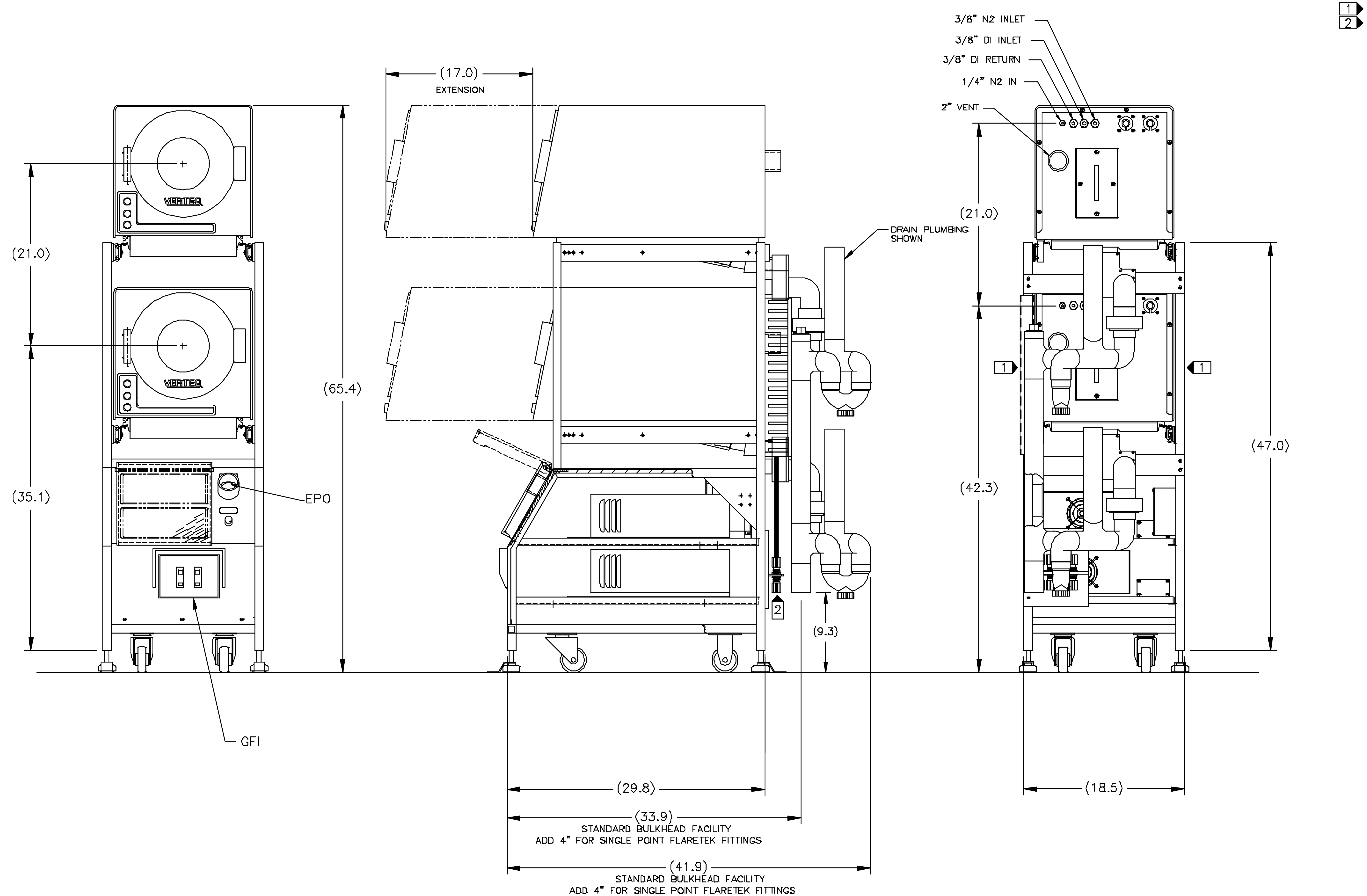
FACILITY REQUIREMENTS
FRONT REMOVEABLE CABINET
1600–55 A & M

SIZE B FSCM: DWG NO: 1098565
SCALE: NONE SH: 1 OF 1

APPROVED FOR CONSTRUCTION – 7/11/00

SIZE	DWG NO:	SH:
B	1098564	1

REVISIONS



NOTES

1 1.) SIDE COVERS FOR FRAME ARE OPTIONAL.

2 2.) FACILITY SINGLE POINT COMPRESSION FITTINGS SHOWN.

DI WATER INPUT

WITHOUT SINGLE POINT OPTION:
3/8" O.D. TEFLON TUBING.

SINGLE POINT FLARETEK OPTION:
1/2" O.D. TEFLON TUBING.

SINGLE POINT COMPRESSION OPTION:
1/2" O.D. TEFLON TUBING.

1.) 3.5 GPM MINIMUM.
2.) 25 PSI DYNAMIC MINIMUM.
3.) 40 PSI DYNAMIC MAXIMUM FOR STANDARD LOW PRESSURE VALVE.
4.) 70 PSI DYNAMIC MAXIMUM FOR OPTIONAL HIGH PRESSURE VALVE.

DI WATER RETURN

WITHOUT SINGLE POINT OPTION:
3/8" O.D. TEFLON TUBING.

SINGLE POINT FLARETEK OPTION:
1/2" O.D. TEFLON TUBING.

SINGLE POINT COMPRESSION OPTION:
1/2" O.D. TEFLON TUBING.

1.) UNDER PRESSURE OF AT LEAST 5 PSI LOWER THAN DI. WATER INPUT PRESSURE.

SYSTEM N2

WITHOUT SINGLE POINT OPTION:
3/8" O.D. TEFLON TUBING.

SINGLE POINT FLARETEK OPTION:
1/2" O.D. TEFLON TUBING.

SINGLE POINT COMPRESSION OPTION:
1/2" O.D. TEFLON TUBING.

1.) 12 – 14 SCFM (GAUGE READING)
2.) 60 PSI DYNAMIC MINIMUM.

CDA/OFA/NZ
(OPERATES PNEUMATIC COMPONENTS)

WITHOUT SINGLE POINT OPTION:
1/4" O.D. TEFLON TUBING.

SINGLE POINT FLARETEK OPTION:
1/2" O.D. TEFLON TUBING.

SINGLE POINT COMPRESSION OPTION:
3/8" O.D. TEFLON TUBING.

1.) 80 – 90 PSI DYNAMIC.

DRAIN

1.) 1 1/2" MNPT (DRAIN BOX) 1 1/2" PVC PIPE (DRAIN PLUMBING OPTIONS)

VENT

1.) 1 1/2" PIPE (–0.5 TO –1.0 INCHES OF WATER IF NOT VENTED TO FAB)

POWER:

1.) 120VAC, 15 AMPS, 50/60 HZ PER RINSER/DRYER.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES ON:

.XX DECIMALS ±	.03	X° ±	1°
.XXX DECIMALS ±	.010	X/X ±	1/32
FINISH	32 √		

	SIGNATURES	DATE
DRAWN:	W. GODWIN	6/30/00
ENGR:		
CHECKED:		
MFGE:		
APPROVED:	M. MANRIQUEZ	6/30/00

VERTEQ SANTA ANA, CA

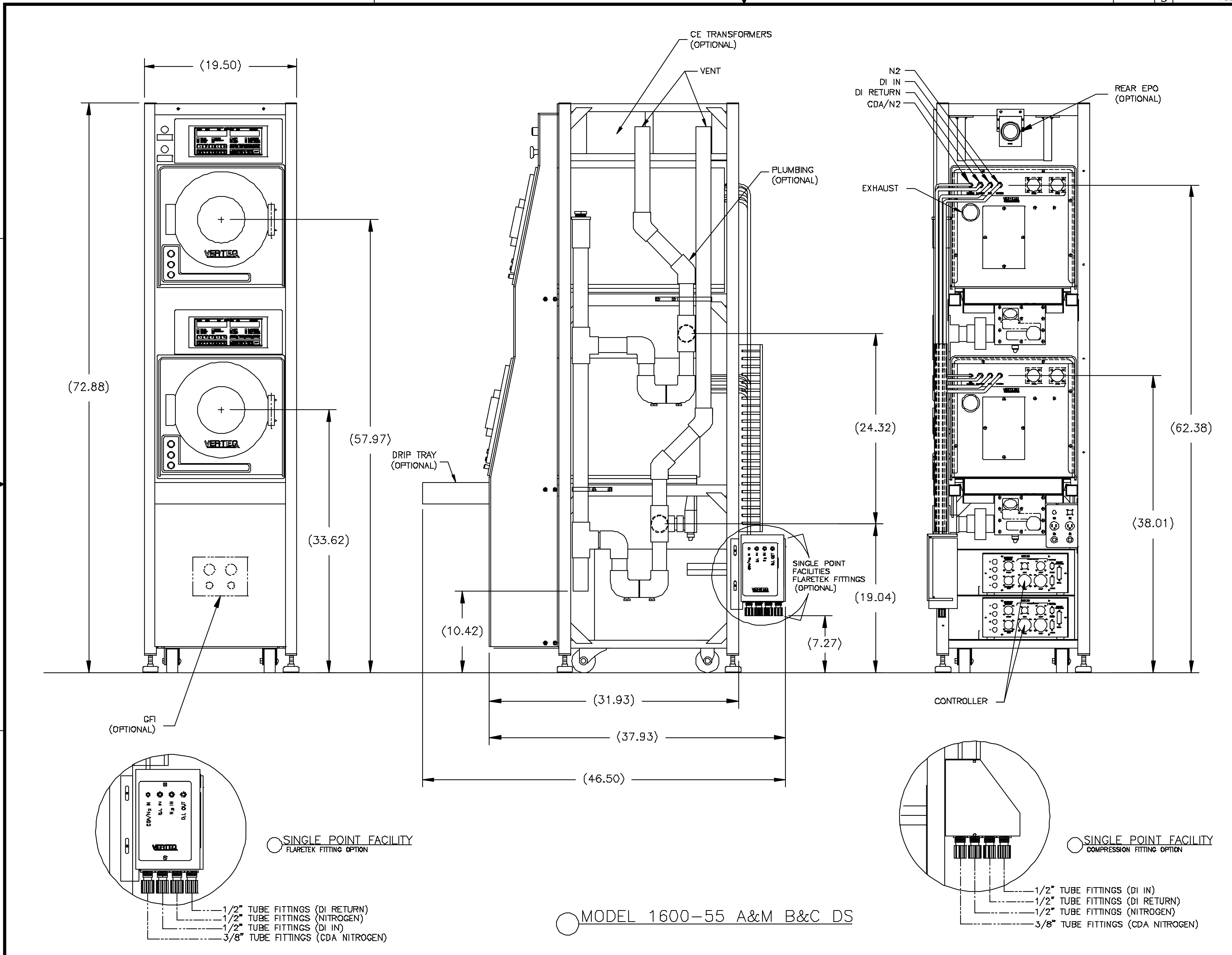
FACILITY REQUIREMENTS FRONT REMOVABLE 1600–55 A & M

SIZE	FSCM:	DWG NO:
B		1098564

SCALE: NONE SH: 1 OF 1

APPROVED FOR CONSTRUCTION – 7/11/00

SIZE B | DWG NO: 1098563 | SH: 1



REVISIONS

NOTES

DI WATER INPUT

WITHOUT SINGLE POINT OPTION:
3/8" O.D. TEFLON TUBING.
SINGLE POINT FLARETEK OPTION:
1/2" O.D. TEFLON TUBING.
SINGLE POINT COMPRESSION OPTION:
1/2" O.D. TEFLON TUBING.

1.) 3.5 GPM MINIMUM.
2.) 25 PSI DYNAMIC MINIMUM.
3.) 40 PSI DYNAMIC MAXIMUM FOR STANDARD LOW PRESSURE VALVE.
4.) 70 PSI DYNAMIC MAXIMUM FOR OPTIONAL HIGH PRESSURE VALVE.

DI WATER RETURN

WITHOUT SINGLE POINT OPTION:
3/8" O.D. TEFLON TUBING.
SINGLE POINT FLARETEK OPTION:
1/2" O.D. TEFLON TUBING.
SINGLE POINT COMPRESSION OPTION:
1/2" O.D. TEFLON TUBING.

1.) UNDER PRESSURE OF AT LEAST 5 PSI LOWER THAN D.I. WATER INPUT PRESSURE.

SYSTEM N2

WITHOUT SINGLE POINT OPTION:
3/8" O.D. TEFLON TUBING.
SINGLE POINT FLARETEK OPTION:
1/2" O.D. TEFLON TUBING.
SINGLE POINT COMPRESSION OPTION:
1/2" O.D. TEFLON TUBING.

1.) 12 - 14 SCFM (GAUGE READING)
2.) 60 PSI DYNAMIC MINIMUM.

CDA/DFA/N2
(OPERATES PNEUMATIC COMPONENTS)

WITHOUT SINGLE POINT OPTION:
1/4" O.D. TEFLON TUBING.
SINGLE POINT FLARETEK OPTION:
1/2" O.D. TEFLON TUBING.
SINGLE POINT COMPRESSION OPTION:
3/8" O.D. TEFLON TUBING.

1.) 60 - 90 PSI DYNAMIC.

DRAIN

1.) 1 1/2" MNPT (DRAIN BOX) 1 1/2" PVC PIPE (DRAIN PLUMBING OPTIONS)

VENT

1.) 1 1/2" PIPE (-0.5 TO -1.0 INCHES OF WATER IF NOT VENTED TO FAB)

POWER:

1.) 120VAC, 15 AMPS, 50/60 HZ PER RINSER/DRYER.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES ON:

.XX DECIMALS ± .03	X° ± 1°	
.XXX DECIMALS ± .010	X/X ± 1/32	
FINISH 32		

	SIGNATURES	DATE
DRAWN:	W. GODWIN	6/29/00
ENGR:	W. GODWIN	6/29/00
CHECKED:		
MFGE:		
APPROVED:	M. MANRIQUEZ	6/29/00

VERTEQ SANTA ANA, CA

FACILITY REQUIREMENTS BAY & CHASE DOUBLE STACK 1600-55 A&M

SIZE B | FSCM: | DWG NO: 1098563

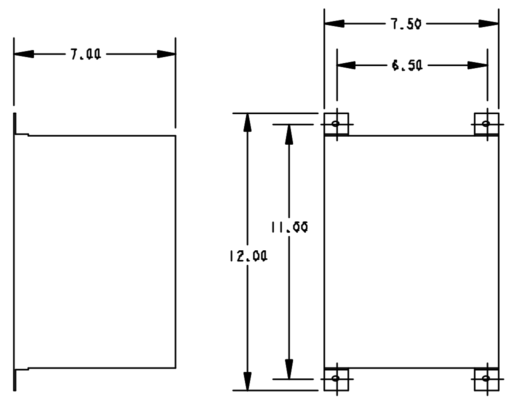
SCALE: NONE | SH: 1 OF 1

APPROVED FOR CONSTRUCTION - 7/11/00

DWG NO: 1098577	SH: 1	REV: A

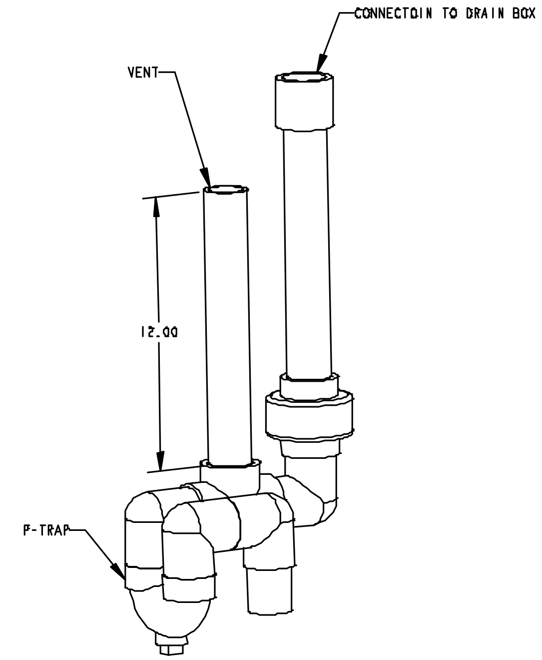
REVISIONS

REV	DESCRIPTION	DATE	APPD
NC	INITIAL RELEASE	29-Jun-00	BA
A	SEE EO	05-May-01	BA



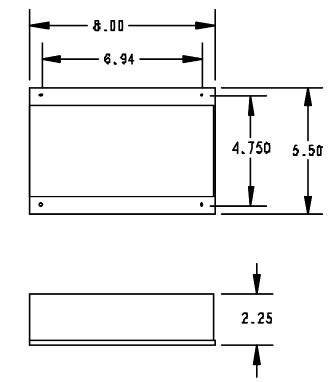
STEP DOWN TRANSFORMER (OPTIONAL)

TO BE LOCATED OUTSIDE OF DRYER
SCALE 0.187



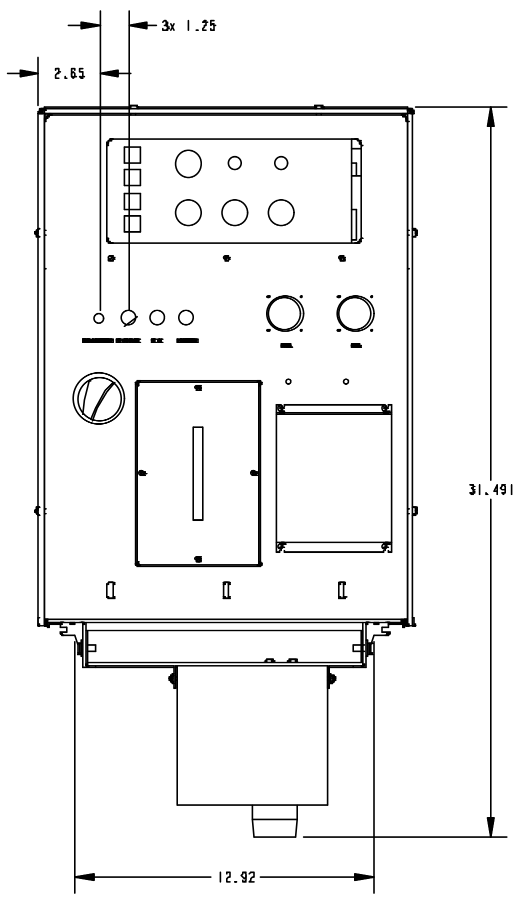
RECOMENDED DRAIN PLUMBING

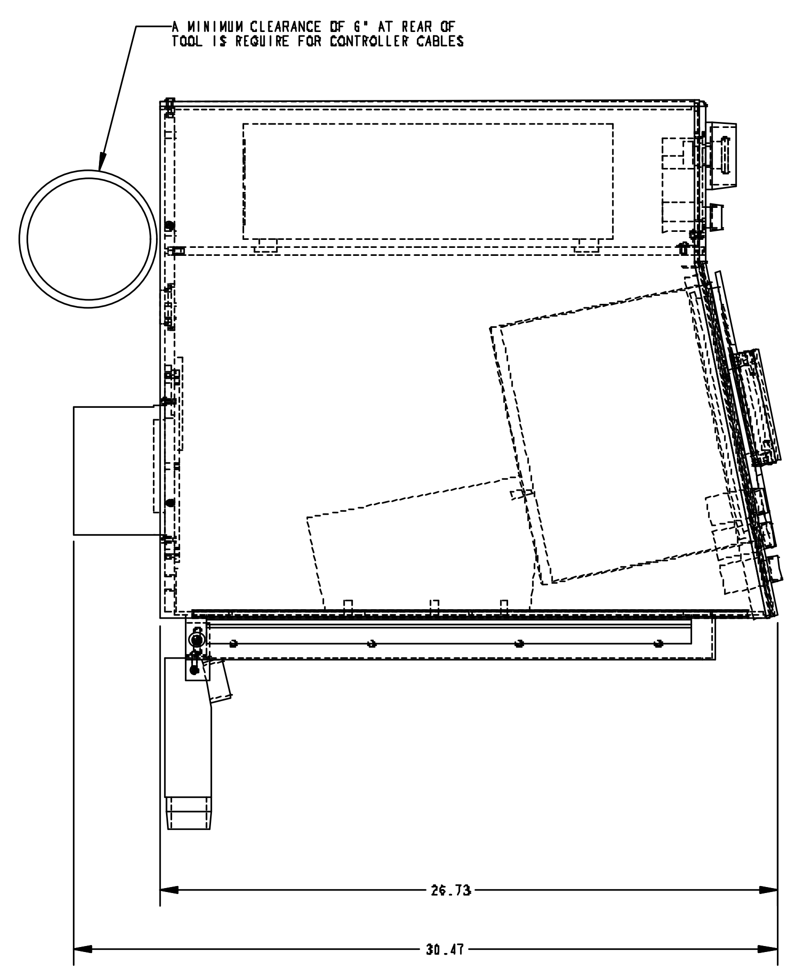
SCALE 0.187

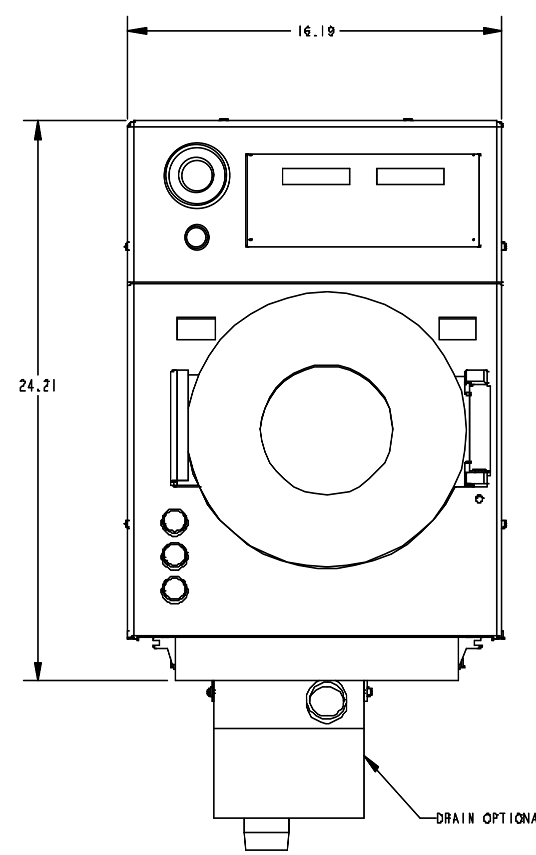


RESISTIVITY MONITOR (OPTIONAL)

TO BE LOCATED OUTSIDE OF DRYER
SCALE 0.187







DRAIN HOOKUP

NOTES

1.) SLOPE ON FRONT FACE IS 11°50' FROM VERTICLE.
BOWL SLOPES DOWN 11°50' FROM HORIZONTAL SURFACE.

2.) FACILITY HOOKUPS DO NOT CHANGE FROM RH TO LH CONFIGURATIONS.

DI WATER INPUT
3/8" O.D. TEFLON TUBING.
1.) 1.75 GPM MINIMUM.
2.) 25 PSI DYNAMIC MININUN.
3.) 40 PSI DYNAMIC MAXINUN FOR STANDARD LOW PRESSURE VALVE.
4.) 70 PSI DYNAMIC MAXINUN FOR OPTIONAL HIGH PRESSRE VALVE.

DI WATER RETURN
3/8" O.D. TEFLON TUBING.
1.) UNDER PRESURE OF AT LEAST 5 PSI LOWER THAN DI WATER INPUT PRESSURE.

SYSTEM N2
3/8" O.D. TEFLON TUBING.
1.) 6 - 7 SCFM (GAUGE READING)
2.) 60 PSI DYNAMIC MININUN.

CDA/OFA/N2
(OPERATES PNEUMATIC CONPONENTS)
1/4" O.D. TEFLON TUBING.
660 - 90 PSI DYNAMIC

DRAIN
1.) 1 1/2" MNPT (DRAIN BOX) 1 1/2" PVC PIPE.

VENT
1.) 1 1/2 PIPE (-0.5 TO -1.0 INCHES OF WATER IF NOT VENTED TO LAB)

ELECTRICAL REQUIREMENTS
1. ELECRICAL DIAGRAM:..1069316.1
2. SUPPLY VOLTAGE:.....120 VAC
3. PHASE: 1
4. FREQUENCY...........50/60 Hz
5. FULL LOAD CURRENT...10 AMPS
6. NUMBER OF WIRES.....2
7. LARGEST LOAD CURRENT.5 AMPS
8. MAIN CB SHORT CIR. INTERRUPT CAPACITY.
........................1000 AMPS
1.) 120VAC, 10 AMPS, 50/60 HZ.

CONFIG	DESCRIPTION
-1	

MATERIAL SPEC	FINISH SPEC

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES ON:

.XX DECIMALS ±	0.03	X°±	1.0
.XXX DECIMALS ±	0.010	X/X ±	-

SIGNATURES		DATE
DRAWN:	B.ALNAZAN	29-Jun-00
ENGR:	B.ALNAZAN	29-Jun-00

VERTEQ

NEXT ASSY	USED ON

FACILITY REQUIREMENTS
1600.55M
TABLE TOP

C | DWG NO: 1098577

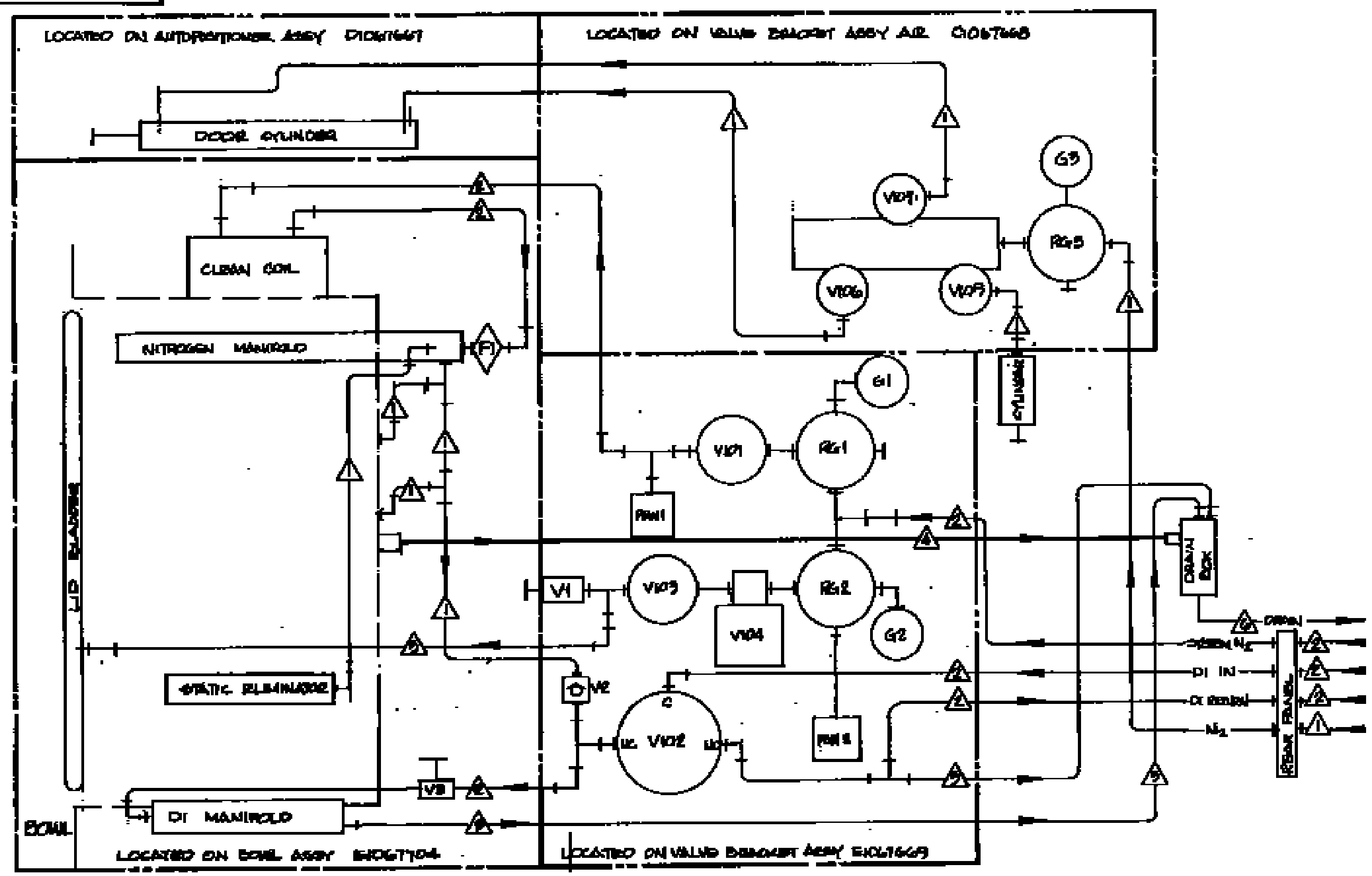
SCALE: 0.187 | PROD: 1600.55 | SHEET 1 OF 1

CREATED WITH PRO-E

APPROVED FOR CONSTRUCTION - 5/9/01

APPROVED FOR CONSTRUCTION - 5/27/98

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
	INITIAL RELEASE		
A	SEE ECO		
B	SEE ECO		T.N.
C	SEE ECO		



LIST OF MATERIALS		
SYM	DESCRIPTION	FUNCTION
V1	3 WAY MANUAL RELIEF VALVE	BLADDER BLEED
V2	2 WAY CHECK VALVE TFE	N_2 BLOWOUT
V3	2 WAY FLOW CONTROL VALVE TFE	FLOW ADJUST.
V101	2 WAY N.C. SOLENOID VALVE TFE	SYSTEM N_2
V102	3 WAY N.C. SOLENOID VALVE TFE	SYSTEM DI
V103	2 WAY NC SOLENOID VALVE	[illegible] VALVE
V104	3 WAY NC SOLENOID VALVE	[illegible] VALVE
V105	3 WAY NC SOLENOID VALVE	AUTOPOSITIONER
V106	3 WAY NC SOLENOID VALVE	DOOR OPEN VALVE
V107	3 WAY NC SOLENOID VALVE	DOOR CLOSE VALVE
RG1	REGULATOR	SYSTEM N_2
RG2	REGULATOR	LID BLADDER
RG3	REGULATOR	VALVE EXIT
G1	GAGE	SYSTEM N_2
G2	GAGE	LID BLADDER
G3	GAGE	VALVE EXIT
PSW1	PRESSURE SWITCH	SYSTEM N_2 PRESSURE
PSW2	PRESSURE SWITCH	BLADDER PRESSURE
F1	FILTER & CARTRIDGE	N_2 FILTRATION

PLUMBING MATERIALS			
SYM	MATERIAL	SYM	MATERIAL
1	1/4 OD TEFLON TUBING	5	1/4 OD TYGON TUBING
2	3/8 OD TEFLON TUBING	6	1 1/2 NPT
3	1/16 ID TYGON TUBING		
4	1 1/4 ID VINYL TUBING		

NOTES: 1. FOR ALL PART NUMBERS SEE RESPECTIVE ASSEMBLIES

2. FACILITIES

DI WATER IN — 3/8 OD TEFLON TUBING 60PSI DYNAMIC MAX 75PSI DYNAMIC — 1 1/4 GPM

SYSTEM N_2 — 3/8 OD TEFLON TUBING 60PSI STATIC — 4-5CFM

N_2 IN — 1/4 OD TEFLON TUBING 60PSI STATIC

DRAIN — 1 1/2 NPT

ELECTRICAL

3. SET UP

RG1 (SYSTEM N_2) SET TO 25PSI DYNAMIC
PSW1 (SYSTEM N_2) SET TO 15PSI DYNAMIC
RG2 (BLADDER N_2) SET TO 20PSI STATIC
PSW2 (BLADDER N_2) SET TO 17-18PSI DYNAMIC
RG3 (VALVE EXIT) SET TO 40PSI DYNAMIC MIN
V3 (FLOW CONTROL) CLOSED AT 75PSI DI WILL GIVE 1 1/4 GPM
OPEN AT 65PSI DI WILL GIVE 1 1/4 GPM

LIST OF MATERIALS OR PARTS LIST

APPLICATION

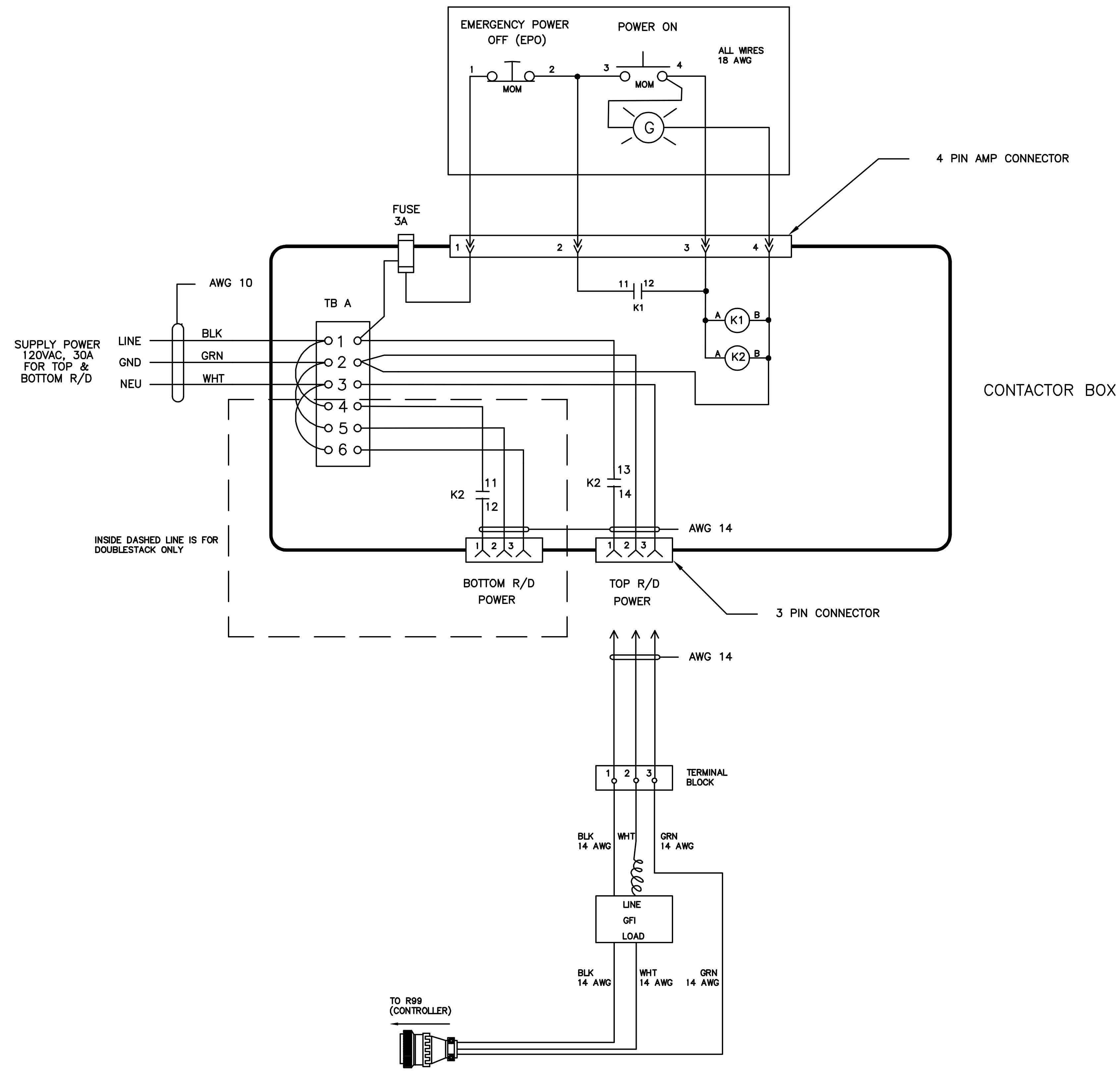
DRAWN: BOLENT — 18 NOV 87

VERTEQ

TITLE: PLUMBING SCHEMATIC

SIZE: D — DWG NO. D1067705

SHEET 1 OF 1



DWG NO: 1074044	SH: 1	REV: C

REVISIONS

REV	DESCRIPTION	DATE	APPD
NC	INITIAL RELEASE	5/21/92	GS
A	SEE EO	10-5-00	BB
B	SEE EO	6/19/02	DEC
C	SEE EO	3.24.03	RPB

NOTES

CONFIG	DESCRIPTION
-1	–

MATERIAL SPEC	FINISH SPEC
–	–
–	–
–	–
–	–

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES ON:

.XX DECIMALS ±	–	X° ±	–
.XXX DECIMALS ±	–	X/X ±	–

SIGNATURES		DATE
DRAWN:	G SHERIFF	5/21/92
ENGR:		

VERTEQ

NEXT ASSY	USED ON
–	–
–	–
–	–
–	–
–	–
–	–

Electrical Schematic

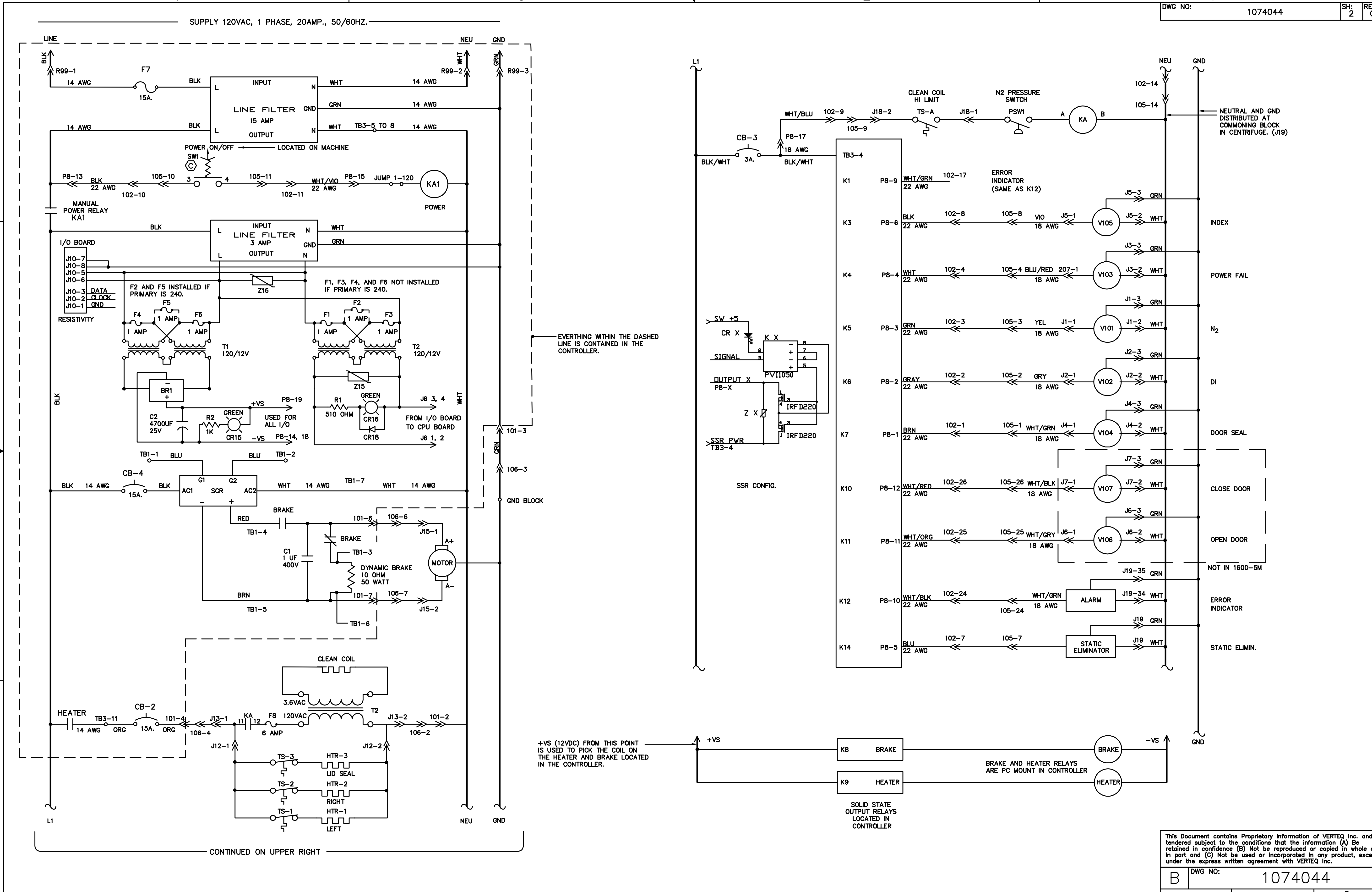
1600-55 M, A

B DWG NO: 1074044

SCALE: – PRD: – SHEET 1 OF 4

10.13.95.NC

APPROVED FOR CONSTRUCTION - 4/1/03



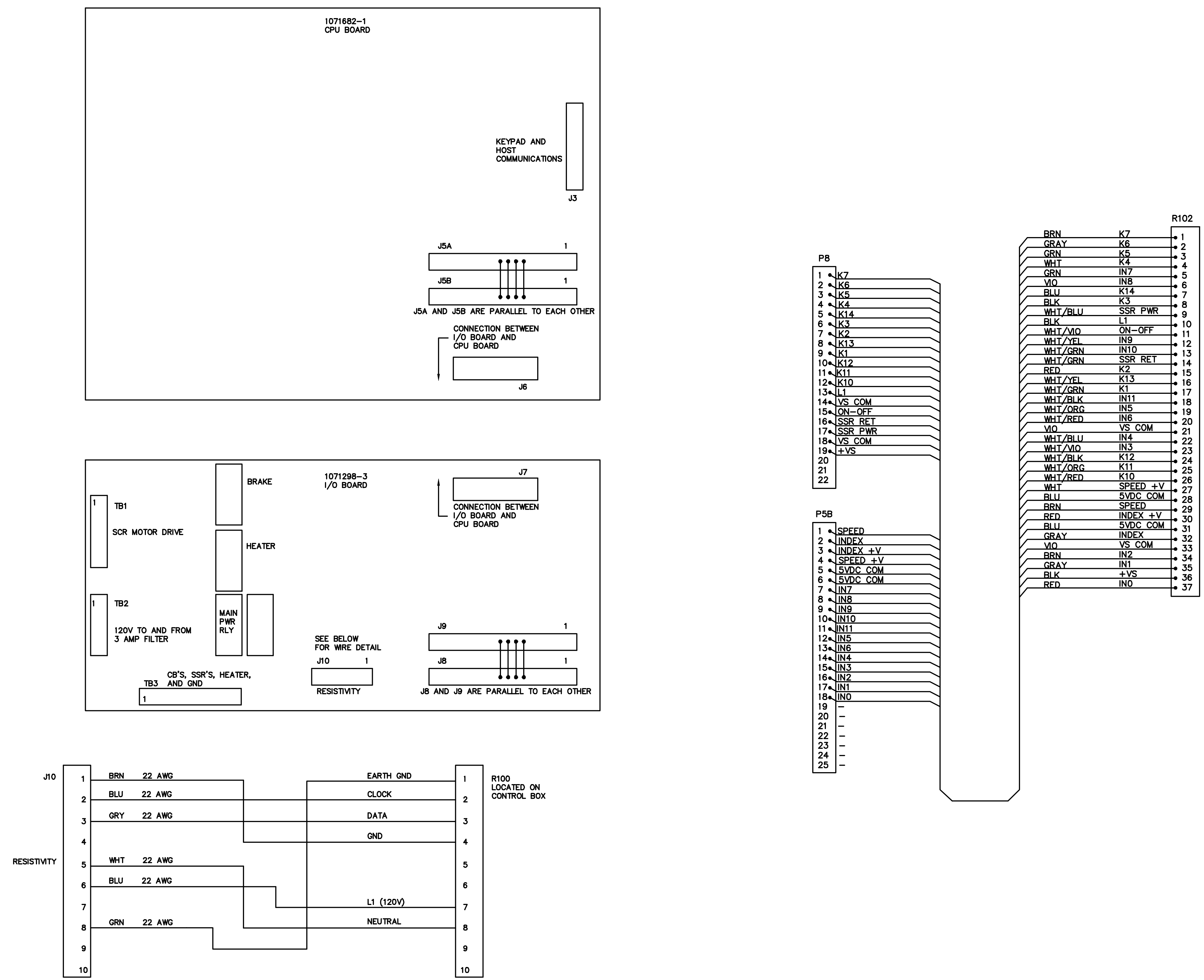
DWG NO: 1074044 SH: 2 REV: C

B DWG NO: 1074044

SCALE: — PRD: — SHEET 2 OF 4

10.13.95.NC

APPROVED FOR CONSTRUCTION - 4/1/03



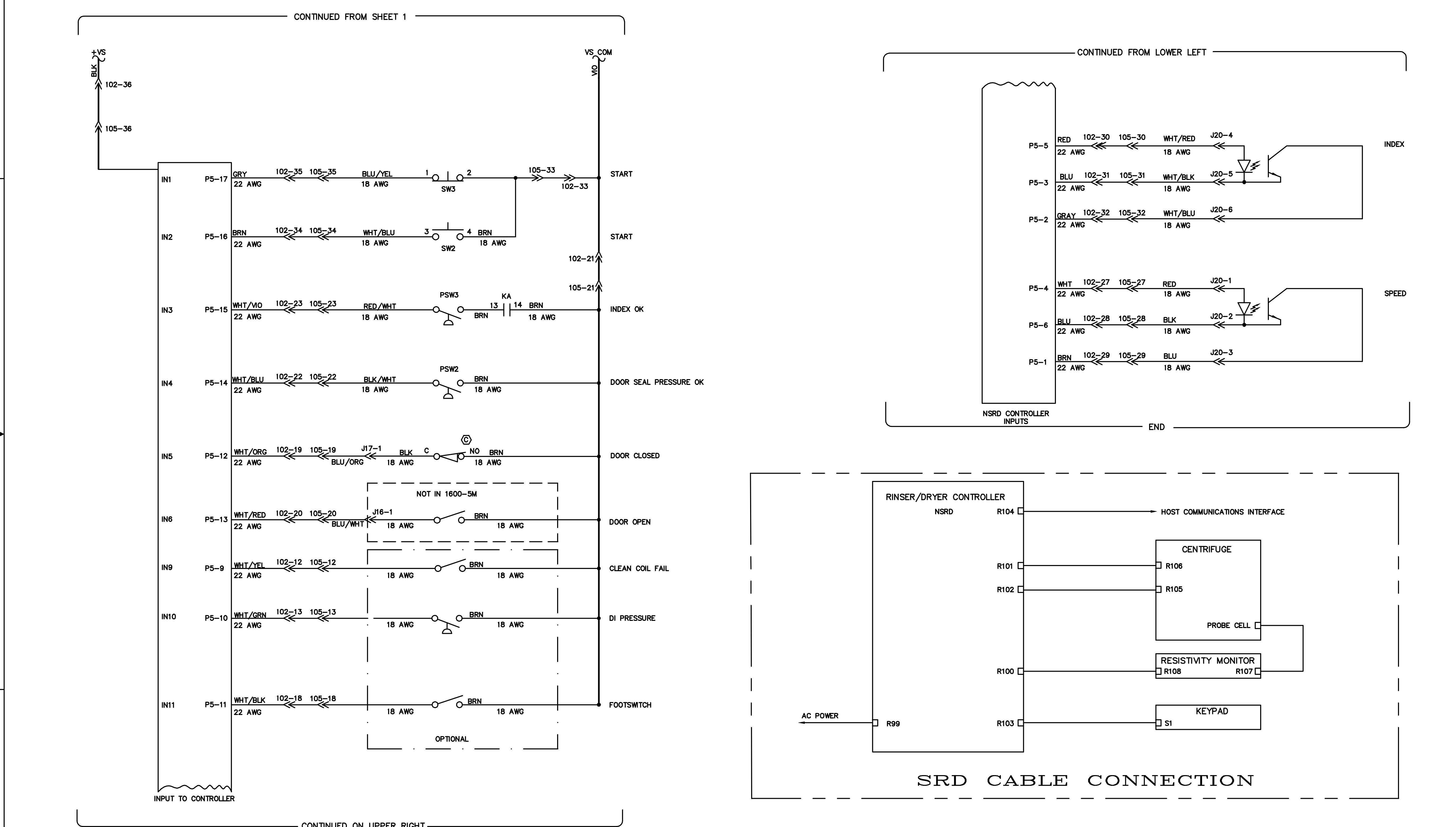
SERIES: 1600

INPUTS	IN0	SPARE
	IN1	STOP NC
	IN2	START NO
	IN3	N2 OK
	IN4	BLAD. OK
	IN5	CLOSE DOOR
	IN6	OPEN DOOR
	IN7	–
	IN8	–
	IN9	C. COIL FAIL
	IN10	DI FLOW
	IN11	(FOOT SW. OPEN)
OUTPUTS	K1	(ERROR)
	K2	–
	K3	INDEX
	K4	POWER FAIL VALVE
	K5	N2 VALVE
	K6	DI VALVE
	K7	BLADDER VALVE
	K8	BRAKE
	K9	HEATER
	K10	CLOSE DOOR
	K11	OPEN DOOR
	K12	ERROR
	K13	–
	K14	STATIC ELIMIN.

B DWG NO: 1074044

SCALE: – PRD: – SHEET 3 OF 4

10.13.95.NC



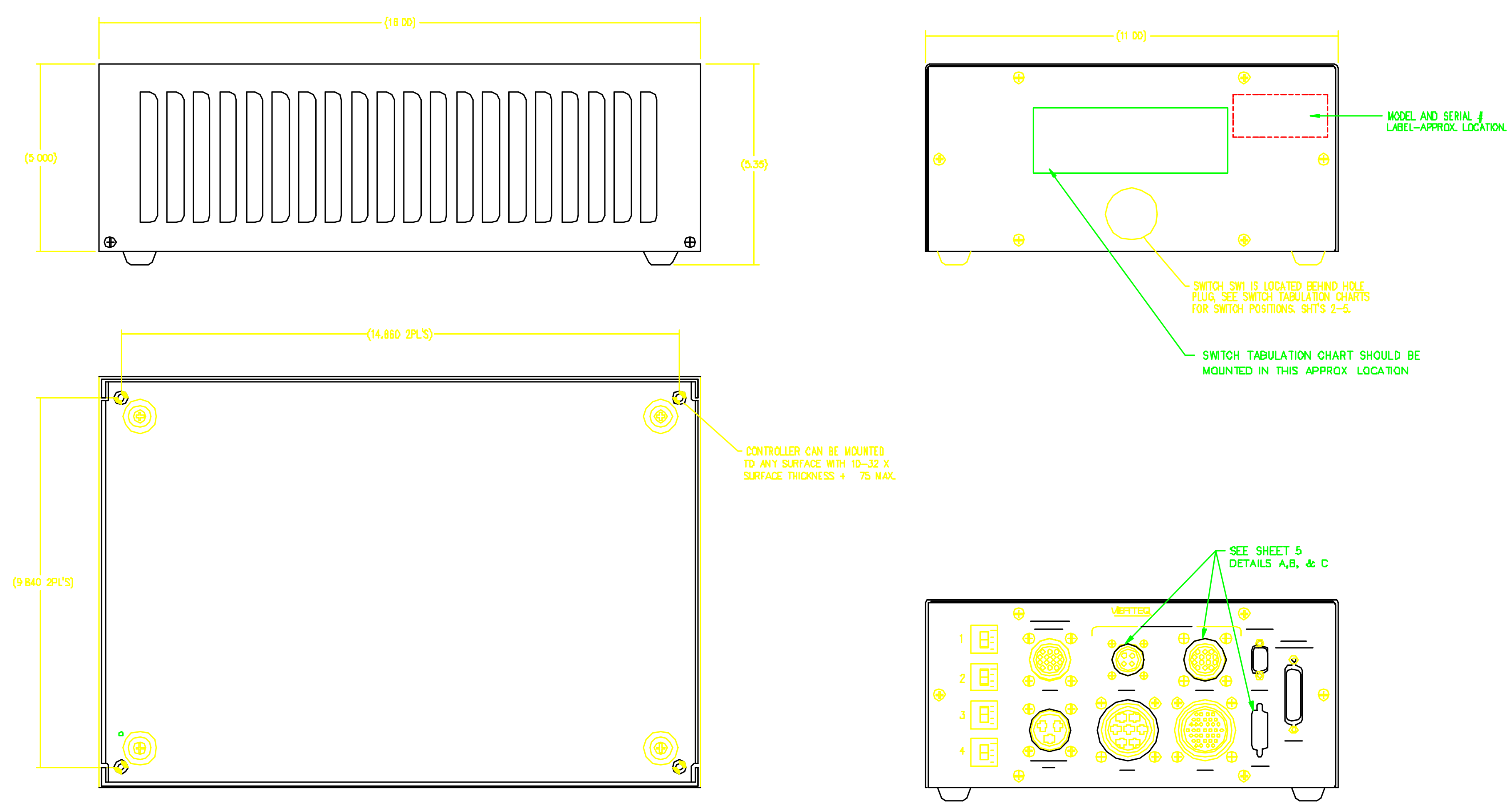
DWG NO: 1074044 SH: 4 REV: C

B DWG NO: 1074044

SCALE: — PRD: — SHEET 4 OF 4

10.13.95.NC

APPROVED FOR CONSTRUCTION - 4/1/03



REVISIONS

LTR	DESCRIPTION	DATE	APPD
NC	INITIAL RELEASE	5/10/93	MSS
A	SEE E.O.	6/29/93	MSS
B	SEE E.O.	7/6/93	MSS
C	SEE E.O.	7/14/93	MF
D	SEE E.O.	8/2/93	MSS
E	SEE E.O.	11-1-93	G.S.
F	SEE E.O.	11-8-93	G.S.
G	SEE E.O.	11-23-93	AJH
H	SEE E.O.	2-18-94	G.S.
I	SEE E.O.	2-24-94	MGF
J	SEE E.O.	4-11-94	HT
K	SEE E.O.	4-25-94	MGF
L	SEE E.O.	7-21-94	MGF
M	SEE E.O.	8-11-94	LM
N	SEE E.O.	11/7/94	MGF
P	SEE E.O.	4/3/95	LS
R	MOVED COVER TO BASE ASSY	6/30/95	RBC
S	SEE E.O.	9-20-95	LS
T	SEE E.O. (ADD -717)	1-19-96	LS
U	ADDED -718,-719,-720	5-29-96	LS
V	SEE E.O.	3-18-97	LS
W	ADDED -721 CONFIG	4-8-97	LS
X	ADDED -1,-3 &-5 CONFIGs	5-13-97	LS
Y	ADDED -709 CONFIG. SEE E.O.	8-8-97	RGJ
AA	ADDED 750, 751 CONFIG SEE E.O.	12-9-97	RGJ
AB	SEE E.O.	12-3-98	MGF
AC	SEE E.O.	6-21-99	MGF
AE	SEE E.O.	12-9-99	MGF
AF	SEE E.O.	12-27-99	MGF
AG	SEE E.O.	2/17/00	MGF
AH	ADDED 710, 110 CONFIG SEE E.O.	7/21/00	KJQ
AJ	SEE E.O.	10/31/00	MGF

SPECIFICATIONS

WEIGHT: 10 LBS.
VOLTAGE: 104-115 VAC
AMPS: 15
1 PHASE, 50/60 Hz.

PARTS LIST

QTY REQD		PART NO.	DESCRIPTION	SIZE	ITEM NO
	-1				
-	-	-	-	-	-

NEXT ASSY	USED ON
-	-

VERTEQ

DATE OF DWG 10 MAY 93

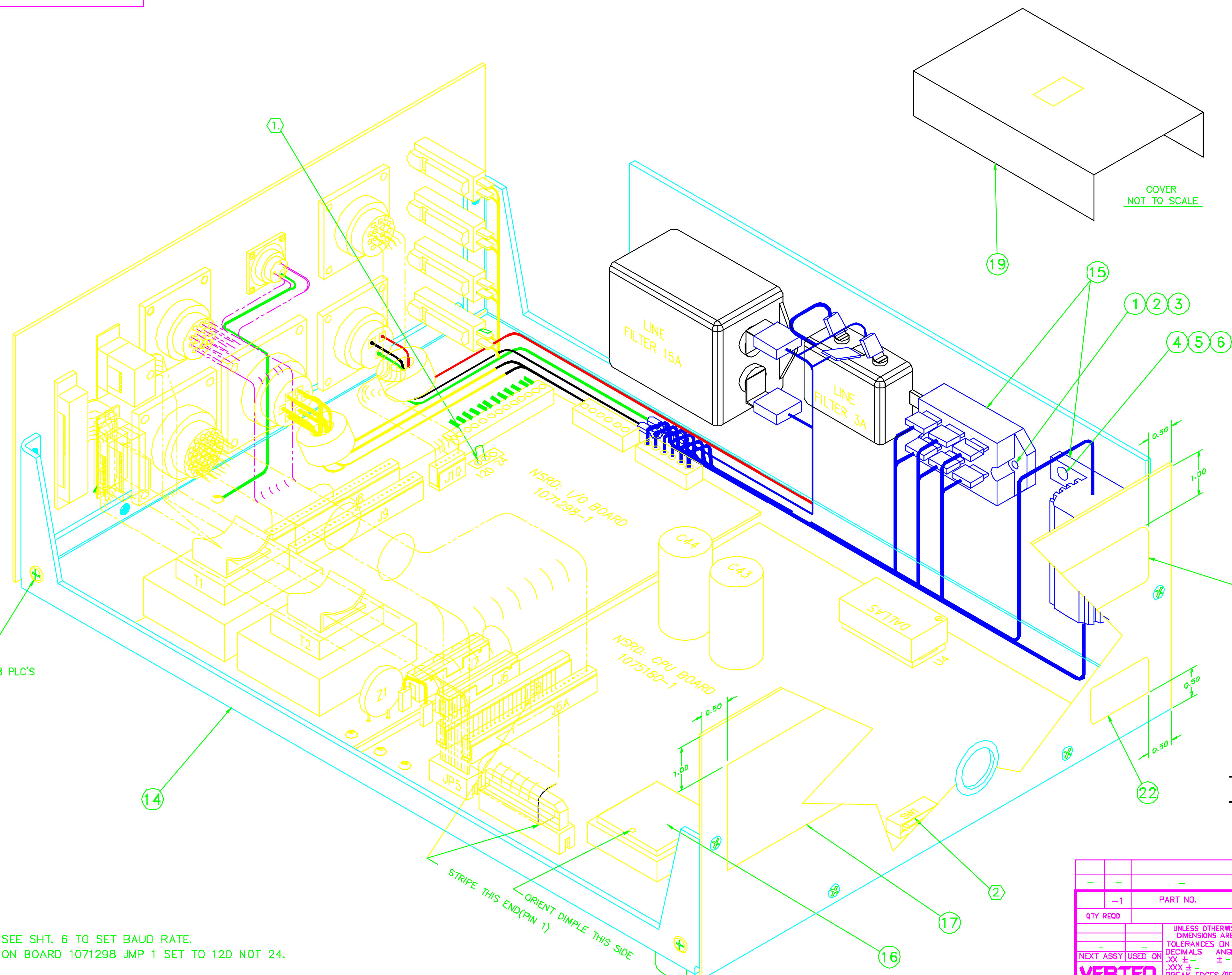
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .XX ± - .XXX ± - ANGLES ± -
BREAK EDGES/REMOVE BURRS

DRAWN M SCHUK 5/10/93
CHECKED
APPD

TITLE
ENCLOSURE ASSY: NSRD CONTROLLER

SIZE D 1075227
SCALE 1=2 SHEET 1 OF 8

AJ 1075227



-SEE PARTS LIST-
-1 CONFIGURATION
1600-55 SRD

NOTES:
1. ON BOARD 1071298 JMP 1 SET TO 120 NOT 24.
2. SEE SHT. 6 TO SET BAUD RATE.

QTY REQD	-1	PART NO.	DESCRIPTION	SIZE	ITEM NO
		PARTS LIST			

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS .XX ± - .XXX ± - ANGLES ± -
BREAK EDGES/REMOVE BURRS

NEXT ASSY | USED ON

VERTEQ

DATE OF DWG 10 MAY 93

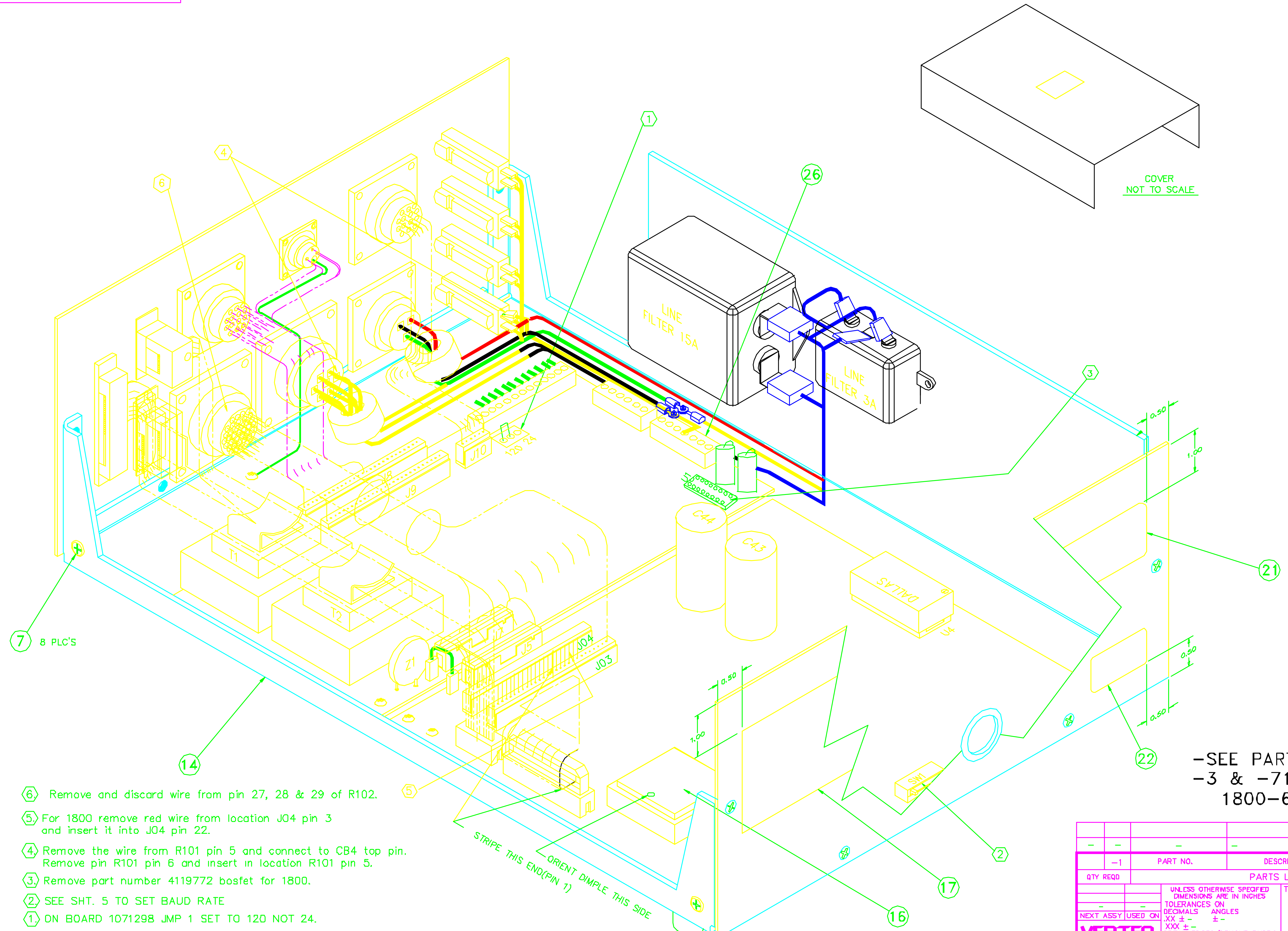
DRAWN M. SCHUK 5/10/93
CHECKED
APPD

TITLE CONTROLLER, NSRD

D 1075227

SCALE FULL SHEET 2 OF 8

1075227 AJ



NOTES:

1. ON BOARD 1071298 JMP 1 SET TO 120 NOT 24.
2. SEE SHT. 5 TO SET BAUD RATE
3. Remove part number 4119772 bosfet for 1800.
4. Remove the wire from R101 pin 5 and connect to CB4 top pin. Remove pin R101 pin 6 and insert in location R101 pin 5.
5. For 1800 remove red wire from location J04 pin 3 and insert it into J04 pin 22.
6. Remove and discard wire from pin 27, 28 & 29 of R102.

To convert 1075227-703 to 1075227-707 complete note 3, 4, 5 & 6 remove the brake resistor harness 1072055-1 and change CPU chip to 1800.

-SEE PARTS LIST-
-3 & -710 CONFIGURATION
1800-6 SRD

QTY REQD	-1	PART NO.	DESCRIPTION	SIZE	ITEM NO

PARTS LIST

NEXT ASSY | USED ON

VERTEQ

DATE OF DWG 10 MAY 93

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ANGLES
.XX ± - ± -
.XXX ± -
BREAK EDGES/REMOVE BURRS

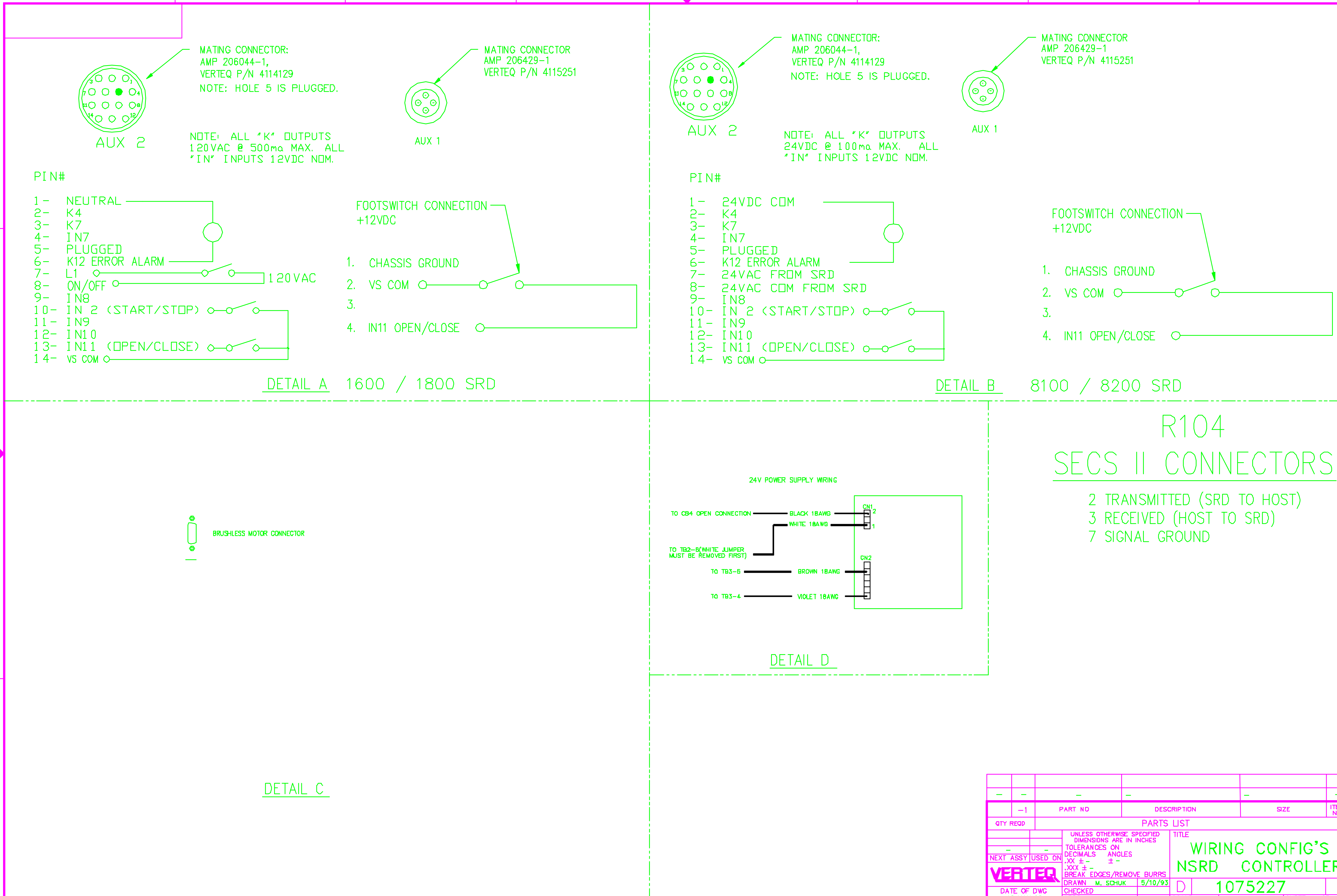
DRAWN M SCHUK 5/10/93
CHECKED
APPD

TITLE
CONTROLLER, NSRD

D 1075227

SCALE FULL - SHEET 3 OF 8

1075227 AJ



MATING CONNECTOR:
AMP 206044-1,
VERTEQ P/N 4114129
NOTE: HOLE 5 IS PLUGGED.
AUX 2
MATING CONNECTOR
AMP 206429-1
VERTEQ P/N 4115251
AUX 1
NOTE: ALL "K" OUTPUTS 120VAC @ 500ma MAX. ALL "IN" INPUTS 12VDC NOM.
PIN#
1- NEUTRAL
2- K4
3- K7
4- IN7
5- PLUGGED
6- K12 ERROR ALARM
7- L1
8- ON/OFF
9- IN8
10- IN 2 (START/STOP)
11- IN9
12- IN10
13- IN11 (OPEN/CLOSE)
14- VS COM
120VAC
FOOTSWITCH CONNECTION
+12VDC
1. CHASSIS GROUND
2. VS COM
3.
4. IN11 OPEN/CLOSE
DETAIL A 1600 / 1800 SRD
MATING CONNECTOR:
AMP 206044-1,
VERTEQ P/N 4114129
NOTE: HOLE 5 IS PLUGGED.
AUX 2
MATING CONNECTOR
AMP 206429-1
VERTEQ P/N 4115251
AUX 1
NOTE: ALL "K" OUTPUTS 24VDC @ 100ma MAX. ALL "IN" INPUTS 12VDC NOM.
PIN#
1- 24VDC COM
2- K4
3- K7
4- IN7
5- PLUGGED
6- K12 ERROR ALARM
7- 24VAC FROM SRD
8- 24VAC COM FROM SRD
9- IN8
10- IN 2 (START/STOP)
11- IN9
12- IN10
13- IN11 (OPEN/CLOSE)
14- VS COM
FOOTSWITCH CONNECTION
+12VDC
1. CHASSIS GROUND
2. VS COM
3.
4. IN11 OPEN/CLOSE
DETAIL B 8100 / 8200 SRD
BRUSHLESS MOTOR CONNECTOR
DETAIL C
24V POWER SUPPLY WIRING
TO CB4 OPEN CONNECTION
BLACK 18AWG
WHITE 18AWG
TO TB2-6(WHITE JUMPER MUST BE REMOVED FIRST)
TO TB3-5
BROWN 18AWG
TO TB3-4
VIOLET 18AWG
CN1
CN2
DETAIL D
R104
SECS II CONNECTORS
2 TRANSMITTED (SRD TO HOST)
3 RECEIVED (HOST TO SRD)
7 SIGNAL GROUND
AJ
1075227
QTY REQD
PART NO
DESCRIPTION
SIZE
ITEM NO
PARTS LIST
NEXT ASSY
USED ON
VERTEQ
DATE OF DWG
10 MAY 93
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ANGLES
.XX ± - ± -
.XXX ± -
BREAK EDGES/REMOVE BURRS
DRAWN M. SCHUK 5/10/93
CHECKED
APPD
TITLE
WIRING CONFIG'S
NSRD CONTROLLER
D 1075227
SCALE 1=2
SHEET 4 OF 8

NOTE:
USE WITH 1600-004-nn
1600-005-03 AND
CODES BASED THERE ON.

DIP SWITCH SELECTIONS

1600:

SWITCH TABULATION CHART

POSITION	SWITCH 1	SWITCH 2	SWITCH 3	SWITCH 4	SWITCH 5	SWITCH 6
UP	50 Hz	AUTO	EOP	CC*	DI**	NO SECS II
DOWN	60 Hz	MANUAL	-----	NO CC*	NO DI**	SECS II

* CC- CLEAN COIL SENSOR INSTALLED.
** DI- DI FLOW SENSOR INSTALLED

BAUD TABULATION CHART

IF SW 6 DOWN, SECS II INSTALLED,
IF SW 6 IS DOWN, THEN:

SWITCH 7	SWITCH 8	BAUD IS:
DOWN	DOWN	9600
DOWN	UP	4800
UP	DOWN	2400
UP	UP	1200

NOTE:
USE WITH 1600-005-05
AND CODES BASED THERE ON.

1600:

SWITCH TABULATION CHART

SECS II Always Available

POSITION	SWITCH 1	SWITCH 2	SWITCH 3	SWITCH 4	SWITCH 5	SWITCH 6	SWITCH 7	SWITCH 8
UP	50 Hz	AUTO	EOP	CC*	BLOW TILL DOOR CLOSE	WARNING BOAT NOT PRESENT	4800 BAUD	Go to Recipe 0 After Idle 10 min
DOWN	60 Hz	MANUAL	-----	NO CC*	30 SEC BLOW-OFF	NO WARNING	9600 BAUD	NO GO

* CC- CLEAN COIL SENSOR INSTALLED.

1800:

SWITCH TABULATION CHART

POSITION	SWITCH 1	SWITCH 2	SWITCH 3	SWITCH 4	SWITCH 5	SWITCH 6
UP	Ⓐ	NO N2 BLOW-OFF	BLOW TILL DOOR CLOSE	SPECIAL *	ENABLE HEAT DETECTOR	NO SECS II
DOWN	Ⓑ	YES N2 BLOW-OFF	30 SEC BLOW-OFF	NO SPECIAL	HEAT DETECT-OR OFF	SECS II

SW 1. A-HINGE DOOR W/OBST. SENSOR.
B-DROP DOWN DOOR OR HINGE DOOR
W/O OBST. SENSOR.

* SET SWITCH 4 TO SPECIAL (UP) POSITION WHEN OPTIONAL DI WATER AND NITROGEN FLOW SENSORS ARE INSTALLED.

BAUD TABULATION CHART

IF SW 6 DOWN, SECS II INSTALLED,
IF SW 6 IS DOWN, THEN:

SWITCH 7	SWITCH 8	BAUD IS:
DOWN	DOWN	9600
DOWN	UP	4800
UP	DOWN	2400
UP	UP	1200

8100/8200

SWITCH TABULATION CHART

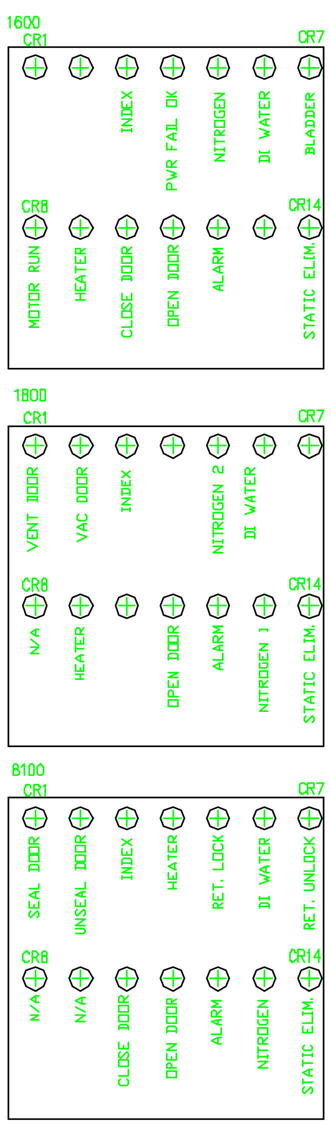
POSITION	SWITCH 1	SWITCH 2	SWITCH 3	SWITCH 4	SWITCH 5	SWITCH 6
UP	8200	NO N2 BLOW-OFF	BLOW TILL DOOR CLOSE	HEATER ON IN STANDBY		NO SECS II
DOWN	8100	YES N2 BLOW-OFF	30 SEC BLOW-OFF	HEATER OFF IN STANDBY		SECS II

BAUD TABULATION CHART

IF SW 6 DOWN, SECS II INSTALLED,
IF SW 6 IS DOWN, THEN:

SWITCH 7	SWITCH 8	BAUD IS:
DOWN	DOWN	9600
DOWN	UP	4800
UP	DOWN	2400
UP	UP	1200

RELAY LED'S DISPLAY ON CONTROLLER I/O BOARD



HELP MESSAGES

DISPLAY	1600	1800	8100
0001	POWER FAILURE ①	DI PRESSURE * ②	–
0002	HEATER FAILURE * ②	DI FLOW * ②	–
0004	DI FLOW * ②	HEATER FAILURE * ②	–
0008	–	–	RETAINER ③
0010	INDEX FAILURE ①	INDEX FAILURE ①	INDEX FAILURE ①
0020	RPM TOO HIGH ②	RPM TOO HIGH ②	RPM TOO HIGH ②
0040	–	DOOR NOT CLOSED @ START ②	–
0080		–	–
0100	N2 PRES. FAIL ②	N2 PRES. FAIL ②	N2 PRES. FAIL ②
0200	–	N2 FLOW * ②	–
0400	–	POWER FAILURE ①	POWER FAILURE ①
0800	–	–	–
1000	DOOR OPEN IN RUN ②	DOOR OPEN IN RUN ②	DOOR OPEN IN RUN ②
2000	BLADDER PRESS FAIL ②	DOOR UNSEAL IN RUN ②	DOOR UNSEAL IN RUN ②
4000	DOOR OPEN ERROR ③	DOOR OPEN/CLOSE ERROR ③	DOOR OPEN/CLOSE ERROR ③
8000	DOOR CLOSE ERROR ③	OBSTRUCTION ③	OBSTRUCTION ③
4444	–	–	FAILURE OF RETAINER OR INDEX ON POWER UP ③
8888	LOSS OF SPEED FEED-BACK WHILE RUNNING ④	LOSS OF SPEED FEED-BACK WHILE RUNNING ④	LOSS OF SPEED FEED-BACK WHILE RUNNING ①

* OPTIONAL SENSOR REQUIRED: WARNING MESSAGE ONLY- DOES NOT STOP RUN.

① PRESS "START" TO CLEAR
② PRESS "CANCEL" TO CLEAR
③ PRESS "OPEN/CLOSE" TO CLEAR
④ TURN POWER OFF & ON TO CLEAR

INPUT RELAY LED'S, DISPLAYED ON CPU BOARD OF CONTROLLER.

	D19	D18	D17	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6
1600			HEATER		FOOT SWITCH N/O	DOOR CLOSED	DOOR OPENED	BLADDER OK	N2 PRESSURE OK	START N/O	STOP N/C		SPEED	INDEX
1800 *	DI PRESSURE	DI FLOW LOW	DI FLOW HI / HEATER	N2 FLOW HI	OPEN/CLOSE	DOOR CLOSED	DOOR OPEN	DOOR SEALED	N2 PRESSURE	START/STOP	WINDOW UNSEAED Ⓒ	OBSTRUCT	SPEED	INDEX
8100	NEUTRAL		LOCK	UNLOCK	OPEN/CLOSE	DOOR CLOSED	DOOR OPENED	WINDOW SEALED	N2 PRESSURE OK	START/STOP	DOOR UNSEALED	OBSTRUCT-	SPEED	INDEX

*IF DIP SWITCH 4 IS IN THE UP POSTION(SPECIAL) YOU WILL SEE THE DI AND N2 FLOW SENSORS.

PROGRAMING MODES

KEYPAD DISPLAY

SYSTEM	SELECT	DESCRIPTION	RECIPE	STEP	TIME				RPM				RESISTIVITY		
1600	1600	STARTS PROGRAMING MODE	INPUT 0-9	INPUT 0-9	MAX INPUT OF 9999 SECS				MAX INPUT OF 3200 RPM'S				MAX INPUT 20.0		
	1601	SET PARAMETERS FOR AUTOWASH WARNING	NOT USED	NOT USED	MAX INPUT OF 9999 SECS				MAX INPUT OF 9999 CYCLES				NOT USED	NOT USED	BLANK
	1602	DISPLAYS REVISION OF SOFTWARE	1	6	–	0		X	–	–	X	X	BLANK	BLANK	BLANK
			TYPE								REVISION				
	1603	DISPLAYS INPUT SIGNALS * Ⓐ	NOT USED	FOOT SWITCH	NOT USED	HEATER		BLADDER	N2 PRESS	START N/O	STOP N/C	NOT USED	NOT USED	NOT USED	BLANK
	1604	SET PARAMETER FOR AUTOWASH Ⓑ	NOT USED	NOT USED	MAX INPUT OF 9999 SECS				NOT USED				NOT USED	NOT USED	BLANK
	123	LAST STEP OF LAST RUN *	DISPLAYS THE LAST STEP OF THE LAST RUN												

SYSTEM	SELECT	DESCRIPTION	RECIPE	STEP	TIME				RPM				RESISTIVITY		
1800	1800	STARTS PROGRAMING MODE	INPUT 0-9	INPUT 0-9	MAX INPUT OF 9999 SECS				MAX INPUT OF 2000 RPM'S				MAX INPUT 20.0		
	1801	SET PARAMETERS FOR AUTOWASH	NOT USED	NOT USED	MAX INPUT OF 9999 HOURS				MAX INPUT OF 9999 CYCLES				NOT USED	NOT USED	BLANK
	1802	DISPLAYS REVISION OF SOFTWARE	1	8	–	0	0	X	–	–	X	X	BLANK	BLANK	BLANK
			TYPE			VERSION					REVISION				
	1803	DISPLAYS INPUT SIGNALS * Ⓐ	* N2 FLOW HI	OPEN/CLOSE	DI PRESS	DOOR OPEN	DOOR CLOSED	DOOR SEALED	N2 PRESS	START/STOP	WINDOW UNSEAL Ⓒ	OBSTRU-CTION	DI FLOW HI	DI FLOW LO / HTR	BLANK
	123	LAST STEP OF LAST RUN *	DISPLAYS THE LAST STEP OF THE LAST RUN												

*IF DIP SWITCH 4 IS IN THE UP POSTION(SPECIAL) YOU WILL SEE THE DI AND N2 FLOW SENSORS.

SYSTEM	SELECT	DESCRIPTION	RECIPE	STEP	TIME				RPM				RESISTIVITY		
8100	8100	STARTS PROGRAMING MODE	INPUT 0-9	INPUT 0-9	MAX INPUT OF 9999 SECS				MAX INPUT OF 1200 RPM'S, FOR 8100 MAX INPUT OF 1000 RPM'S, FOR 8200				MAX INPUT 20.0		
	8101	SET PARAMETERS FOR AUTOWASH	NOT USED	NOT USED	MAX INPUT OF 9999 SECS				MAX INPUT OF 9999 CYCLES				NOT USED	NOT USED	BLANK
	8102	DISPLAYS REVISION OF SOFTWARE	8	1	–	0	0	X	–	–	X	X	BLANK	BLANK	BLANK
			TYPE			VERSION					REVISION				
	8103	DISPLAYS INPUT SIGNALS * Ⓐ	RETAINER OPEN	OPEN/CLOSE	NOT USED	DOOR OPEN	DOOR CLOSED	DOOR SEALED	N2 PRESS	START/STOP	DOOR UNSEAL	OBSTRU-CTION	RETAINER CLOSED	NOT USED	BLANK
	8104	LOCAL MODE	SECS CAN ONLY CHECK STATUS OR SET LOCAL/REMOTE MODE												
	8105	REMOTE MODE	SECS PERFORMS ALL FUNCTIONS												

ALL "NOT USED" ARE DISPLAYED "0"

*DESELECT BY PRESSING CANCEL.

Ⓐ EXAMPLE- IF ON A 1600, YOU ENTERED A 1603 AND AN ERROR MESSAGE CODE OF 0 0 0100 0000 00 WAS DISPLAYED IT WOULD MEAN, AS THE CHART SHOWS, THAT THE DOOR IS OPEN. 0= INPUT OFF; 1= INPUT ACTIVATED.

Ⓑ ONLY USED WHEN "AUTOWASH" SPECIAL FEATURE FEATURE EPROM IS INSTALLED.

Ⓒ ALWAYS ON FOR HINGED DOOR.

–	–	–	–	–	–
	-1	PART NO.	DESCRIPTION	SIZE	ITEM NO.
QTY REQD		PARTS LIST			

NEXT ASSY	USED ON
–	–

VERTEQ

DATE OF DWG
10 MAY 93

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ANGLES
XX ± – ± –
XXX ± –
BREAK EDGES/REMOVE BURRS

DRAWN M. SCHUK 5/10/93
CHECKED
APPD

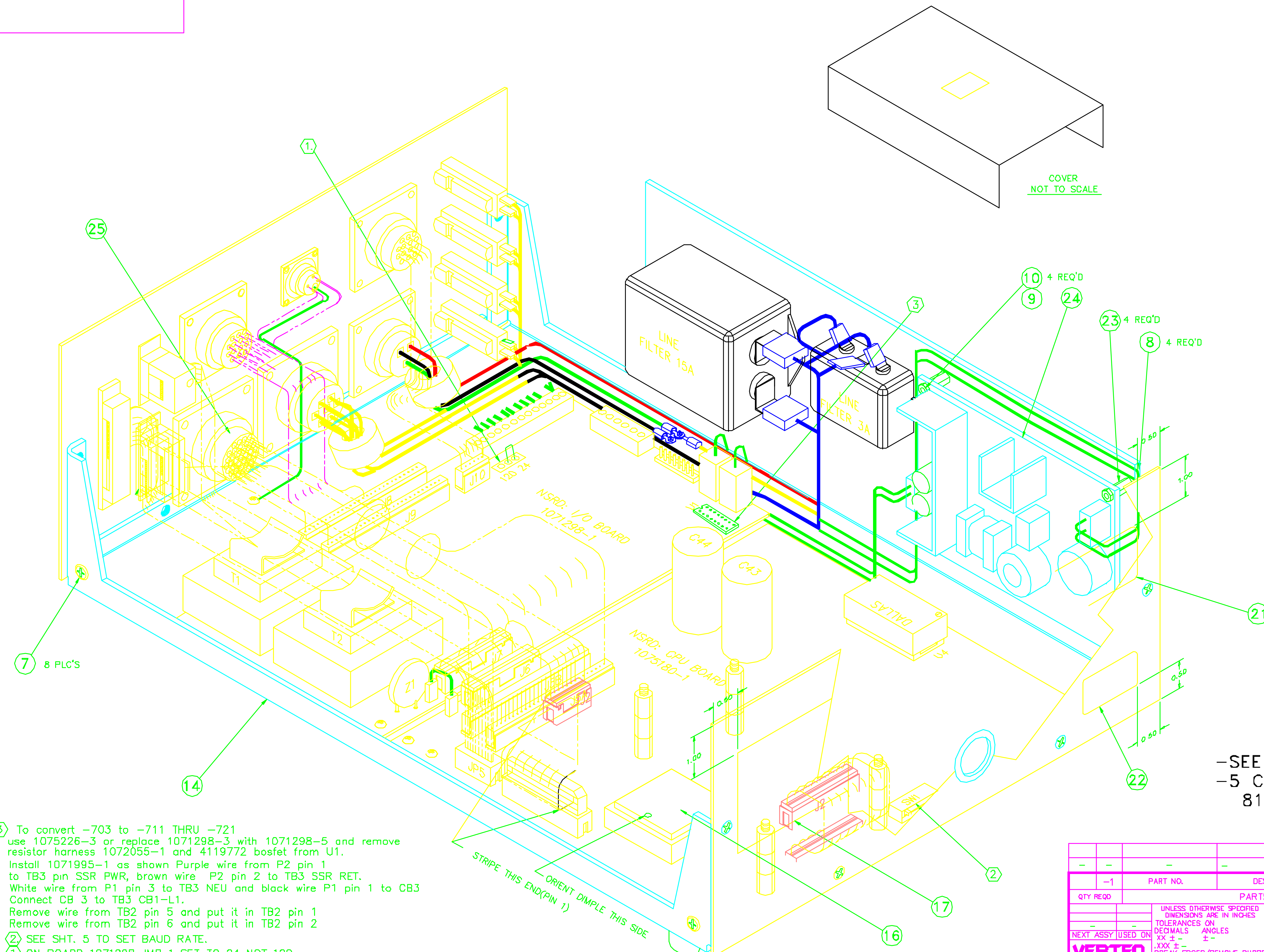
TITLE
WIRING CONFIG'S
NSRD CONTROLLER

D 1075227

SCALE 1=2 SHEET 5 OF 8

1075227

AJ



-SEE PARTS LIST-
-5 CONFIGURATION
81/8200 SRD

NOTES:

3. To convert -703 to -711 THRU -721
use 1075226-3 or replace 1071298-3 with 1071298-5 and remove resistor harness 1072055-1 and 4119772 bosfet from U1.
Install 1071995-1 as shown Purple wire from P2 pin 1 to TB3 pin SSR PWR, brown wire P2 pin 2 to TB3 SSR RET.
White wire from P1 pin 3 to TB3 NEU and black wire P1 pin 1 to CB3
Connect CB 3 to TB3 CB1-L1.
Remove wire from TB2 pin 5 and put it in TB2 pin 1
Remove wire from TB2 pin 6 and put it in TB2 pin 2

2. SEE SHT. 5 TO SET BAUD RATE.

1. ON BOARD 1071298 JMP 1 SET TO 24 NOT 120.

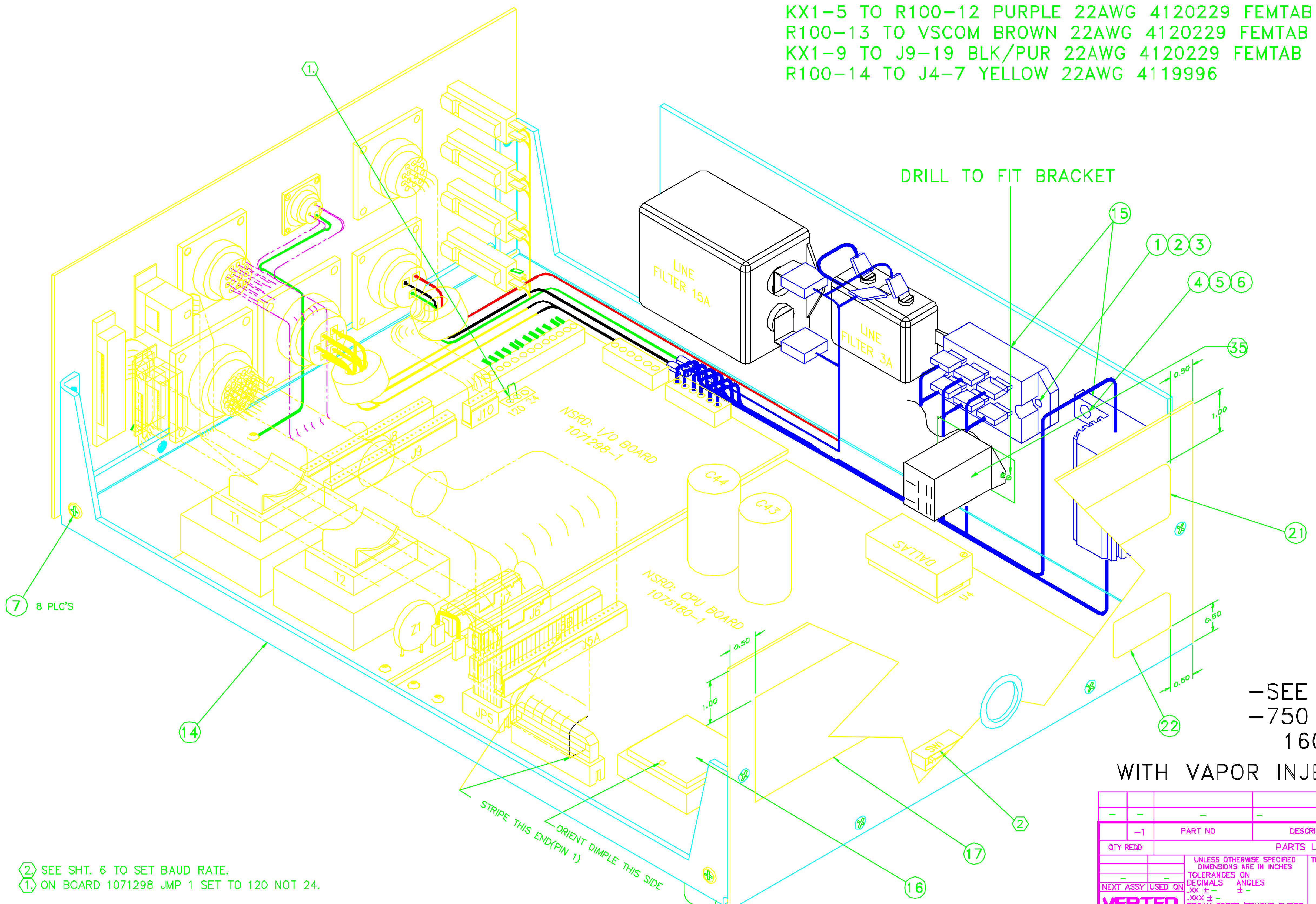
-	-	-	-	-	-
	-1	PART NO.	DESCRIPTION	SIZE	ITEM NO.
QTY REQD		PARTS LIST			

NEXT ASSY: -	USED ON: -	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS ANGLES XX ± - ± - .XXX ± - BREAK EDGES/REMOVE BURRS	TITLE CONTROLLER, NSRD
VERTEQ		DRAWN M. SCHUK 5/10/93	D 1075227
DATE OF DWG 10 MAY 93		CHECKED	SCALE FULL -
		APPD	SHEET 6 OF 8

1075227

AJ

ADDITIONAL WIRING FOR CONFIG. -750
KX-1-13 TO TB3 SSRRET WHITE 22AWG 4120229 FEMTAB
KX-1-14 TO J9-7 BLACK 22AWG 4120229 FEMTAB
KX1-5 TO R100-12 PURPLE 22AWG 4120229 FEMTAB 4119996 SOC
R100-13 TO VSCOM BROWN 22AWG 4120229 FEMTAB 4119996
KX1-9 TO J9-19 BLK/PUR 22AWG 4120229 FEMTAB
R100-14 TO J4-7 YELLOW 22AWG 4119996



-SEE PARTS LIST-
-750 CONFIGURATION
1600-55 SRD
WITH VAPOR INJECTION MODULE

NOTES:
1. ON BOARD 1071298 JMP 1 SET TO 120 NOT 24.
2. SEE SHT. 6 TO SET BAUD RATE.

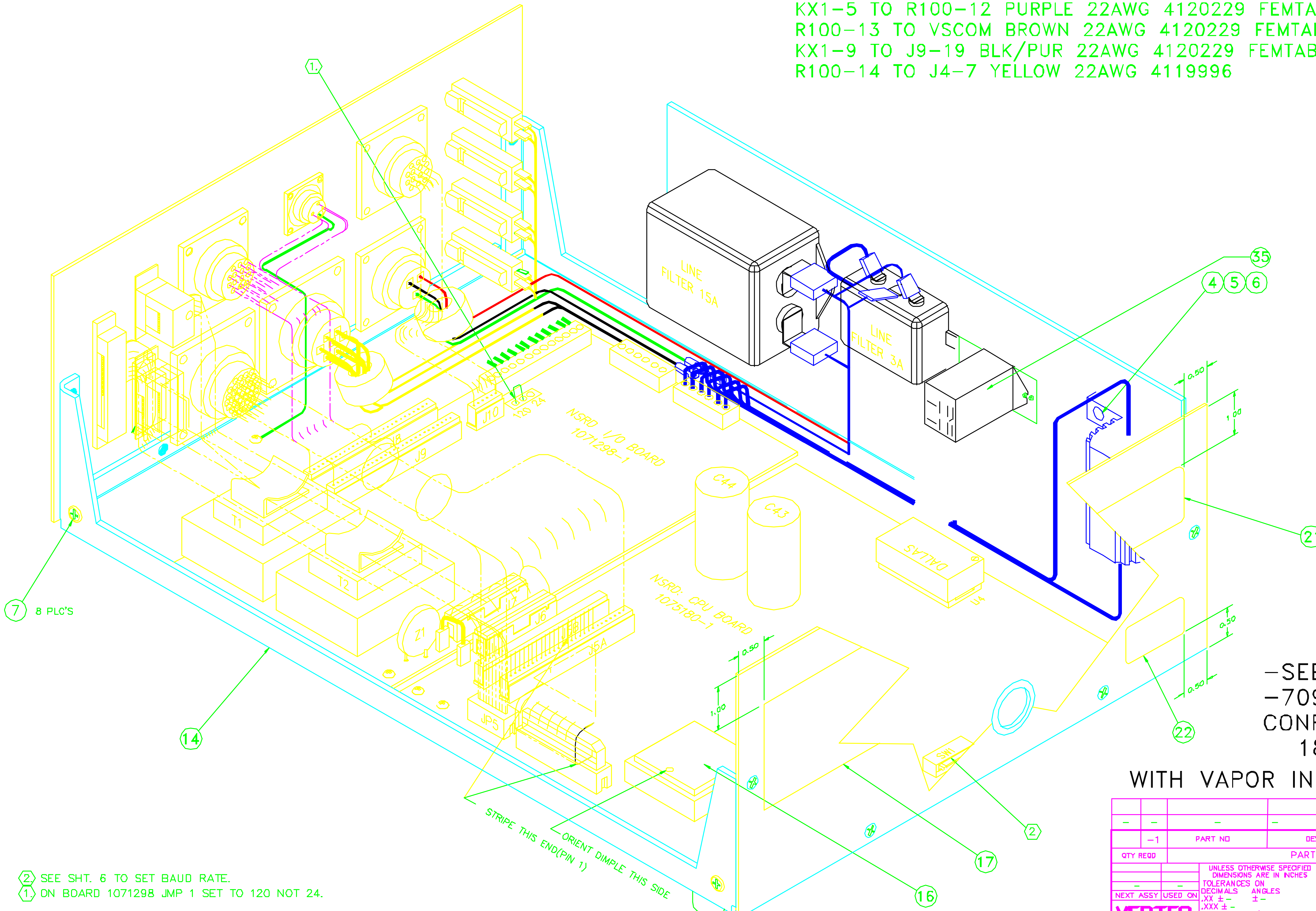
QTY REQD	-1	PART NO	DESCRIPTION	SIZE	ITEM NO

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS .XX ± - .XXX ± - ANGLES ± -
BREAK EDGES/REMOVE BURRS
NEXT ASSY | USED ON
VERTEQ
DATE OF DWG 10 MAY 93
DRAWN M. SCHUK 5/10/93
CHECKED
APPD
TITLE CONTROLLER, NSRD
D 1075227
SCALE FULL SHEET 7 OF 8
AJ 1075227

ADDITIONAL WIRING FOR CONFIG. -709

KX-1-13 TO TB3 SSRRET WHITE 22AWG 4120229 FEMTAB
KX-1-14 TO J9-12 BLACK 22AWG 4120229 FEMTAB
KX1-5 TO R100-12 PURPLE 22AWG 4120229 FEMTAB 4119996 SOC
R100-13 TO VSCOM BROWN 22AWG 4120229 FEMTAB 4119996
KX1-9 TO J9-19 BLK/PUR 22AWG 4120229 FEMTAB
R100-14 TO J4-7 YELLOW 22AWG 4119996



-SEE PARTS LIST-
-709
CONFIGURATIONS
1800-6 SRD
WITH VAPOR INJECTION MODULE

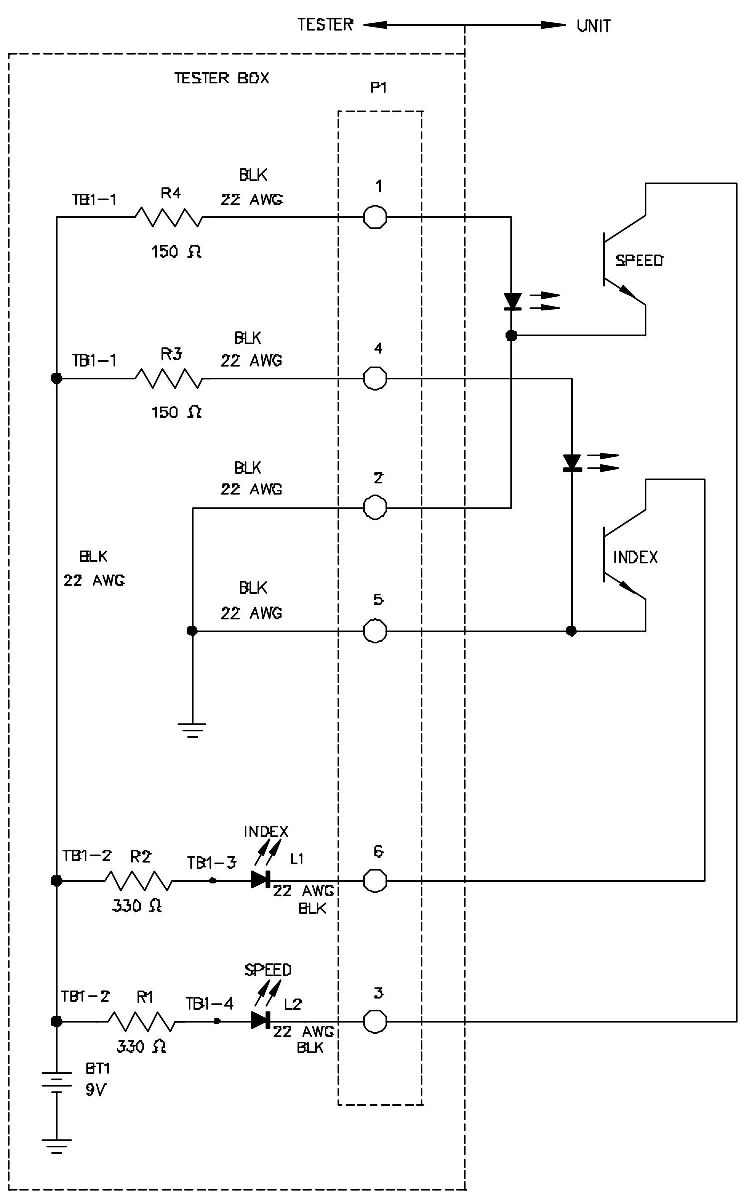
NOTES:
2. SEE SHT. 6 TO SET BAUD RATE.
1. ON BOARD 1071298 JMP 1 SET TO 120 NOT 24.

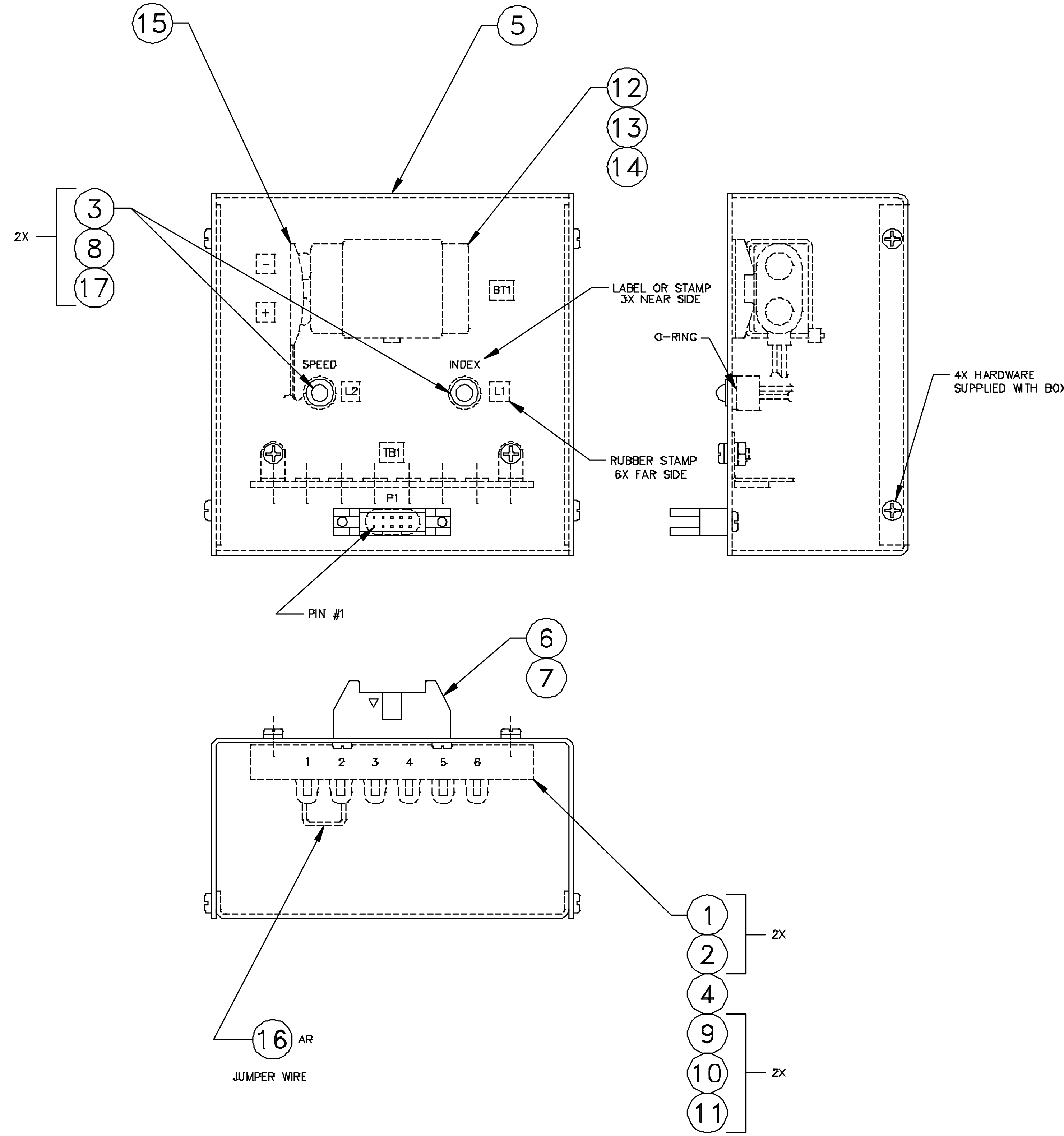
QTY REQD		PART NO	DESCRIPTION	SIZE	ITEM NO.
-	-	-	-	-	-
	-1				

PARTS LIST

NEXT ASSY / USED ON	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS ANGLES .XX ± - ± - .XXX ± - BREAK EDGES/REMOVE BURRS	TITLE CONTROLLER, NSRD
VERTEQ	DRAWN M. SCHUK 5/10/93	D 1075227
DATE OF DWG 10 MAY 93	CHECKED / APPD	SCALE FULL - SHEET 8 OF 8

AJ 1075227





1. ALL RESISTORS ARE IN OHM, 1/4 WATT, 5%.

NOTES: UNLESS OTHERWISE SPECIFIED.

APPROVED FOR CONSTRUCTION - 5/22/98

P/N 1068949

REVISIONS

LTR	DESCRIPTION	DATE	APPD
NC	INITIAL RELEASE	10-18-88	EDT
A	SEE EO	8-8-94	LM
B	SEE E.O.	7/11/96	RWW.
C	SEE E.O.	12-31-98	R.W.W

—SEE PARTS LIST—

-1	
CONFIG	DESCRIPTION

MATERIAL SPEC.	FINISH SPEC.

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ANGLES
.XX± .030 ± 1°
.XXX± .010
BREAK EDGES/REMOVE BURRS

DRAWN	CN
CHECKED	
APPROVED	
DATE OF DWG	10-18-88

VERTEQ

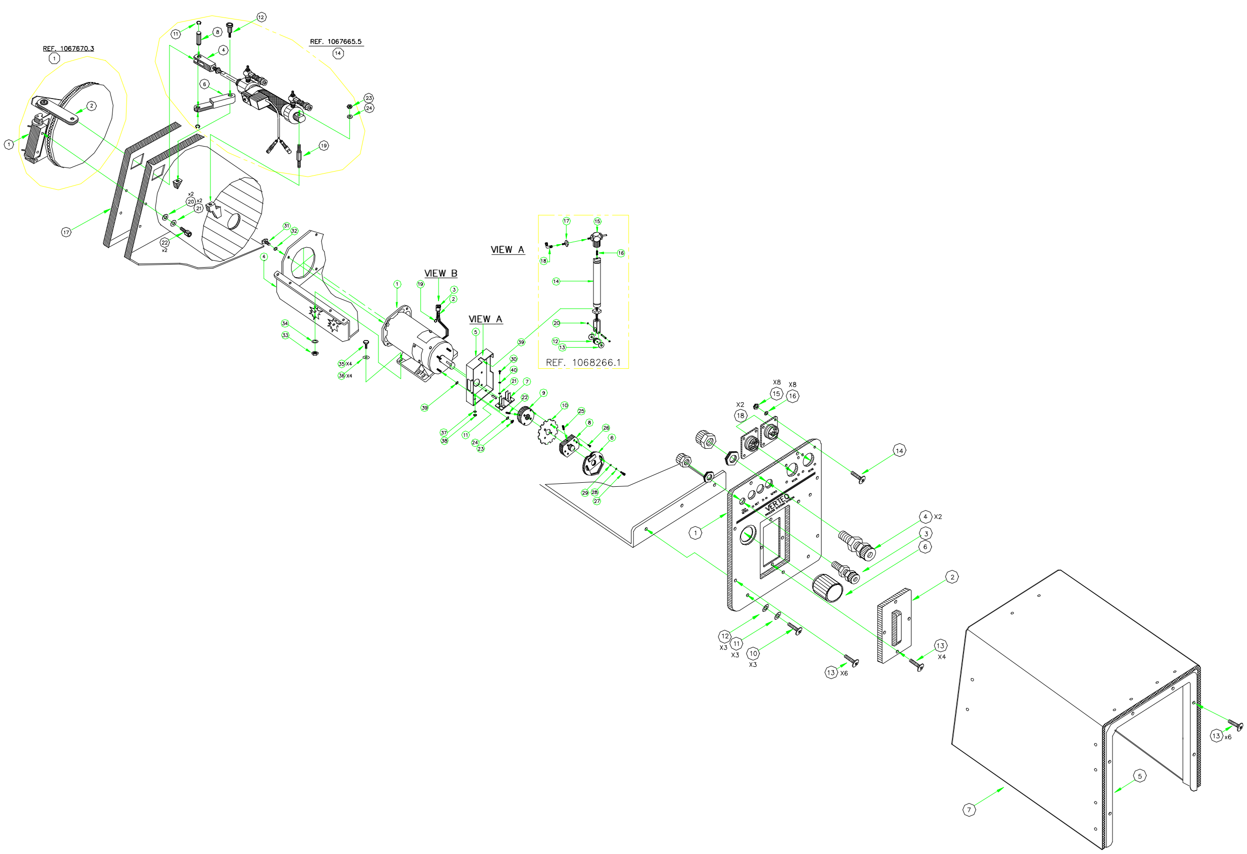
NEXT ASSY | USED ON

TITLE

OPTICAL SENSOR TESTER

C 1068949

SCALE NONE | 1600 R/D | SHEET 1 OF 1


VIEW A
VIEW B
VIEW A
REF. 1068266.1

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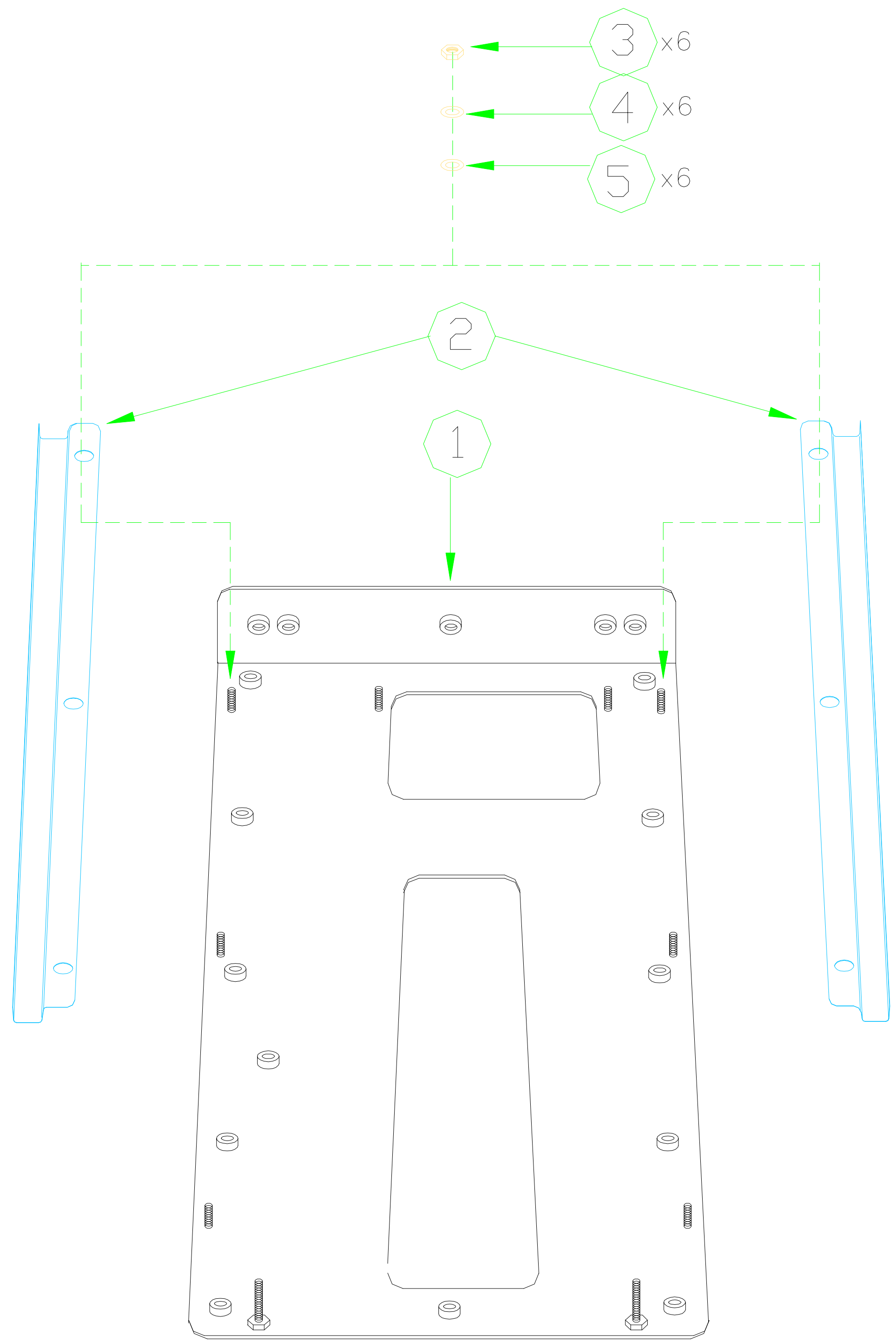
BASE PLATE FRONT and TOP VIEW
1600-55 A/M – (-1 Shown)



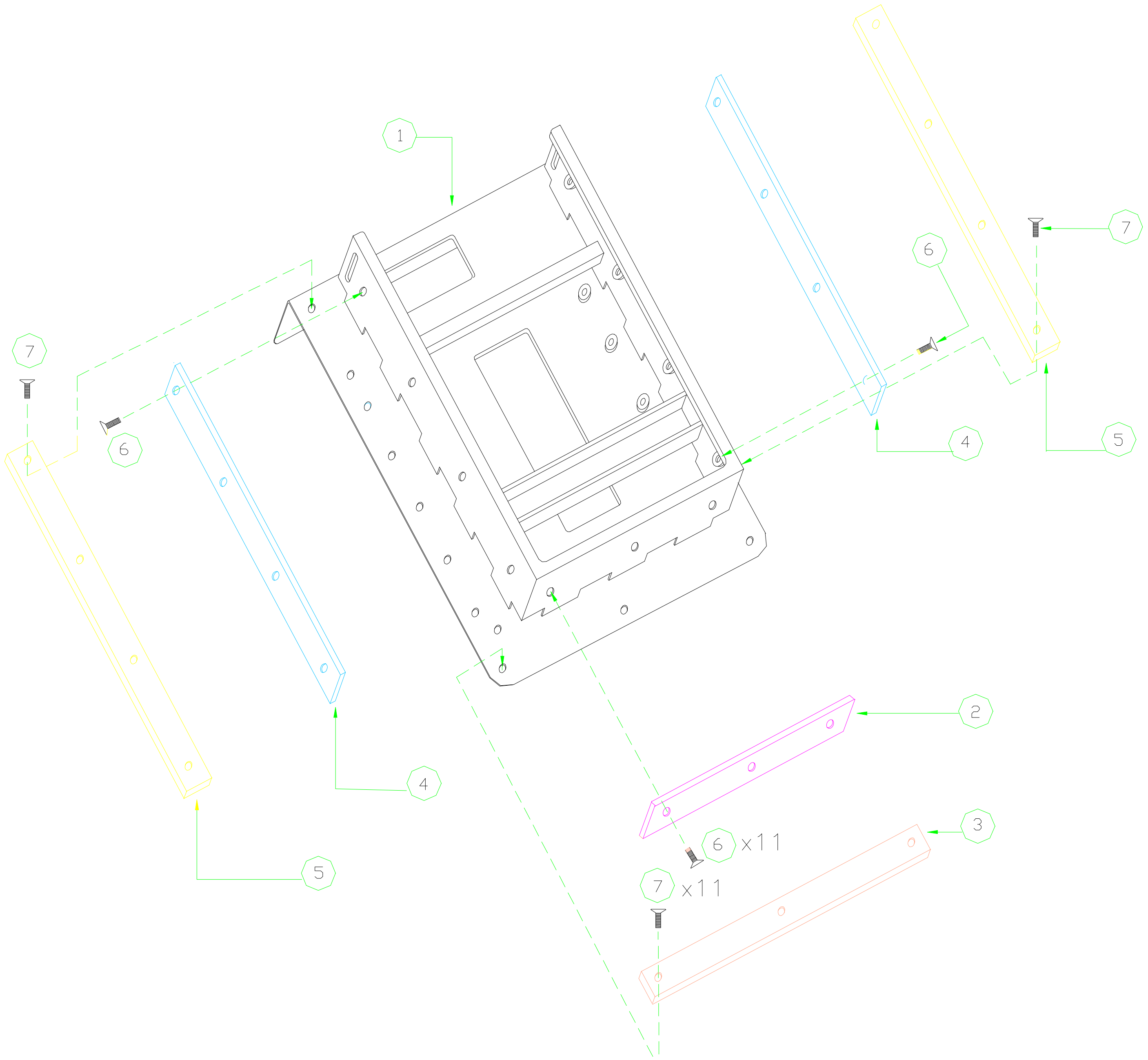
1600 BASE PLATE, FRONT & TOP VIEW

ITEM	PART #	DESCRIPTION	QTY
1	1067656.1	BASE PLATE	1
2	1067635.1	SLIDE COVER	2
3	6X32	HEX NUT	6
4	6X32	STAR WASHER	6
5	6X32	FLAT WASHER	6

INSTRUCTIONS

- ATTACH 2-SLIDE COVERS TO THE BASE PLATE (1) BY USING: 6-6X32 HEX NUTS(3), 6-6X STAR WASHERS(4), AND 6-6X FLAT WASHERS(5).
- SEE DRAWING FOR RELATIVE POSITIONS.

BASE PLATE UPSIDE DOWN ASSEMBLY
1600-55 A/M – (-1 Shown)



1600 BASE PLATE FRONT & TOP VIEW

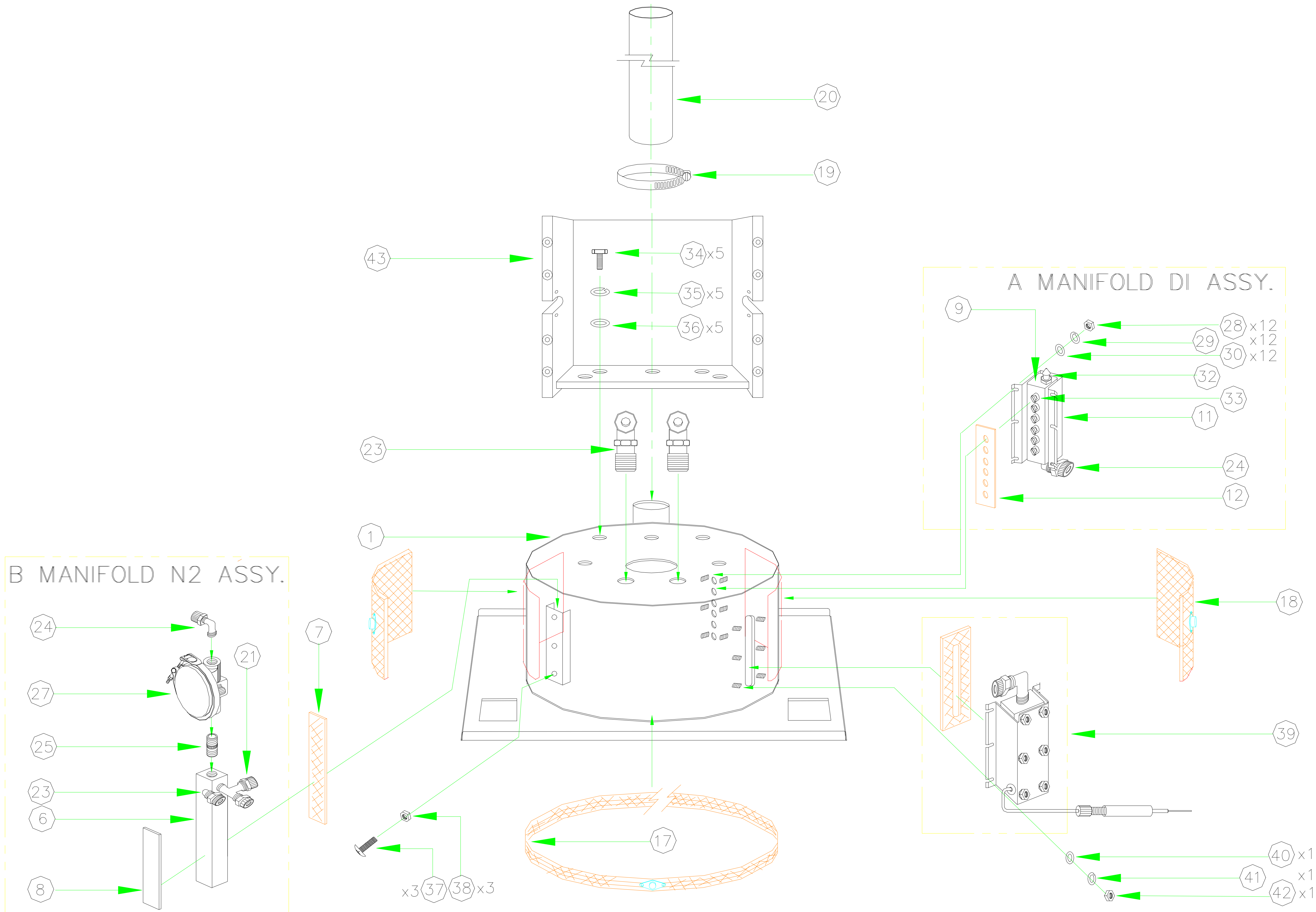
(UP SIDE DOWN)

ITEM	PART #	DESCRIPTION	QTY
1	1067656.1	BASE PLATE	1
2	1067623.1	SUPPORT FRONT	1
3	1067619.1	SUPPORT BASE	1
4	1067622.1	GUIDE BASE SIDE	2
5	1067624.1	SUPPORT SIDE	2
6	10X32X1/2	FLAT SCREWS	11
7	10X32X3/8	FLAT SCREWS	11

INSTRUCTIONS

1-TURN THE BASE UPSIDE DOWN.
2-ATTACH SUPPORT FRONT (2) TO THE BASE PLATE (1) BY USING 3-10X32X1/2 FLAT SCREWS (7).
3-ATTACH SUPPORT BASE (3) TO THE BASE PLATE (1) BY USING 3-10X32X5/8 FLAT SCREWS (6).
4-ATTACH GUIDE BASE (4) TO THE BASE PLATE (1) BY USING 8-10X32X1/2 FLAT SCREWS (6).
5-ATTACH SUPPORT SIDE (5) TO THE BASE PLATE (1) BY USING 8-10X32X5/8 FLAT SCREWS (7).

BOWL ASSEMBLY 1
1600-55 A/M – (-1 Shown)



BOWL ASSEMBLY INSTRUCTIONS 2
1600-55 A/M

ITEM	PART #	DESCRIPTION	QTY
1	1067657	1600-BOWL	1
6	1065682.1	MANIFOLD, N2	1
7	1065681.1	GASKET, N2	1
8	1062532	PLATE, LOCKING	1
9	1062537.1	MANIFOLD, DI	1
11	1062552.1	BRACKET DI, MANIFOLD	1
12	1062531.1	SEAL, GASKET DI	1
17	1064832.3	HEATER, STRIP 1X36	1
18	1064827.1	HEATER, BLANKET 5X5	2
19	4115761	CLAMP, HOSE	1
21	4118949	TEE, MALE 1/4	1
20	5115521	TUBE, 1X3/4X2"	20 IN
23	4118941	ELBOWL 1/8X1/4T	3
24	4118953	ELBOWL 3/8X1/4NPT	4
25	4116338	NIPPLE, CLOSE	1
27	1067798.1	PRESSURE VALVE	1
28&42	8X32	HEX NUT	12
29X41	8X	STAR WASHER	12
30&40	8X	FLAT WASHER	12
32	4114030	TUBE CONNECTOR	1
33	4117876	NOZZEL	6
34	10X32X3/4	5/16 HEX HEAD SCREW	5
35	10X	STAR WASHER	5
36	10X	FLAT WASHER	5
37	10X32X3/4	ROUND HEAD SCREW	3
38	10X32	HEX NUT	3
39	1069254.1	STATIC ASSY.	1
43	1066893.1	MOTOR, SUPPORT	1

EXTRA PARTS REQUIREMENT FOR BOWL ASSY.			
	4114357	TAPE GLASS	
	4114561	TEFLON TAPE	
	5115241	WATLOW	
	5115242	WATLOW MIXER	

A MANIFOLD, DI ASSEMBLY:

1- USING TEFLON TAPE APPLY TO ALL NOZZEL AND ELBOW THREADS.
2- ATTACH 6-NOZZELS (33) TO THE MANIFOLD DI (9).
3- ATTACH TUBE COONECTOR (32) TO THE MANIFOLD DI (9).
4- ATTACH ELBOW (24) TO THE MANIFOLD DI (9).
5- INSERT MANIFOLD DI (9) INTO THE MANIFOLD DI BRACKET (11).

B MANIFOLD, N2 ASSEMBLY:

1- USING TEFLON TAPE APPLY TO ALL ELBOW AND NIPPLE THREADS.
2- ATTACH ELBOW 3/8X1/4 (24), AND NIPPLE (25) TO THE PRESSURE VALVE (27).
3- ATTACH PRESSURE VALVE (24),(25),(27) TO THE MANIFOLD N2 (6).
4- ATTACH ELBOW 1/8X1/4 (23), AND TEE MALE 1/4 (21) TO THE MANIFOLD N2 (6).

BOWL ASSEMBLY INSTRUCTIONS:

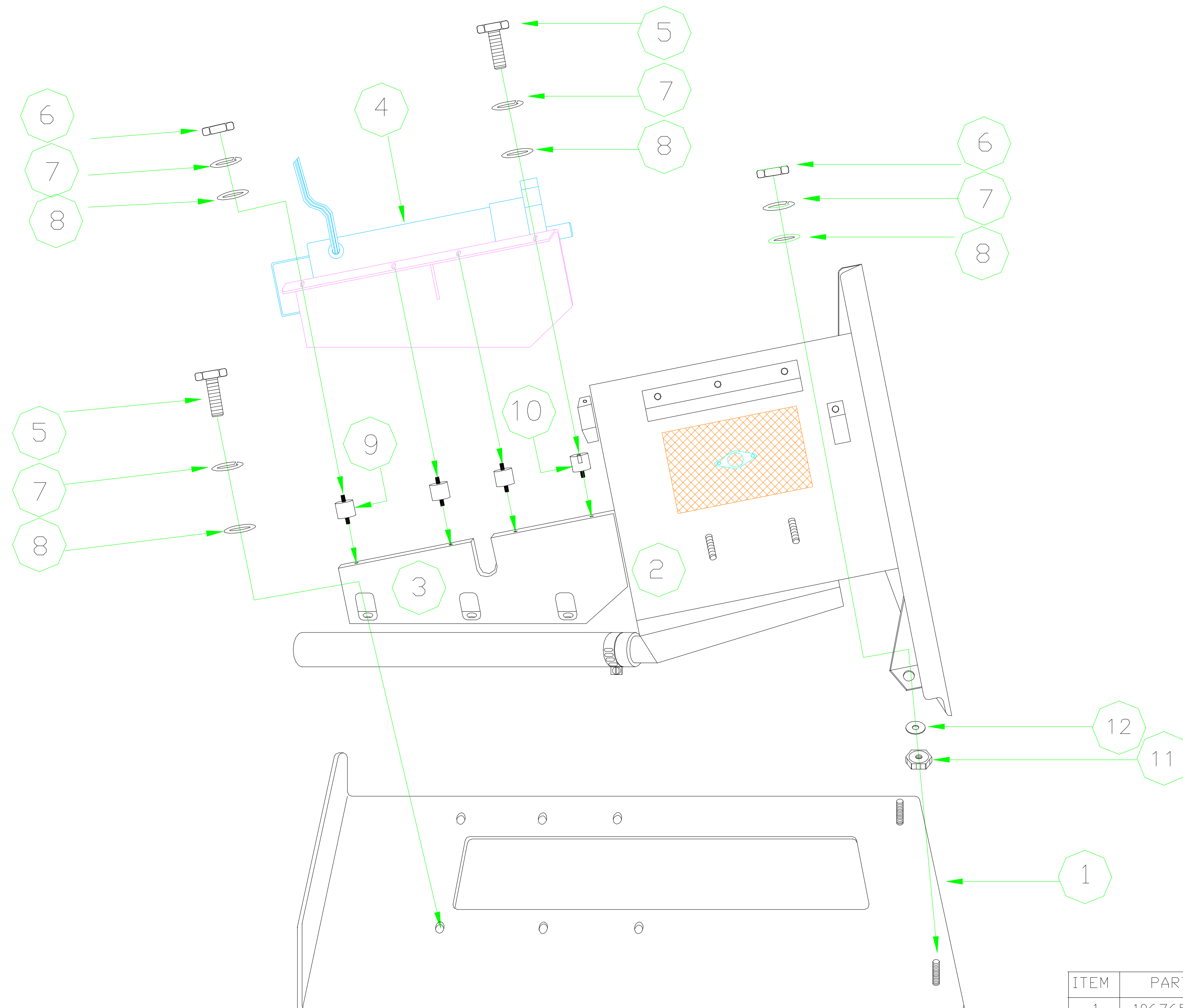
1- TURN THE 1600 BOWL(1) FACE DOWN.
2- PLACE THE HEATER BLANKET (18) AND HEATER STRIP (17) TO THE BOWL, USING PENCIL TO MARK THE SIZE OF HEATER BLANKETS (18) AND HEATER STRIP ON EACH SIDE OF THE BOWL (SEE DRAWING).
3- USING WATLOW & MIXER APPLY ON THE SURFACE OF HEATER BLANKETS (18), HEATER STRIP (17), AND THE SURFACE OF THE BOWL, WHERE YOU JUST MARKED BY PENCIL, THEN WAITING FOR 20 MINUTE.
4- ATTACH HEATER BLANKETS (18) AND HEATER STRIP (17) TO THE BOWL.
5- USING TAPE GLASS COVER AROUND THE HEATER STRIP (17).
6- ATTACH STATIC ASSEMBLY (39) TO THE BOWL, USING 6-8X32 HEX NUTS (42), 6-8X STAR WASHERS (41), AND 6-8X FLAT WASHERS (40).
7- ATTACH DI SEAL GASKET (12), AND DI MANIFOLD ASSEMBLY (A), TO THE BOWL (1), USING 6-8X32 HEX NUTS (28), 6-8X STAR WASHERS (29), AND 6-8X FLAT WASHERS (30).
8- ATTACH N2 GASKET (7), N2 MANIFOLD ASSEMBLY (B), AND PLATE LOCKING (8) TO THE BOWL (1). USING 3-10X32X3/4 ROUND HEAD SCREWS (37), AND 3-10X32 HEX NUTS (38).
9- ATTACH MOTOR SUPPORT (43) TO THE BOWL (1), USING 5-10X32X3/4 HEX NUT SCREWS(34), 5-10X SPLIT WASHERS(35), AND 5-10X FLAT WASHERS(36).
10- ATTACH 2-1/8X1/4 ELBOW(23) TO THE BOWL.
11- ATTACH TUBE, 1-3/4X2" (20) TO THE BOWL, BY USING CLAMP (19).

(SEE DRAWING FOR RELATIVE POSITIONS).

NOTE

BE SURE APPLY TEFLON TAPE TO ALL ELBOWLS AND NIPPLES THREAD.

BOWL ASSEMBLY INSTRUCTIONS 3
1600-55 A/M

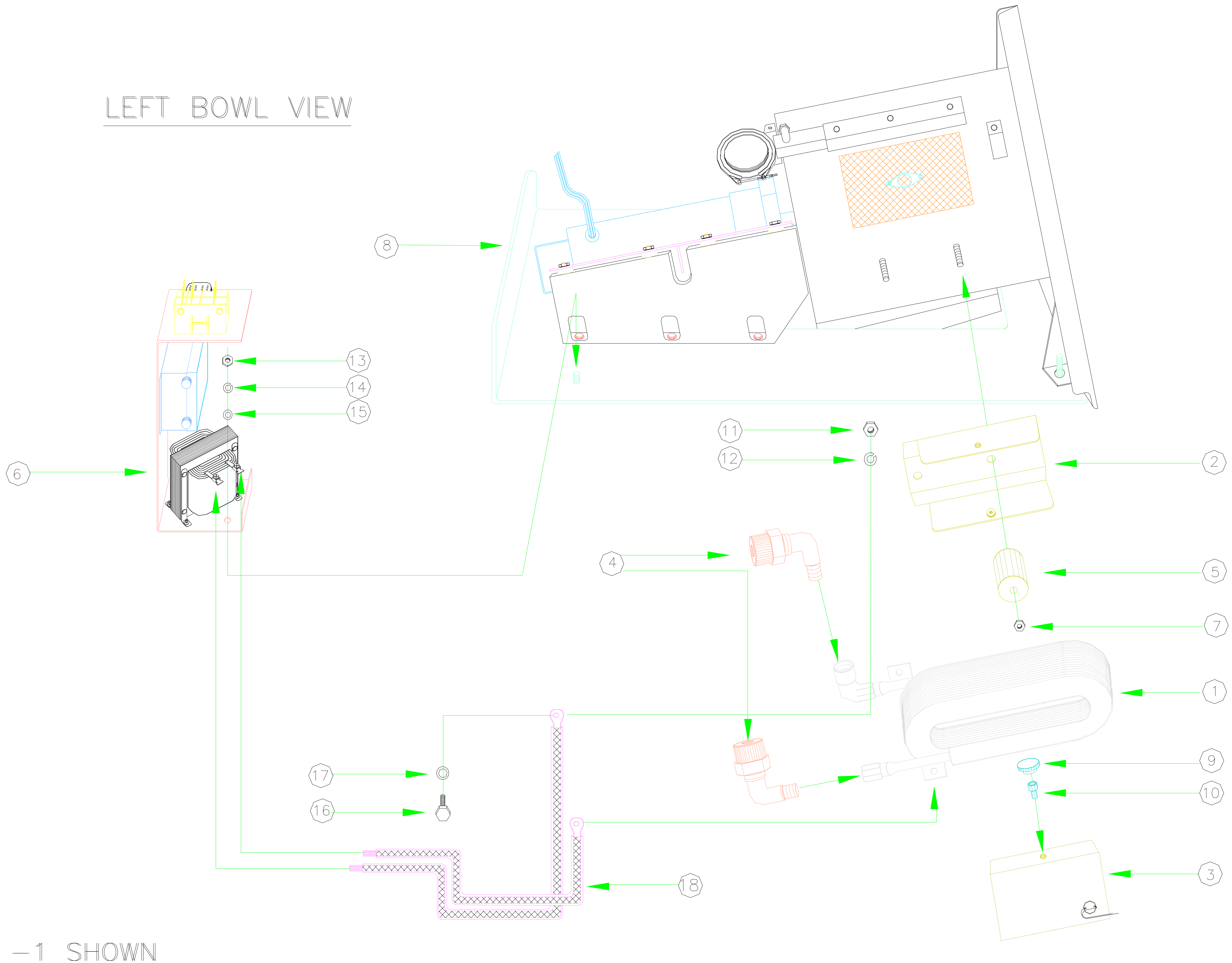


INSTRUCTIONS:

1- ATTACH 2-1/4X20 HEX NUTS(11), AND 2-1/4X WASHERS (12) TO THE STUDS OF BASE PLATE(1). THEN ADJUST IT AT THE MIDLE OF STUDS.
2- ATTACH BOWL ASSEMBLY & MOTOR SUPPORT BASE (2)(3) TO THE BASE PLATE (1). USING 6-1/4X20X3/4 HEX HEAD SCREWS(5), 2-1/4X20 HEX NUTS(6), 8-1/4X20 SPLIT WASHERS(7), AND 8-1/4X FLAT WASHERS(8).
3- ATTACH 6-MOUNTING SHOCKS 4-(9) & 2-(10) TO THE MOTOR SUPPORT BASE (3).
4- ATTACH MOTOR ASSEMBLY (4) TO THE MOTOR SUPPORT (3). USING 2-1/4X20 HEX SCREWS(5) TO MOUNTING SHOCKS(10). 6-1/4X20 HEX NUTS(6), 8-1/4X SPLIT WASHERS(7), AND 8-1/4X FLAT WASHERS(8) TO MOUNTING SHOCKS(9). (SEE DRAWING FOR RELATIVE POSITIONS).

ITEM	PART #	DESCRIPTION	QTY
1	1067656	BASE PLATE	1
2	1067704.1	BOWL ASSY.	1
3	1066893.1	MOTOR SUPPORT	1
4	1070291.3	MOTOR ASSY.	1
5	1/4X20X3/4	HEX HEAD SCREW	8
6&11	1/4X20	HEX NUT	12
7	1/4X20	SPLIT WASHER	16
8&12	1/4X20	FLAT WASHER	20
9	4116635	SHOCK	6
10	4116634	SHOCK	2

BOWL ASSEMBLY INSTRUCTIONS 4
1600-55 A/M



BOWL ASSEMBLY INSTRUCTIONS 5
1600-55 A/M

1- ATTACH TRANSFORMER ASSY. BLOCK(6) TO THE BOWL ASSY.(8), USING 3-10X32 HEX NUTS(13), 3-10X SPLIT WASHERS(14), AND 3-10X FLAT WASHERS(15).
2- ATTACH CLEANCOIL ENCLOSURE (2) TO THE LEFTBOWL, USING 2-1/4X20 LOCK NUTS (7).
3- ATTACH 2-ELBOW 3/8X1/4 (4) TO THE CLEANCOIL (1).
4- ATTACH 2-PLATE, LOCATOR (5) TO THE BOWL STUDS, THEN TIGHTEN IT BY 2-1/4X20 LOCK NUTS (7).
5- ATTACH 2-CLEANCOIL CABLES (5) TO THE CLEANCOIL (1), USING 2-1/4X20X1/4 HEX SCREWS(16), 2-1/4X20 FLAT WASHERS(17), 2-1/4X20 SPLIT WASHERS(12), AND 2-1/2X20 HEX NUTS (11).
6- ATTACH CLEANCOIL ASSY.(1) TO THE CLEANCOIL ENCLOSURE (2).
7- ATTACH CLEANCOIL COVER (3) TO THE CLEANCOIL ENCLOSURE (2), USING 2-10X32X1/4 SOCKET SCREWS(10), AND 2-BLACK KNOBS (9).
8- ATTACH OTHER SIDE OF 2-CLEANCOIL CABLES (18) TO THE TRANSFORMER (6).

NOTE

USING TEFLON TAPE FOR ALL ELBOW THREADS

ITEM	PART #	DESCRIPTION	QTY
1	1068271.1	CLEANCOIL A, WRAPPING	1
2	1062558.1	ENCLOSURE A, WRAPPING	1
3	1062555.1	COVER, ENCLOSURE	1
4	4118953	ELBOW 3/8X1/4 NPT	2
5	1062620.1	PLATE, LOCATOR	2
6	1067666.5	TRANSFORMER ASSY.	1
7	1/4X20	LOCK NUTS 1/4X20/SS	2
8	1067704.1	BOWL ASSY.	1
9	4115590	KNOB, BLACK 99-602-5	1
10	10X32X1/4	SOCKET HEAD SCREW	1
11	1/4X20	HEX NUTS	2
12	1/4	SPLIT WASHERS	2
13	10X32	HEX NUTS	3
14	10X32	SPLIT WASHERS	3
15	10X32	FLAT WASHERS	3
16	1/4X20X1/4	HEX HEAD SCREWS	2
17	1/4	FLAT WASHERS	2
18	1073934.1	CLEANCOIL CABLES	2

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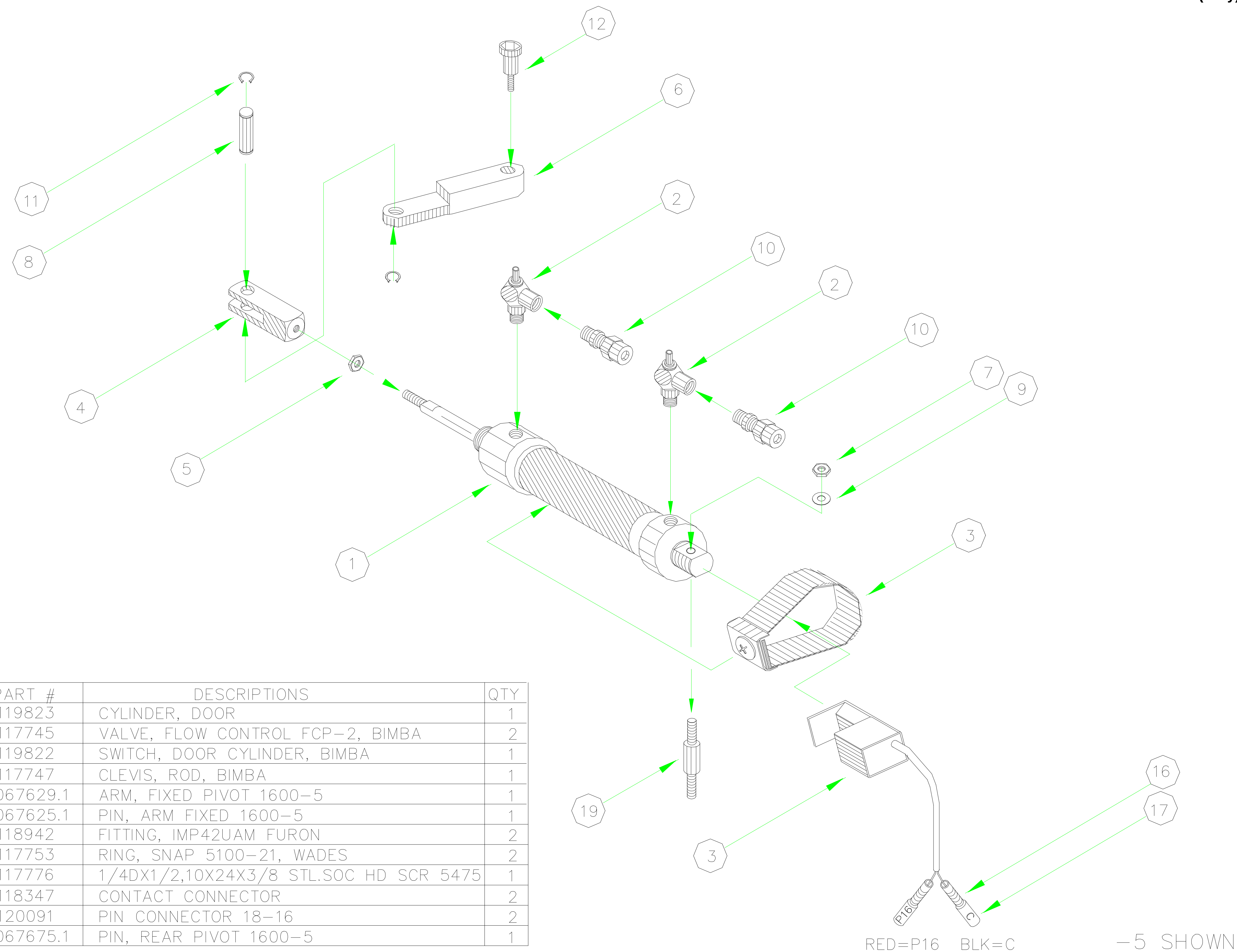
DOOR CYLINDER ASSEMBLY and INSTRUCTIONS 1
1600-55 A (Only)



ITEM	PART #	DESCRIPTIONS	QTY
1	4119823	CYLINDER, DOOR	1
2	4117745	VALVE, FLOW CONTROL FCP-2, BIMBA	2
3	4119822	SWITCH, DOOR CYLINDER, BIMBA	1
4	4117747	CLEVIS, ROD, BIMBA	1
6	1067629.1	ARM, FIXED PIVOT 1600-5	1
8	1067625.1	PIN, ARM FIXED 1600-5	1
10	4118942	FITTING, IMP42UAM FURON	2
11	4117753	RING, SNAP 5100-21, WADES	2
12	4117776	1/4DX1/2,10X24X3/8 STL.SOC HD SCR 5475	1
16	4118347	CONTACT CONNECTOR	2
17	4120091	PIN CONNECTOR 18-16	2
19	1067675.1	PIN, REAR PIVOT 1600-5	1

DOOR CYLINDER ASSEMBLY and INSTRUCTIONS 2
1600-55 A (Only)

DOOR CYLINDER ASSEMBLY AND INSTRUCTIONS:

1- USING TEFLON TAPE APPLY TO 2-FLOW CONTROL VALVES (2) AND 2-FITTINGS (10) THREAD.
2- ATTACH 2-FITTINGS (10) TO THE 2-FLOW CONTROL VALVES (2).
3- ATTACH 2-FLOW CONTROL VALVES (2) TO THE BIMBA CYLINDER (1). BE SURE 2-FITTINGS FACE BACK TO THE END OF CYLINDER (1).
4- SCREW ON THE 10X24 HEX NUT (5), AND THE CLEVIS ROD (4) TO THE SHAFT OF CYLINDER (1).
5- ATTACH SWITCH DOOR CYLINDER (3) TO THE BIMBA CYLINDER (1). MAKE SURE THE SWITCH TURN TO LEFT SIDE IF THE CLEVIS ROD (4) FACE TO NORTH DIRECTION.

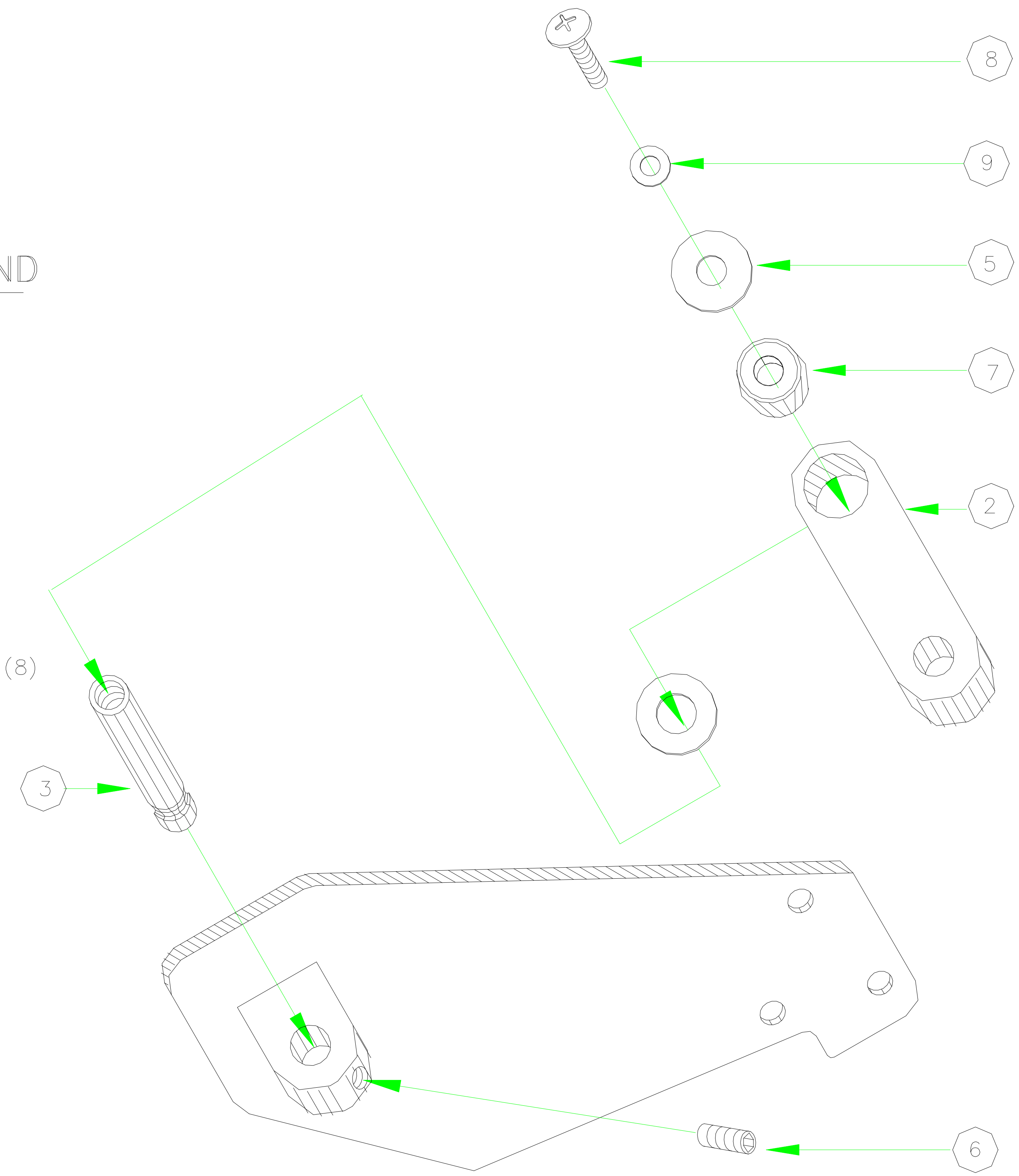
AUTOMATIC DOOR ASSEMBLY INSTRUCTIONS:

1- ATTACH FRONT PANEL(17) TO THE BOLW FACE.
2- ATTACH REAR PIVOT PIN(19) TO THE REAR BOLW.
3- ATTACH FIXED PIVOT ARM(6) TO THE BOLW BY USING 1-10X24X3/8 HEX SCREW(12).
4- ATTACH DOOR CYLINDER(14) TO THE BOLW AT THE REAR PIVOT PIN(19). THEN TIGHTEN IT BY USING 1-6X32 HEX NUT(23) AND 1-6X FLAT WASHER(24).
5- REMOVE THE RING CLIP(11) AND ARM PIN(8) FROM CLEVIS ROD(4).
6- MOUNT THE HINGE, FRONT DOOR(1) TO THE FRONT PANEL(17). THE ARM PUSH(3) OF LINKASSY MUST GO THROUGH THE LITTLE WINDOW OF FRONT PANEL(17). USING 2-10X32X1/2 SOCKET HEAD SCREW(22), 2-10X32 STAR WASHERS(21), AND 2-10X32 FLAT WASHERS(20).
7- SLIDE PUSH ARM(2) INTO THE CLEVIS ROD(4) OF THE CYLINDER. LEAVES IT SIT ON TOP OF THE FIXED ARM PIVOT(6), THEN INSERT BACK THE ARM PIN (8) AND RING CLIP(11).

DOOR PIVOT ASSEMBLY and INSTRUCTIONS 1
1600-55 A (Only)

LINKASSY. DOOR PIVOT 1600-5A RIGHT HAND
ASSEMBLY AND INSTRUCTIONS

1-ATTACH PIN PIVOT (3) TO THE BRACKET DOOR PIVOT,
THEN TIGHTEN IT BY USING 1-6X32X3/8 SOCKET SET SCREW (9).
2-ATTACH THE WASHER PIVOT (4) TO THE PIN PIVOT (3).
3-SNAP THE BEARING (7) INTO THE ARM PUSH (2).
4-ATTACH THE WASHER LOCK PIVOT (5) TO THE PIN PIVOT (3),
ON TOP OF THE BEARING ((7).
5-ATTACH 1-4X FLAT WASHER AND 1-4X40X5/16 TRUSS HEAD SCREW (8)
TO THE PIVOT PIN(3), THEN TIGHTEN IT.



ITEM	PART #	DESCRIPTIONS	QTY
1	1071933.1	BRACKET DOOR PIVOT L/RH	1
2	1071929.1	ARM PUSH	1
3	1071930.1	PIN PIVOT	1
4	1071931.1	WASHER PIVOT	1
5	1071932.1	WASHER LOCK PIVOT	1
6	6X32X3/8	SOCKET SET SCREW CONE POINT SS	1
7	4119872	BEARING, SPHERICAL CORR RES 3/16	1
8	4X32X5/16	TRUSS HEAD SCREW	1
9	4X	FLAT WASHER	1

-1 SHOWN

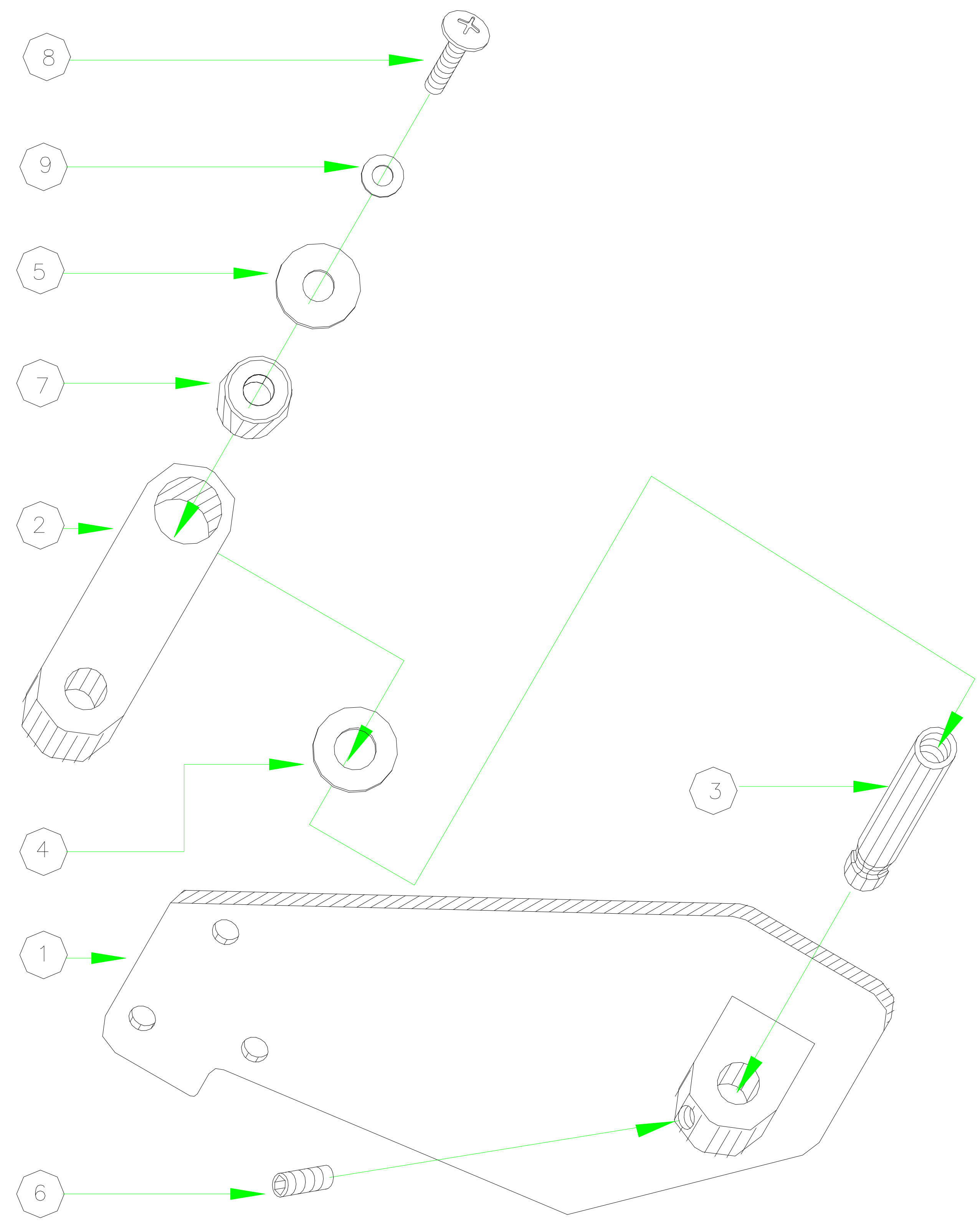
LINKASSY DOOR PIVOT 1600-5A RIGHT HAND

DOOR PIVOT ASSEMBLY and INSTRUCTIONS 2
1600-55 A (Only)

LINKASSY. DOOR PIVOT 1600-5A LEFT HAND
ASSEMBLY AND INSTRUCTIONS

1-ATTACH PIN PIVOT (3) TO THE BRACKET DOOR PIVOT,
THEN TIGHTEN IT BY USING 1-6X32X3/8 SOCKET SET SCREW (9).
2-ATTACH THE WASHER PIVOT (4) TO THE PIN PIVOT (3).
3-SNAP THE BEARING (7) INTO THE ARM PUSH (2).
4-ATTACH THE WASHER LOCK PIVOT (5) TO THE PIN PIVOT (3),
ON TOP OF THE BEARING ((7).
5-ATTACH 1-4X FLAT WASHER AND 1-4X40X5/16 TRUSS HEAD SCREW (8)
TO THE PIVOT PIN(3), THEN TIGHTEN IT.

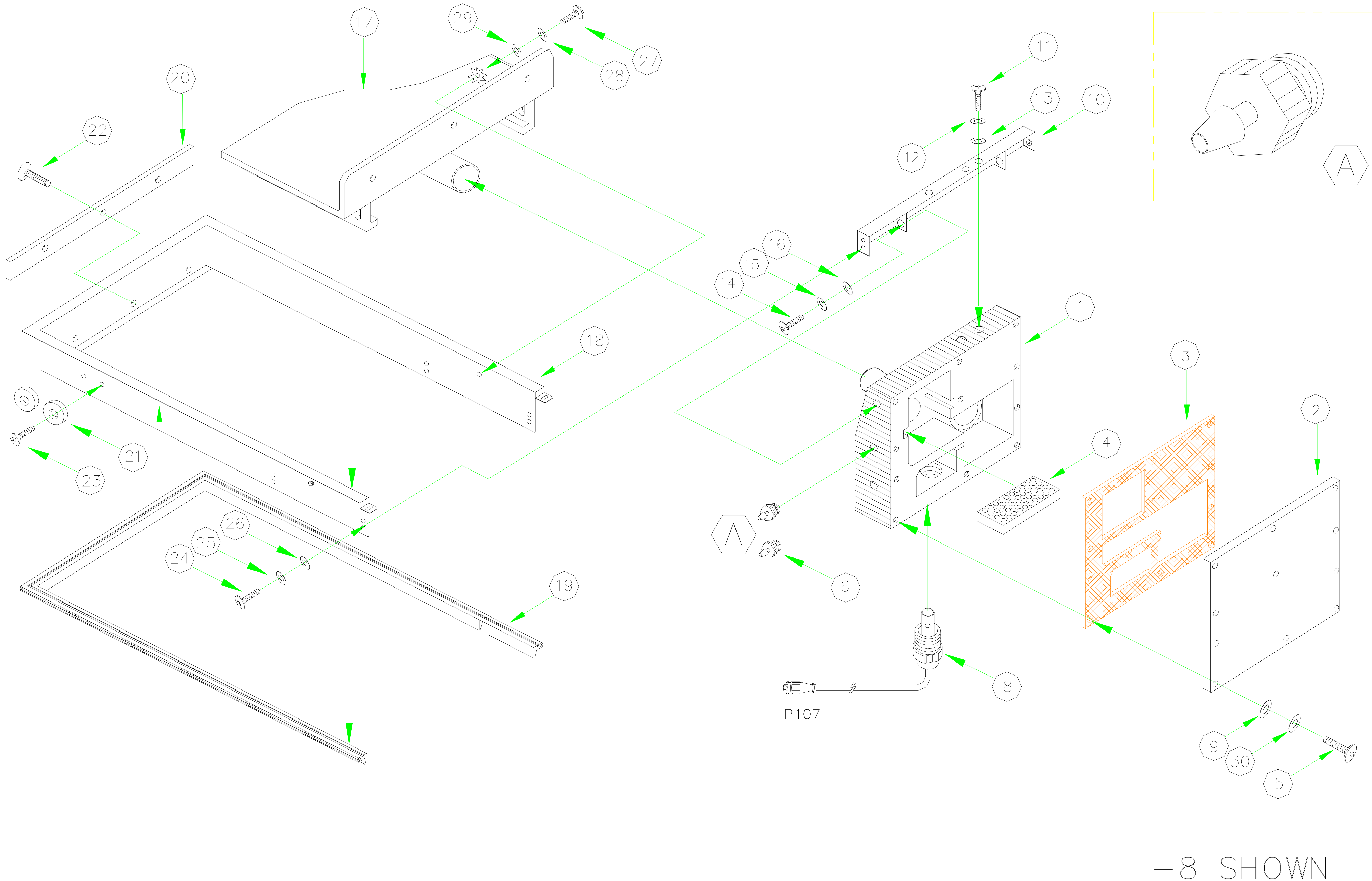
ITEM	PART #	DESCRIPTIONS	QTY
1	1071933.1	BRACKET DOOR PIVOT L/RH	1
2	1071929.1	ARM PUSH	1
3	1071930.1	PIN PIVOT	1
4	1071931.1	WASHER PIVOT	1
5	1071932.1	WASHER LOCK PIVOT	1
6	6X32X3/8	SOCKET SET SCREW CONE POINT SS	1
7	4119872	BEARING, SPHERICAL CORR RES 3/16	1
8	4X32X5/16	TRUSS HEAD SCREW	1
9	4X	FLAT WASHER	1



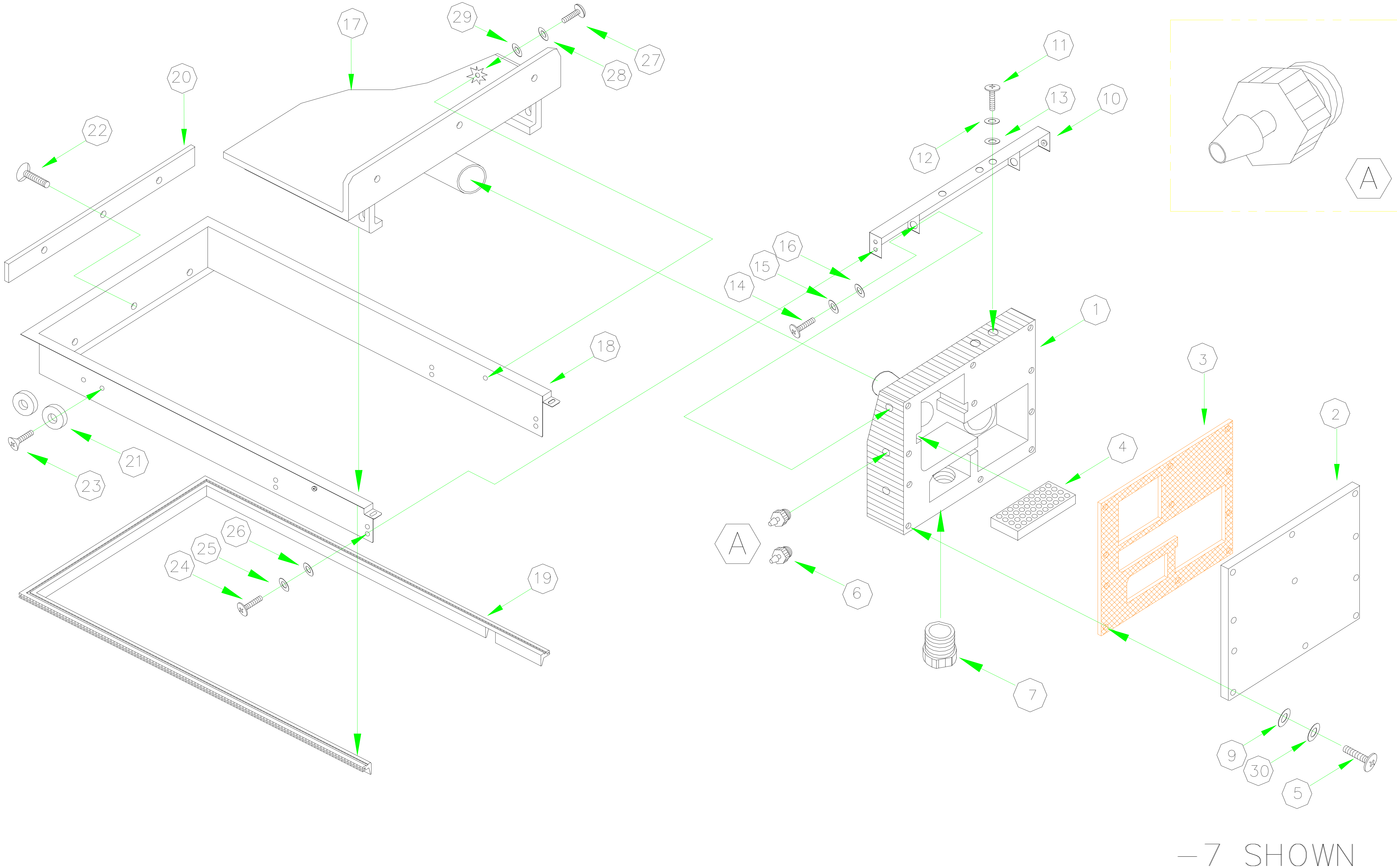
-2 SHOWN

LINKASSY DOOR PIVOT 1600-5A LEFT HAND

DRAIN with RESISTIVITY BAY and CHASE 1
1600-55 A/M



DRAIN without RESISTIVITY BAY and CHASE 2
1600-55 A/M



DRAIN BAY and CHASE 3
1600-55 A/M

B & C DRAIN RESIST. ASSEMBLY INSTRUCTIONS

1- CLUE GASKET BASE(19) TO WELDMENT BASE MOUNT(18), AND ATTACH STOP BASE ASSY.(20) TO FRONT OF WELDMENT BASE(18). USING 3-10X32X1/2 FLAT HEAD SCREWS(22).
2- SLIDE SCREEN DRAIN(4) INTO DRAIN BOX(1).
3- ATTACH GASKET DRAIN(3) TO DRAIN BOX(1). THEN ATTACH DRAIN COVER(2), USING 11-8X32X3/4 TRUSS HEAD SCREWS(5), 11-8X32 STAR WASHERS(14), AND 11-8X32 FLAT WASHERS(15).
4- ATTACH 2-1/16 FITTING(6) TO LEFT SIDE OF DRAIN BOX(1). (THE CLEAR DRAIN BOX COVER IS FACING TO YOU).
5- USING TEFLON TAPE WRAP AROUND THE THREADS OF RESIST. PROBE(12). THEN ATTACH IT TO BOTTOM OF DRAIN BOX(1).
6- ATTACH BASE CROSS MEMBER(10) TO TOP OF DRAIN BOX(1), USING 2-10X32X3/4 TRUSS HEAD SCREWS(11), 2-10X32 STAR WASHERS(12), AND 2-10X32 FLAT WASHERS(13). THEN USING 2-10X32X3/4 TRUSS HEAD SCREWS(14), 2-10X32 STAR WASHERS(15), AND 2-10X32 STAR(15) AND 2-10X32 FLAT WASHERS(16) MOUNT THROUGH LEFT AND RIGHT SIDE OF THE DRAIN BOX(1).
7- ATTACH DRAIN BOX SET(1) WITH BASE CROSS MEMBER(10) TO WELDMENT BASE(18). USING 4-8X32X3/8 TRUSS HEAD SCREWS(24), 4-8X32 STAR WASHERS(25), AND 4-8X32 FLAT WASHERS(26).

ITEM	PART #	DESCRIPTIONS	QTY
1	1067646.1	BOX, DRAIN 1600-5	1
2	1067641.1	COVER, DRAIN BOX 1600-5	1
3	1067640.1	GASKET, DRAIN BOX 1600-5	1
4	1067621.1	SCREEN, DRAIN 1600-5	1
5	8X32X3/4	TRUSS HEAD SCREWS	11
6	4114030	FITTING, BARB, 1/16-10X32	2
7	4117303	PLUG, 3/4	1
8	1067803.1	PROBE, RESISTIVITY CABLE ASSY.	1
9,26	8X32	FLAT WASHERS	15
10	1073217.1	BASE CROSS MEMBER	1
11,14,27	10X32X3/4	TRUSS HEAD SCREWS	6
12,15,28	10X32	STAR WASHERS	6
13,16,29	10X32	FLAT WASHERS	6
17	1067656.1	BASE PLATE	1
18	1067653.1	WELDMENT BASE MOUNT	1
19	1067637.1	GASKET BASE	1
20	1067649.1	STOP BASE	1
21	1067650.1	GUIDE, BASE	4
22,23	10X32X1/2	FLAT SCREWS	7
24	8X32X3/8	TRUSS HEAD SCREWS	4
30,25	8X32	STAR WASHERS	15

NOTE

FOR THE SYSTEM WITH OUT RESISTIVITY. REPLACE PROBE RESISTIVITY BY USING 1-3/4 PLUG(7) TO THE BOTTOM OF DRAIN BOX(1).

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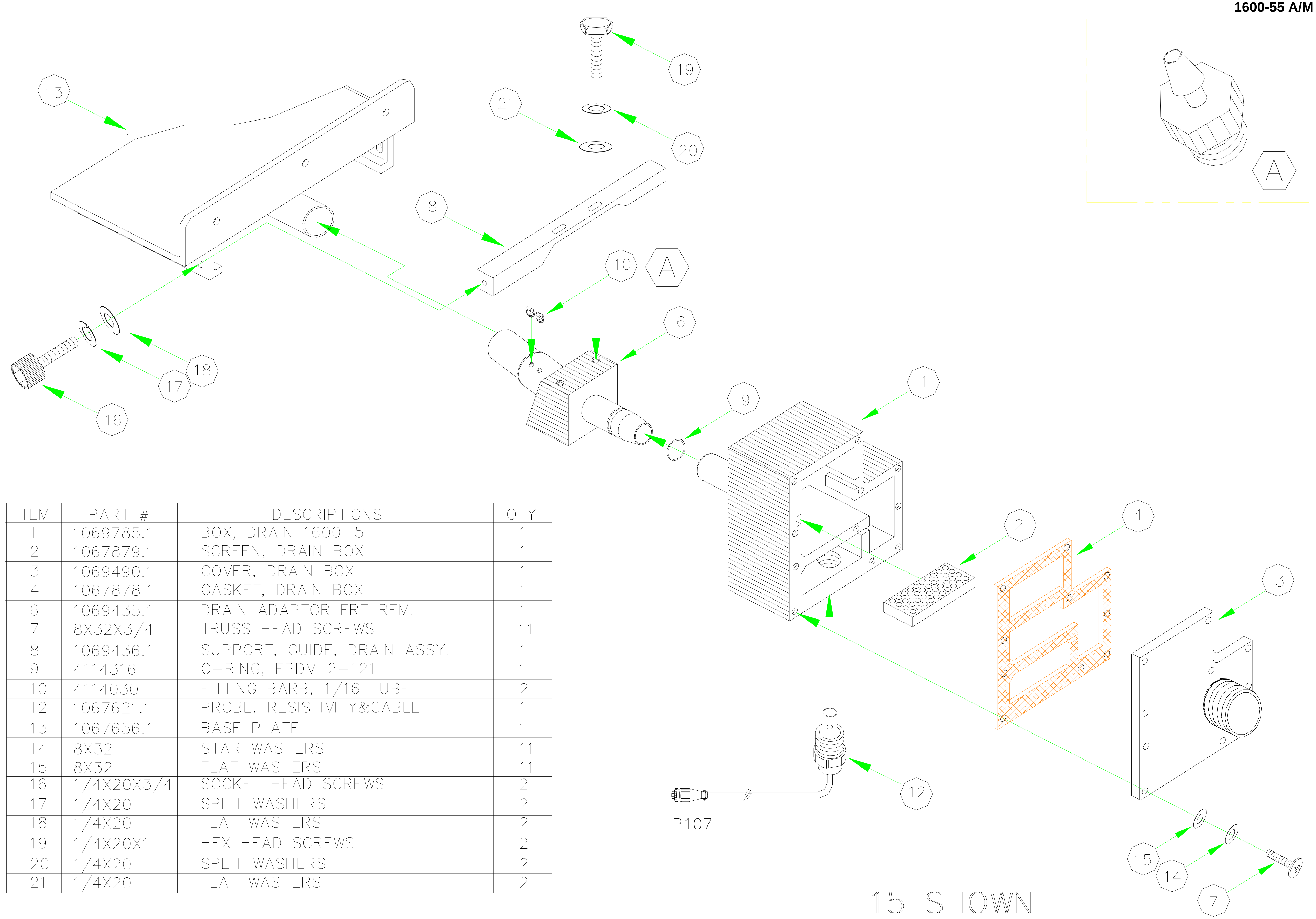
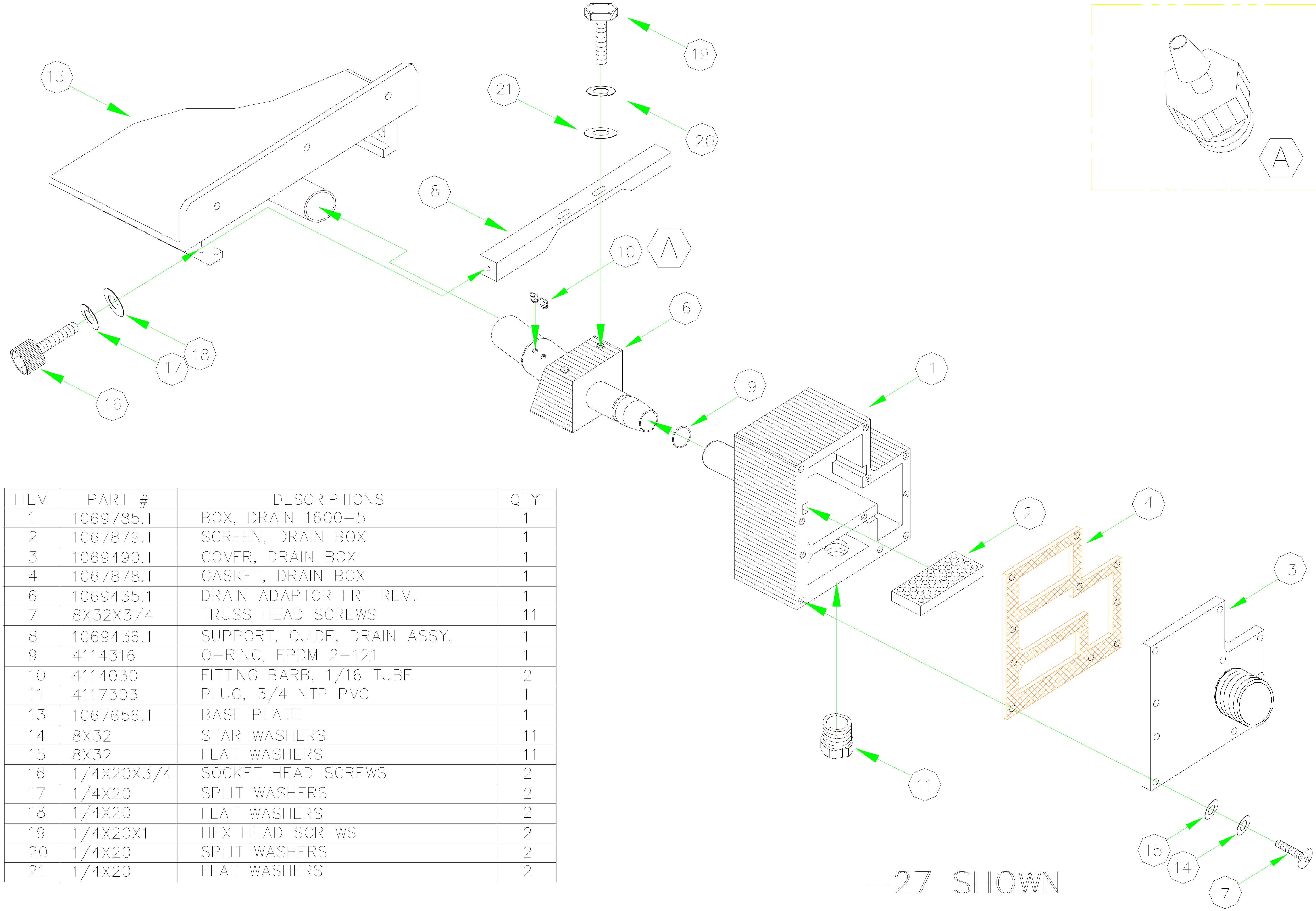
DRAIN with RESISTIVITY FRONT REMOVEABLE 1
1600-55 A/M



ITEM	PART #	DESCRIPTIONS	QTY
1	1069785.1	BOX, DRAIN 1600–5	1
2	1067879.1	SCREEN, DRAIN BOX	1
3	1069490.1	COVER, DRAIN BOX	1
4	1067878.1	GASKET, DRAIN BOX	1
6	1069435.1	DRAIN ADAPTOR FRT REM.	1
7	8X32X3/4	TRUSS HEAD SCREWS	11
8	1069436.1	SUPPORT, GUIDE, DRAIN ASSY.	1
9	4114316	O–RING, EPDM 2–121	1
10	4114030	FITTING BARB, 1/16 TUBE	2
12	1067621.1	PROBE, RESISTIVITY&CABLE	1
13	1067656.1	BASE PLATE	1
14	8X32	STAR WASHERS	11
15	8X32	FLAT WASHERS	11
16	1/4X20X3/4	SOCKET HEAD SCREWS	2
17	1/4X20	SPLIT WASHERS	2
18	1/4X20	FLAT WASHERS	2
19	1/4X20X1	HEX HEAD SCREWS	2
20	1/4X20	SPLIT WASHERS	2
21	1/4X20	FLAT WASHERS	2

DRAIN without RESISTIVITY FRONT REMOVEABLE 2
1600-55 A/M



ITEM	PART #	DESCRIPTIONS	QTY
1	1069785.1	BOX, DRAIN 1600–5	1
2	1067879.1	SCREEN, DRAIN BOX	1
3	1069490.1	COVER, DRAIN BOX	1
4	1067878.1	GASKET, DRAIN BOX	1
6	1069435.1	DRAIN ADAPTOR FRT REM.	1
7	8X32X3/4	TRUSS HEAD SCREWS	11
8	1069436.1	SUPPORT, GUIDE, DRAIN ASSY.	1
9	4114316	O–RING, EPDM 2–121	1
10	4114030	FITTING BARB, 1/16 TUBE	2
11	4117303	PLUG, 3/4 NTP PVC	1
13	1067656.1	BASE PLATE	1
14	8X32	STAR WASHERS	11
15	8X32	FLAT WASHERS	11
16	1/4X20X3/4	SOCKET HEAD SCREWS	2
17	1/4X20	SPLIT WASHERS	2
18	1/4X20	FLAT WASHERS	2
19	1/4X20X1	HEX HEAD SCREWS	2
20	1/4X20	SPLIT WASHERS	2
21	1/4X20	FLAT WASHERS	2

FRONT REMOVEABLE DRAIN RESIST. ASSEMBLY INSTRUCTIONS

1- ATTACH 2-1/16 FITTING(10) TO DRAIN ADAPTOR(6).
2- SLIDE DRAIN SCREEN(2) INTO DRAIN BOX(1).
3- ATTACH GASKET DRAIN(4) TO DRAIN BOX(1). THEN ATTACH DRAIN COVER(3), USING 11-8X32X3/4 TRUSS HEAD SCREWS, 11-8X32 STAR WASHERS(14), AND 11-8X32 FLAT WASHERS(15).
4- USING TEFLON TAPE WRAP AROUND THE THREADS OF RESIST. PROBE(12). THEN ATTACH TO BOTTOM OF DRAIN BOX(1).
5- ATTACH DRAIN SUPPORT GUIDE(8) TO DRAIN ADAPTOR(6). USING 2-1/4X20X1 HEX SCREWS(19), 2-1/4X20 SPLIT WASHERS(20), AND 2-1/4X20 FLAT WASHERS(20).
6- ATTACH DRAIN SUPPORT GUIDE(8) WITH DRAIN ADAPTOR(6) TO REAR OF BASE PLATE(13). USING 2-1/4X20X3/4 SOCKET SCREWS(16), 2-1/4X20 SPLIT WASHERS(17), AND 2-1/4X20 FLAT WASHERS(18).
7- ATTACH DRAIN BOX ASSY. SET(1) TO DRAIN ADAPTOR(6).

NOTE

FOR THE SYSTEM WITH OUT RESISTIVITY. REPLACE PROBE RESISTIVITY BY USING 1-3/4 PLUG(11) TO THE BOTTOM OF DRAIN BOX(1).

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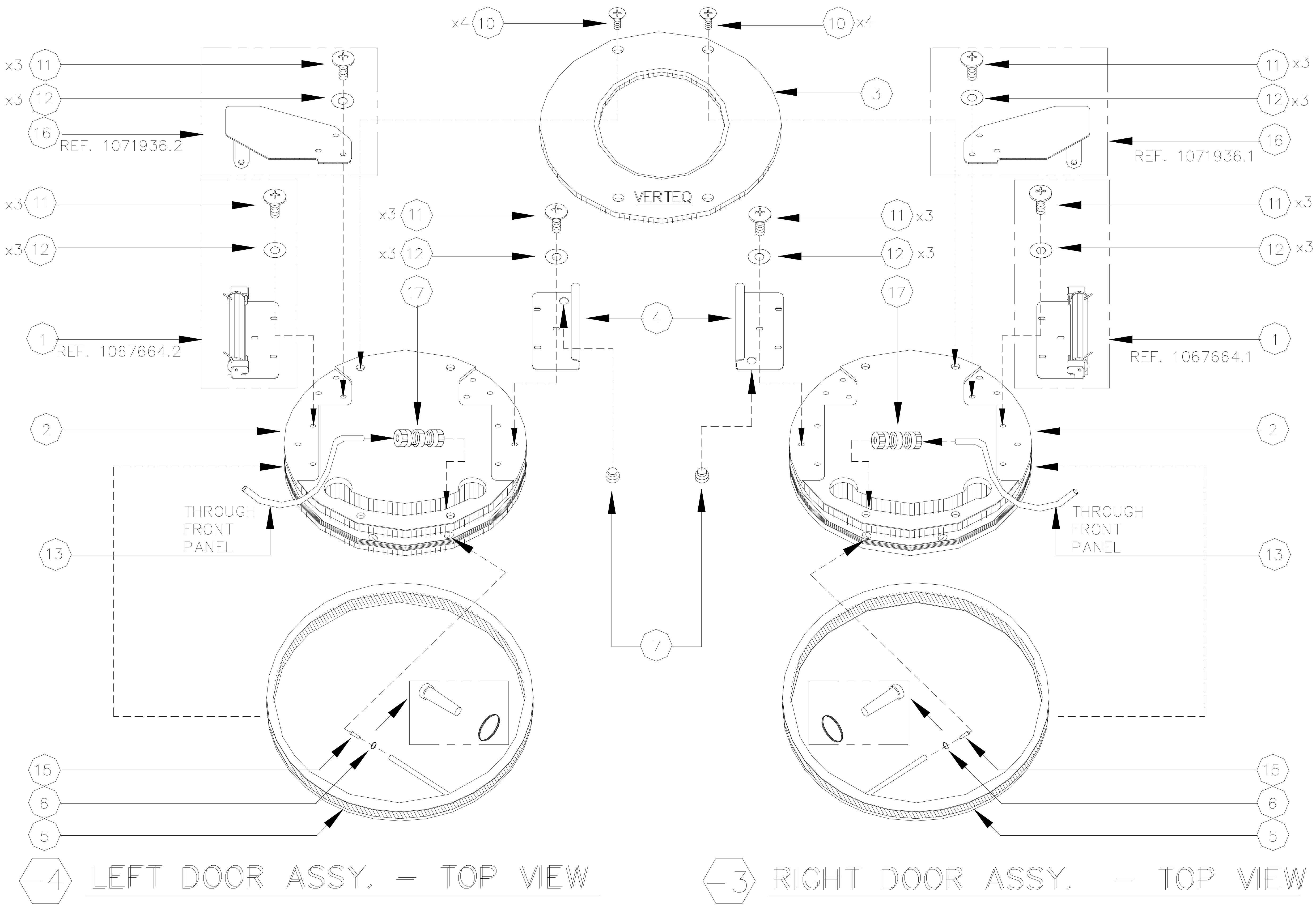
HINGE with PANEL ASSEMBLY and INSTRUCTIONS 1
1600-55 A (Only)

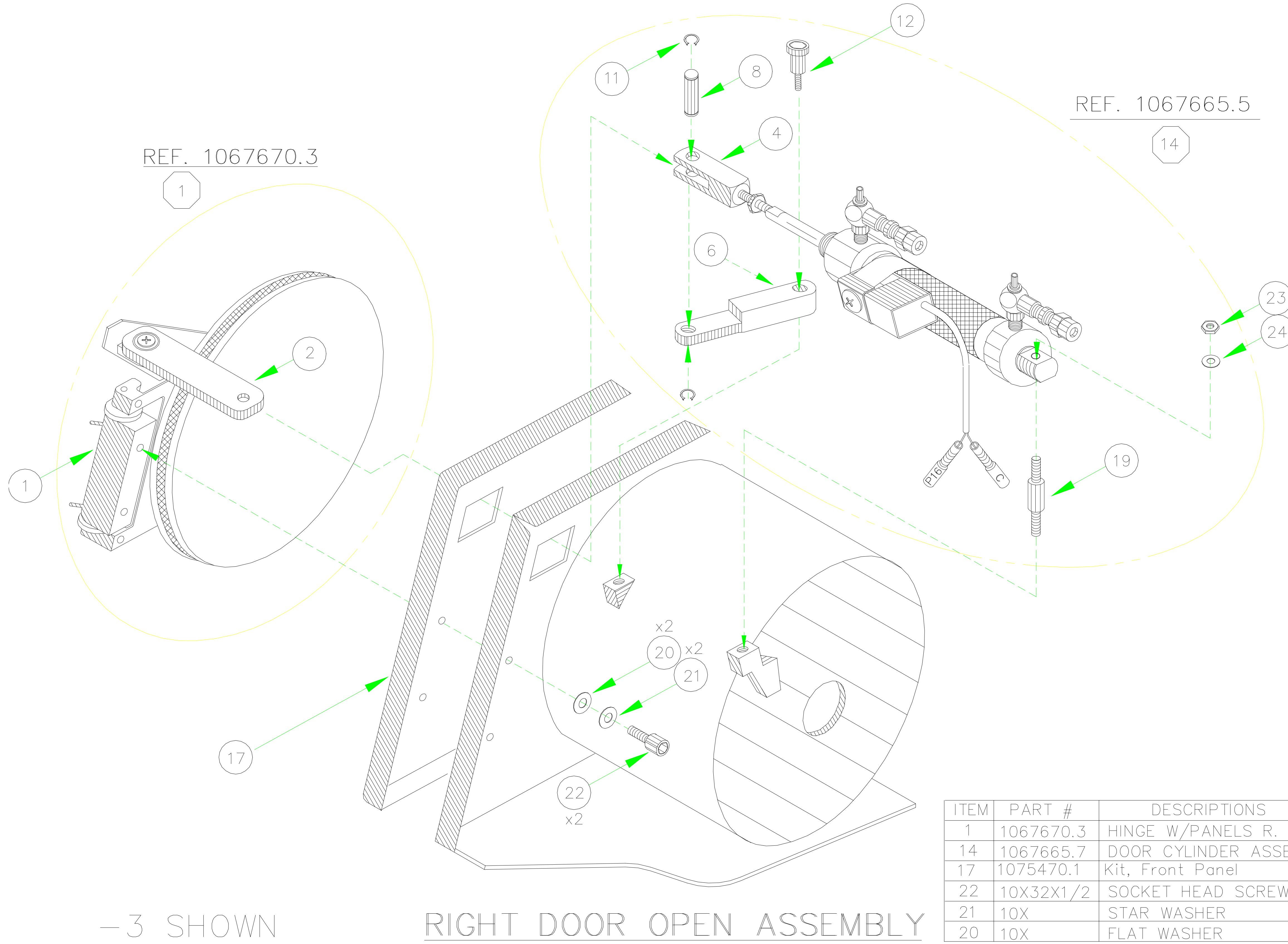


HINGE with PANEL ASSEMBLY and INSTRUCTIONS 2
1600-55 A (Only)

1– ATTACH HINGE ASSY. LEFT OR RIGHT HAND(1) TO THE SOLID CLEAR LID(2), USING 3–8X32X1/2 ROUND HEAD SCREWS(11), AND 3–8X32 FLAT WASHERS(12).
2– ATTACH LINKASSY DOOR PIVOT L. OR R. HAND(16) TO THE SOLID CLEAR LID(2), USING 3–8X32X1/2 ROUND HEAD SCREWS(11), AND 3–8X32 FLAT WASHERS(12)
3– ATTACH L. OR R. HAND DOOR HANDLE(4) TO THE SOLID CLEAR LID(2), USING 3–8X32X1/2 ROUND HEAD SCREWS(11), AND 3–8X32 FLAT WASHERS(12).
4– ATTACH 1–1/4–3' TYGON TUBE(13) TO THE 1–1/4 FITTING(17).
5– INSERT THE TUBE OF DOOR SEAL(5) THROUGH THE HOLE OF SOLID CLEAR LID(2), ATTACH VITON O–RING(6), THEN INSERT 1–1/4 INSERT TUBING(15) TO THE TUBE OF DOOR SEAL(5).
6– ATTACH 1–1/4 FITTING(17) AND –1/4–3' TYGON TUBE(13) TO THE TUBE OF DOOR SEAL(5), THEN PUSH THE FITTING(17) INTO THE SPACE, WHERE THE DOOR SEAL TUBE(5) COMES OUT.
7– ATTACH THE SILKSCREEN DOOR COVER(3) TO THE SOLID CLEAR LID(2), USING 4–8X32X1/2 FLAT HEAD SCREWS(10).

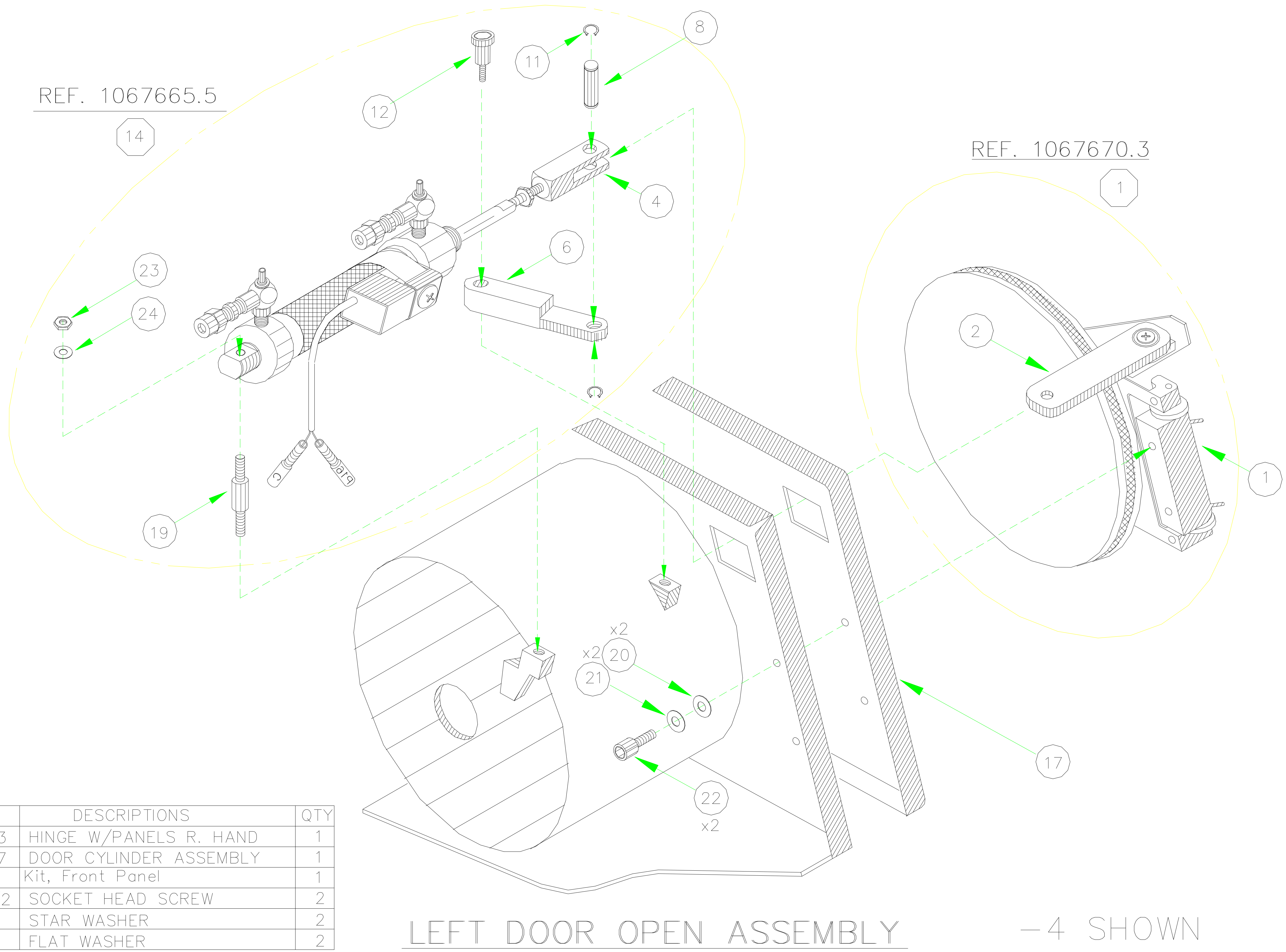
ITEM	PART #	DESCRIPTIONS	QTY
1	1067664.1	HINGE ASSY, RIGHT HAND	1
2	1067661.3	SOLID CLEAR LID, LEFT OR RIGHT HAND	1
3	1067660.3	SILKSCREEN DOOR COVER	1
4	1067118.1	DOOR HANDLE	1
5	1064788.1	DOOR SEAL	1
6	4120866	VITON O–RING	1
7	1062533.1	BUTTON, STOP MINI	1
8	1067662.1	BRACKET, DOOR PIVOT	1
10	8X32X1/2	FLAT HEAD SCREWS, CAD PLATED STEEL	4
11	8X32X1/2	ROUND HEAD SCREWS, CAD PLATED STEEL	9
12	8X32	FLAT WASHERS, CAD PLATED STEEL	9
13	1/4–3'	1/4 TYGON TUBE	3'
14	1067665.5	DOOR CYLINDER ASSEMBLY	1
15	4117513	INSERT, TUBING 1/4	1
16	1071936.1	LINKASSY DOOR PIVOT RIGHT HAND	1
17	4118950	1/4 FITTING	1

HINGE with PANEL ASSEMBLY and INSTRUCTIONS 3 (Right-Hand) 1600-55 A (Only)



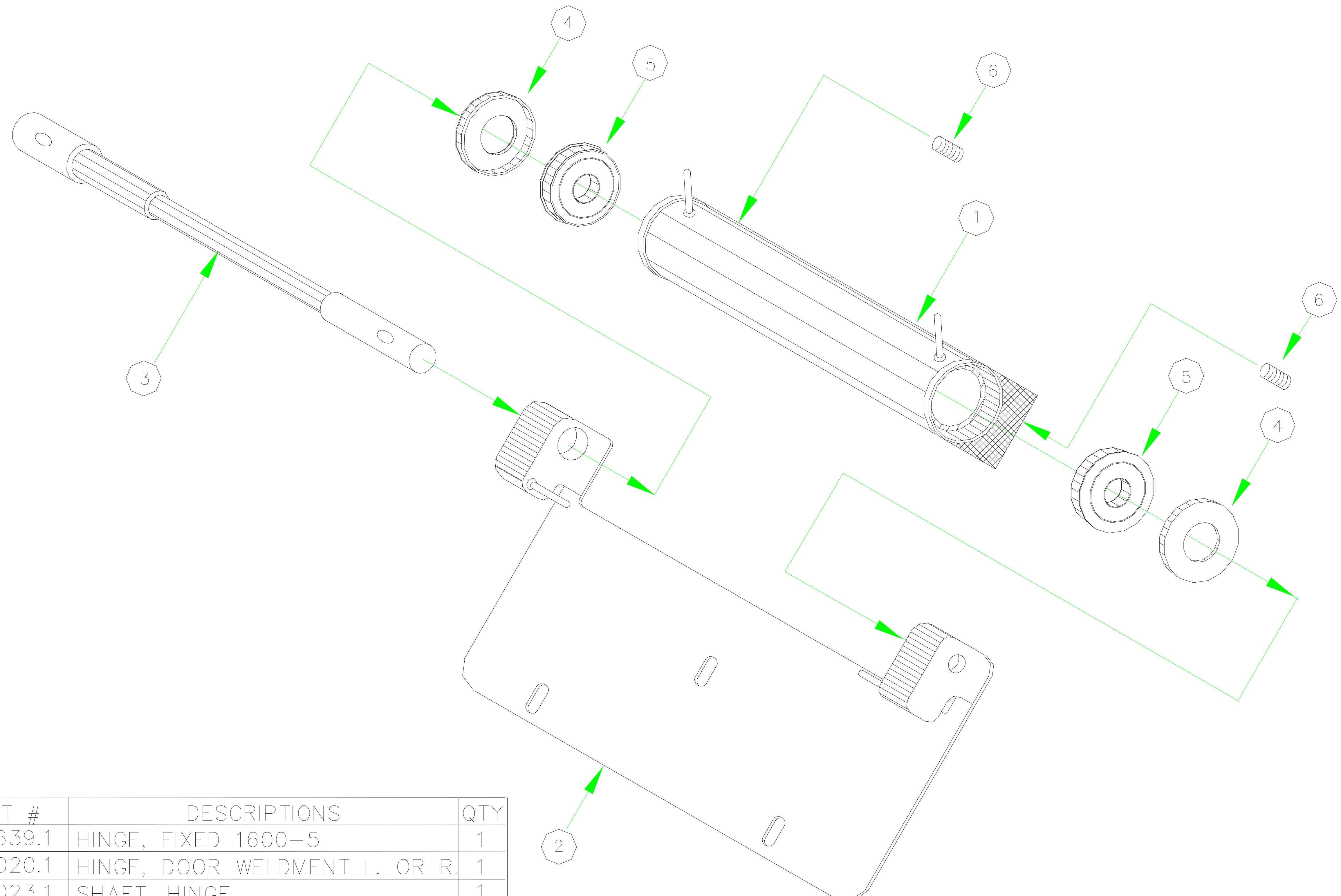
ITEM	PART #	DESCRIPTIONS	QTY
1	1067670.3	HINGE W/PANELS R. HAND	1
14	1067665.7	DOOR CYLINDER ASSEMBLY	1
17	1075470.1	Kit, Front Panel	1
22	10X32X1/2	SOCKET HEAD SCREW	2
21	10X	STAR WASHER	2
20	10X	FLAT WASHER	2

HINGE with PANEL ASSEMBLY and INSTRUCTIONS 4
(Left-Hand) 1600-55 A (Only)



ITEM	PART #	DESCRIPTIONS	QTY
1	1067670.3	HINGE W/PANELS R. HAND	1
14	1067665.7	DOOR CYLINDER ASSEMBLY	1
17	1075470.1	Kit, Front Panel	1
22	10X32X1/2	SOCKET HEAD SCREW	2
21	10X	STAR WASHER	2
20	10X	FLAT WASHER	2

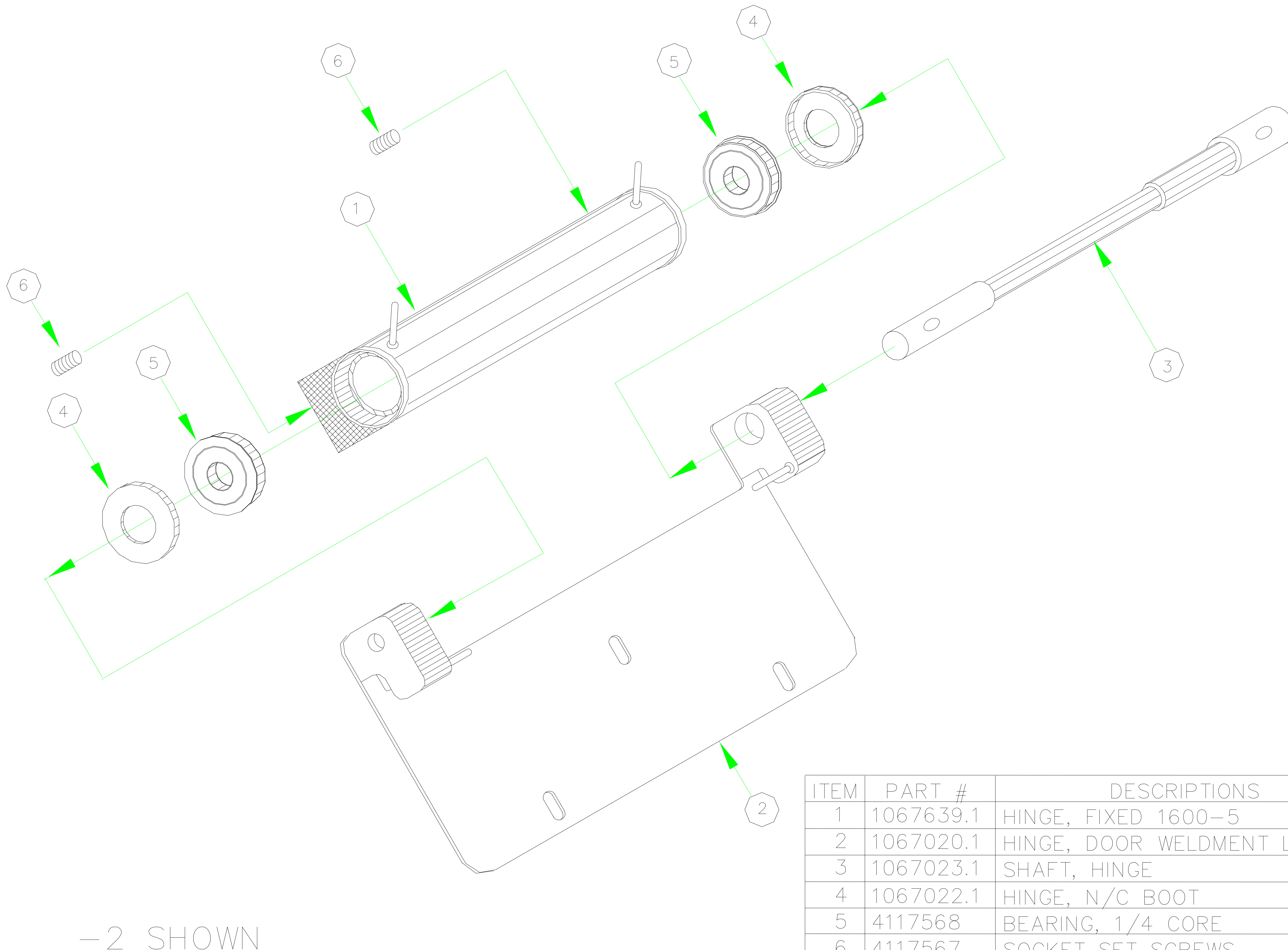
HINGE ASSEMBLY and INSTRUCTIONS 1
(Right-Hand) 1600-55 A/M



ITEM	PART #	DESCRIPTIONS	QTY
1	1067639.1	HINGE, FIXED 1600-5	1
2	1067020.1	HINGE, DOOR WELDMENT L. OR R.	1
3	1067023.1	SHAFT, HINGE	1
4	1067022.1	HINGE, N/C BOOT	2
5	4117568	BEARING, 1/4 CORE	2
6	4117567	SOCKET SET SCREWS	2

-1 SHOWN

HINGE ASSEMBLY and INSTRUCTIONS 2
(Left-Hand) 1600-55 A/M



ITEM	PART #	DESCRIPTIONS	QTY
1	1067639.1	HINGE, FIXED 1600-5	1
2	1067020.1	HINGE, DOOR WELDMENT L. OR R.	1
3	1067023.1	SHAFT, HINGE	1
4	1067022.1	HINGE, N/C BOOT	2
5	4117568	BEARING, 1/4 CORE	2
6	4117567	SOCKET SET SCREWS	2

HINGE ASSEMBLY and INSTRUCTIONS 3
1600-55 A/M

LEFT AND RIGHT HAND HINGE ASSEMBLY INSTRUCTIONS:

1- SNAP 2-1/4 BEARINGS (5) INTO BOTH SIDES OF THE FIXED HINGE (1).
2- ATTACH 2-BOOTS HINGE (4) TO EACH SIDE OF THE FIXED HINGE (1), NEXT OF BEARINGS.
3- HOLD BOTH SIDES OF THE FIXED HINGE (1), THEN SLIDE IT INTO THE FIXED DOOR HINGE(2).
4- INSERT THE SAFT, HINGE (3) FROM THE BIG HOLE OF THE DOOR HINGE (2) THROUGH FIXED HINGE (1).
(BE SURE 2-LOCK HOLES OF THE SHAFT HINGE IS MATCHING WITH 2-HOLES OF THE SOCKET SET SCREWS).
5- TIGHTEN 2-10X32X3/8 SOCKET SET SCREWS (6) TO LOCK THE SHAFT HINGE (3).

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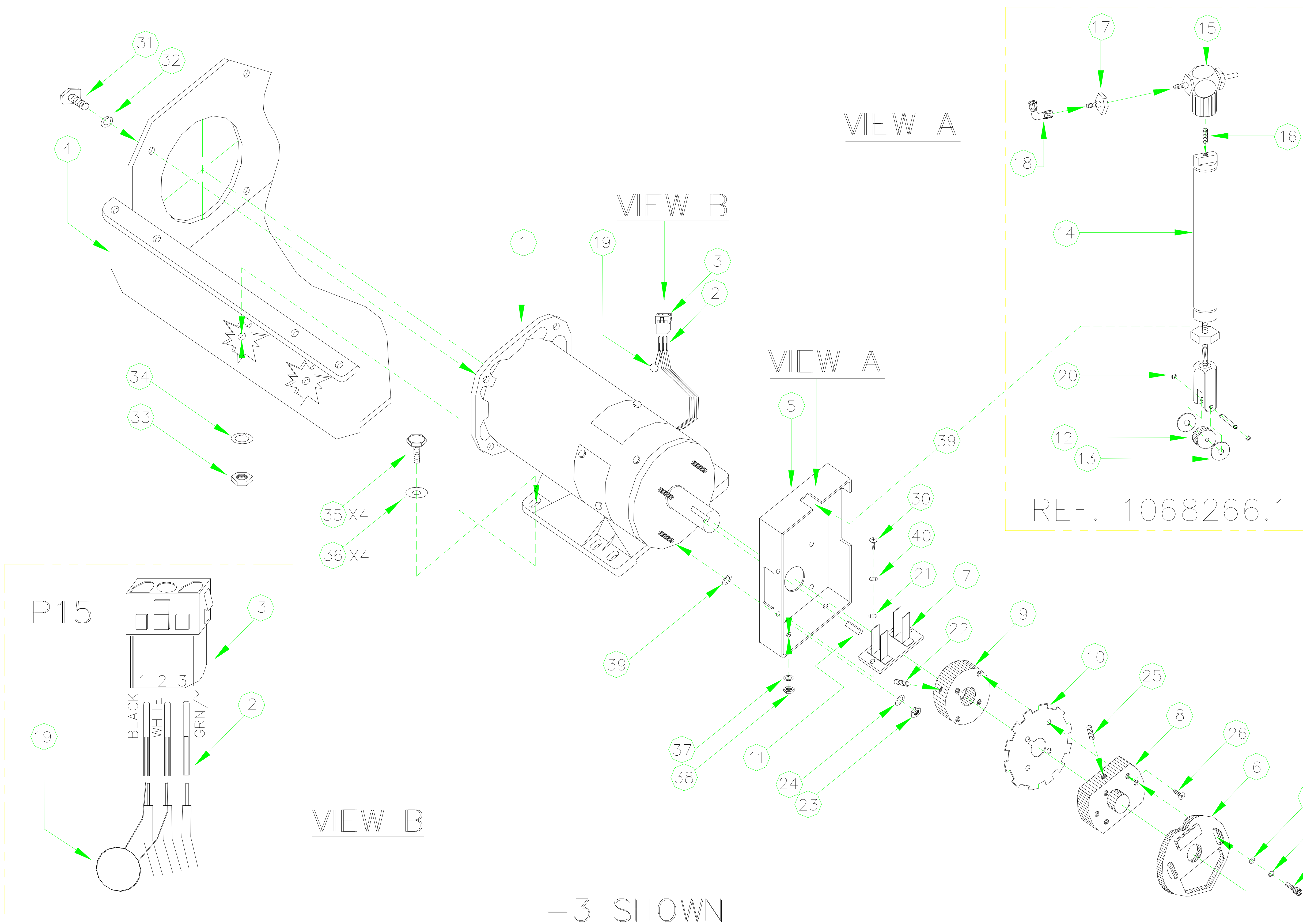
MOTOR ASSEMBLY
1600-55 A (Only)



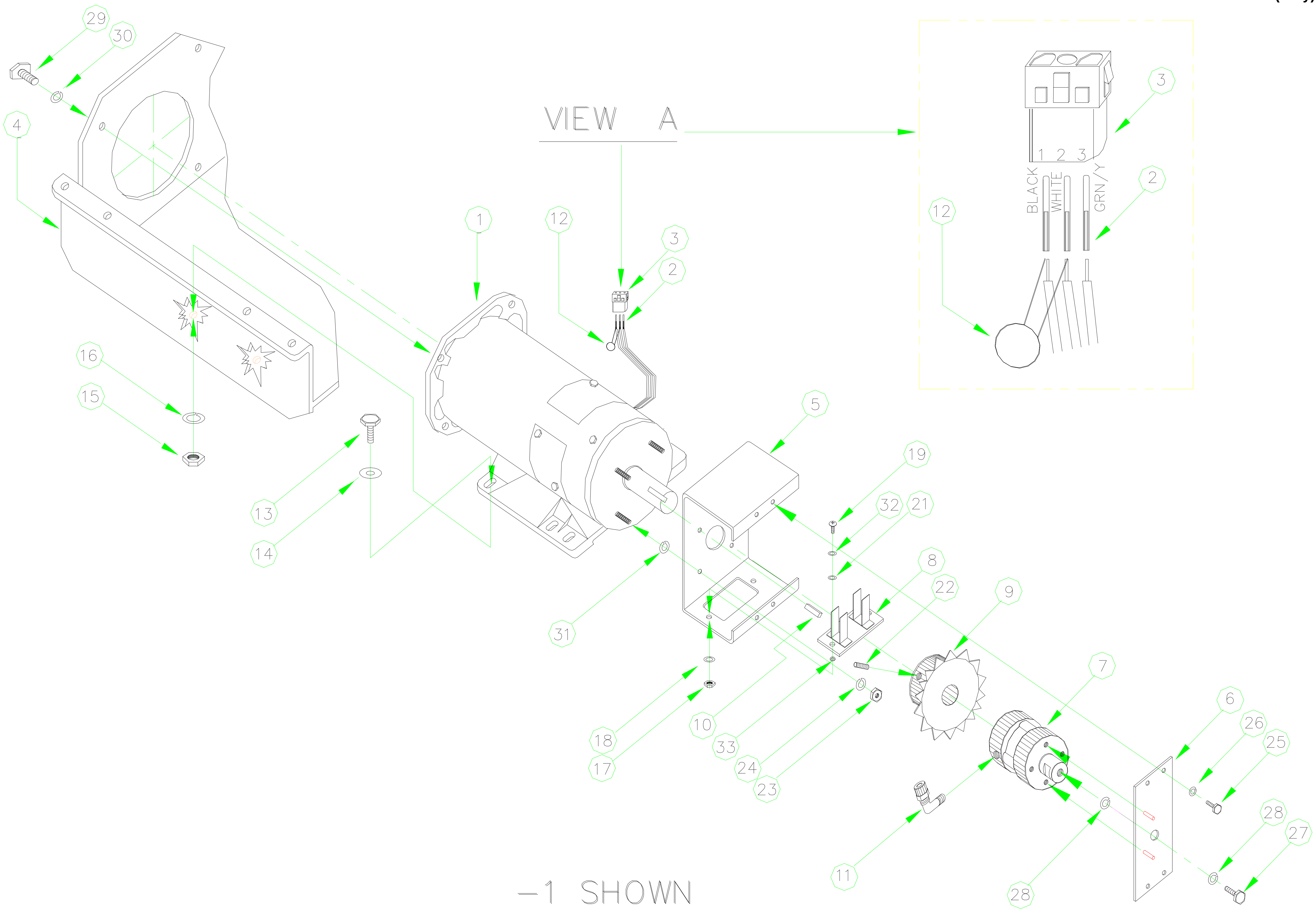
MOTOR ASSEMBLY INSTRUCTIONS and PARTS LISTS
1600-55 A (Only)

1600–55A MOTOR ASSEMBLY INSTRUCTIONS

1– ATTACH MOTOR (1) TO THE BRACKET MOTOR (4) USING 4–3/8X1 HEX HEAD SCREWS (31), AND 4–3/8 SPLIT WASHERS (32) (FRONT OF MOTOR BRACKET).
2– USING 4–1/4X20X3/4 HEX HEAD SCREWS (35), 4–1/4 FLAT WASHERS (36). TO INSEATED THROUGH THE BASE OF MOTOR, USING 4–1/4 SPLIT WASHERS ((34) AND 4–1/4 HEX NUTS (33) TO MOUNT THROUGH THE BOTTOM OF THE BRACKET.
3– TIE WRAP ALL THREE COLOR WIRES ABOUT 1/2" FROM THE HOLE, THEN MEASURE 14" OF WIRE FROM THE HOLE AND CUT ALL THREE WIRES THE SAME LENGTH, THEN STRIP OFF 1/16" TO 1/8" OF INSULATION FROM WIRES. THEN APPLY ONE PIN TO GREEN WIRE, KNOW WITH ONE VASISTOR (19) INSOLATE WITH BOTH PRONGS WITH SINGLE TUBING (MAKE SURE YOU HAVE 1/8" AT THE PRONGS). THE CRIMP VASISTOR (19) WITH BLACK AND WHITE WIRE. USING CONNECTOR HOUSING (3) BY SETTING #3 PIN WITH GREEN, #2 PIN WITH WHITE, AND #1 PIN WITH BLACK. THEN MARKED CONNECTOR P–15.
4– PUT 4–1/4 SPLIT WASHERS (39) ON TO THE MOTOR STUDS, THEN MOUNT ON THE MOUNTING BRACKET (5) TO THE REAR OF THE MOTOR. USING 4–1/4 SPLIT WASHERS (24) , AND 4–1/4 HEX NUTS (23) TO MOTOR STUDS.
5– SET ROTOR SHAFT AT A 12 OCLOCK POSITION FOR INDEX ASSEMBLY.
6– SET 1–8X32X1/2 SET SCREW (11) INTO WHEEL SHAFT (9) , AND USING KEY MOTOR (11) WITH WHEEL SHAFT #(9). THEN PLACE ONTO MOTOR SHAFT AND GAP OUT .050 FROM THE MOUNTING BRACKET PLATE (A LARGE TIE WRAP IS EQUIVALENT OF .050 GAP METERIAL).
7– INSTALL OPTIC SENSOR BOARD TO THE MOUNTING BRACKET PLATE BY INSERTING 2–6X32X1/2 ROUND HEAD SCREW (30) WITH 2–6X32 FLAT WASHERS (21), AND 2–6X32 STAR WASHERS (40). THEN HAND TIGHTEN THE SENSOR BOARD WITH 2–6X32 STAR WASHERS (37), AND 2–6X32 HEX NUTS (38).
8– PLACE PHOTO SHELL CAREFULLY INTO MOTOR SHAFT.
9– PLACE 1–8X32X1/2 SETSCREW (25) INTO SHAFT FLANGE.
10– ATTACH SHAFT FLANGE ONTO MOTOR SHAFT. TIGHTEN ALL SET SCREWS, THEN REMOVE THE GAP METERIAL.
11– TO ADJUST SENSOR BOARD FOR CORRECT INDEXING, YOU MUST NEED A OPTICAL SENSOR TESTOR BY APPLYING THE CONNECTOR TO THE BOTTOM OF THE SENSOR PLATE. MOVE THE SENSOR PLATE LEFT TO RIGHT, YOU CAN GET A LIGHT READING ON THE TESTOR.
***SET THE MOTOR SHAFT IN A 12 O'CLOCK POSITION, THEN TIGHTEN THE SENSOR DOWN.
12– MOUNT IN SET OF 4–8X32X1 FLAT SCREWS (26) TO THE SHAFT FLANGE (8).
13– ATTACH THE CAM AUTO–POSITIONER (6) BY 2–1/4X20X1/2 SOCKET SCREWS (27), 2X1/4 SPLIT WASHERS (28), AND 2–1/4 FLAT WASHERS.
14– REMOVE THE DUST COVER AT THE TOP END OF BIMBA CYLINDER (14).
15– USING A TEFLON TAPE TO WRAP THE THREADS OF THE 1/4 BRASS NIPPLE (16) 4 TIMES.
16– ATTACH THE BRASS NIPPLE (16) INTO THE TOP OF THE BIMBA CYLINDER, THEN HANDS TIGHTEN IT.
17– ATTACH THE FLOW CONTROL VALVE (15) INTO BRASS NIPPLE (16), THEN SCREW IT TIGHTLY.
18– ATTACH 1–1/4X1/4 M.I.P NIPPLE (17) TO THE FLOW CONTROL VALVE (15), THEN TIGHTEN IT UNTIL SMALL GAP IS SHOWN.
19– APPLYING 4 TIMES OF TEFLON TAPE ON THE NIPPLE (17).
20– ATTACH 1–1/4X1/4 M.I.P ELBOW (18) TO THE NIPPLE (17).
21– TAKING OFF 1 E–CLIP FROM THE KNUCKLE OF THE BOTTOM OF THE CYLINDER. THEN PRESSING OUT THE PIN.
22– ATTACH A SMALL WASHER (13) FOR BOTH SIDES OF THE BEARING THROUGH THE PIN, THEN INSERT BACK THE E–CLIP ON THE KNUCKLE.
23– ATTACH THE BIMBA CYLINDER (14) TO THE MOUNTING BRACKET (5). MAKE SURE THE ELBOW IS FACING LEFT OF YOU, AND THE KNUCKLE IS NOT TOUCHING THE CAM AUTO–POSITIONER.

ITEM	PART #	DESCRIPTIONS	QTY
1	4115758	MOTOR 1/2	1
2	4118349	CONNECTOR, CONTACT	3
3	4118346	CONNECTOR, PLUG	1
4	1062562.3	BRACKET MOTOR	1
5	1067644.3	MOUNTING BRACKET	1
6	1067647.3	CAM, AUTOPOSITIONER	1
7	1067811.1	SENSOR, OPTICAL	1
8	1067631.1	SHAFT FLANGE	1
9	1067633.3	WHEEL SHAFT	1
10	1067642.1	PHOTO SHELL	1
11	1062608.3	MOTOR KEY	1
12	4117750	BEARING SIK–7	1
13	4117755	WASHER 5710–56–10	2
14	1068266.1	BIMBA CYLINDER	1
15	4117745	FLOW CONTROL VALVE	1
16	4114082	NIPPLE CLOSE B–20N	1
17	4119301	NIPPLE	1
18	4119123	FITTING, ELBOW	1
19	4117725	VASISTOR, 150 AC	1
20		E–CLIPS	2
21	6X32	FLAT WASHER	4
22&25	8X32X1/2	SET SCREW	2
23&33	1/4X20	HEX NUT	8
24&34&39	1/4	SPLIT WASHER	12
26	8X32X1	FLAT SCREW	4
27	1/4X20X1/2	SOCKET HEAD SCREW	2
36	1/4	FLAT WASHER	4
30	6X32X1/2	ROUND HEAD SCREW	2
31	3/8X1	HEX HEAD SCREW	4
32	3/8	SPLIT WASHER	4
35	1/4X20X3/4	HEX HEAD SCREW	4
37&40	6X32	STAR WASHER	4
38	6X32	HEX NUT	2

MOTOR ASSEMBLY
1600-55 M (Only)



MOTOR ASSEMBLY INSTRUCTIONS and PARTS LISTS
1600-55 M (Only)

1- ATTACH MOTOR (1) TO THE BRACKET MOTOR (4) USING 4-HEX HEAD SCREWS 3/8X1 (29), 4-SPLIT WASHERS 3/8 (30) (FRONT OF MOTOR). USING 4-HEX HEAD SCREWS 1/4X20X3/4 (13), 4-FLAT WASHERS 1/4 (14), 4-SPLIT WASHERS 1/4 (16), AND 4-HEX NUTS 1/4 (15), MOUNT THROUGH THE BOTTOM OF BRACKET MOTOR.

2- ATTACH MOUNTING BRACKET (5) TO THE REAR MOTOR (1) USING 4-HEX NUTS 1/4X20 (17), AND 4-SPLIT WASHERS 1/4 (18).

3- ATTACH PCB OPTICAL SENSOR (8) TO THE BOTTOM OF MOUNTING BRACKET (5), USING 2-ROUND HEAD SCREWS 6X32X1/2 (19), 2-FLAT WASHERS 6X32 (21), 2-SPECIAL WASHER(33) UNDERNEATH OF OPTICAL BOARD, AND 2-SPLIT WASHERS 6X32 (18).

4- ATTACH LOCATOR (9) TO THE MOTOR (1), USING 1-KEY MOTOR (10) AND 1-SET SCREW 8X32X1/2 (22).

5- USING THE TEFLON TAPE TO WRAP AROUND THE THREADS OF ELBOW 1/8X1/4T (11).

6- ATTACH ELBOW 1/8X1/4T (11) TO THE CYLINDER ASSEMBLY AIR (7).

7- ATTACH CYLYNDER ASSEMBLY AIR (7) TO THE BRACKET MOUNTING COVER (6) USING 1-HEX HEAD SCREW 3/8X1 (27), AND 2-SPLIT WASHER 3/8 (28). (ONE FOR EACH SIDE). MAKE SURE 2-PINS OF THE BRACKET MOUNTING COVER (6) IS LOCKED IN 2-HOLES OF THE CYLINDER ASSEMBLY AIR (7).

8- ATTACH BRACKET MOUNTING COVER & CYLYNDER (6)&(7) TO THE BRACKET MOUNTING (5) USING 4-HEX HEAD SCREWS 1/4X20X3/4 (25), AND 4-SPLIT WASHERS 1/4 (26).

9- USING CRIMPER TOOL TO CONNECT 3-PINS CONNECTOR CONTACT TO THE MOTOR AC POWER WIRES (BLACK, WHITE, AND GREEN/YELLOW).

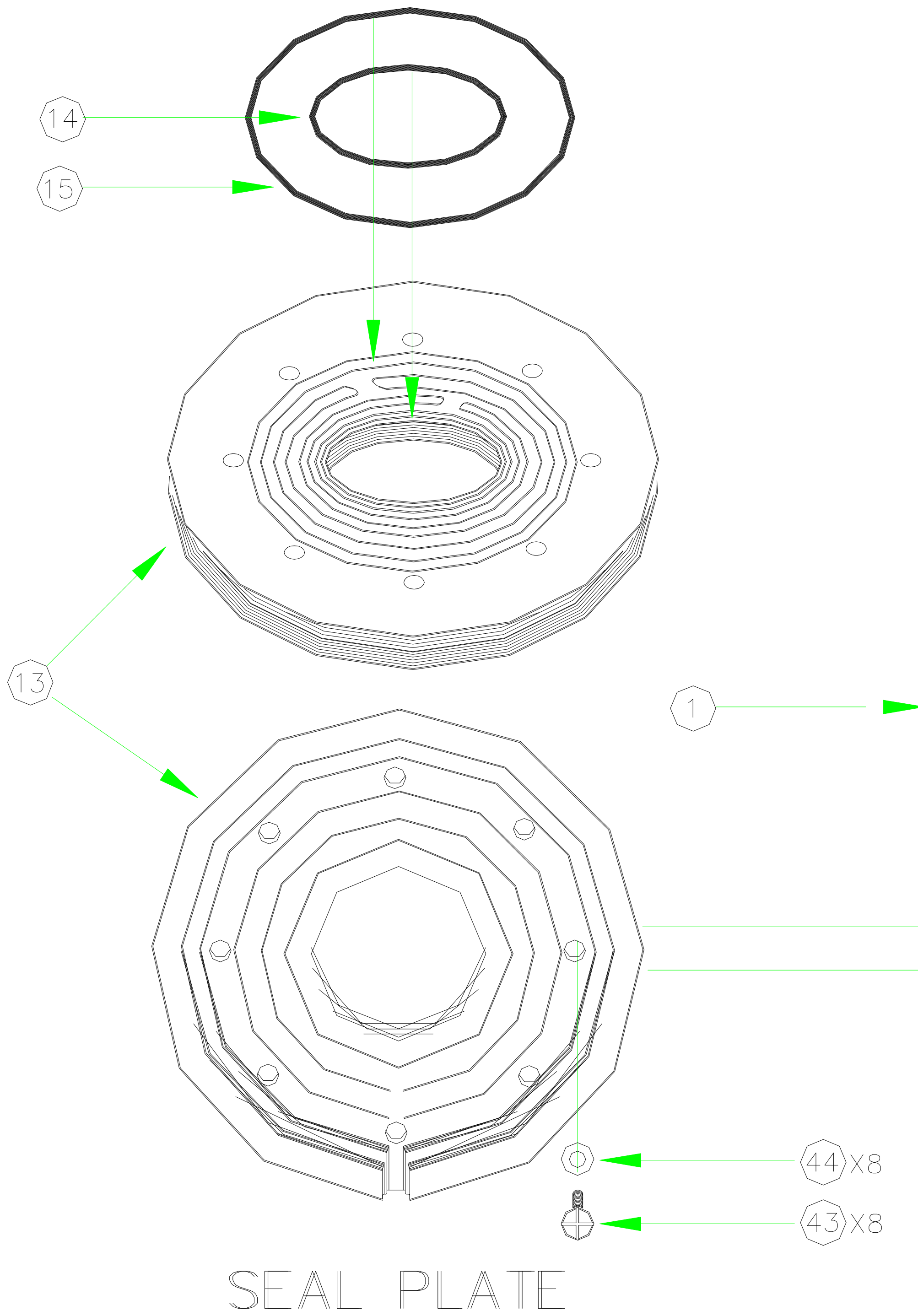
10- ATTACH 3-PINS (2) TO THE CONNECTOR PLUG (3). MAKE SURE BLACK WIRE GO TO PIN #1 OF CONNECTOR.

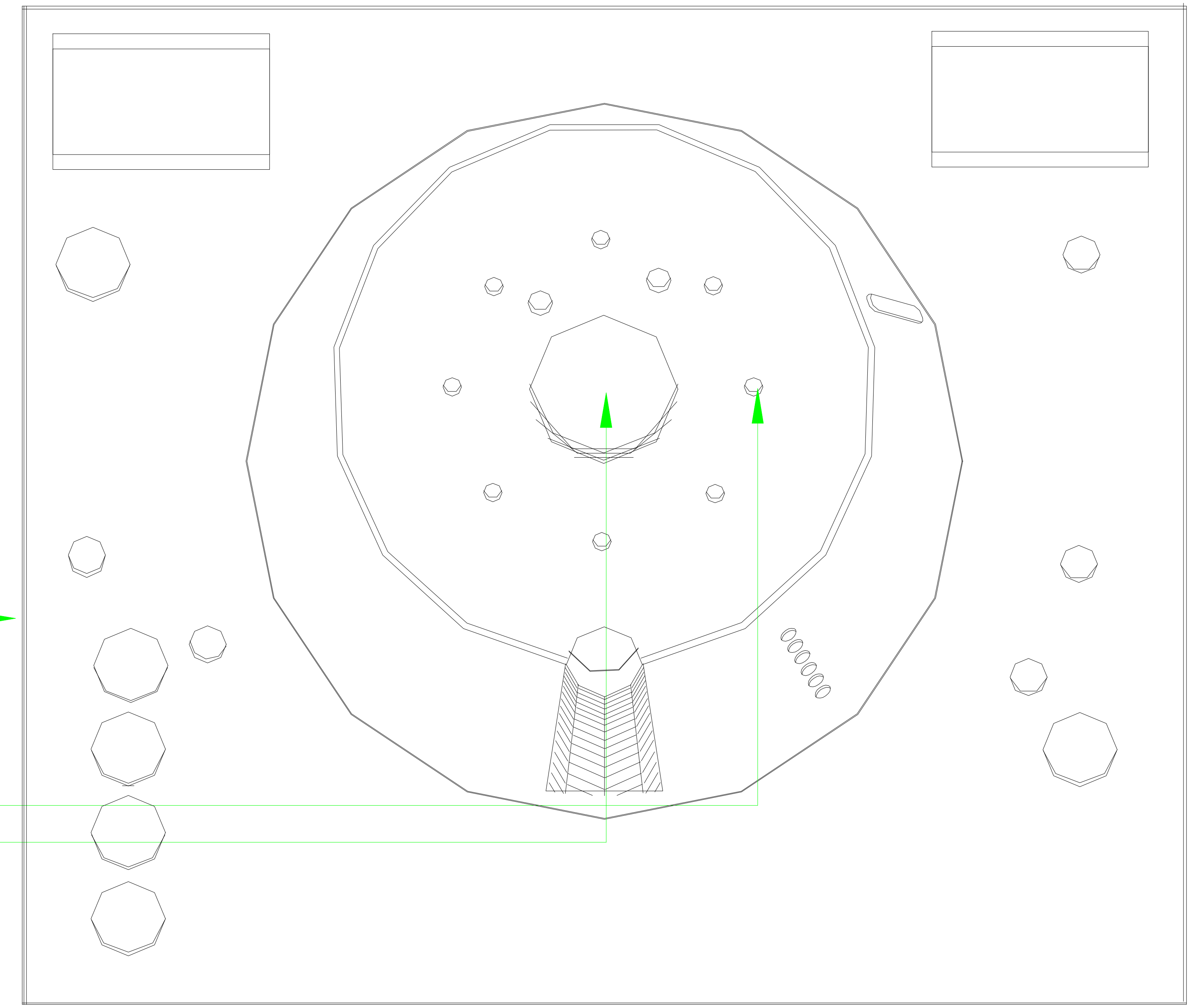
(SEE DRAWING FOR RELATION POSITIONS)

ITEM	PART #	DESCRIPTION	QTY
1	4115758	MOTOR 1/2	1
2	4118349	CONNECTOR, CONTACT	3
3	4118346	CONNECTOR, PLUG	1
4	1062562.3	BRACKET MOTOR	1
5	1065307.3	MOUNTING BRACKET	1
6	1065308.3	BRACKET MOUNTING COVER	1
7	1070027.1	CYLYNDER ASSY., AIR	1
8	1067811.1	SENSOR, OPTICAL	1
9	1065749.1	LOCATOR 1600-3	1
10	1062608.3	KEY, MOTOR	1
11	4118941	ELBOWL 1/8X1/4	1
12	4117725	VASISTOR, 150 VAC	1
13&25	1/4X20X3/4	HEX HEAD SCREW	8
16&24&32	1/4	SPLIT WASHER	12
15&23	1/4X20	HEX NUT	8
16&26	1/4	SPLIT WASHER	8
17	6X32	HEX NUT	2
18&32	6X32	STAR WASHER	4
19	6X32X1/2	ROUND HEAD SCREW	2
21	6X32	FLAT WASHER	2
22	8X32X1/2	SET SCREW	1
26	8X32X1	FLAT SCREW	4
27&29	3/8X1	HEX HEAD SCREW	5
28&30	3/8	SPLIT WASHER	6
33	6x	SPECIAL WASHER	2

SEAL PLATE ASSEMBLY and INSTRUCTIONS

1600-55 A/M





1600–55 BOWL FRONT VIEW

INSTRUCTIONS:

1– ATTACH 2–O–RING (14)(15) TO THE SEAL PLATE (13).
2– ATTACH SEAL PLATE (13) TO THE BOWL(1) USING 8–8X32X1/2 TRUSS HEAD SCREWS(44), AND 8–8X32 FLAT WASHERS (44). CODE 316SS ELECTROPOLISH.

ITEM	PART #	DESCRIPTION	QTY
1	1067657.1	BOWL, 1600–55	1
13	1062546.1	SEAL, PLATE MINI	1
14	4115770	RING_O, 2–228	1
15	4115771	RING_O, 2–248	1
43	8X32X1/2	TRUSS HEAD SCREW	8
44	8X	FLAT WASHER	8

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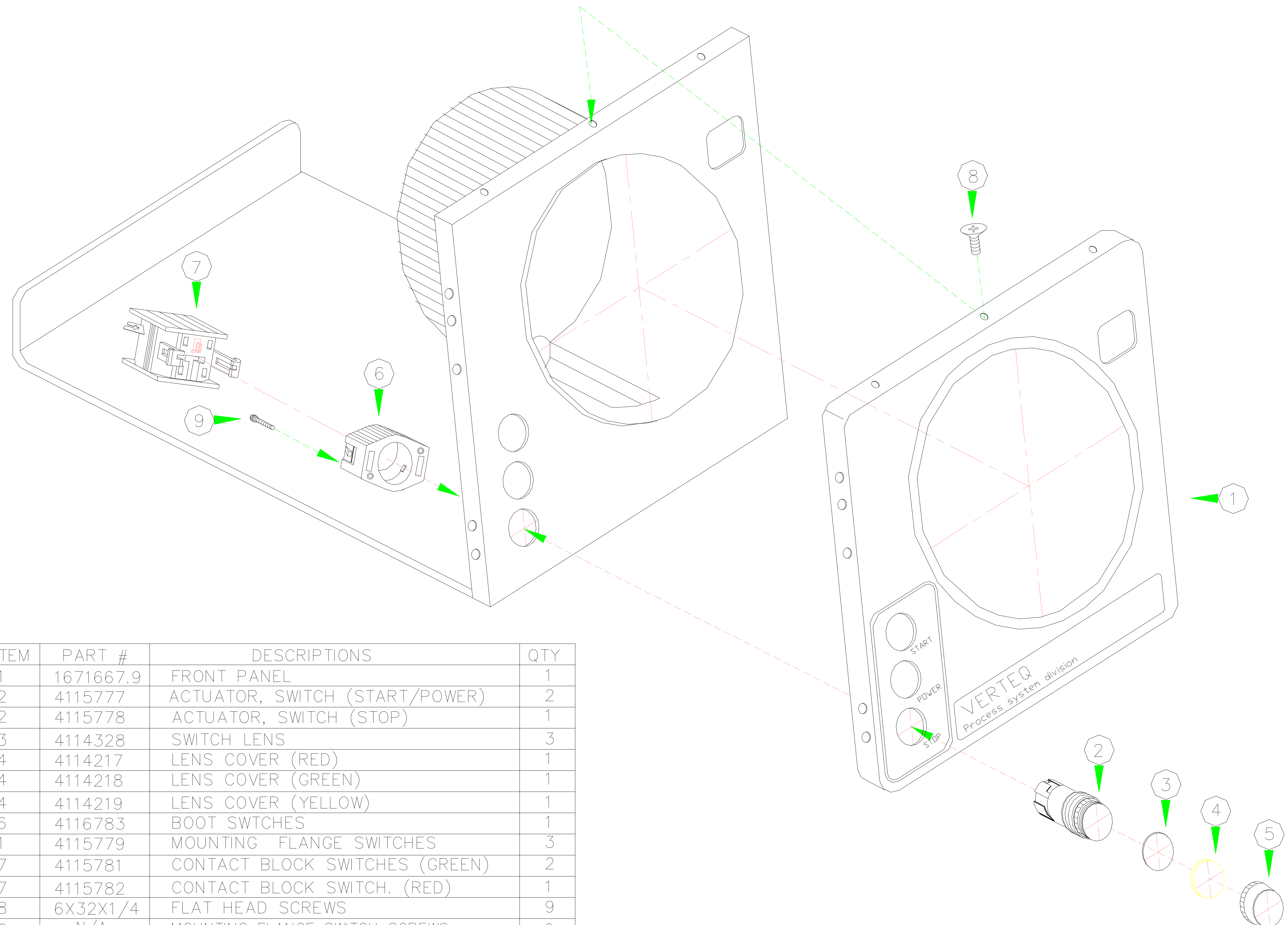
FRONT PANEL ASSEMBLY and INSTRUCTIONS 1
1600-55 A/M



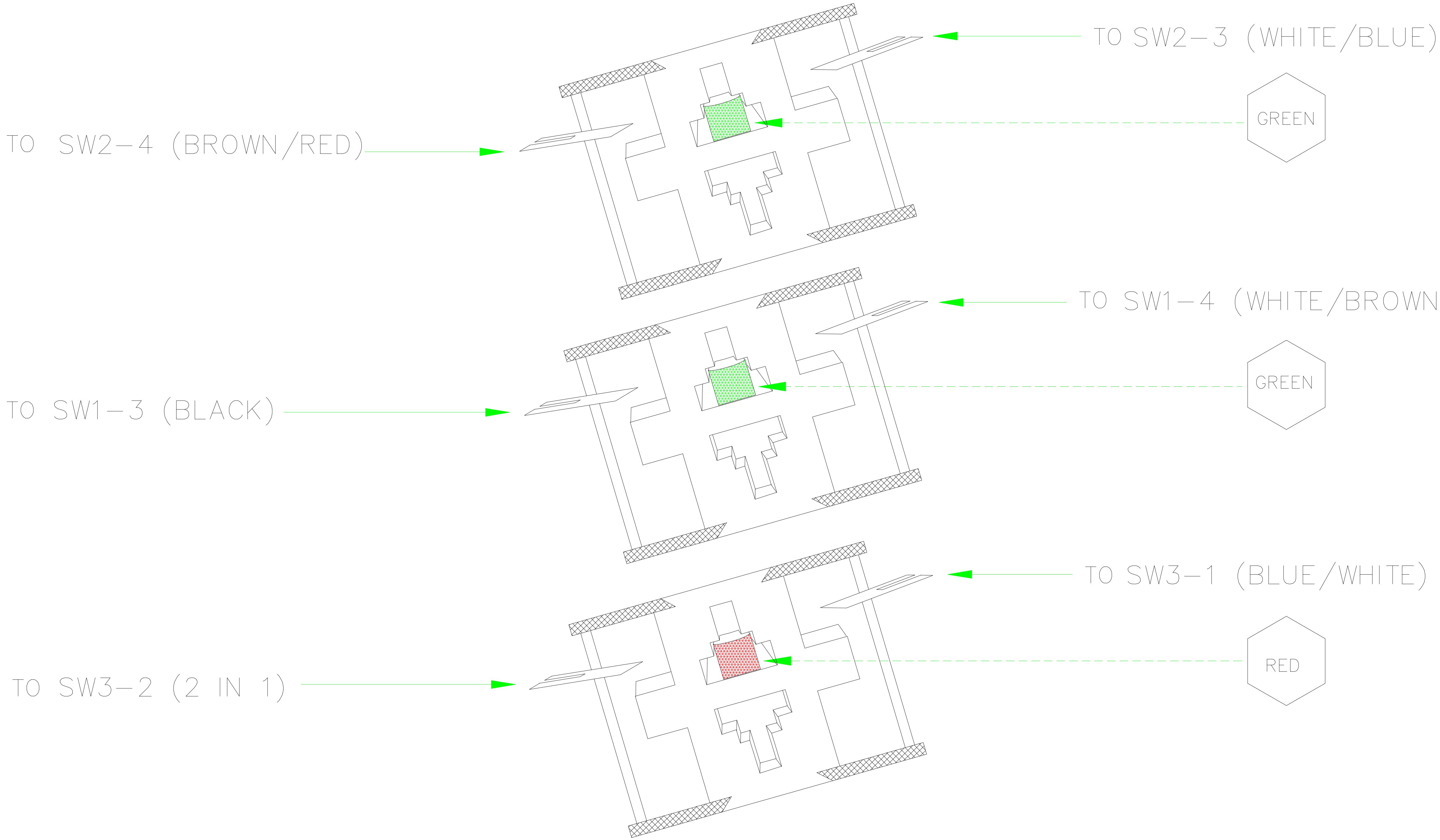
ITEM	PART #	DESCRIPTIONS	QTY
1	1671667.9	FRONT PANEL	1
2	4115777	ACTUATOR, SWITCH (START/POWER)	2
2	4115778	ACTUATOR, SWITCH (STOP)	1
3	4114328	SWITCH LENS	3
4	4114217	LENS COVER (RED)	1
4	4114218	LENS COVER (GREEN)	1
4	4114219	LENS COVER (YELLOW)	1
6	4116783	BOOT SWTCHES	1
1	4115779	MOUNTING FLANGE SWITCHES	3
7	4115781	CONTACT BLOCK SWITCHES (GREEN)	2
7	4115782	CONTACT BLOCK SWITCH. (RED)	1
8	6X32X1/4	FLAT HEAD SCREWS	9
9	N/A	MOUNTING FLANGE SWITCH SCREWS	2

FRONT PANEL ASSEMBLY and INSTRUCTIONS 2
1600-55 A/M

START, POWER, STOP SWITCHES ASSEMBLY INSTRUCTIONS

1- ATTACH FRONT PANEL (1) TO THE 1600 BASE. USING 9-6X32X1/4 FLAT HEAD SCREWS (8).
2- LEFT HAND HOLD THE MOUNTING FLANGE SWITCH (6) BEHIND THE FRONT PANEL (1). ATTACH 3-START, POWER, AND STOP ACTUATOR SWITCHES (2). PN# 4115777, AND 4115778 THROUGH THE START, POWER, AND STOP SWITCHES LOCATION ON FRONT PANEL (1). TURN THE ACTUATOR SWITCHES (2) TO CLOCKWISE DIRECTION IN THE MOUNTING FLANGE SWITCHES (6), THEN TIGHTEN 2-SCREWS (9), MAKE SURE IT IS LOCKED AND AGAINST THE FRONT PANEL (1).
3- SNAP SWITCH LENS (3) INTO THE START/POWER/STOP ACTUATOR SWTCHES (2).
4- HAND TIGHTEN THE 3-COLOR LENS COVER (4) INTO THE ACTUATOR SWITCHES (2). GREEN FOR START, YELLOW FOR POWER, AND RED FOR STOP.
5- HAND TIGHTEN THE 3-BOOT SWITCHES (5) INTO THE 3-ACTUATOR SWITCHES (2).
6- SNAP 3-CONTACT BLOCK SWITCHES (7) INTO THE MOUNTING FLANGE SWITCHES (6). BE SURE THE PRONGS IS UP.

FRONT PANEL ASSEMBLY and INSTRUCTIONS 3
1600-55 A/M



START/POWER/STOP SWITCHES REAR VIEW

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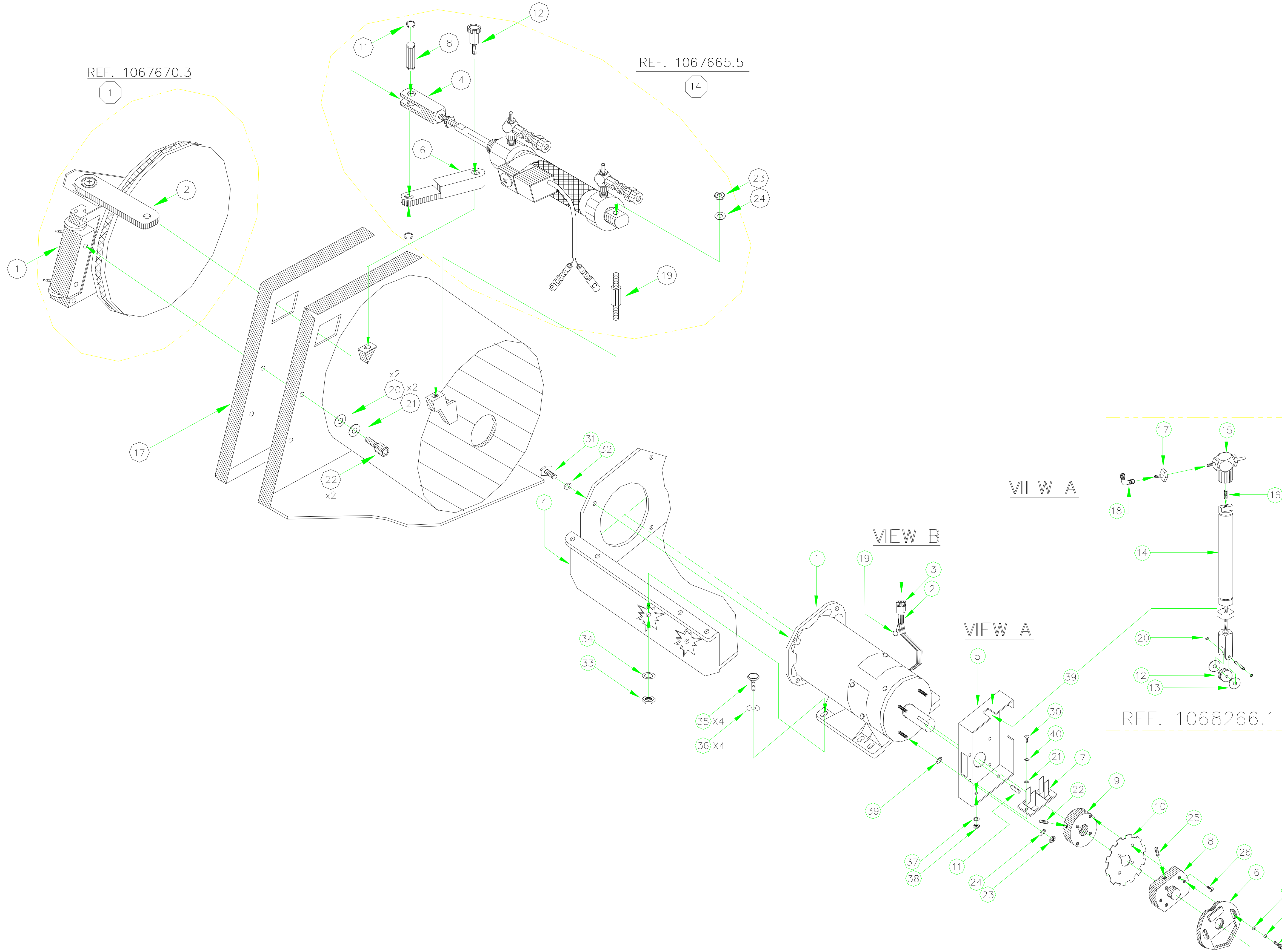
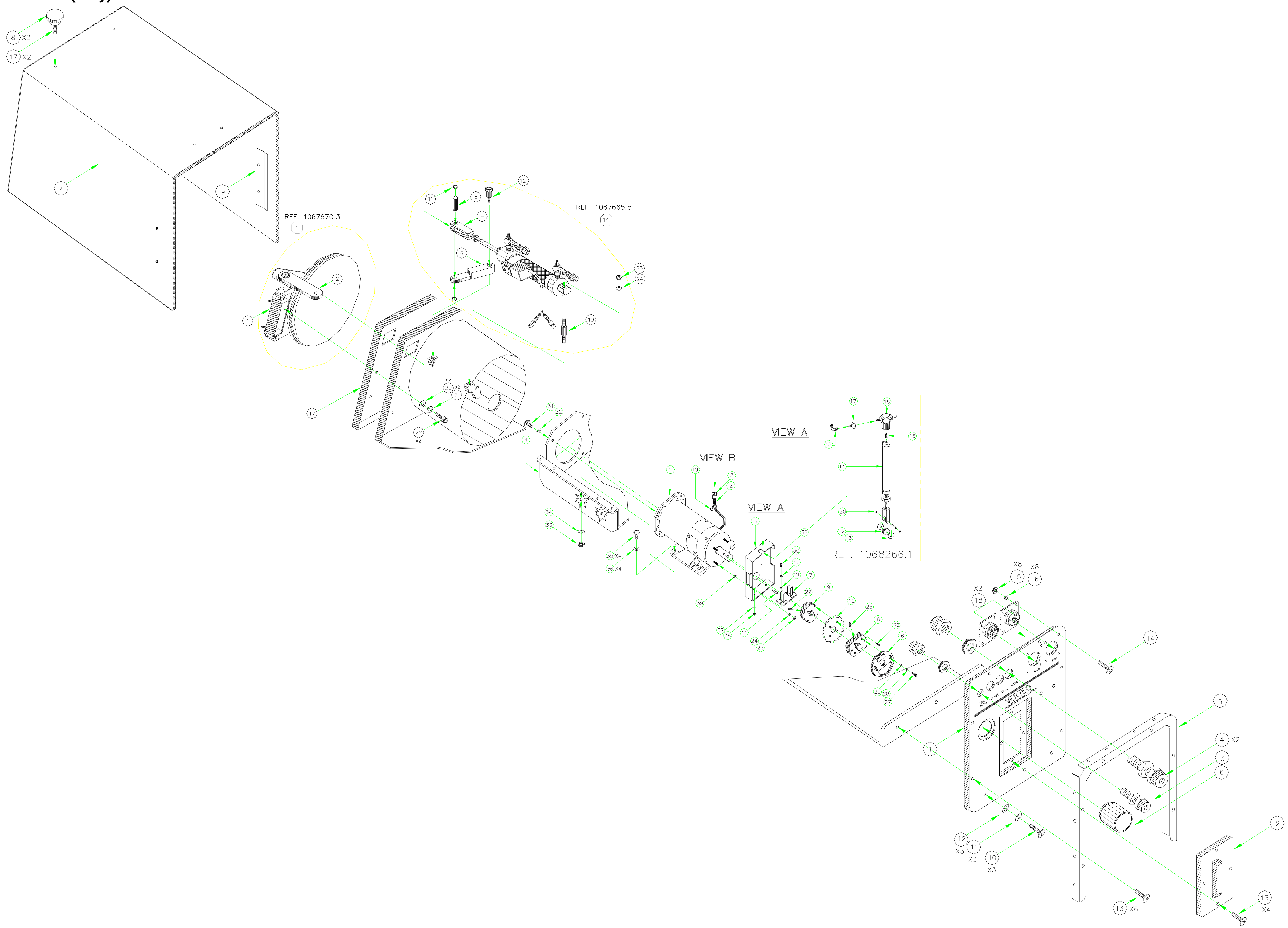
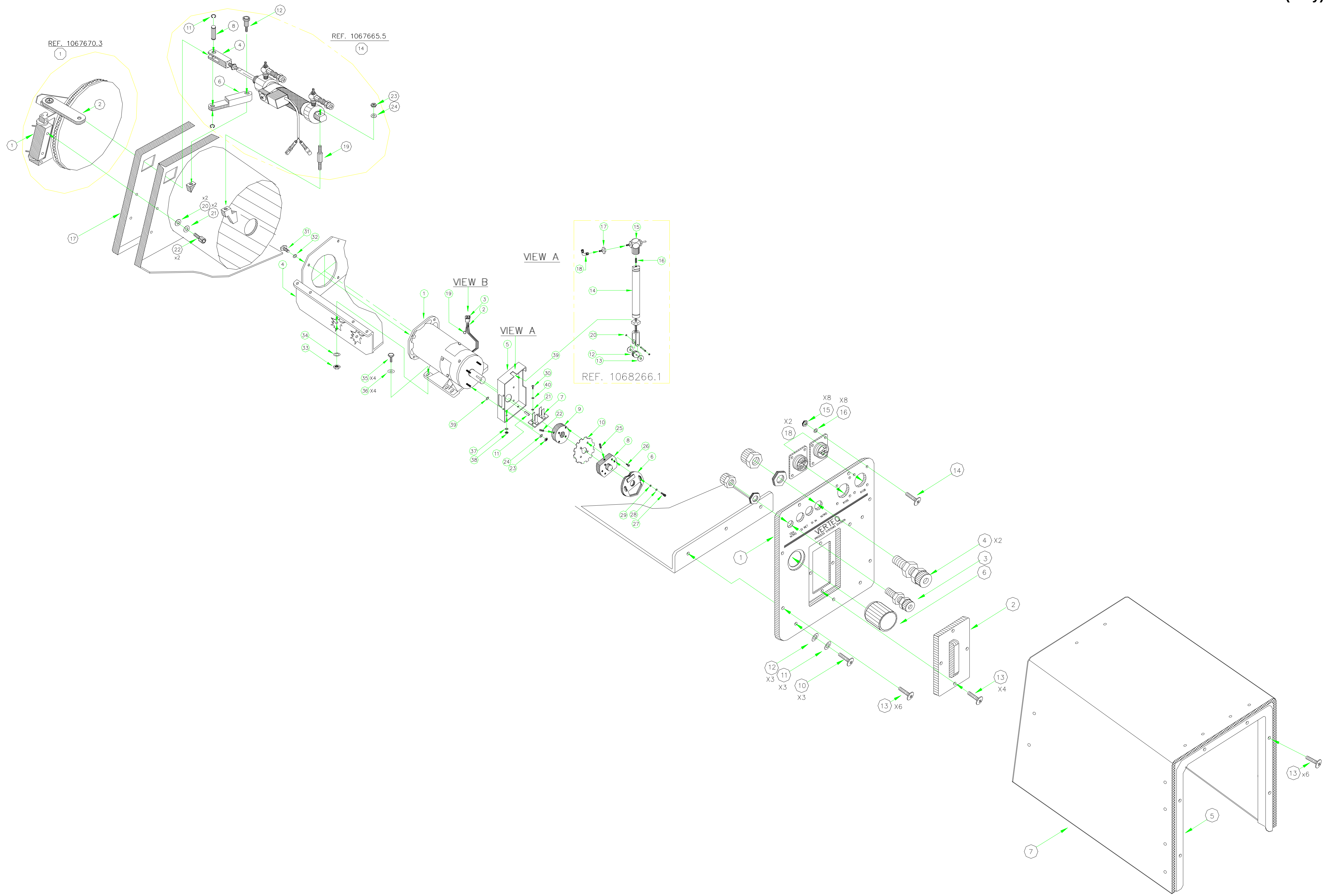
TOP ASSEMBLY 1
1600-55 A (Only)



TOP ASSEMBLY 2
1600-55 A (Only)



TOP ASSEMBLY 3
1600-55 A (Only)



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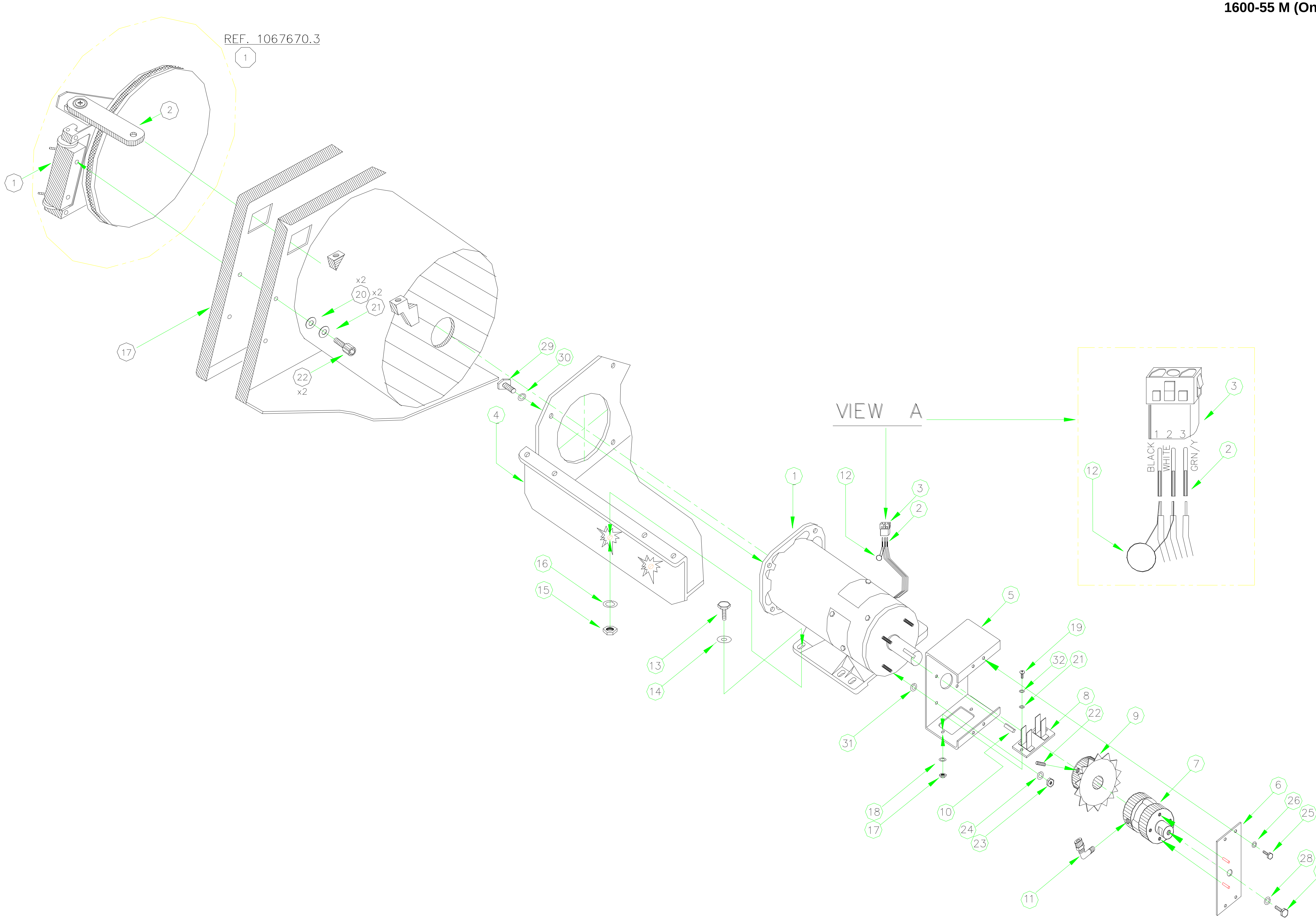
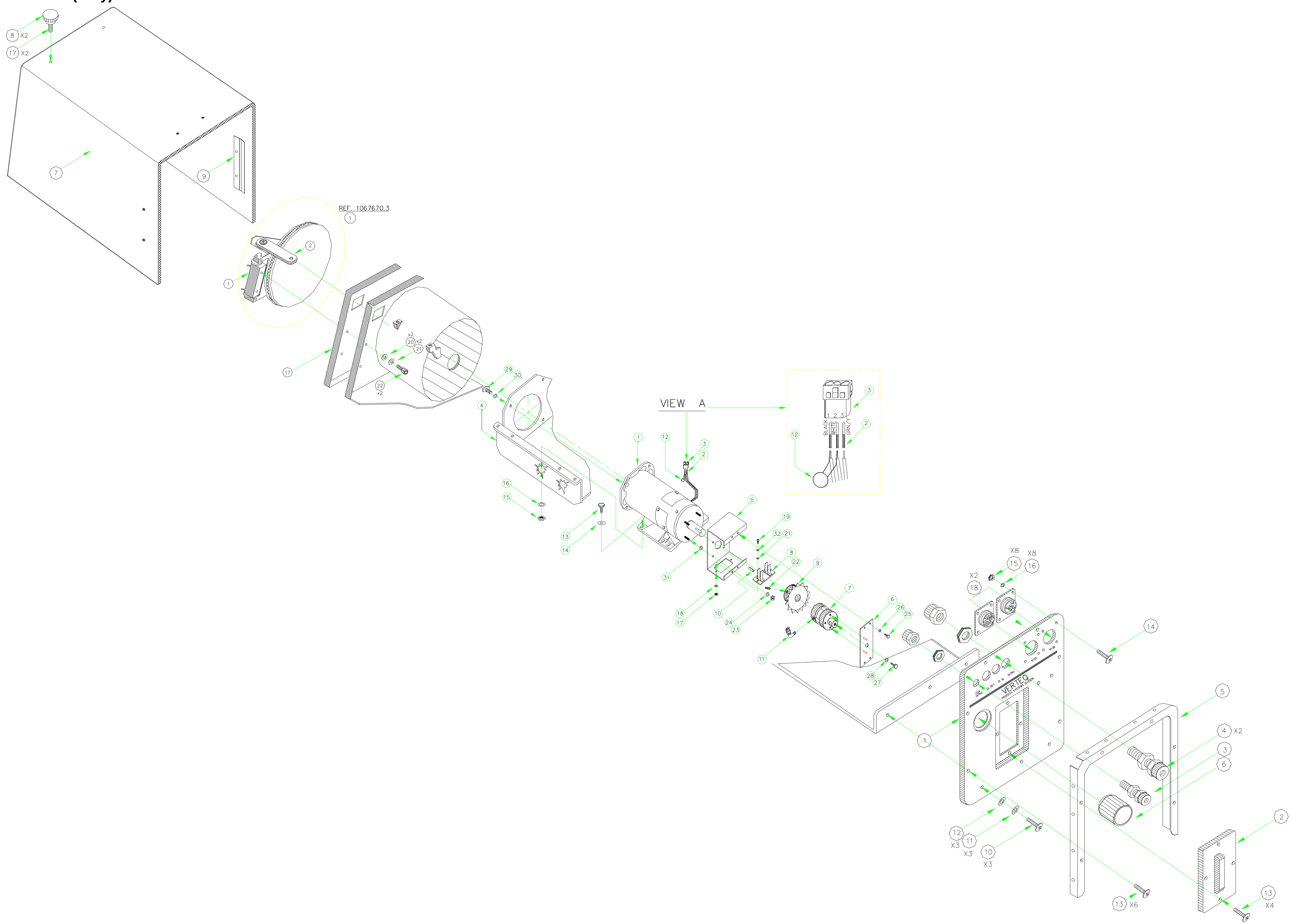
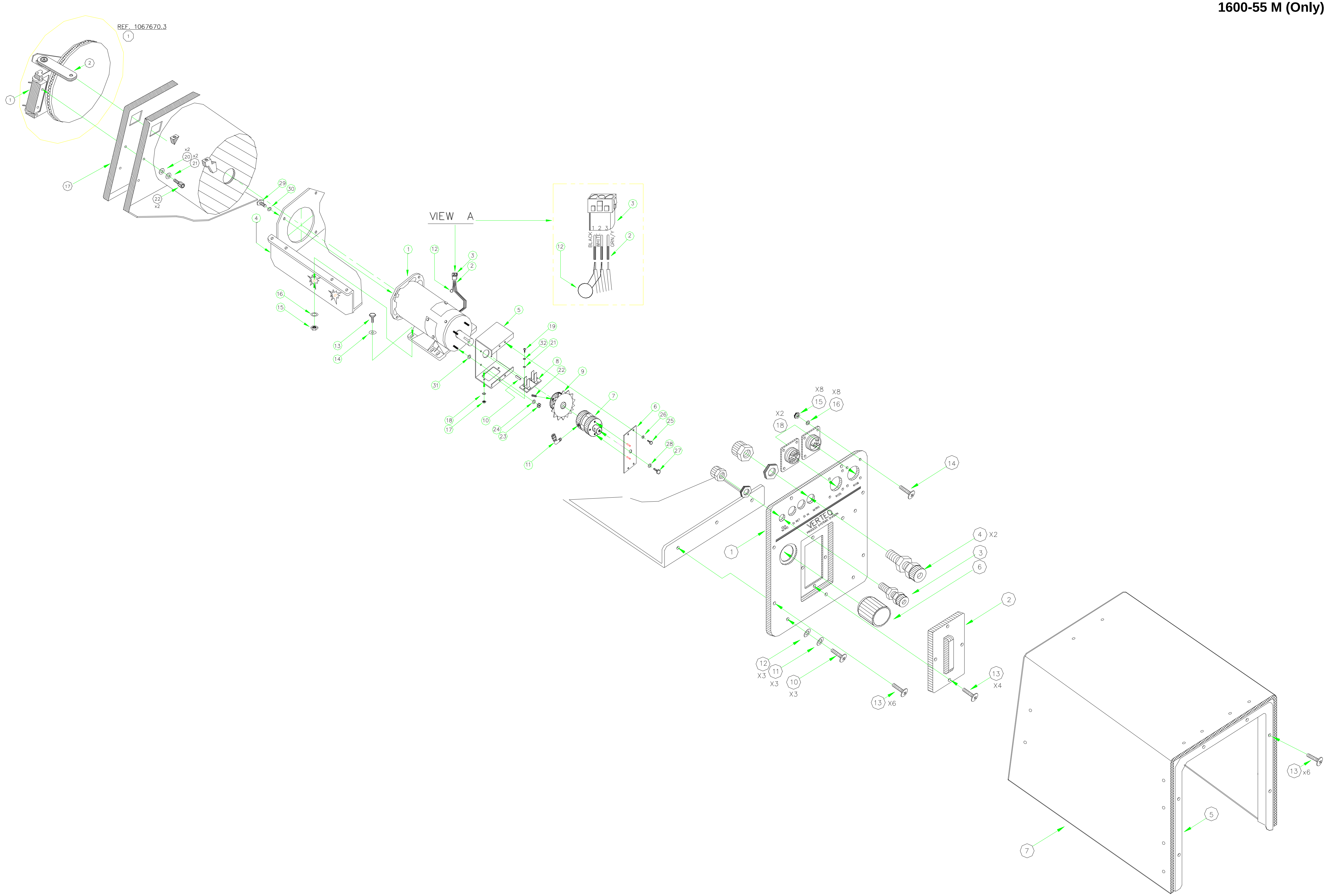
TOP ASSEMBLY 1
1600-55 M (Only)



TOP ASSEMBLY 2
1600-55 M (Only)



TOP ASSEMBLY 3
1600-55 M (Only)



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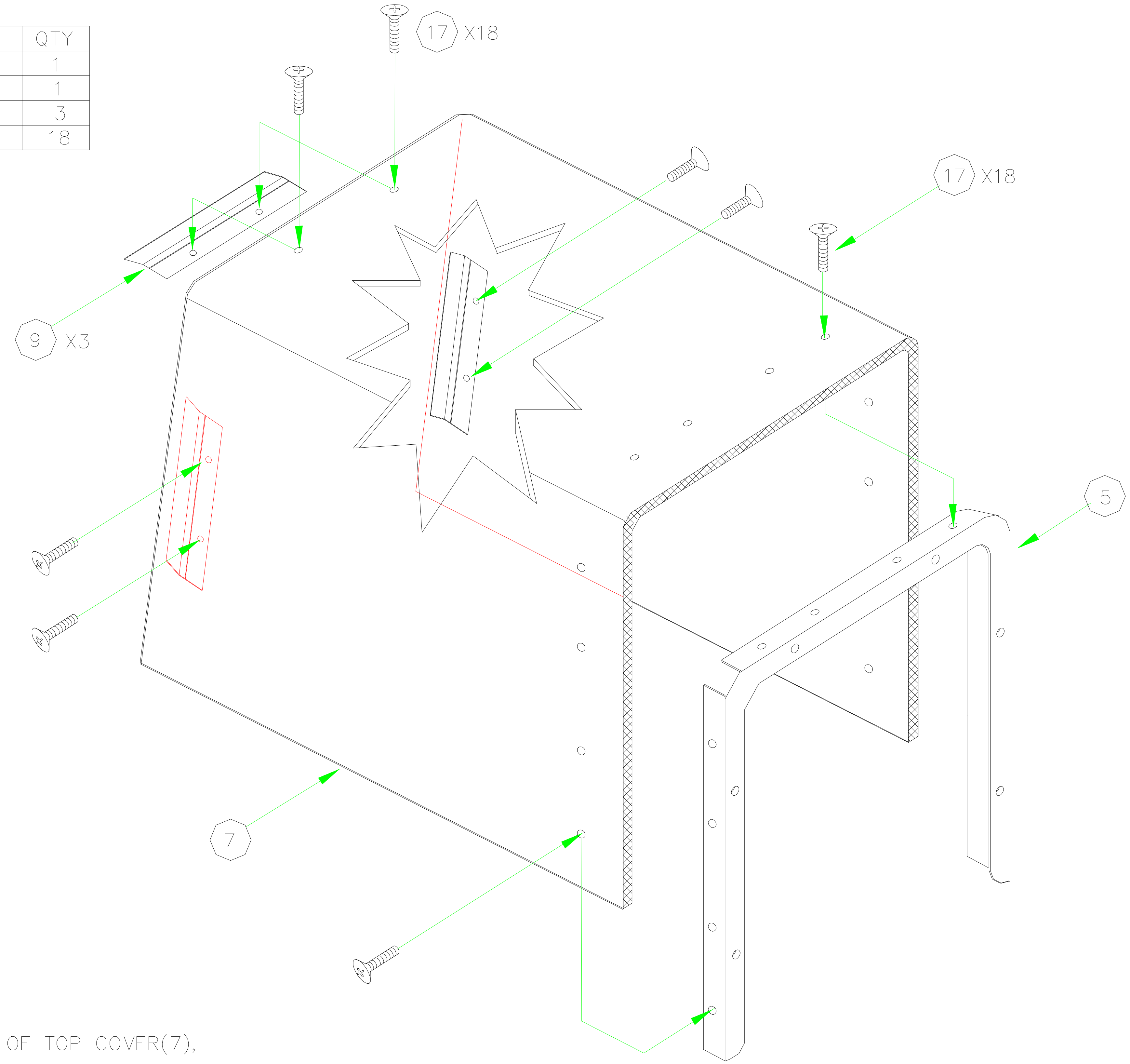
TOP COVER BAY and CHASE 1
1600-55 A/M

ITEM	PART #	DESCRIPTIONS	QTY
5	1067643.1	COLAR COVER	1
7	1067654.3	TOP COVER	1
9	1067636.1	CLAMP COVER	3
17	6X32X3/4	FLAT SCREWS	18

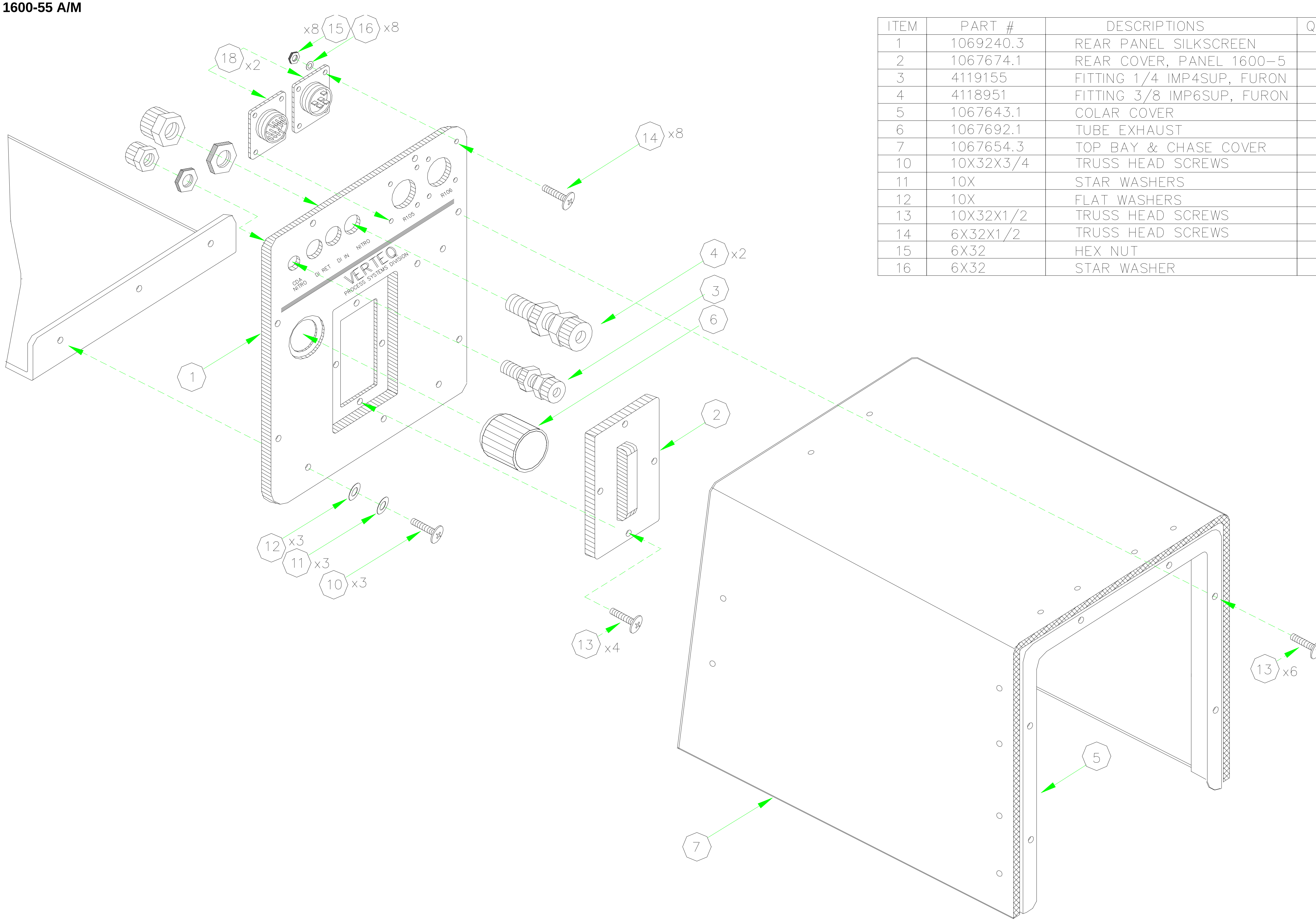
x6



INSTRUCTIONS

1– ATTACH 3–CLAMP COVERS(9) TO THE FRONT OF TOP COVER(7), USING 6–6X32X3/4 FLAT HEAD SCREWS(17).
2– ATTACH COLAR COVER(5) TO THE REAR TOP COVER(7), USING 12–6X32X3/4 FLAT HEAD SCREWS(17).

TOP COVER BAY and CHASE 2
1600-55 A/M



ITEM	PART #	DESCRIPTIONS	QTY
1	1069240.3	REAR PANEL SILKSCREEN	1
2	1067674.1	REAR COVER, PANEL 1600-5	1
3	4119155	FITTING 1/4 IMP4SUP, FURON	1
4	4118951	FITTING 3/8 IMP6SUP, FURON	3
5	1067643.1	COLAR COVER	1
6	1067692.1	TUBE EXHAUST	1
7	1067654.3	TOP BAY & CHASE COVER	1
10	10X32X3/4	TRUSS HEAD SCREWS	3
11	10X	STAR WASHERS	3
12	10X	FLAT WASHERS	3
13	10X32X1/2	TRUSS HEAD SCREWS	10
14	6X32X1/2	TRUSS HEAD SCREWS	8
15	6X32	HEX NUT	8
16	6X32	STAR WASHER	8

TOP COVER BAY and CHASE 3
1600-55 A/M

REAR PANEL ASSEMBLY INSTRUCTIONS

1- ATTACH REAR PANEL(1) TO THE REAR BASE. USING 3-10X32X3/4 TRUSS HEAD SCREWS(10), 3-10X STAR WASHERS(11), AND 3-10X FLAT WASHERS(12).
2- ATTACH 1-1/4 FITTING(3), AND 3-3/8 FITTING(4) TO THE REAR PANEL(1).
3- ATTACH 2-FLANGE MOUNT CONNECTORS(18) TO THE REAR PANEL(1), USING 8-6X32X1/2 TRUSS HEAD SCREWS(14), 8-6X STAR WASHERS(16), AND 8-6X32 HEX NUTS(15).
4- GLUE THE TUBE EXHAUST(6) TO THE REAR PANEL(1).
5- AFTER FINAL Q.C. TEST. SLIDE THE TOP COVER(7) FROM REAR TO FRONT PANEL, MAKE SURE THE CLAMP COVER (9)LOCK IN THE FRONT PANEL, AND SCREW IN 6-10X32X1/2 TRUSS HEAD SCREWS(13).
6- ATTACH REAR COVER(2), USING 4-10X32X1/2 TRUSS HEAD SCREWS(13).

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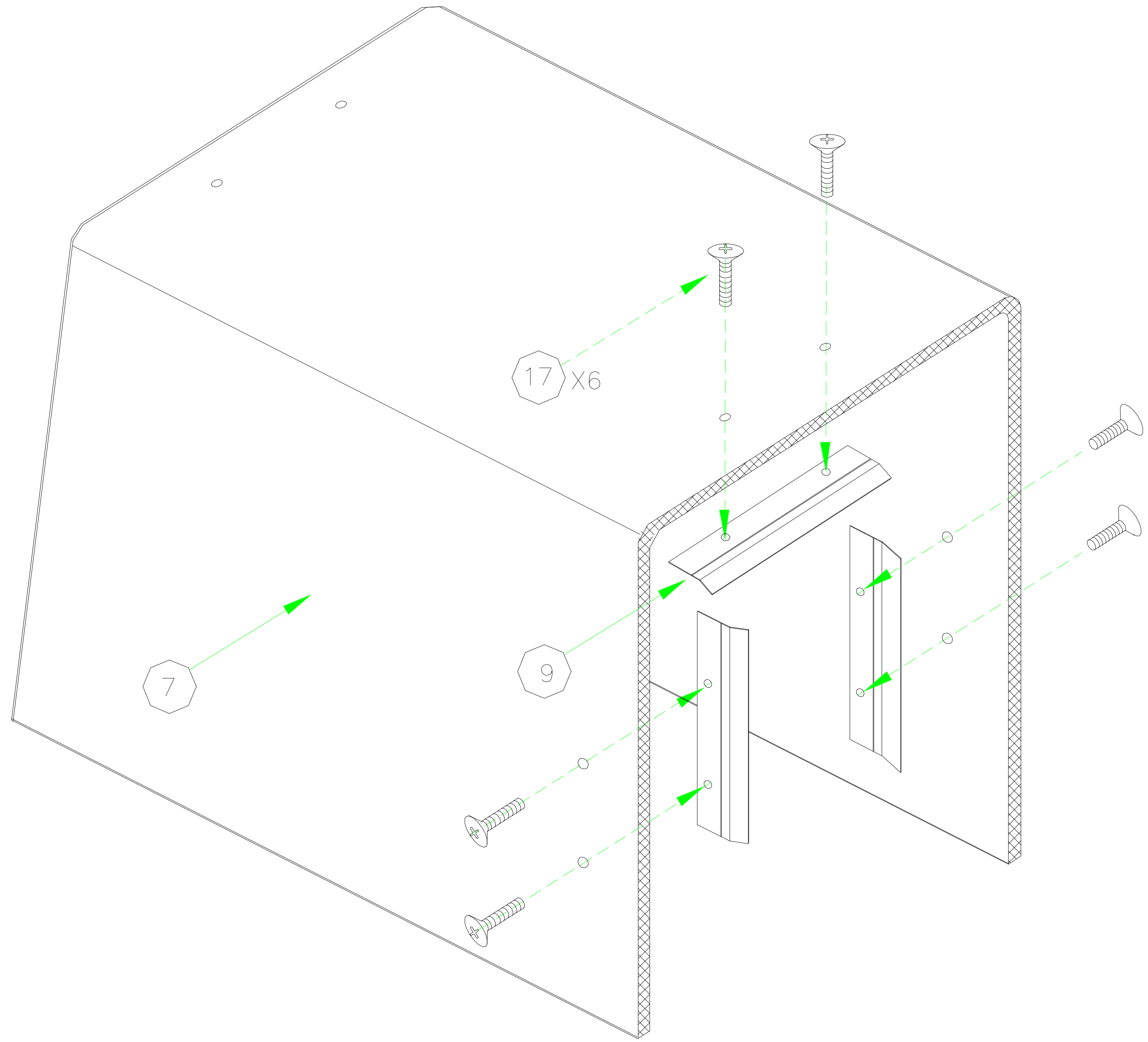
TOP COVER FRONT REMOVEABLE 1
1600-55 A/M

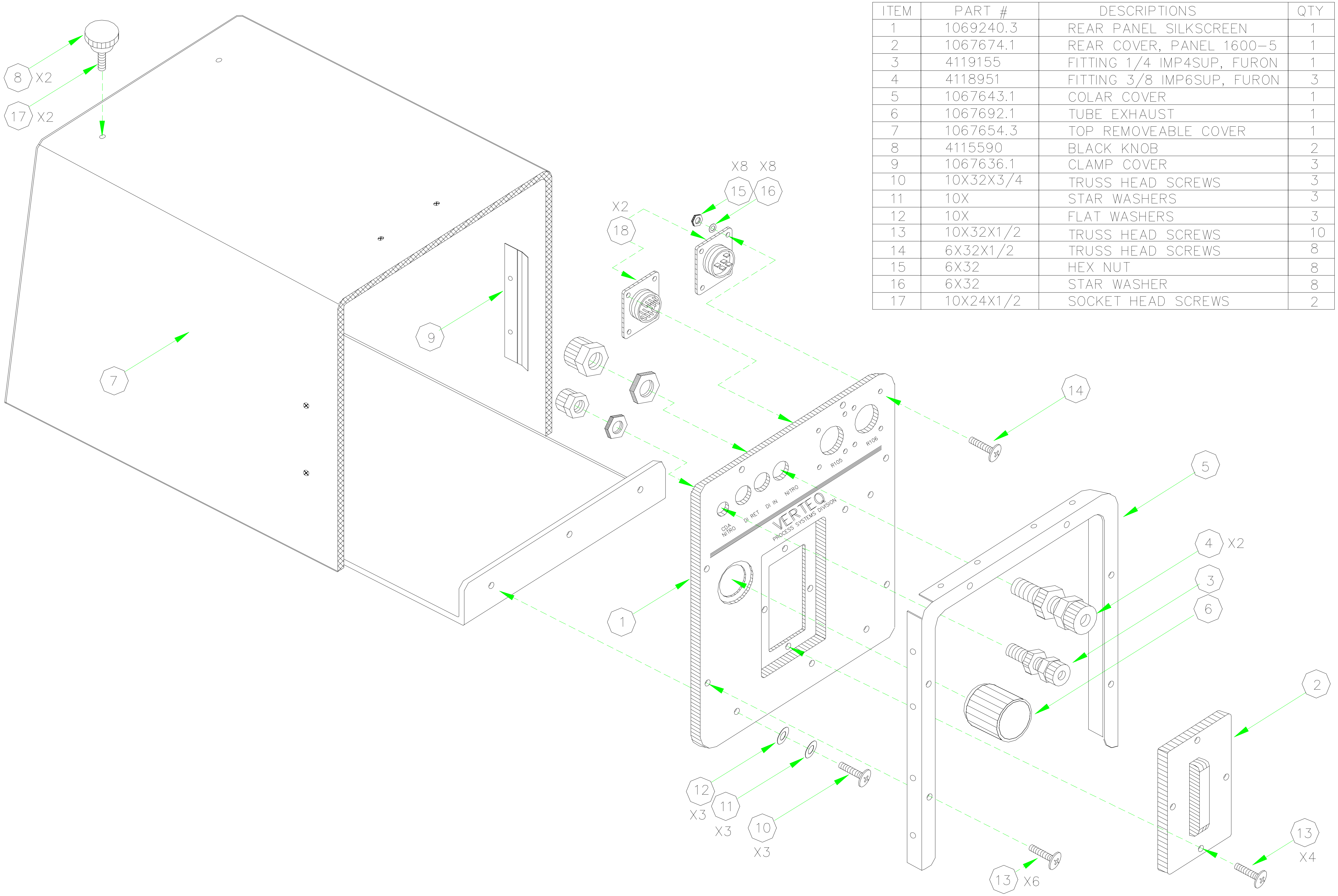


1— ATTACH 3-CLAMP COVERS(9) TO THE REAR OF TOP REMOVEABLE COVER (7), USING 6-6X32X3/4 FLAT HEAD SCREWS(17).

ITEM	PART #	DESCRIPTIONS	QTY
7	1067654.3	TOP COVER	1
9	1067636.1	CLAMP COVER	3
17	6X32X3/4	FLAT SCREWS	18

TOP COVER FRONT REMOVEABLE 2
1600-55 A/M

ITEM	PART #	DESCRIPTIONS	QTY
1	1069240.3	REAR PANEL SILKSCREEN	1
2	1067674.1	REAR COVER, PANEL 1600-5	1
3	4119155	FITTING 1/4 IMP4SUP, FURON	1
4	4118951	FITTING 3/8 IMP6SUP, FURON	3
5	1067643.1	COLAR COVER	1
6	1067692.1	TUBE EXHAUST	1
7	1067654.3	TOP REMOVEABLE COVER	1
8	4115590	BLACK KNOB	2
9	1067636.1	CLAMP COVER	3
10	10X32X3/4	TRUSS HEAD SCREWS	3
11	10X	STAR WASHERS	3
12	10X	FLAT WASHERS	3
13	10X32X1/2	TRUSS HEAD SCREWS	10
14	6X32X1/2	TRUSS HEAD SCREWS	8
15	6X32	HEX NUT	8
16	6X32	STAR WASHER	8
17	10X24X1/2	SOCKET HEAD SCREWS	2



TOP COVER FRONT REMOVEABLE 3
1600-55 A/M

REAR PANEL ASSEMBLY INSTRUCTIONS

1- ATTACH REAR PANEL(1) TO THE REAR BASE. USING 3-10X32X3/4 TRUSS HEAD SCREWS(10), 3-10X STAR WASHERS(11), AND 2-10X FLAT WASHERS(12).
2- ATTACH COLAR COVER(5) TO THE REAR PANEL(1). USING 6-10X32X1/2 TRUSS HEAD SCREWS(13).
3- ATTACH 1-1/4 FITTING(3), AND 3-3/8 FITTING(4) TO THE REAR PANEL(1).
4- ATTACH 2-FLANGE MOUNT CONNECTORS(18) TO THE REAR PANEL(1), USING 8-6X32X1/2 TRUSS HEAD SCREWS(14), 8-6X STAR WASHERS(16), AND 8-6X32 HEX NUTS(15).
5- GLUE THE TUBE EXHAUST(6) TO THE REAR PANEL(1).
6- AFTER FINAL Q.C. TEST. SLIDE THE TOP COVER(7) FROM FRONT TO REAR PANEL, MAKE SURE THE CLAMP COVER LOCK IN THE COLAR COVER(5), AND SCREW IN 2-10X24X1/2 SOCKET SCREW(17), THEN ATTACH 2-BLACK KNOB (8) ON TOP OF 2-SOCKET SCREWS(8).AFTER FINAL Q.C. TEST.
7- ATTACH REAR COVER(2), USING 4-10X32X1/2 TRUSS HEAD SCREWS(13).

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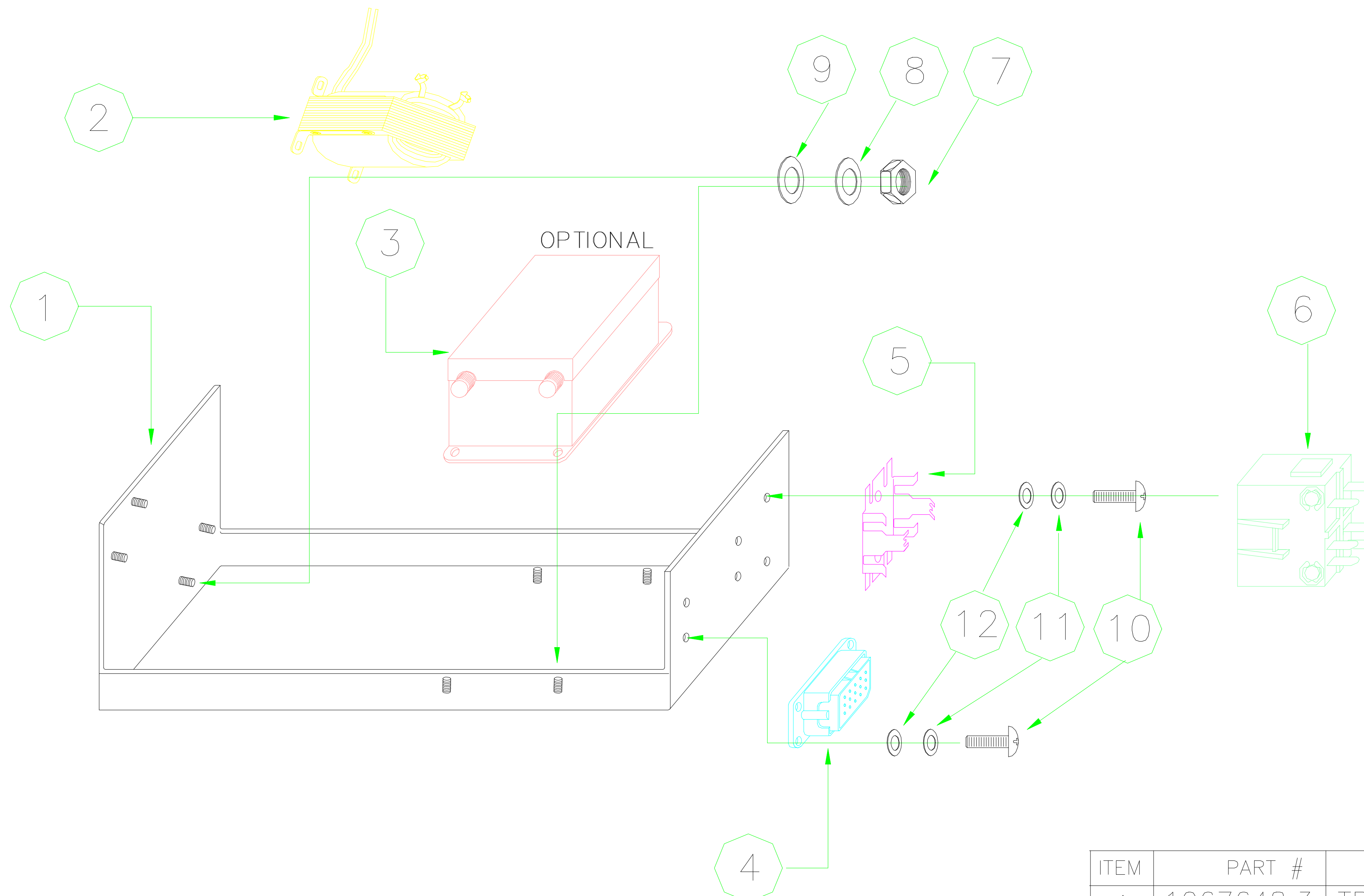
TRANSFORMER ASSEMBLY and INSTRUCTIONS
1600-55 A/M

–5 SHOWN



INSTRUCTIONS:

1–ATTACH TRANSFORMER (2) TO THE TRANSFORMER BRACKET (1). USING 4–10X32 HEX NUTS(7), 4–10X32 STAR WASHERS(8), AND 4–10X32 FLAT WASHERS (9).
2–ATTACH STATIC TRANSFORMER (3) TO THE TRANS. BRACKET(1). USING 4–10X32 HEX NUTS(7),4–10X32 STAR WASHERS (8), AND 4–10X32 FLAT WASHERS (9).
3–ATTACH CONNECTOR PLUG(4) TO THE TRANSFORMER BRACKET(1) BY USING 4–6X32X3/8 ROUND HEAD SCREWS(10), 4–6X32 STAR WASHERS (11), AND 4–6X32 FLAT WASHERS (12).
4–ATTACH RELAY ADAPTOR(5) TO THE TRANSFORMER BRACKET(1) BY USING 2–6X32X3/8 ROUND HEAD SCREWS(10), 2–6X32 STAR WASHERS(11), AND 2–6X32 FLAT WASHERS(12).
5–SNAP RELAY (6) IN TO THE RELAY ADAPTOR (5).

NOTE: ITEM #3 OPTIONAL

ITEM	PART #	DESCRIPTION	QTY
1	1067648.3	TRANSFORMER BRACKET	1
2	1070294.1	TRANSFORMER	1
3	4114388	STATIC TRANSFORMER	1
4	4118346	CONNECTOR PLUG	1
5		RELAY ADAPTOR	1
6	4115243	RELAY	1
7	10X32	HEX NUT	8
8	10X32	STAR WASHER	8
9	10X32	FLAT WASHER	8
10	6X32X3/8	ROUND HEAD SCREW	10
11	6X32	STAR WASHER	10
12	6X32	FLAT WASHER	10

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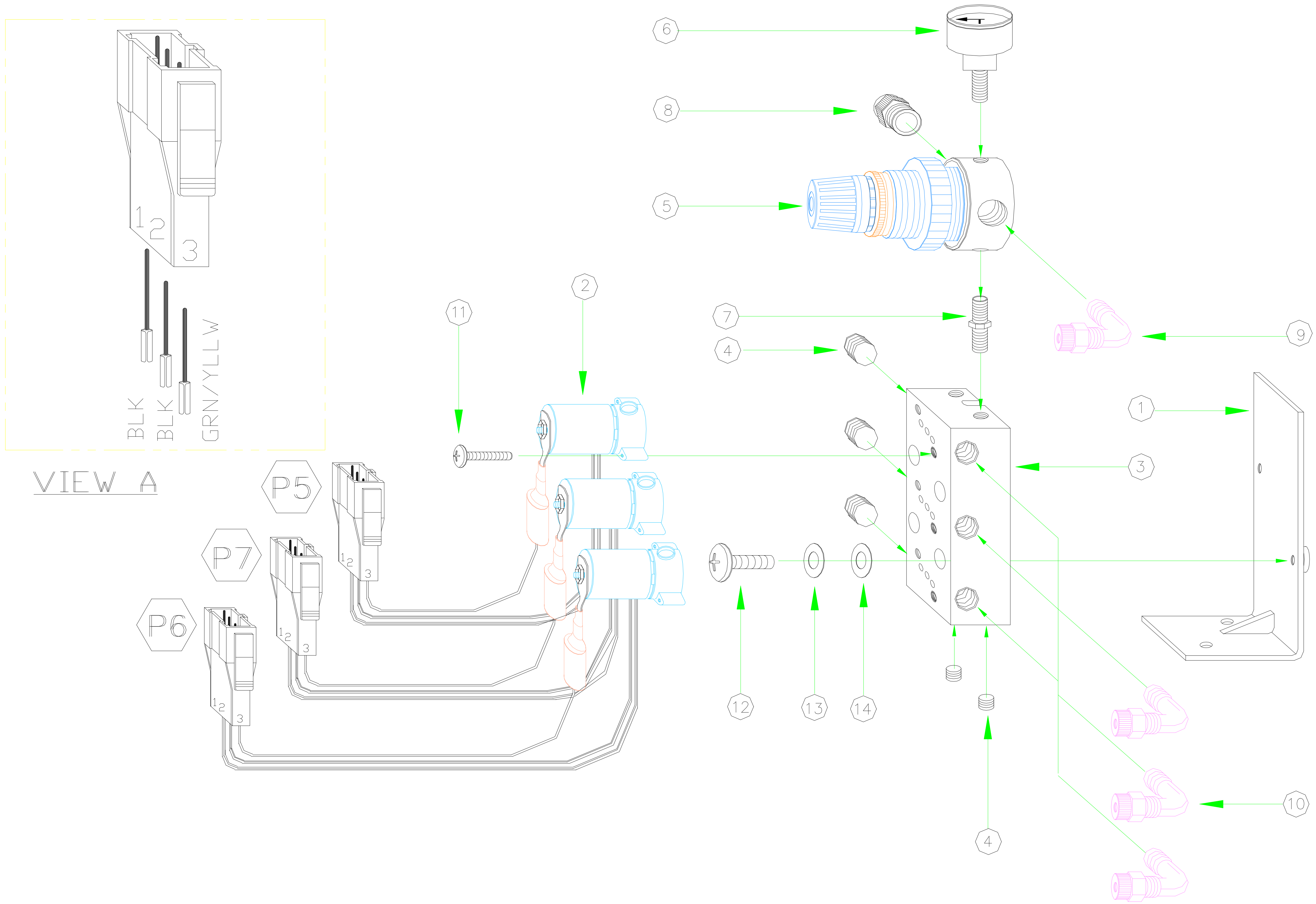
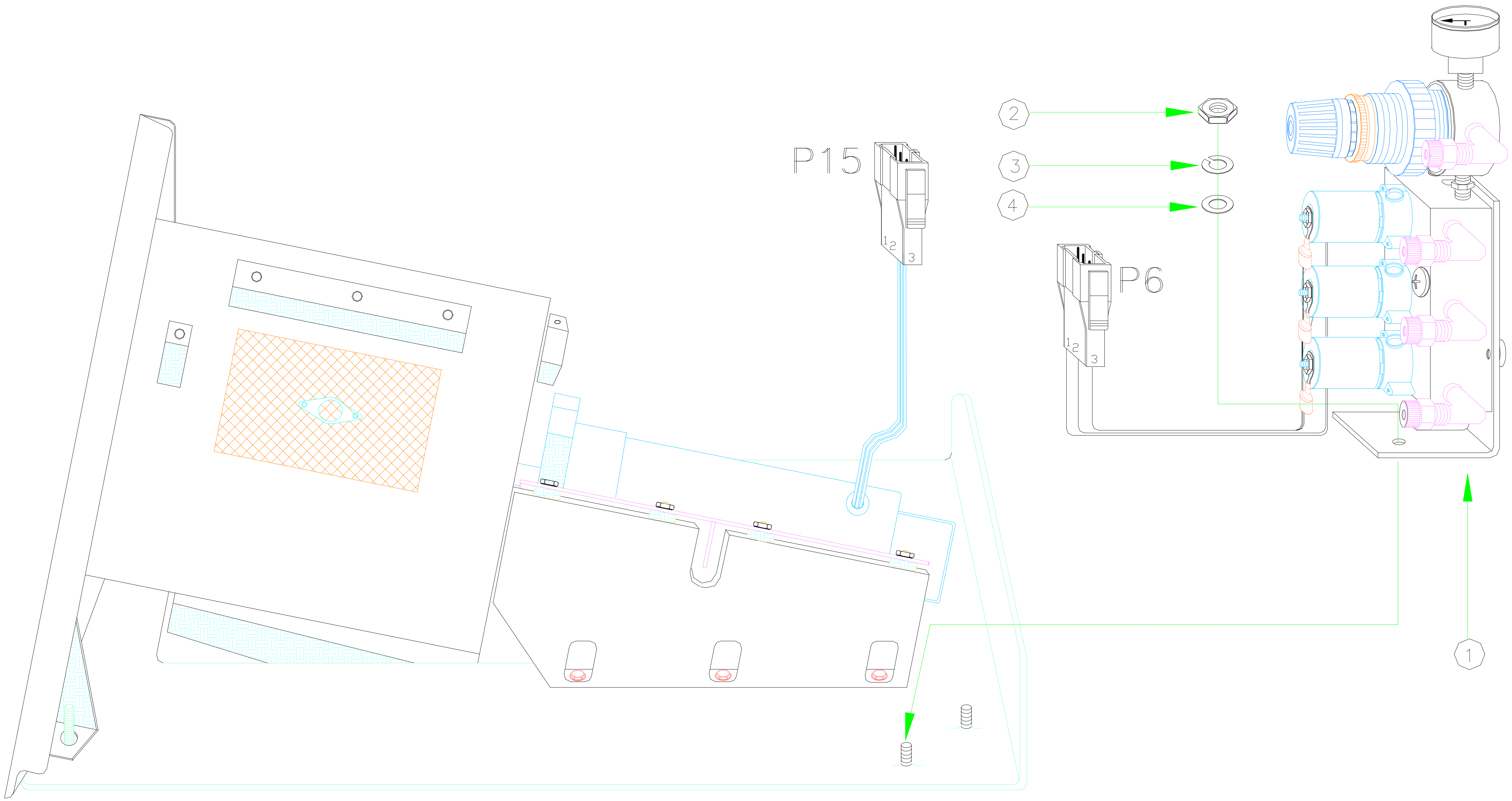
VALVE ASSEMBLY and INSTRUCTIONS 1
1600-55 A (Only)



VALVE ASSEMBLY and INSTRUCTIONS 2
1600-55 A (Only)



INSTRUCTIONS:

1– MOUNT THE AIR VALVES SET (1) ONTO THE BASE PLATE. USING 2–10X32 HEX NUTS (2), 2–10X32 SPLIT WASHERS (3), AND 2–10X32 FLAT WASHERS (4).

ITEM	PART #	DESCRIPTIONS	QTY
1	1067668	AIR VALVES	1 SET
2	10X32	HEX NUT	2
3	10X32	SPLIT WASHERS	2
4	10X32	FLAT WASHERS	2

VALVE ASSEMBLY and INSTRUCTIONS 3
1600-55 A (Only)

AIR VALVE ASSEMBLY INTSRUCTIONS:

NOTE: ALL PARTS HAS TO APPLY TEFLON TAPE.

1- TURN THE MANIFOLD BASE(3)TO VERTICALY VIEW.
2- ATTACH 3-HOLE PLUGS(4) TO THE FAR SIDE, AND 2-HOLE PLUGS(4) TO THE BOTTOM OF MANIFOLD BASE (3).
3- ATTACH NIPPLE (7) TO THE TOP, NEAR SIDE OF THE MANIFOLD BASE (3).
4- ATTACH REGULATOR (5) TO THE NIPPLE (7).
5- ATTACH GAUGE (6) TO THE REGULATOR (5).
6- ATTACH 1-HOLE PLUG(8) TO THE FAR SIDE, AND 1-1/4 ELBOW(9) TO [IN] POSITION OF REGULATOR(5).
7- ATTACH 3-1/8X1/4 ELBOW (10) TO THE NEAR SIDE OF MANIFOLD BASE (3).
8- MOUNT THE MANIFOLD BASE(3) TO THE VALVE BRACKET(1). USING 2-8X32X1 ROUND HEAD SCREWS(12), 2-8X32 STAR WASHERS(13) AND 2-8X32 FLAT WASHERS (14).
9- ATTACH 3-SKINNER VALVES (2) TO THE MANIFOLD BASE (3), USING 6-6X32X1/2 ROUND HEAD SCREWS (11). (SEE DRAWING FOR MORE RELATION POSITIONS).

ITEM	PART #	DESCRIPTIONS	QTY
1	1067663.3	BRACKET, VALVE	1
2	1070210.1	VALVE, SKINNER	3
3	4116299	MANIFOLD, BASE 3 STATIONS	1
4	4116301	MANIFOLD KIT	1 SET
5	4114273	REGULATOR 1/4	1
6	4116212	GAUGE, 0-60 PSI	2
7	4114082	NIPPLE CLOSE B-20 1/8 PIPEBR.	1
8	4118192	PLUG, PIPE 1/4	1
9	4118943	ELBOW MALE 1/4x1/4	1
10	4118941	ELBOW, IMP42EAM 1/8X1/4T	3
11	6X32X1/2	ROUND HEAD SCREW	6
12	8X32X1/2	ROUND HEAD SCREW	2
13	8X32	STAR WASHER	2
14	8X32	FLAT WASHER	2

P5	P6	P7
1=BLACK 2=BLACK 3=GREEN/YELLOW	1=BLACK 2=BLACK 3=GREEN/YELLOW	1=BLACK 2=BLACK 3=GREEN/YELLOW

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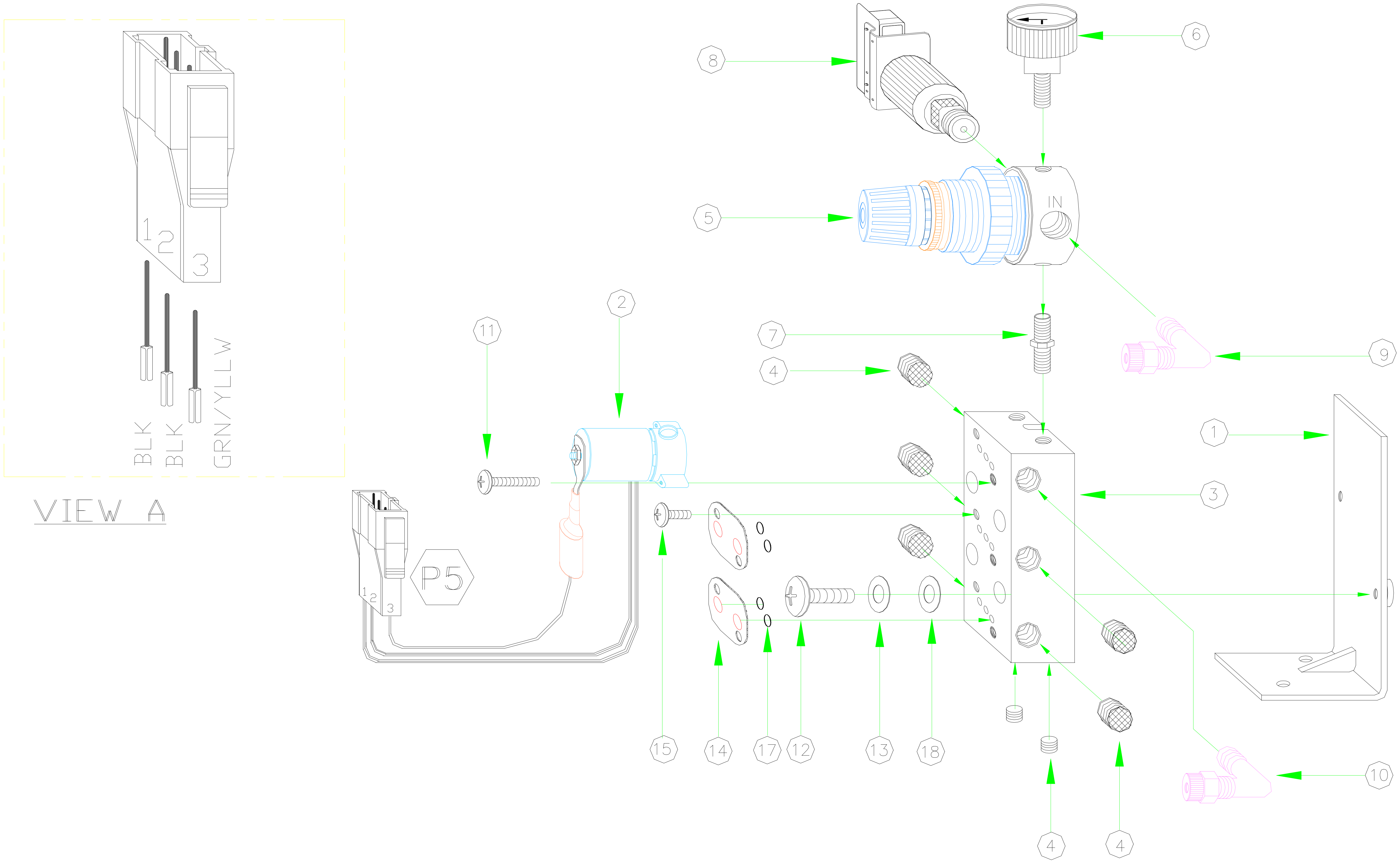
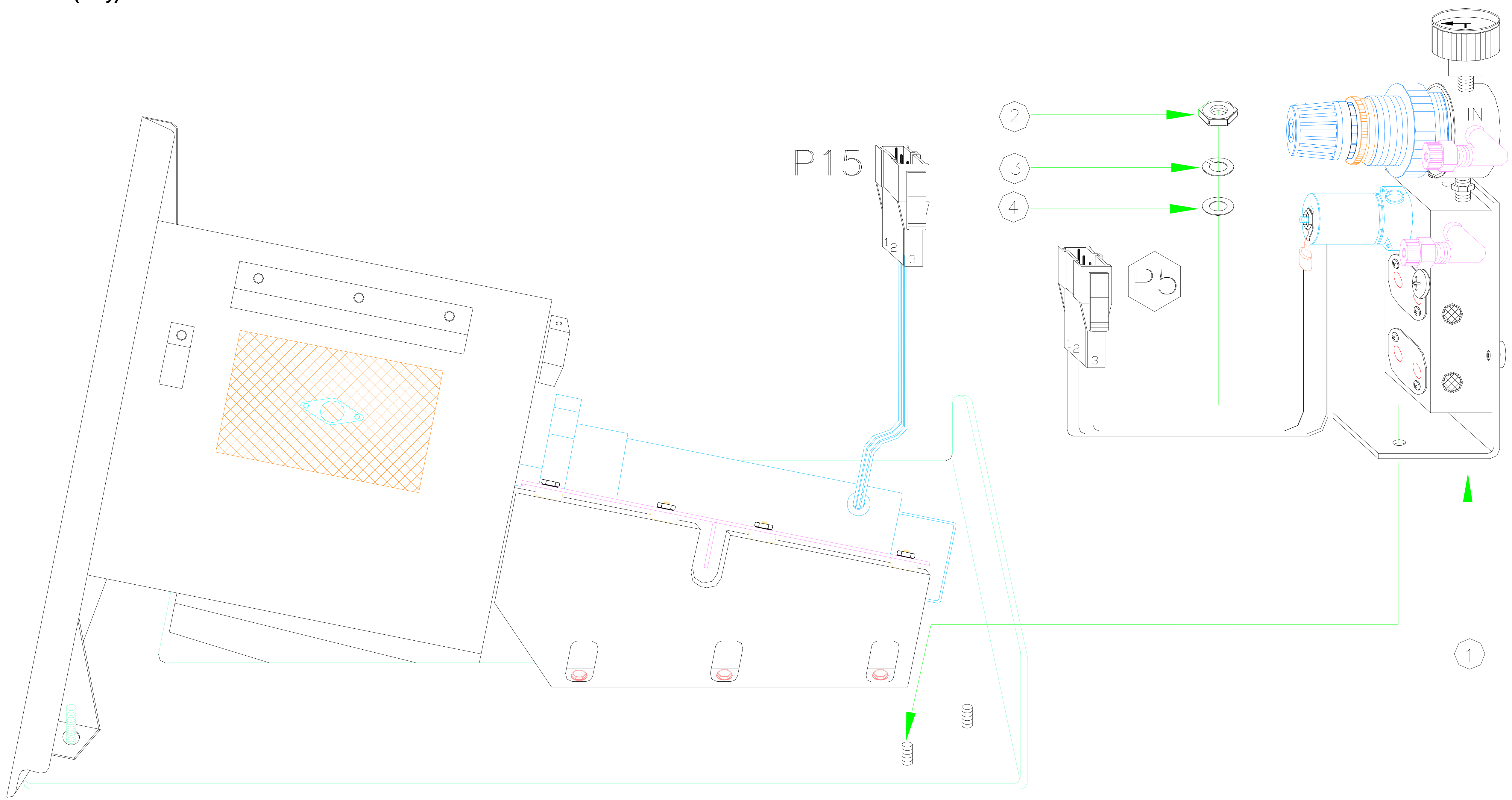
VALVE ASSEMBLY and INSTRUCTIONS 1
1600-55 M (Only)



VALVE ASSEMBLY and INSTRUCTIONS 2
1600-55 M (Only)



INSTRUCTIONS:

1– MOUNT THE AIR VALVES SET (1) ONTO THE BASE PLATE. USING 2–10X32 HEX NUTS (2), 2–10X32 SPLIT WASHERS (3), AND 2–10X32 FLAT WASHERS (4).

ITEM	PART #	DESCRIPTIONS	QTY
1	1067668	AIR VALVES	1 SET
2	10X32	HEX NUT	2
3	10X32	SPLIT WASHERS	2
4	10X32	FLAT WASHERS	2

VALVE ASSEMBLY and INSTRUCTIONS 3
1600-55 M (Only)

AIR VALVE ASSEMBLY INSTRUCTIONS:

NOTE: ALL PARTS HAS TO APPLY TEFLON TAPE.

1- TURN THE MANIFOLD BASE(3)TO VERTICALY VIEW.
2- ATTACH 3-HOLE PLUGS(4) TO THE FAR SIDE, 2-HOLE PLUGS TO THE NEAR SIDE, AND 2-HOLE PLUGS(4) TO THE BOTTOM OF MANIFOLD BASE (3).
3- ATTACH NIPPLE (7) TO THE TOP, NEAR SIDE OF THE MANIFOLD BASE (3).
4- ATTACH REGULATOR (5) TO THE NIPPLE (7).
5- ATTACH GAUGE(6) TO THE TOP OF REGULATOR(5), THE PRESSURE SWITCH(8) TO THE FAR SIDE OF REGULATOR(5), AND THE ELBOW(9) TO (IN) POSITION OF REGULATOR(5).
6- ATTACH 1-1/8X1/4 ELBOW (10) TO THE BOTTOM, NEAR SIDE OF MANIFOLD BASE (3).
7- MOUNT THE MANIFOLD BASE(3) TO THE VALVE BRACKET(1). USING 2-8X32X1 ROUND HEAD SCREWS(12), 2-8X32 STAR WASHERS(13) AND 2-8X32 FLAT WASHERS (14).
8- ATTACH 1-SKINNER VALVES (2) TO THE TOP ONE OF THE MANIFOLD BASE (1), USING 2-6X32X1/2 ROUND HEAD SCREWS (11).
9- ATTACH 4-SKINNER O-RINGS, AND 2-SKINNER BLANK KIT COVERS(14) INTO THE MIDLE AND BOTTOM STATIONS OF MANIFOLD BASE(3). USING 4-6X32X1/4 ROUND HEAD SCREWS(15).
(SEE DRAWING FOR MORE RELATION POSITIONS).

P5
1=BLACK 2=BLACK 3=GREEN/YELLOW

ITEM	PART #	DESCRIPTIONS	QTY
1	1067663.3	BRACKET, VALVE	1
2	1070210.1	VALVE, SKINNER	1
3	4116299	MANIFOLD, BASE 3 STATIONS	1
4	4116301	MANIFOLD KIT	1 SET
5	4114273	REGULATOR 1/4	1
6	4116212	GAUGE, 0-60 PSI	2
7	4119234	NIPPLE CLOSE B-20 1/8 PIPEBR.	1
8	4114327	PRESSURE SWICTH J54S-24-9711	1
9	4118943	ELBOW 1/4 X 1/4	1
10	4118941	ELBOWL, IMP42EAM 1/8X1/4T	1
11	6X32X1/2	ROOUND HEAD SCREW	2
12	8X32X1/2	ROUND HEAD SCREW	2
13	8X32	STAR WASHER	2
14	4116528	SKINNER BLANK KIT (WITH O-RINGS)	2
15	6X32X1/4	ROUND HEAD SCREW	4
16	8X32	FLAT WASHERS	2
17	4116528	O-RING(COME WITH SKINNER BLANK KIT)	4

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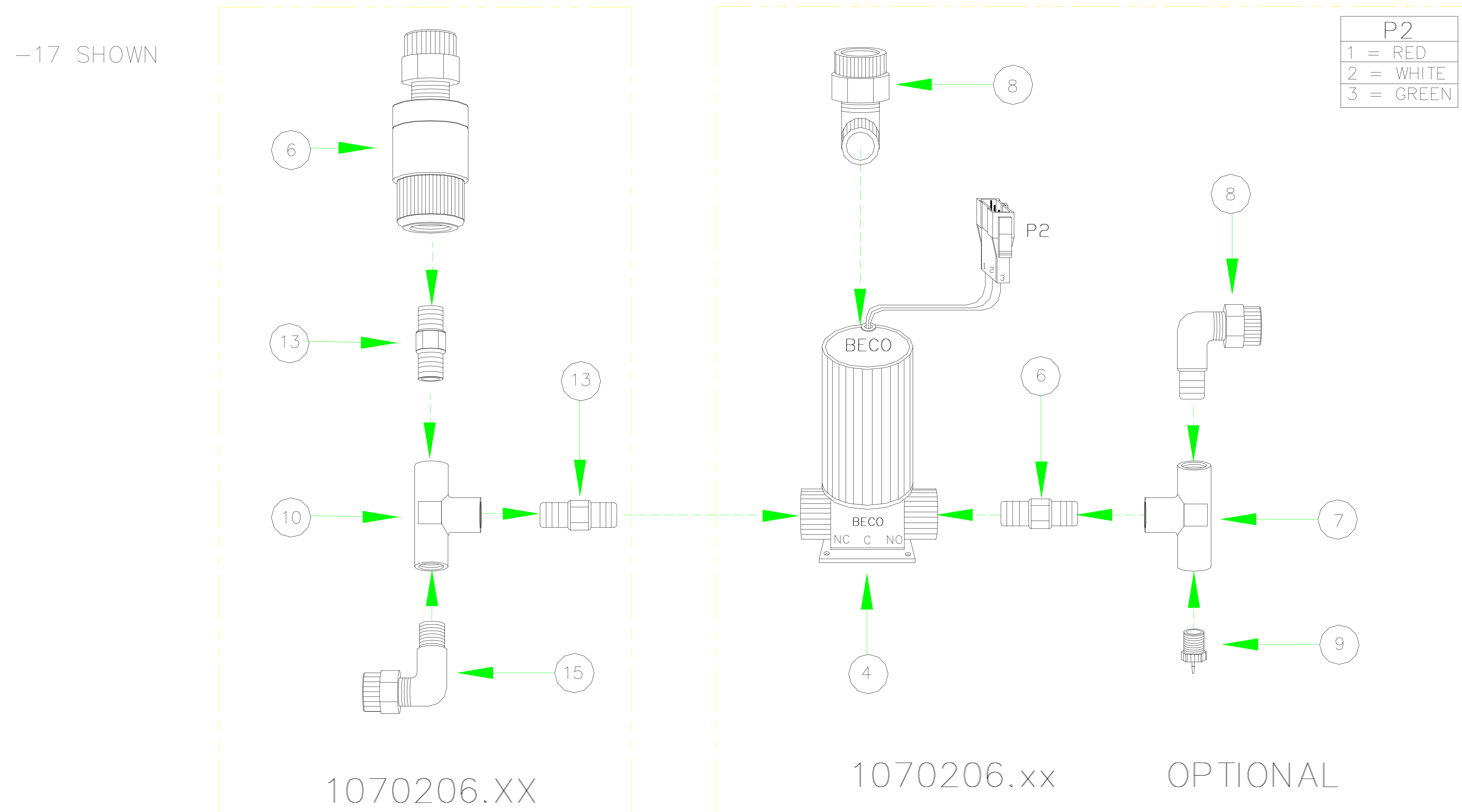
HIGH PRESSURE DI VALVE ASSEMBLY and INSTRUCTIONS 1
1600-55 A/M



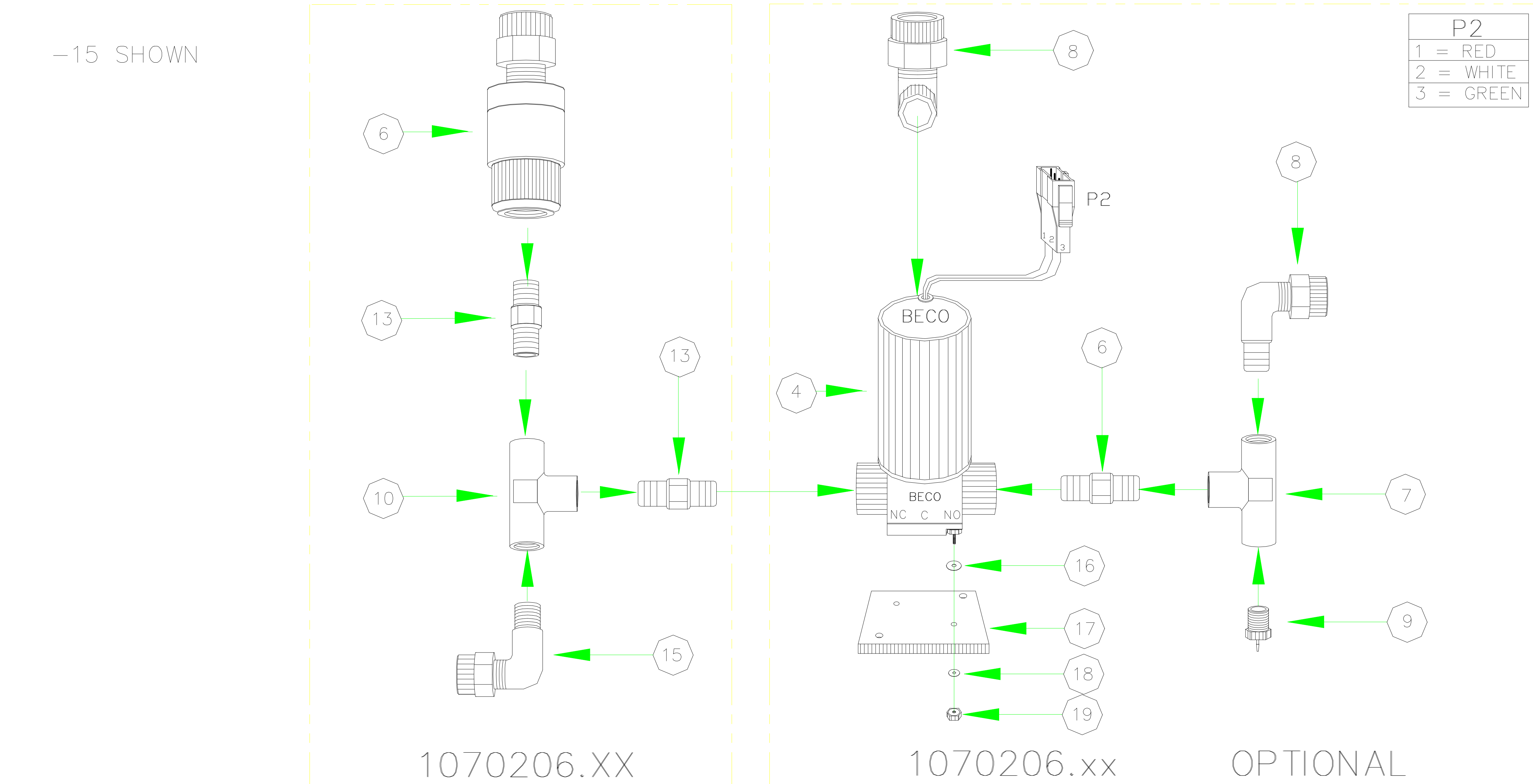
INSTRUCTIONS:

1- APPLY TEFLON TAPE TO ALL ELBOW, TEE, AND NIPPLE THREADS.
2- ATTACH 1-1/4 NIPPLE(6) TO THE RIGHT SIDE OF DI VALVE(4). BE SURE THE BECO STAMPED ON THE BASE OF VALVE FACE TO YOU.
3- ATTACH 1-1/4 NPT ADAPTOR(9), AND 1-3/8X1/4 ELBOW(8) TO EACH SIDE OF THE 1/4 NPT TEE(7).
4- ATTACH ASSY. TEE(7) TO THE NIPPLE(6). BE SURE THE NIPLE FACE TO GROUND.

ITEM	PART #	DESCRIPTIONS	QTY
4	1070206.17	VALVE ASSY. DI HP W/ELEC CONN.	1
6	4119233	1/4 NPT NIPPLES FURON	1
7	4119234	TEE, 1/4 NPT FURON MPF4T	1
8	4119732	FITTING 3/8X 1/4P	2
9	4114709	ADAPTOR, 1/4 NPT, PLASTIC	1
4	1/4X20	FLAT SCREW	3

HIGH PRESSURE DI VALVE ASSEMBLY and INSTRUCTIONS 2

1600-55 A/M



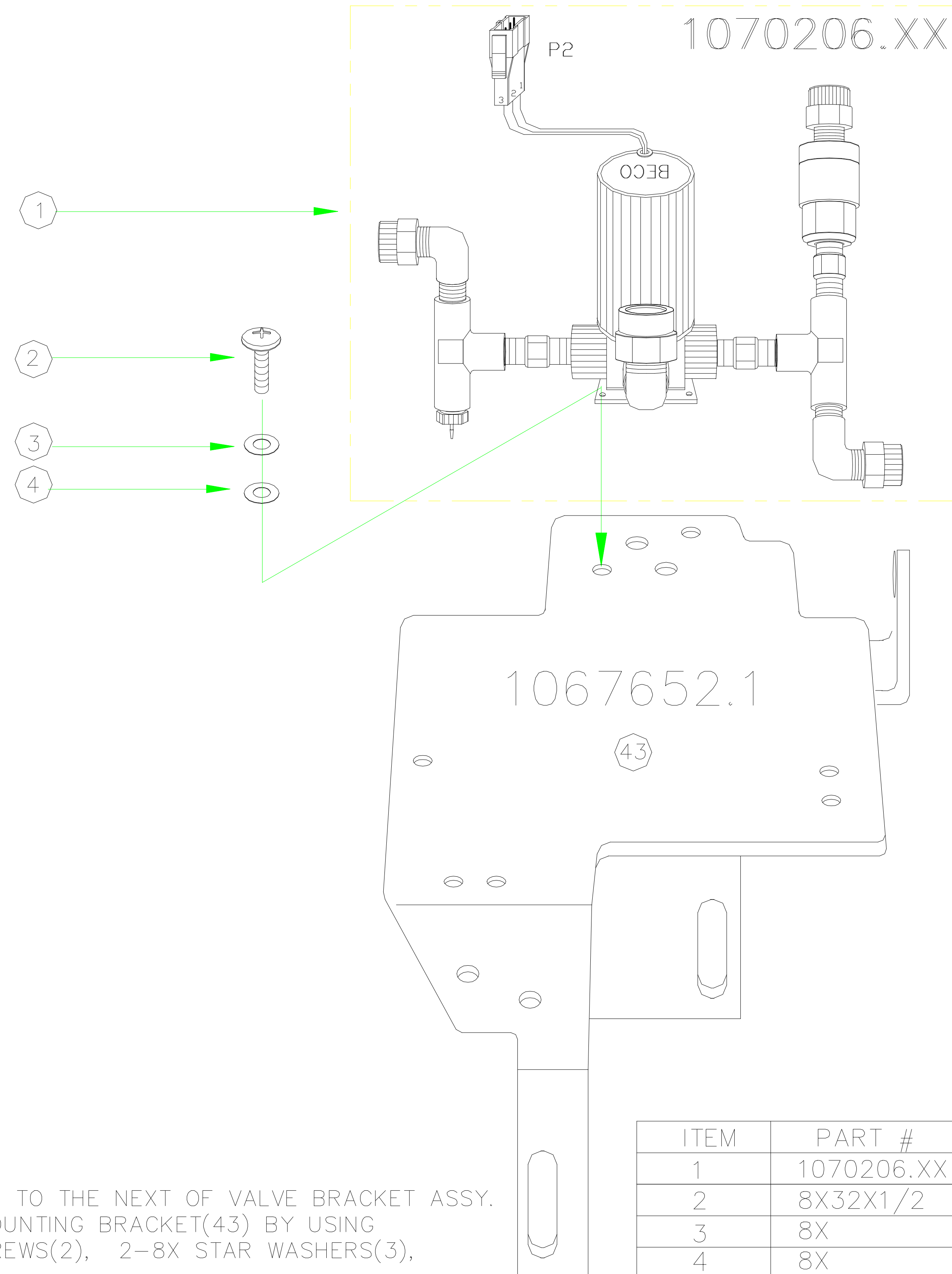
INSTRUCTIONS:

1- APPLY TEFLON TAPE TO ALL ELBOW, TEE, AND NIPPLE THREADS.
2- ATTACH 1-1/4 NIPPLE(6) TO THE RIGHT SIDE OF DI VALVE(4). BE SURE THE BECO STAMPED ON THE BASE OF VALVE FACE TO YOU.
3- ATTACH 1-1/4 NPT ADAPTOR(9), AND 1-3/8X1/4 ELBOW(8) TO EACH SIDE OF THE 1/4 NPT TEE(7).
4- ATTACH ASSY. TEE(7) TO THE NIPPLE(6). BE SURE THE NIPLE FACE TO GROUND.
5- REMOVE 2-4X40 HEX NUTS(19) FROM THE BASE OF DI VALVE(4).
6- APPLY 2-6X FLAT WASHER(16) TO 2-DI VALVE STUDS.
7- ATTACH DI VALVE PAD(17) TO THE BASE OF DI VALVE(4), AND INSERT 2-4X FLAT WASHERS(18), THEN TIGHTEN IT BY 2-4X40 HEX NUTS(19).

ITEM	PART #	DESCRIPTIONS	QTY
4	1070206.17	VALVE ASSY. DI HP W/ELEC CONN.	1
6	4119233	1/4 NPT NIPPLES FURON	1
7	4119234	TEE, 1/4 NPT FURON MPF4T	1
8	4119732	FITTING 3/8X 1/4P	2
9	4114709	ADAPTOR, 1/4 NPT, PLASTIC	1
16	6X	FLAT WASHERS	2
17	1065801.1	PAD, DI VALVE 1/4" (4'X8')	1
18	4X	FLAT WASHERS	2

HIGH PRESSURE DI VALVE ASSEMBLY and INSTRUCTIONS 3

1600-55 A/M



INSTRUCTIONS:

1– PLACE THE DI VALVE BLOCK(1) TO THE NEXT OF VALVE BRACKET ASSY. THEN TIGHTEN IT TO VALVE MOUNTING BRACKET(43) BY USING 2–8X32X1/2 ROUND HEAD SCREWS(2), 2–8X STAR WASHERS(3), AND 2–8X FLAT WASHERS(4).

ITEM	PART #	DESCRIPTIONS	QTY
1	1070206.XX	VALVE ASSY. DI HP. OR LP.	1
2	8X32X1/2	ROUND HEAD SCREWS	2
3	8X	STAR WASHERS	2
4	8X	FLAT WASHERS	2
43	1067652.1	VALE MOUNT. BRACKET	1

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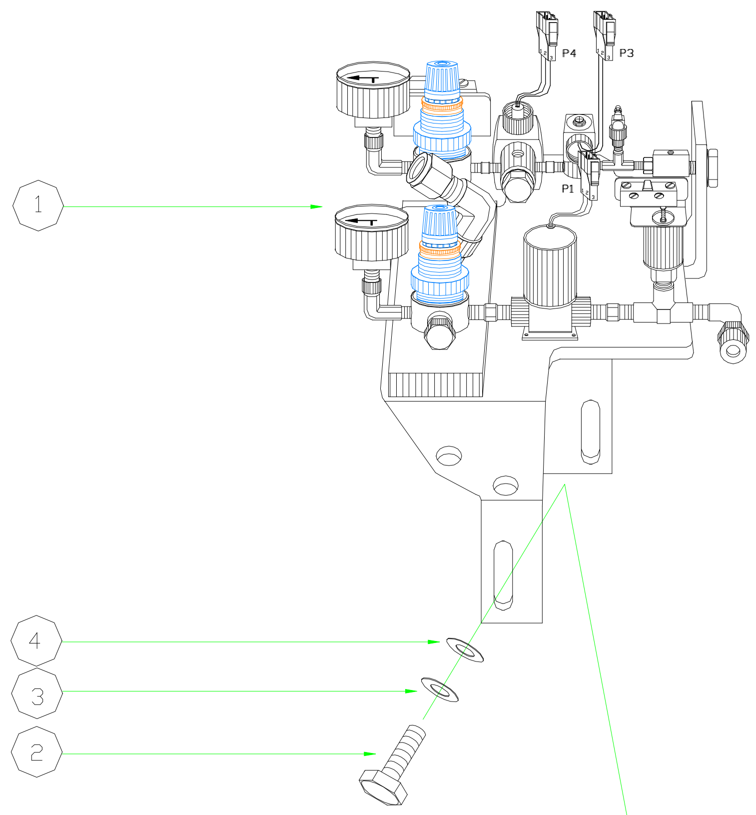
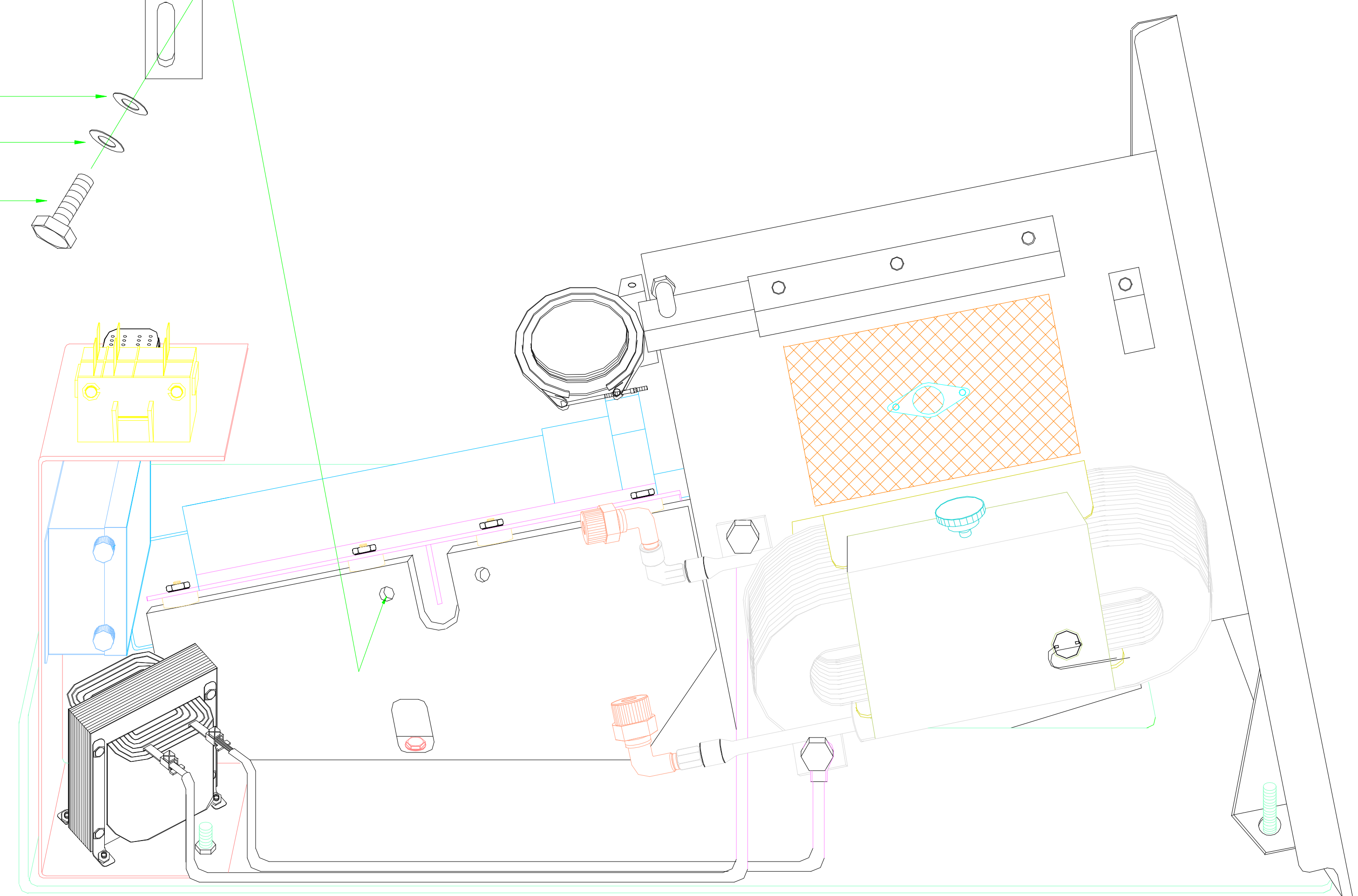
TOP VALVE ASSEMBLY and INSTRUCTIONS
1600-55 A/M

TOP VALVES ASSEMBLY INSTRUCTIONS:

1- ATTACH THE TOP VALVES SET (1) ONTO THE TOP OF MOTOR SUPPORT BASE. USING 3-1/4X20X1/2 HEX SCREWS (2), 3-1/4X20 SPLIT WASHERS (3), AND 3-1/4X20 FLAT WASHERS (4), MOUNT THROUGH THE VALVE BRACKET TO THE MOTOR SUPPORT BASE. 1-HEX SCREW SET FOR LEFT SIDE, AND 2-HEX SCREWS SET FOR RIGHT SIDE OF MOTOR SUPPORT BASE.
(LOOK FROM FRONT OF THE MACHINE. SEE DRAWING FOR MORE RELATION POSITIONS).

ITEM	PART #	DESCRIPTIONS	QTY
1	1067668	TOP VALVES SET	1 SET
2	1/4X20X1/2	HEX SCREW	3
3	1/4X20	SPLIT WASHER	3
4	1/4X20	FLAT SCREW	3





LEFT BOWL VIEW

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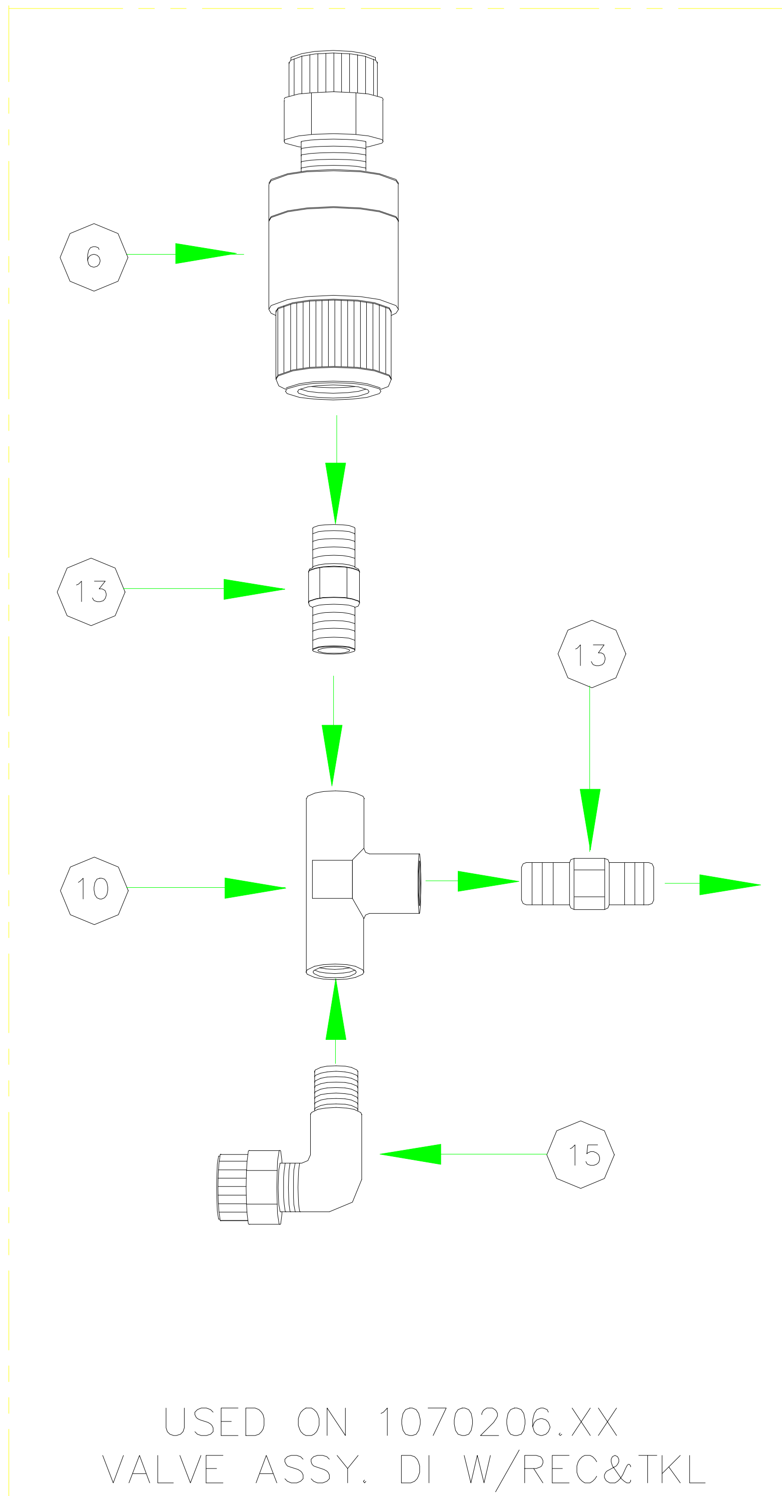
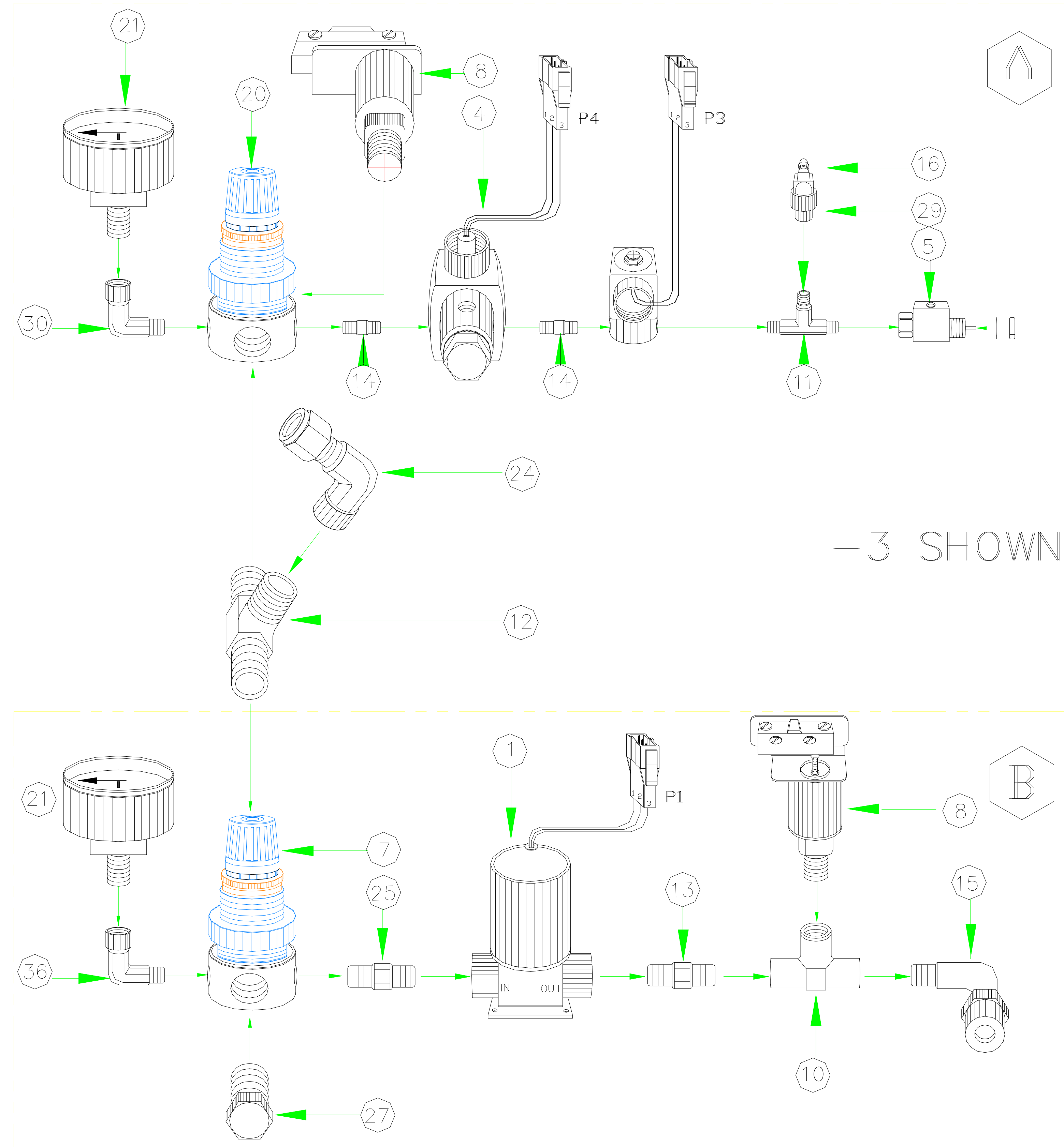
VALVE BRACKET ASSEMBLY and INSTRUCTIONS 1
1600-55 A/M





VALVE BRACKET ASSEMBLY and INSTRUCTIONS 2
1600-55 A/M

VALVE BRACKET ASSEMBLY INSTRUCTIONS:

NOTE: ALL PARTS HAS TO APPLY TEFLON TAPE.

BLOCK A ASSEMBLY:
1- ATTACH TEE (11) TO THE VALVE, BLADE (5).
2- ATTACH BUSHING (29) TO THE TEE (11).
3- ATTACH FITTING (16) TO THE BUSHING (29).
4- ATTACH SOLONOIL VALVE (3) TO THE TEE (11).
5- ATTACH NIPPLE (14) TO THE SOLONOIL VALVE (3).
6- ATTACH VALVE (4) TO THE NIPPLE (14).
7- ATTACH NIPPLE (14) TO THE VALVE (4).
8- ATTACH REGULATOR (20) TO THE NIPPLE (14).
9- ATTACH ELBOW (30) TO THE REGULATOR (20).
10- ATTACH GAUGE (21) TO THE ELBOW (30).
11- ATTACH PRESSURE SWITCH(8) TO THE REGULATOR(20).

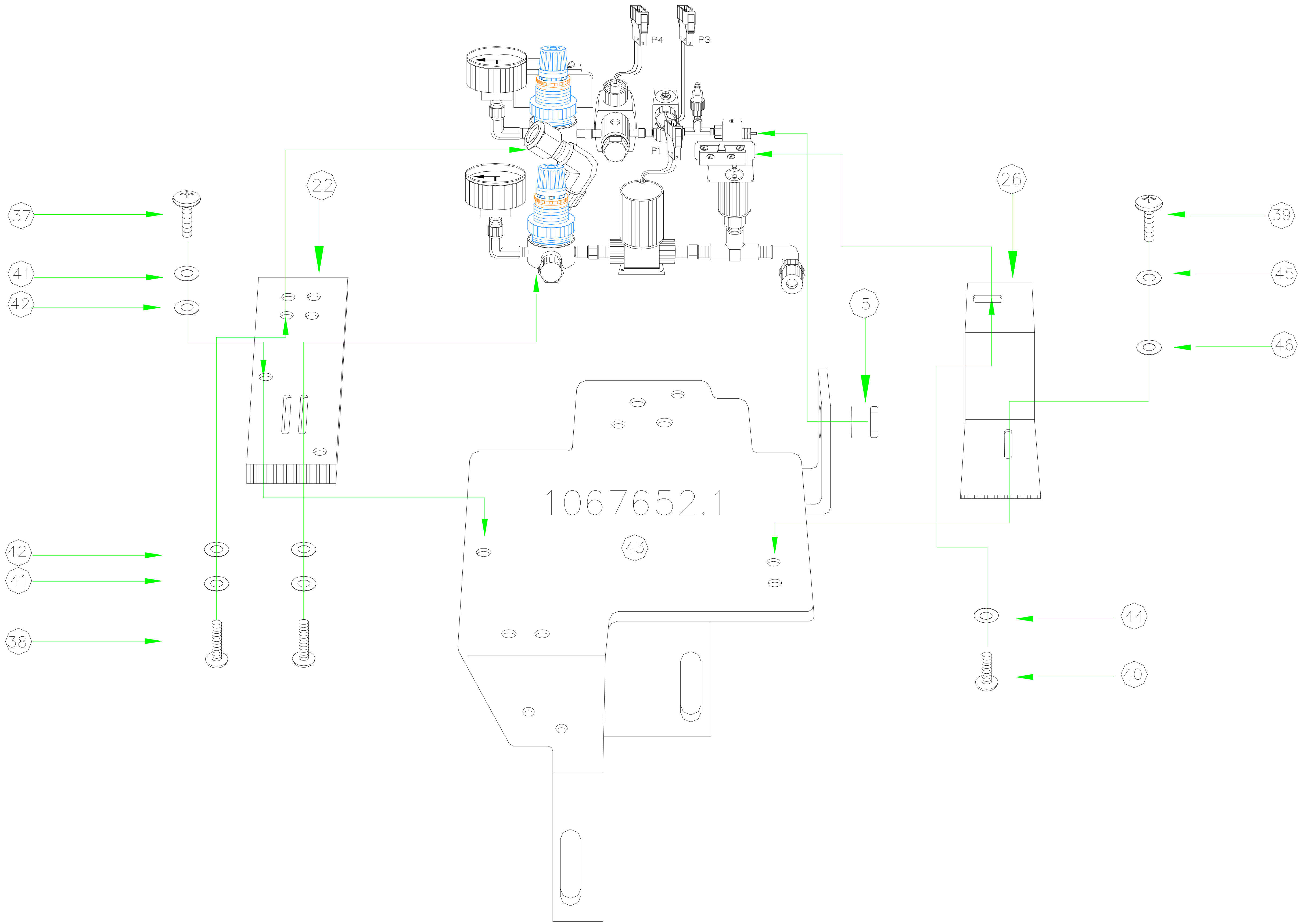
BLOCK B ASSEMBLY:
1- ATTACH PRESSURE SWITCH (8) TO THE TEE (10).
2- ATTACH ELBOWL (15) TO THE END OF TEE (10).
3- ATTACH NIPPLE (13) TO THE TEE (10).
4- ATTACH DELTA VALVE (1) TO THE NIPPLE (13).
5- ATTACH NIPPLE (25) TO THE DELTA VALVE (1).
6- ATTACH PLUG (27) TO THE REGULATOR (7).
7- ATTACH REGULATOR (7) TO THE NIPPLE (25).
8- ATTACH ELBOWL (36) TO THE REGULATOR (36).
9- ATTACH GAUGE (7) TO THE ELBOW (36).

BLOCK (A) & (B) ASSEMBLY:
1- ATTACH ELBOW (24) TO THE TEE (12).
2- ATTACH TEE (12) TO THE REGULATOR (7) OF BLOCK B.
3- ATTACH BLOCK A TO THE END OF TEE (12).

ITEM	PART #	DESCRIPTIONS	QTY
1	1070207.1	DELTA VALVE	1
3	1070208.1	VALVE SOLONOIL	1
4	1071972.501	VALVE, BLADDER ASSY.	1
5	4115679	VALVE BLADDER RELIEF	1
6	4119147	VALVE CK. LOW PRESS. MCV-9012X.5	1
7	1055411.3	REGULATOR	1
8	4114327	PREESURE SWITCH	2
10	4119234	TEE, 1/4 NPT MOLD. PIPE MPF4T	2
11	4117134	TEE	1
12	4115685	TEE MALE 1/4	1
13	4119233	NIPPLES, 1/4" NPT	3
14	4115682	NIPPLE, 1/8 CLOSE	2
15	4118953	ELBOW, 3/8X1/4NPT	2
16	4119123	FITTING, IMP44EAF	1
20	1055411.1	REGULATOR	1
21	4116212	GAUGE	2
24	4117137	ELBOW, FEMALE	1
25	4117135	NIPPLE, HEX	1
27	4117768	PLUG, PIPE 1/4 NPT	1
29	4119301	BUSHING, REDUCER	1
30	4117132	ELBOW, STREET	1
36	4117796	ELBOW, ST1/4X1/8FNPT	1

P1	P3	P4
1=RED 2=WHITE 3=GREEN	1=BLACK 2=BLACK 3=NONE	1=RED 2=RED 3=GREEN/YELLOW

VALVE BRACKET ASSEMBLY and INSTRUCTIONS 3
1600-55 A/M



VALVE BRACKET ASSEMBLY and INSTRUCTIONS 4
1600-55 A/M

VALVE BRACKET ASSEMBLY INSTRUCTIONS:

1- ATTACH REGULATOR PAD (22) TO UNDERNEATH OF 2-REGULATORS(20) BLOCK A & (7) BLOCK B. USING 4-8X32X3/8 ROUND HEAD SCREWS (38), 4-8X32 STAR WASHERS (41), AND 4-8X32 FLAT WASHERS (42).
2- ATTACH PRESSURE BRACKET (26) TO THE PRESSURE SWITCH (8) OF BLOCK (B) ASSEMBLY. USING 1-10X32X1/4 ROUND HEAD SCREW (40), AND 1-10X32 STAR WASHER (44).
3- UNSCREW HEX NUT AND STAR WASHER FROM THE VALVE (5) OF BLOCK ASSEMBLY (A).
4- PUT VALES ASSEMBLY ONTO TOP OF THE MOUNTING BRACKET (43), MAKE SURE THE HEAD OF VALVE (5) (BLOCK ASSEMBLY A) GET THROUGH THE HOLE OF MOUNTING BRACKET STAND OFF (43).
5- ADJUST THE PRESSURE BRACKET (26) TO GET THROUGH THE HOLE OF MOUNTING BRACKET (43). USING 1-6X32X3/8 ROUND HEAD SCREW (39), 1-6X32 STAR WASHER (45), AND 1-6X32 FLAT WASHER (46).
6- SCREW BACK THE HEX NUT AND STAR WASHER INTO THE VALVE(5) OF BLOCK ASSY.(A).THEN TIGHTEN IT BY BOTH SCREWS(39)&(40).
7- USING 2-8X32X3/4 ROUND HEAD SCREWS(37), 2-8X32 STAR WASHERS(41), AND 2-8X32 FLAT WASHERS(42) MOUNT FROM THE TOP OF REGULATOR PAD (22) THROUGH THE MOUNTING BRACKET (43).

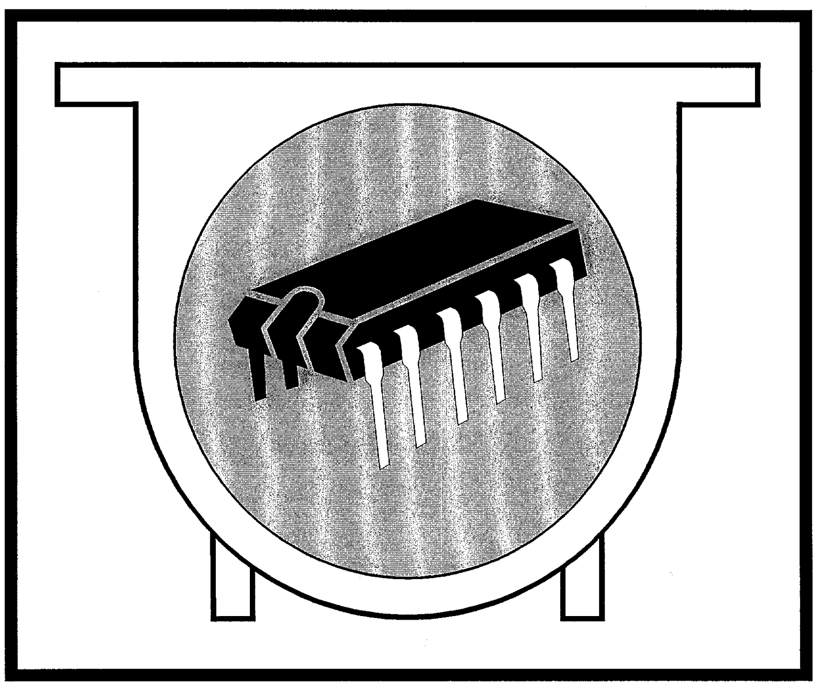
ITEM	PART #	DESCRIPTIONS	QTY
22	1063343.1	REGULATOR PAD	1
26	1067287.1	PRESSURE SWITCH BRACKET	1
37	8X32X3/4	ROUND HEAD SCREW	2
38	8X32X3/8	ROUND HEAD SCREW	4
39	6X32X3/8	ROUND HEAD SCREW	1
40	10X32X1/4	ROUND HEAD SCREW	1
41	8X32	STAR WASHER	6
42	8X32	FLAT WASHER	6
43	1067652.1	VALVES MOUNTING BRACKET	1
44	10X32	STAR WASHER	1
45	6X32	STAR WASHER	2
46	6X32	FLAT WASHER	2

SRD 1600-55M

SUPPLEMENT

CONVERSION TO
SRD 1600-55A

RETROFIT PROCEDURES



901002

RETROFIT OVERVIEW

The following list outlines the procedures to be followed when converting a SRD 1600-55M to a SRD 1600-55A:

Remove and Replacement the Front Cover Panel in order to accommodate the door actuator cylinder assembly, linkage, and bracket.

Remove and Re-use of the 3-pushbutton assembly.

Remove and Replace the existing Indexing Unit Assembly.

Remove the existing (-55M) manifold assembly.

Assemble a new Auto-Positioner assembly on the rear of motor housing.

Remove and Replace the Hinge Assembly.

Install a footswitch and its connection to the controller.

Install an additional door *OPEN* sensor.

DETAILED PROCEDURES

DISASSEMBLY/REMOVAL OF FRONT PANEL

- ☐ REMOVE top cover by extracting the thumbscrews and rear panel screws.
- ☐ REMOVE front door blue ring panel and set aside.
- ☐ DISCONNECT door bladder supply line at the coupling.
- ☐ REMOVE three screws that secure the door to the hinge.
- ☐ REMOVE the door and set aside.
- ☐ REMOVE the hinge by extracting the two remaining hex-head bolts located inside the unit at the rear of the front panel.

☐ REMOVE all screws that secure the front panel to its foundation bracket.

☐ REMOVE the 3-pushbutton assembly hold-down rings by unscrewing them counter-clockwise.

☐ REMOVE front panel cover.

NOTE
RTV is used to assist in securing the front panel. Observe placement of RTV in order to duplicate during re-assembly.

DISASSEMBLY; AUTO-POSITIONER AND MANIFOLD

☐ DISCONNECT all facility lines from inside coupling at the rear of the centrifuge unit.

☐ RE-POSITION the rear panel by flipping it over from top-to-bottom allowing it to rest on top of the valve bracket assembly area.

☐ DISCONNECT the (red) hi-voltage cable from the static eliminator transformer.

CAUTION
Exercise care in removing and disassembling the cable. Observe all hardware removed in order to facilitate correct re-assembly.

☐ DISCONNECT the two leads from pressure switch (PSW3) located on the manifold assembly at the right rear of the unit.

NOTE
The referenced manifold assembly incorporates RG3 (regulator) and V105 (solenoid valve).

☐ DISCONNECT the solenoid valve by following the cable back to its connector (P5) and unplug it.

☐ REMOVE the manifold assembly by removing the mounting screws attaching it to the base of the centrifuge unit.

PLEASE REFER TO DRAWING **1065746**
ASSY, AUTO-POSITIONER

☐ At the auto-positioner assembly, LOOSEN the set-screw securing the encoder (sprocket wheel) to the motor shaft.

☐ DISCONNECT the cable connector (J20) from the optical sensor board.

☐ DETACH the auto-positioner unit by removing the hardware used securing it to the unit at the rear of the motor.

NOTE

Auto-positioner detachment involves removal of the unit and its encoder wheel simultaneously.

ASSEMBLY

The following assembly procedure presumes that all preliminary disassembly and removal procedures have been followed as described previously. A majority of the assembly procedures are simply the reversal of the previous disassembly procedures.

DOOR HINGE

- ☐ INSTALL the replacement (new) door hinge.
- ☐ REPLACE the original pushbutton restaining rings.
- ☐ RE-INSTALL the door.
- ☐ RECONNECT the bladder.
- ☐ INSTALL the linkage, bimba cylinder, and bracket assembly (door air cylinder assembly).

PLEASE REFER TO DRAWING **1075418**
SHEET 1 OF 2

  - ☐ REMOVE the pin through the clevis and retain.
  - ☐ MOUNT the linkage to door.
  - ☐ MOUNT the air cylinder assembly to the bowl.
  - ☐ RE-INSTALL the pin in the clevis.

- ☐ CONNECT the electrical cable leading form the proximity reed switch utilizing the "Y" (door cylinder cable) PART NUMBER 1076030.1 provided in the kit for the "C" or "common." The J16 connector will mate with P16.
- ☐ REMOUNT the blue ring panel on the door.

AUTO-POSITIONER

☐ **INSTALL** the new auto-positioner assembly.

> **NOTE**
>
> The auto-positioner assembly is fabricated using the parts provided in the kit. It must be mounted to the back of the motor in stages in order to complete the assembly.

☐ Assemble the auto-positioner to the rear of the motor housing as follows:

> PLEASE REFER TO DRAWING **1075418**
> SHEET 2 OF 2

Utilizing the above referenced engineering drawing, observe the auto-positioner assembly. The pictorial balloon numbers depict the parts listed on the "parts list" provided in this supplement.

☐ **MOUNT** bracket (1)

☐ **MOUNT** wheel and key (5) with (23) to motor shaft, and tighten the set-screw.

☐ **MOUNT** the encoder (sprocket) disk to the wheel while simultaneously installing the optical sensor board to the bracket.

☐ **MOUNT** the cam with the shoulder screws, flat washers, and lock-washers provided.

> **NOTE**
>
> These screws are used in conjunction with the elongated holes in the cam providing accurate adjustment for 12 o'clock positioning during the *INDEX* condition.

☐ MOUNT the indexing air (BIMBA) cylinder (8).

MANIFOLD

☐ MOUNT the replacement (new) solenoid valve assembly (15).

☐ CONNECT electrical cables to connectors.

- ☐ P105 to J105
- ☐ P106 to J106
- ☐ P107 to J107

☐ CONNECT together the two wires previously disconnected from PSW3 using the (red) butt-type connector supplied.

☐ PLUMB-in all tubing as shown in the pictorial.

- ☐ V105, index cylinder
- ☐ V107
- ☐ V106
- ☐ Manifold Assembly

PLEASE REFER TO DRAWING **1075418**
SHEET 1 OF 2

☐ ADJUST "OPEN" sensor.

☐ ADJUST Flow Control Valves (Door open and close needle valves)

☐ ADJUST "INDEX" for 12 o'clock

FINAL RE-ASSEMBLY

☐ RE-ASSEMBLE

- ☐ Rear Panel
- ☐ Facilitize the unit and check for leaks.

PARTS LIST [page 1]

1600-55M to -55A CONVERSION KIT

PART #	DESCRIPTION	QUANTITY
1067644.3	Bracket, mtg autopositioner	(1)
1067647.3	Cam, autopositioner	(1)
1067811.1	PCB Assy., optical sensor	(1)
1067631.3	Shaft, flange	(1)
1067633.1	Wheel, shaft 1600-5	
1067642.1	Disk, photocell 1600-5	(1)
1075936.1	BIMBA cylinder, auto-positioner	(1)
	Screw, #8-32 x 1" Flathead Phillips	(4)
	Tape, Teflon (A/R)	(1)
	Lockwasher #1/4 SS	(2)
	Flatwasher, #1/4 SS	(2)
5115268	Tubing, 82 in. of 1/4" OD teflon	(#)
	Nut, 8-32 HEX SS	(2)
1067668.505	Bracket, valve assy-air	(1)

PARTS LIST [page 2]

1600-55M to -55A CONVERSION KIT

PART #	DESCRIPTION	QUANTITY
1071667.1	Panel, Front 55A RH w/gasket	(1)
	Flatwasher, #8 SS	(2)
1067664.1	Hinge, Assy, RH	(1)
1067665.5	Door Cylinder Assy	(1)
1071936.1	Linkassy, door pivot 1600-5A RH	(1)
4117776	Scr, sld 1/4d x 1/2, 10-24 x 3/8 hex soc. hd stl 5475 Fastener West	(2)
1072843.120	Switch A, foot, NSRD 10' Cabinet	(1)
	Screw, set #8-32 x 3/8	(2)
1076030.1	Cable Assembly	(1)
	Butt Splice	(1)

ENGINEERING DRAWING LIST

DRAWING NO.	DESCRIPTION
1065746 (2)	ASSY, AUTO-POSITIONER
1075418 (2)	KIT, 55M-55A CONVERSION RETROFIT

(#) - number of sheets to drawing

A

A See ampere.

Å See Ångstrom unit.

accident An unplanned, unwanted event that disrupts the orderly flow of the work process, involves the motion (energy) of people, objects, or substances, and is indicated by physical injury, illness, and/or property damage. Both a hazard and exposure to the hazard are required for an accident to occur.

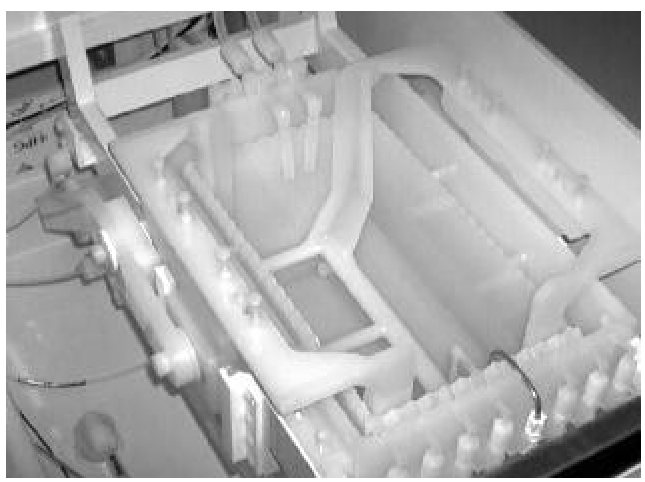
accident investigation Inquiry to determine the root cause of an accident to prevent future similar accidents.

acetic acid $C_2H_4O_2$.

ACK Acknowledge. A touchscreen prompt.

agitation (EE wash tank) The introduction of N_2 into the end effector wash tank. This stream of gas keeps the DI water moving and free of stagnation. Parameters for this function are set in tank configuration.

agitation (mechanical) A platform inside the chemical process tank that moves cassettes up and down at a factory preset frequency of 30 cycles per minute and an amplitude of 1.1 inches (see figure below). This device is adjustable in both frequency and amplitude. The frequency is driven by city water and is adjusted using AOVs. The amplitude can be adjusted to one of three settings; 0.8 inches, 1.1 inches and 1.5 inches. For adjustment procedures see the Preventive Maintenance manual, Part III, Section 2.7, *Mechanical Agitation Adjustment*.



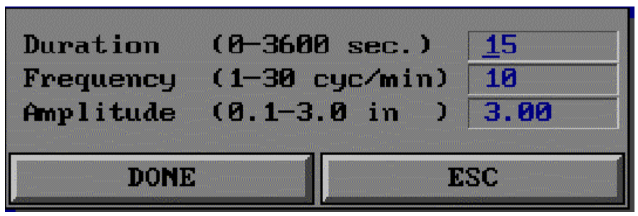
agitation (robot) Agitation is the “dipping” of product lots into and out of a tank. This function is used in semi-automated systems in which the robot holds the process cassette during the entire process recipe. Agitation parameters are configurable on the touchscreen, as described below.

Longer, slower movement of agitation is accomplished by configuring a relatively low frequency and high amplitude. See explanation below.

To edit robot agitation parameters, make the following touchscreen selections:

1. Select **Recipe** from the Process menu button.
2. Select **Edit**.
3. Select a recipe from the displayed list.
4. Select **Edit Parameters**.
5. Select the tank that is to be edited for robot agitation.
6. Select **Robot Agitation**.
7. Enter values as defined below.

Duration is the length of agitation time, which begins as soon as the robot delivers product into a tank. If the entered Duration is greater than the recipe's process time in that tank (set in recipe configuration), the system defaults to 3600 seconds or the process time, whichever is smaller. If agitation is not needed, set Duration to zero (0).



Agitation Parameters

Frequency is the number of agitation cycles per minute. In one cycle, the robot moves up from the taught tank position, to the Amplitude height, then back into the tank. If the value entered is greater than 60, the value defaults to 60.

Amplitude is the height the robot rises during agitation from the taught tank position. The amplitude cannot exceed the taught carry height, regardless of the value entered here.

NOTE
• The value entered for Amplitude places limits on Frequency. • Maximum amplitude is 20 inches *or* the distance between the taught carry height and the taught tank position, whichever is less. • The ranges for Frequency and Amplitude vary for wet systems, but not from module to module within one wet system.

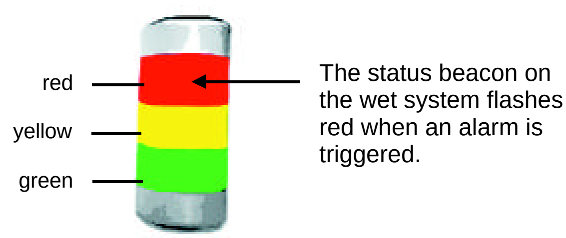
Maximum Configuration Values and Amplitude's Effect on Frequency, Acceleration, and Velocity			
Amplitude (inch)	**Maximum Resulting Frequency (cycles/min)**	**Maximum Acceleration (in/sec/sec)**	**Maximum Velocity (in/sec)**
1	60	16	4
2	58	30	8
3	47	30	12
4	41	30	14
5	21	10 in/sec/sec above 4-inch amplitude	8 in/sec above 4-inch amplitude
6	19		
7	18		
8	17		
9	16		
10 . . 20	15 . . 11		

Al_2O_3

Aluminum oxide.

alarm

An alarm is any abnormal situation that may endanger people, equipment, or material being processed. Every alarm is assigned one automatic response level (see table below) and displayed in real time on the touchscreen.



Status Beacon

Also see critical alarms, exhaust alarms, and status beacon.

Alarm Response Levels		
Key	**Response Level***	**Automatic Actions**
0	No Action	• No effect on recipes in progress • New lots are allowed • Audible and visual alarms • Condition is displayed on the touchscreen and written to log file • Scheduler is *not* notified
1	Runout	• No effect on recipes in progress • New lots are *not* allowed • Audible and visual alarms • Alarm message is displayed on the touchscreen and written to log file
2	GoToSafe	• Lot is moved into or kept in a safe tank until problem is fixed • New lots are *not* allowed until alarm is cleared • Audible and visual alarms • Alarm message is displayed on touchscreen and written to log file
3	System Stop	• Automatic processing stops • Recipes in progress continue to count down and can be resumed • New lots are not allowed • Audible and visual alarms • Alarm message is displayed on the touchscreen and written to log file
4	Process Continues	• No effect on recipes in progress • New lots are allowed • Audible and visual alarms • Alarm message is displayed on the touchscreen and written to log file • Scheduler is notified
*Every alarm is assigned one response level.		

allocated A device (for example, a tank) is powered, functional, and designated for use in a processing recipe.

alloy Composition of two elements, one of which must be metal.

aluminum oxide Al_2O_3.

ambient Surrounding, as in *ambient air* or ambient temperature.

ambient temperature See temperature of process chemicals.

ammonia NH_3.

ammonium chloride NH_4Cl.

ammonium fluoride NH_4F.

ammonium hydroxide NH_4OH.

ammonium peroxide mixture (APM)
See chemical processes.

ammonium persulfate
$NH_4S_2O_2$.

amp
See ampere.

ampere (A or amp)
A unit of electric current.

amplifier
An electronic circuit used to increase voltage, current, or power.

Ångstrom (Å) unit
1 Å = 1×10^{-4} µm or 1×10^{-10} m.

ANSI
American National Standards Institute.

antiresonance frequency
Other terms used: *resonant frequency*, *antiresonant frequency*, *parallel resonance*.

The condition for which the impedance of a given electric, acoustic, or dynamic system is very high, approaching infinity. This frequency is the one that allows GFT's Megasonic systems to have the lowest reflected power. This frequency would therefore be the one that provides the best impedance matching between the amplifier and transducer.

The frequency at which the parallel impedance of a parallel resonant circuit has a power factor of unity.

AOV
Air-operated valve.

A/P
Accounts payable.

APM
Ammonium peroxide mixture. See chemical processes.

AQR
Aqua regia. See chemical processes.

aqua regia
See chemical processes.

Ar
See argon.

AR
Assigned responsibility.

A/R
Accounts receivable.

argon (Ar)
One of the noble (extremely nonreactive) gases.

ASCII
American Standards Code for Information Interchange. A 7-bit standard code.

Aspirated drain (aspirator)
Device in a tank drain line that mixes water, at a predefined ratio, with liquid draining from the tank. Used for cooling and diluting, aspirator typically has no moving parts. See recirculation, draining, and automated drain interlocks for heated tanks.

assist

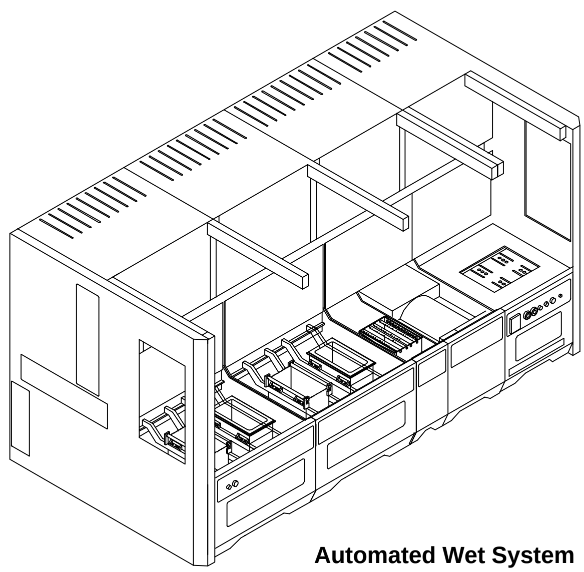
Any unplanned interruption or variance from specifications of equipment operation that requires human intervention of less than 6 minutes to correct. After 6 minutes, an assist becomes a *failure*. [From SEMATECH Official Dictionary, Rev. 5.0, 1995]

automated wet system (AWS)

Automated wet systems have the following features and capabilities:

- The operator enters and removes product lots.
- A one-arm, two-axis or a two-arm, three-axis robot transfers cassettes from one tank to another.
- The control software schedules cassette transfers, cleans the robot end effector when possible, and ensures that a safe (DI water) tank is always available for every product lot.
- Tanks are arranged from one end of the wet system to the other (and *end-to-end* arrangement).
- The wet system has a *dry in-dry out* capability (the robot removes the cassette from the dryer as the final processing step).
- Multiple product lots can be concurrently processed (lot threading). This feature is unique to automated wet systems. The robot retrieves cassettes from an input position and releases them during their dwell time in process tanks, leaving the robot free to retrieve and transfer other product lots.

Also see wet system; semi-automated wet system; manual wet system.



Automated Wet System

autopositioner (SRD)

A mechanical cylinder (air/N_2) that automatically positions the rotor at the end of every cycle so the carrier stops in the upright position, ensuring the wafers cannot fall out during removal

autowash (SRD)

Rinse/dry recipe, programmed to occur automatically after elapsed time intervals and/or number of completed operational cycles. Designed to maintain cleanliness in the SRD.

AWS

See automated wet system.

AWSF

Automated wet system, front access.

AWSR

Automated wet system, rear access.

axis

See robot axes.

B

bath See chemical bath, also see tank.

battery-backed random-access memory (RAM) RAM that is powered by a long-life battery so that it retains information if the unit it is in loses power.

baud A unit for measuring data transmission speed. Divide the baud rate by the number of data bits plus stop bits plus start bits to calculate the characters per second (cps); for example, 9600 baud rate typically equals approximately 960 cps.

bay A section of the cleanroom dedicated to specific pieces of equipment or processes.

Also see cleanroom, bay-and-chase.

BCD Bulk chemical distribution. See chemical delivery system (preferred term).

BCF See bead- and crevice-free.

beacon See status beacon.

bead- and crevice-free (BCF) Refers to plastic welding.

bench See wet system (preferred term).

beta site testing Testing of new equipment (usually at the customer's site).

BHF See buffered hydrofluoric acid.

binary Pertaining to a system that exists in two conditions, such as OFF/ON. Usually represented in computer code by 0 and 1.

binary files Computer files generated in machine language that can be directly executed by the computer.

bit *Abbreviation for* binary digit. The smallest unit of information recognized by a computer; represented as either of the digits 0 or 1.

bit map Individual bits, because of their position in a byte, represent specific information.

bladder (SRD) Seal inflated with nitrogen to keep the front door closed and contaminants out.

blanket heater See temperature controls

block A group of digits, characters, or words that are held in one section of an input/output medium and handled as a unit. *Block Length*: is a measure of the size of a block.

blocks

A VcS recipe management term. Blocks are assigned a number (1 through 6) and are then assigned to a recipe STEP. There is flexibility in which Block number is assigned to which STEP (e.g., Block number 4 can be assigned to be the first Step (1) in the recipe.

Also see Steps and Periods

BNC connector

Bayonet-Neill-Concelman backplate connector used with Thin Ethernet or ThinNet type coaxial cable to connect audio and video devices as well as network components.

boat

See cassette (preferred term).

BOE

Buffered oxide etch. See chemical process.

bowl (SRD)

Process chamber for rinse and dry procedures.

bps

Bits per second.

Bridgman Technique

Method of growing an ingot of silicon by pulling a seed rod from the bottom of a crucible of liquid.

bubbler

See N_2 bubbler.

buffered hydrofluoric acid (BHF)

Hydrofluoric acid and some buffering chemical, typically ammonium fluoride (NH_4F).

buffered oxide etch (BOE)

See chemical process.

bug

A term used to denote an oversight or conflict in a computer program or system.

bulk chemical distribution (BCD)

See chemical delivery system (preferred term).

bulk fill

Chemical is brought directly into the wet-system tank through a facility plumbing line.

Also see manual fill.

bulkhead

The wall (in the cleanroom) that separates the process area from the service chase.

Also see cleanroom, bay-and-chase.

bulkhead mounting

See wet-system mounting.

byte

A group of eight bits. Two bytes equal a word.

C

°C See degrees Celsius.

CH_3COOH Acetic acid.

calibration A set of graduations marked to indicate known values. Alignment of electrical or mechanical equipment against a known standard.

carbon dioxide See CO_2.

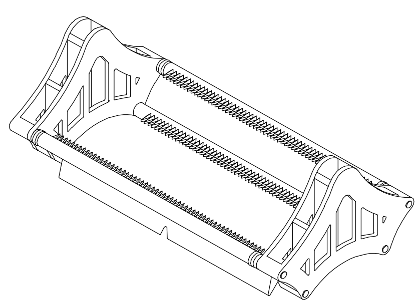
carrier See cassette (preferred term).

cascade rinse See chemical process.

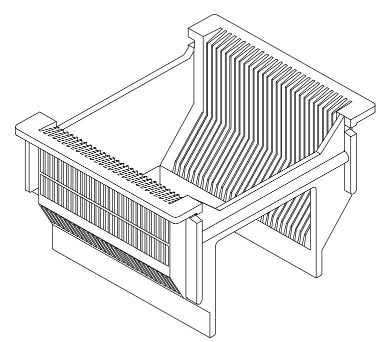
cassette Also known as boat; carrier. Also see H-bar.

The basket, or carrier, that holds the product to be processed (typically wafers). Process cassettes, usually made of PFA, hold wafers during processing. Transport cassettes look like process cassettes, but are usually made of PEEK or polypropylene. Transport cassettes are used to transport wafers from one device or wet system to another but are not used for processing. Some systems use the same cassette for both transport and process.

Cassettes commonly used in GFT wet systems are shown below.

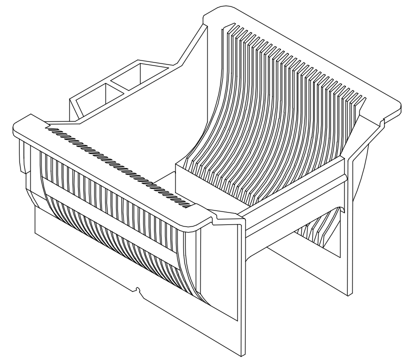


6-inch (150-mm) and 8-inch (200-mm)
PEC (process enhanced cassette)



6-inch (150-mm) and 8-inch (200-mm)
low-profile cassette

4-inch (100-mm),
5-inch (125-mm), and
6-inch (150-mm)
standard cassette



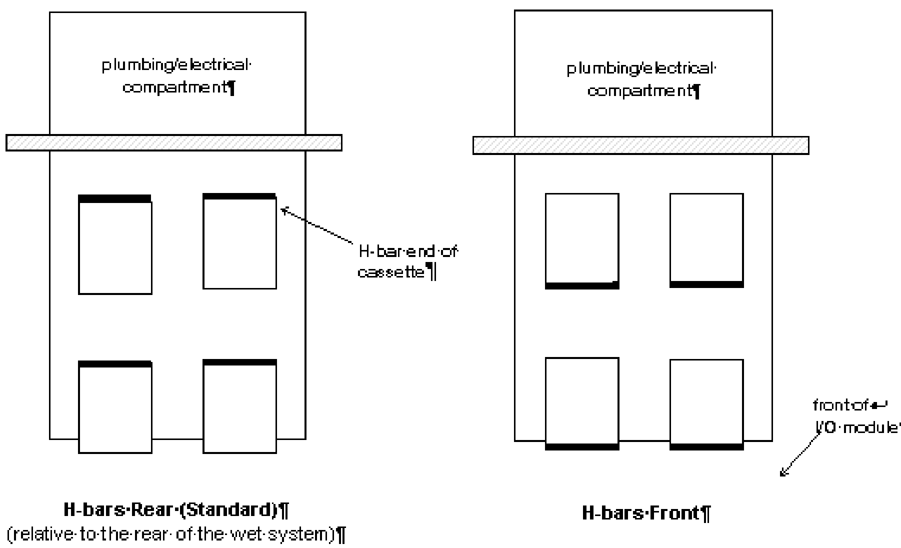
8-inch (200-mm) standard cassette

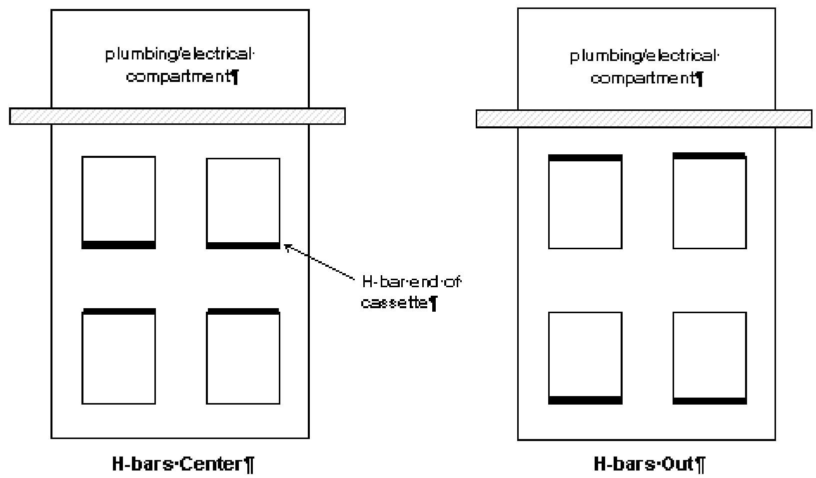
cassette placement

Placement of cassettes in the input/output queue of the wet system is extremely important. Improper placement can result in severe wafer damage. The following drawing shows proper placement of cassettes in the input queue of automated and semi-automated wet systems.

Input/Output Queue—Cassette Placement

A. Automated Wet Systems:



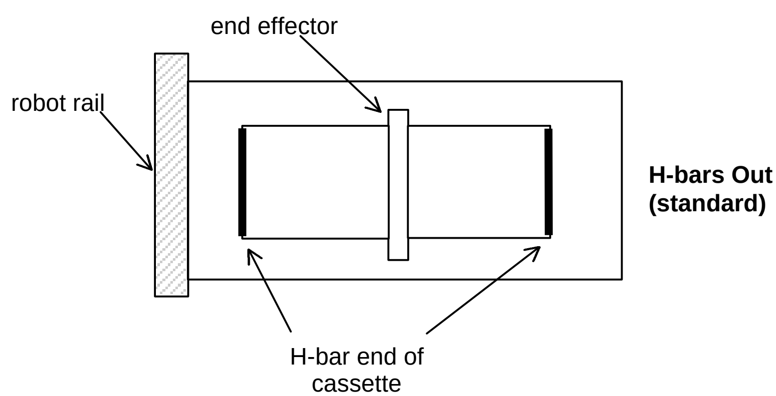


Convention:

1. If input and output queues are both in module 1:
   column of queues closest to module 2 is INPUT
2. If input and output queues are at opposite ends of the wet system:
   INPUT is in module 1
   OUTPUT is in last module (module n+1)

B. Semi-automated Wet Systems:

Semi-automated wet systems have dual cassettes for balance. The H-bars face away from each other with the end effector in the middle.



NOTE: Process enhanced cassettes (PEC) are symmetrical, so orientation is not an issue.

cassette, process

See cassette.

cassette, transport
See cassette.

CB
Circuit breaker.

ccm
Cubic Centimeters per Minute (cfm / 28320 = ccm).

See cfm.

CDA
Clean dry air.

CDS
See chemical distribution system.

CE
Commission of European Communities.

cell controller
Computer that houses a CPU and the control system software. The cell controller communicates with the PLC which controls system devices.

Also see wet-system control system.

Celsius
See degrees Celsius.

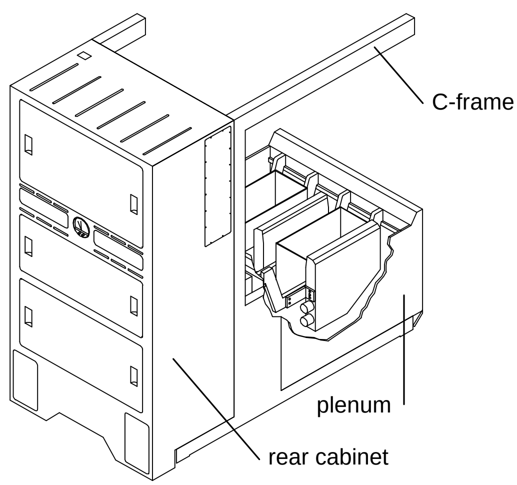
centigrade
See degrees Celsius (preferred term).

cfm
Cubic feet per minute (unit of volumetric flow rate).

See ccm

CFR
Code of Federal Regulations.

C-frame
Located between the rear cabinet and plenum (see drawing). Constructed of powder-coated steel covered with fire-retardant polypropylene (FRPP) or, white polypropylene (WPP), or other plastics.



Module

$CH_3CHOHCH_3$ Isopropyl alcohol (IPA). Also known as 2-Propanol.

CH_3COOH Acetic acid.

character Any symbol, digit, letter, or punctuation mark stored or processed by computing equipment, requiring approximately eight bits.

chase See service chase (preferred term).

checksum A summation of digits or bits used for checking purposes.

chemical The chemical used in wet processing; may be either a rinse chemical or a process chemical.

chemical bath (noun) A washing or soaking of the product in a chemical tank containing a process chemical.

chemical distribution system (CDS) The chemical distribution system (CDS) supplies chemicals to the wet system's processing modules. It is installed in the cleanroom or in the subfab below the wet system. A CDS comprises up to eight individual modules, each of which houses a chemical drum (up to 55-gallons). An air-operated pump dispenses chemical from the drum, through dedicated plumbing lines, to one or two wet system tanks.

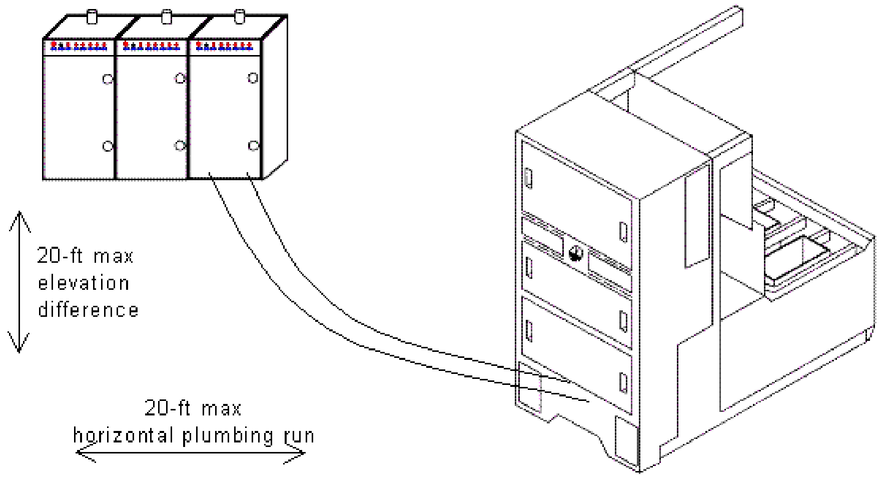
Each module is a stand-alone unit. If one module is shut down for refilling, maintenance, or is experiencing an alarm, the other modules remain functional. For safety, a single electrical disconnect and an EMO (emergency off) pushbutton, located on a main control cabinet, can shut down all modules in the CDS.

The CDS dispenses chemical only when the wet system calls for it during automated operation. There are no manual controls on the CDS for dispensing chemical to the wet system.

When the control system receives the proper signals, chemical is pumped from the specified chemical cabinet to the requesting module's processing or staging tank. When the chemical reaches the tank's process-level sensor, the pump and valves in the chemical cabinet shut down or off.

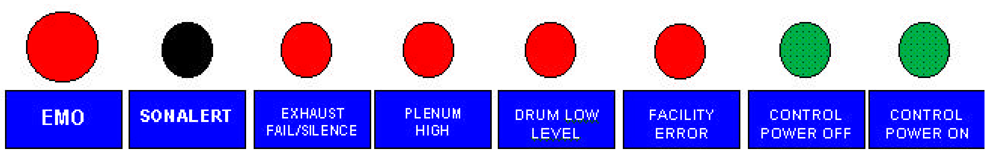
If the wet system simultaneously requests chemical for two tanks, the CDS dispenses chemical on a “first come, first serve” basis.

Also see *Chemical Distribution System* (Part No. 9340032.x).



Each CDS module dispenses only one chemical, but can supply two wet system tanks. Each CDS module has a control panel, with the following indications and controls.

CDS Control Panel



EMO (EMERGENCY POWER OFF)	Cuts all operating power (24 VDC) to the CDS module. Pumps, valves, communication with the wet system, and alarm functions all shut down. The EMERGENCY POWER OFF on the rear of the module also shuts down.
SONALERT	Sounds during an Exhaust Fail alarm.
EXHAUST FAIL/ SILENCE Alarm	• Silences the Sonalert. Does not correct the alarm. • Exhaust fail causes an emergency shutdown (EMO) of the affected module. This occurs after a configurable time delay, which allows transient losses of exhaust flow to recover without shutting down the CDS module.
PLENUM HIGH Alarm	Float switch triggers an EMO when liquid is sensed in the plumbing compartment.
DRUM LOW LEVEL Alarm	• Chemical drum needs to be replaced. • Pump stops and dispense valves close in that cabinet to minimize air introduced into the dispense line. • This alarm occurs after a preset time delay (typically 5 seconds). The delay ensures that all chemical has been dispensed from the drum. • Triggered by a differential pressure sensor (see Technical Reference).

FACILITY ERROR Alarm	• Illuminates when either CDA or N_2 supply is lost. CDA is used for the module's pumps and valves; N_2 is used for 1) purging the chemical drum and 2) the drum low-level sensing. • System Ready signal disabled
CONTROL POWER ON	Must be ON (illuminated) for the module to operate. Turns off automatically when any of the following occur: • door is opened • **CONTROL OFF** is pushed • **EMO** is pushed • exhaust alarm
CONTROL POWER OFF	Turns off the module's control power.

chemical fill

Chemicals are delivered to process tanks in the following ways:

- facility bulk fill directly into process tank
- facility bulk fill into staging tank
- chemical distribution system (CDS)
- manual fill into process tank
- manual fill into staging tank or reservoir

Typically, a wet system uses only one chemical-fill approach; however, different modules of the same wet system can use different chemical fills.

chemical mechanical polish (CMP)

A processing step used in multiple-layer semiconductor devices to flatten the tops of layers to provide a uniform base for subsequent layers.

chemical process

A process used to strip, etch, or clean the product.

Also see process; rinse process.

GFT Baseline Chemical Processes

Name of Process*	Abbrevi-ation*	Other Names Commonly Used	Type of Process	Function	Chemical Composi-tion (Chemical Symbols)	Temper-ature Range (°C)
Chemical Processes						
Ammonium peroxide mixture	APM	Standard clean type 1 (SC1), RCA1, Huang 1	Clean	Removes particles and light organics	DI water/hydrogen peroxide/ ammonium hydroxide ($H_2O/H_2O_2/NH_4OH$)	60 to 70
		Ti strip Ti etch	Strip Etch	Removes titanium	DI water/hydrogen peroxide/ ammonium hydroxide ($H_2O/H_2O_2/NH_4OH$)	30 to 60
Aqua regia	AQR		Clean	Removes gold and mercury	Hydrochloric acid/nitric acid (HCl/HNO_3)	90
Buffered oxide etch	BOE	BHF	Strip or etch	Removes silicon dioxide	Ammonium fluoride/ hydrofluoric surfactant ($NH_4F/HF/$surfactant)	18 to 60
Dilute hydrofluoric acid	DHF	Hydrofluoric acid (HF), oxide etch	Etch or clean	Removes silicon dioxide	Hydrofluoric acid/DI water (HF/H_2O)	18 to 60
Hydrochloric peroxide mixture	HPM	Standard clean type 2 (SC2), RCA2, Huang 2	Clean	Removes metal	DI water/hydrogen peroxide/ hydrochloric acid ($H_2O/H_2O_2/HCl$)	60 to 75
Nano strip (manufac-turer's product name)	NAN		Strip or etch	Removes photoresist and organics	Sulfuric acid/ hydrogen peroxide (H_2SO_4/H_2O_2)	20 to 80
Native oxide etch	NOE		Strip or etch	Removes silicon dioxide	Ammonium fluoride/ethylene glycol/DI water/ surfactant ($NH_4F/HOCH_2CH_2OH/H_2O/$surfactant)	20 to 28
Nitride strip	HP (hot phos-phoric acid)	Hot phos, PHOS	Strip or etch	Removes silicon nitride	DI water/ phosphoric acid (H_2O/H_3PO_4)	150 to 180
Phosphoric acetic nitric etch	PAN	Slope etch	Strip or etch	Removes aluminum	Phosphoric acid/ acetic acid/nitric acid ($H_3PO_4/CH_3COOH/HNO_3$)	55
		Al etch	Etch	Removes aluminum	Phosphoric acid/ nitric acid ($H_3PO_4/HNO_3/H_2O$)	30 to 45

(continued)

GFT Baseline Chemical Processes						
Name of Process*	**Abbrevi-ation***	**Other Names Commonly Used**	**Type of Process**	**Function**	**Chemical Composi-tion (Chemical Symbols)**	**Temper-ature Range (°C)**
Chemical Processes *(continued)*						
Shipley Developer MF-501 (manufac-turer's product name)	DEV	Developer	Strip	Removes positive resist	Tetramethyl ammonium hydroxide ($(CH_3)_4NOH$)	18 to 35
Solvent (typically the name of the solvent such as EKC 944, SST-1, PSR-1)	SLV		Strip or etch	Removes photoresist	Varies	Varies
Sulfuric peroxide mixture	SPM	Piranha strip, resist strip	Strip or etch	Removes photoresist and organics	Sulfuric acid/ hydrogen peroxide (H_2SO_4/H_2O_2)	130 to 160
Verteq clean System	VcS		Strip or etch	Removes particles, metals, silicon dioxide, and organics	DI water/ surfactant/ ammonium hydroxide/ hydrogen peroxide hydrochloric acid/ hydrofluoric acid (H_2O/surfactant/ NH_4OH/H_2O_2/ HCl/HF)	18 to 70 (varies depending on process step)
Rinse Processes						
Overflow rinse	OFR	Cascade rinse	Rinse	Removes excess chemical	DI water (H_2O)	Ambient
Quick dump rinse	QDR		Rinse	Removes excess chemical	DI water (H_2O)	Ambient
Surfactant	SRF		Rinse	Removes excess chemical	DI water/ surfactant (H_2O/ surfactant)	Ambient
*Preferred terms or abbreviations used by GFT.						

chemical processing

(verb) Processing (stripping, etching, or cleaning) the product by washing or soaking it in a chemical bath.

Also see process chemical.

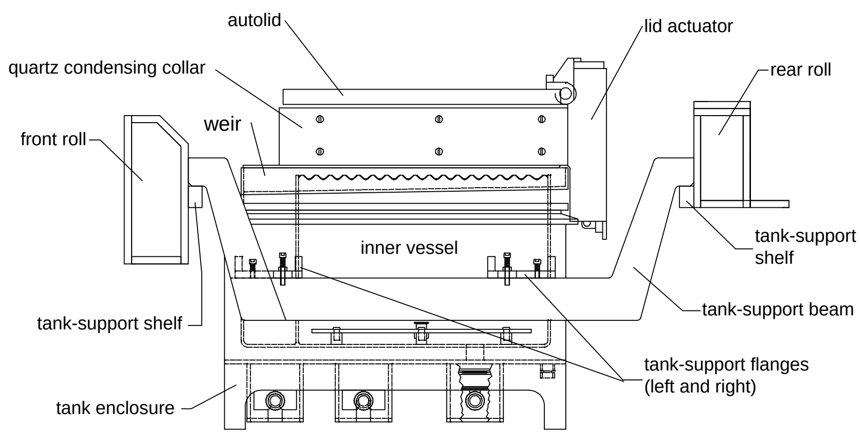
chemical spiking

See metering pump.

chemical tank

Container in which the product is chemically processed. An example of a chemical tank is shown below.

Also see rinse tank.



Chemical Tank (side view)

“chemraz” A trade name for a blend of PTFE with elastomers to form a material used primarily as a sealing medium.

chilled water Water at below-ambient temperature.

Also see temperature of process chemicals.

chilling See temperature of process chemicals.

chip A small component that contains a large amount of micro electronic circuitry.

chromium Cr.

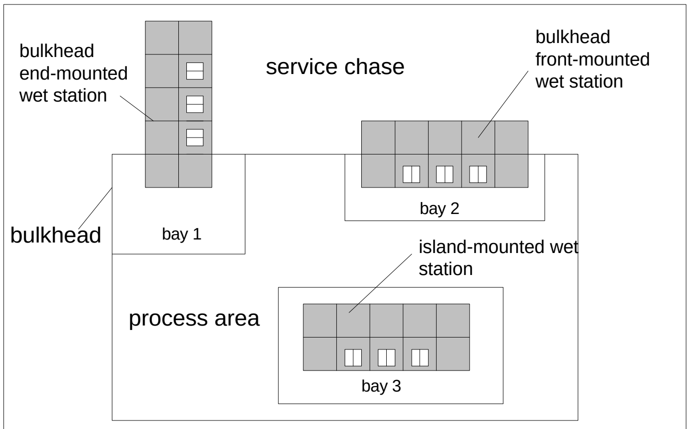
city water Water supplied by the city (tap water). Usually not used in a rinse process. Used to open and close water-actuated tank lids.

cleaning The removal of contaminants from the wafer surface during process steps.

cleanroom, bay-and-chase Bay-and-chase cleanrooms usually consist of a process area and a service chase. The process area is the clean area. Wet systems are located in bays in the process area, and they may extend into the service chase. The service chase around or behind the process area allows access to the plumbing and electrical cabinets of process equipment for servicing.

A simplified bay-and-chase cleanroom is shown in the following drawing. Cleanrooms at customer sites may contain one or more wet systems and associated equipment laid out in any of a number of ways.

Also see wet-system mounting.



Typical Bay-and-Chase Cleanroom (top view)

cleanroom classification Cleanrooms are classified based on the concentration and size of airborne particles in the cleanroom measured in microns (µm) per cubic foot of air. A Class 100 cleanroom has 100 or fewer particles of 0.5 µm and larger (and/or no particles 5.0 µm and larger) in 1 ft^3 of air.

CMOS Complementary metal oxide semiconductor.

CMP See chemical mechanical polish.

CO_2 Carbon dioxide. Used as a fire suppressant.

coax See coaxial cable.

coaxial cable (coax) A special two-conductor shielded cable with fixed impedance that permits the transmission of electrical energy.

Color (in touchscreen displays) See touchscreen displays.

combustible liquid A liquid having a flash point at or above 100°F.

condensing coils Tubes, used to circulate ambient-temperature water, built into the top of some heated tanks. The ambient-temperature water cools chemical vapors and causes condensation on the bottom of the tank lid. If the process chemical includes DI water and the tank's operating temperature is above 100°C, the water boils off, is reduced to liquid on the cold condensing coils, and drips back into the tank. The result provides a more consistent chemical concentration in the process tank and reduces the loss of DI water in the exhaust system. See temperature control for nitride-strip processes. Also called reflux collar.

conductor A substance or body capable of conducting and carrying electric current, usually having low resistance.

contaminants Particles that can cause defects in physical structures or electrical functionality that may result in the failure of a semiconductor device. Contaminants typically come from humans, the chemicals used, the process equipment, the manufacturing environment, and the wafer itself as materials are added and removed.

contaminated part
Wet-system parts that have been exposed to hazardous chemicals. Usually parts in the field or returned from the field.

control software
See wet-system control system; robot control system.

cool-down box
See cooling tank (preferred term).

cooling tank
Used in draining of heated tanks to cool liquid before it is drained into waste or reclaim systems. Cooling tank operation is interlocked with recirculation system valves and pumps. See recirculation and draining.

core
See service chase (preferred term).

CPFA
Carbon-filled PFA.

cps
Cycles per second.

Also see hertz.

CPU
Central processing unit.

Cr
Chromium.

CR
Carriage return. A selection on the touchscreen keyboard; pressing CR enters information and advances the cursor to the next line.

crash detect
See obstruction sensor (preferred term).

critical alarms
Any alarm may be designated as critical, in addition to its automatic response level. Critical is provided to identify a high level of seriousness and requires an additional operator response on the touchscreen to recover from the alarm. (The CRITICAL button on the associated tank control screen turns red and must be touched to clear the alarm.) The GFT default alarm responses include two critical alarm assignments:

- Plenum in module (#) is full
- Rear plumbing area in module (#) is full

Critical alarms do not disable manual commands from tank control screens, the DIO screen, or the robot joystick.

Also see alarms and status beacon.

crystal
A quartz crystal that vibrates at a specific frequency when energy is supplied to it.

crystal structure
A three-dimensional lattice of molecules or atoms of a specified material or element.

CVD
Chemical vapor deposition.

cycle
The application or step in a series that make up a process.

Czochralski Technique
Method of growing an ingot of silicon by pulling a seed rod from the top of a crucible of liquid.

D

damper, exhaust

An adjustment flange (butterfly valve) used to adjust exhaust flow from a module.

Also see exhaust alarm and control systems.

dBA

Decibels (dB) on A-weighted scale.

DCR

See Document Change Request.

DDV

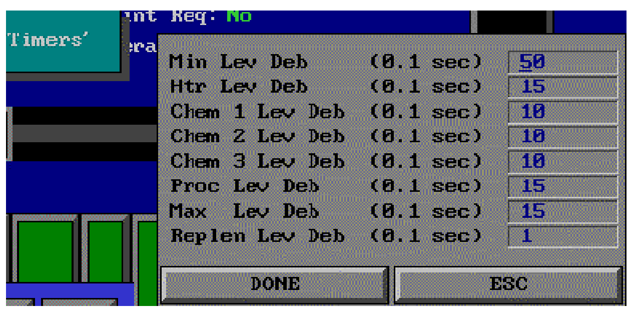
Diluted-drain valve.

dead leg

Any point in the plumbing where more than two times the diameter of the pipe has a possible stoppage of flow. No dead legs are allowed in any DI-water line. DI-water manifolds should have a flow-through design to maintain a continuous flow. Valves in the DI lines should have a trickle flow bypass or 1/8-inch bleeders.

debounce timers

Debounce timers eliminate needless errors and alarms. As tanks fill and drain, or when product enters or leaves, liquid can slosh and trigger sensors. Debounce values allow liquid levels to stabilize inside the tank before needless error messages are sent. Debounce values are set in tank configuration. Tank level operational functions and interlocks are defined in tank levels.



Typical Debounce Configuration Screen

debug

To troubleshoot and correct malfunctions.

decibel (dB)

A unit used to express relative difference in power between acoustic or electrical signals, equal to 10 times the common logarithm of the ratio of the two levels.

decktop

A cover over the plenum and around the chemical tanks to create a physical barrier between the process environment and the lower plenum area. Decktops create a local exhaust system.

default

An action automatically carried out or a value automatically used unless another one is specified.

defect

An area of the wafer that is damaged and thus unusable (the remainder of the wafer is usable). Also see scrap wafer.

degrees Celsius (°C)

A thermometric scale where 0° is the freezing point of water and 100° is the boiling point. Formula to convert to degrees Fahrenheit (°F): 9/5C + 32.

deposition

Application of material onto a substrate or wafer using a chemical, vapor, electricity, or vacuum process.

delta p See differential pressure.

DEQ Department of Environmental Quality.

DEV Developer. See chemical process.

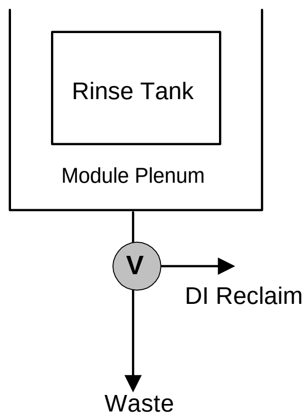
device A mechanism, tool, or piece of equipment designed to serve a special purpose or perform a special function (for example, the robot, SRD, or tank). Use the specific name of the device if possible, rather than the generic term *device*.

DHF Dilute hydrofluoric acid. See chemical process.

DI water Flowmeter Flow meter attached to flow switch or device designed to alarm at a specified rate of flow; may have adjustable threshold.

DI water Deionized water.

DI reclaim



Optional valve installed in the plenum waste-drain piping diverts DI water rinse cycles to facility waste line, then (after a specified number of rinse cycles) to DI reclaim facilities.

DI reclaim is enabled and configured in tank and recipe configuration.

Configure the tank:

1. Select **Process** menu button on the main screen, then **Tank Config**.
2. Select a rinse tank.
3. Select **DI Hardware**.
4. Enter 1 for **DI Reclaim.**
5. Select **Rinse** from the Tank Config menu.
6. Enter the number of rinse cycles to be drained to the facility waste line in **DI dumps to waste**, then save the configuration.

Verify recipe's rinse cycles:

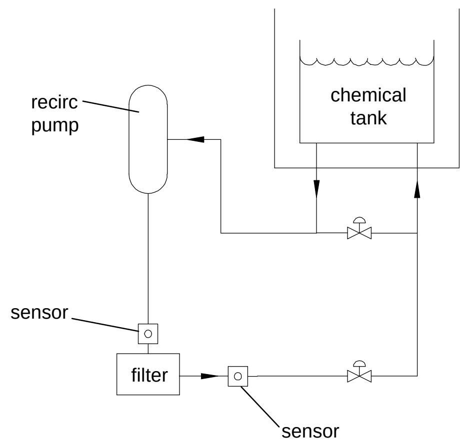
In recipe management, verify that the recipe in question has enough dump cycles (the combined values for **Hot Dump Cycles** and **Cold Dump Cycles**).

DI water drain The system can drain DI water in one of three ways:

- all rinse cycles drain to facility waste.
- all rinse cycles drain to the facility's DI reclaim line.
- after a specified number of rinse cycles have drained to the chemical waste line, the remaining dumps are diverted to DI reclaim. See *DI reclaim*, above.

Differential pressure (DP)

The difference in pressure between two points ($\Delta P = P1 - P2$). Sensors in the chemical tank recirculation lines measure pressure upstream and downstream from the filter. When the pressure differential exceeds a configurable preset value, the filter must be changed. This condition can trigger an alarm and/or a message on the touchscreen advising the operator to change the filter).



Pressure Differential in Chemical-Tank Recirculation System

diffusion process

High-temperature process used to introduce dopant atoms into the silicon surface.

Also known as *doping*.

DI heater

See temperature controls.

DI inject

Injecting DI water into a nitride recirculation system to maintain concentration.

dilute hydrofluoric acid

Dilute hydrofluoric acid (DHF). See chemical process.

Dilution valving

Tank drain scheme that uses an aspirator (inline plumbing device) to dilute liquid draining from a tank. See aspirated drain.

DIO

Discrete input/output. See I/O.

DIP switch

Dual in-line package switch. Small switch used to set up or adjust equipment.

dispersion plate

A plate located in a tank that prevents liquid from spraying as it fills the tank and prevents recirculating liquid from exiting tank too quickly. Also allows laminar flow of liquid across the wafers (bottom to top).

disarm

Keyswitch position. See keyswitch.

DMM

Digital multimeter.

document control

Verteq’s Document Control department is responsible for organizing the company’s documents (primarily parts lists, manuals, and technical drawings) and managing the numerous and frequent changes made to these documents. One or more of the following forms are used, generally in the order listed, before manufacturing begins, and when changes to a document are needed (either during manufacturing or after shipping):

1. **Engineering Work Order (EWO)**
   The EWO form is prepared by a project engineer *before* manufacturing begins. The EWO lists the parts and documents needed for the project, and provides authorization for production to begin.

2. **Manufacturing Engineering Order (MEO)**
   The MEO form is used to request and order a change to any document *during* manufacturing.

3. **Engineering Change Request (ECR)**
   The ECR form is used:
   - to request a change to any document for a product, part, or assembly that has been shipped to the customer, and
   - to request a change on a “stand-alone” document (one that is not related to a particular Verteq product).

4. **Engineering Order (EO)**
   The EO form is used to *order* (direct an employee to make) the change specified on an ECR, and explains the change needed.

See the Document Control department for instructions on using these forms.

“dog house”

Plastic assembly covering the pillow block bearing above the swingarm.

dopant

Impurity added to semiconductor material to change or improve its ability to conduct electrical current.

doping

See diffusion process (preferred term).

DOS

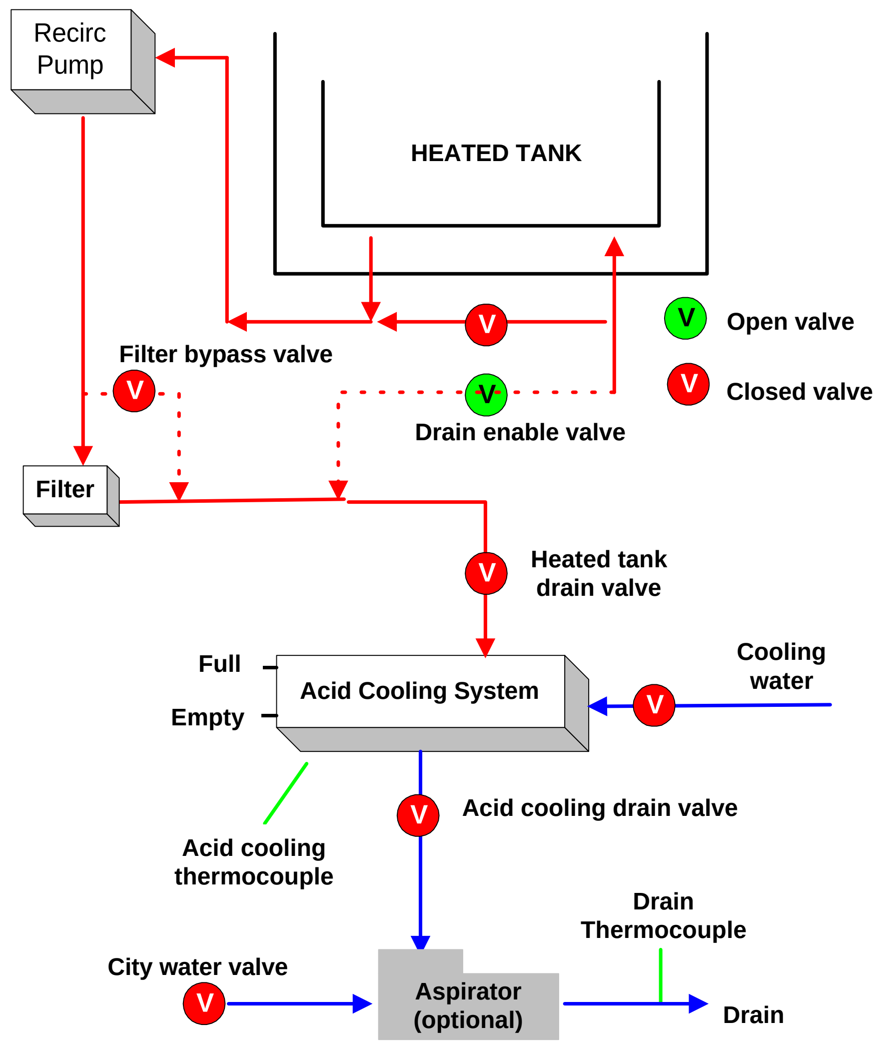
Disk operating system.

DOT

U.S. Department of Transportation. Regulates transportation of chemicals and other substances for the protection of the public.

draining (heated tanks)

Heated tanks drain when 1) a “Main Tank is overfull” alarm occurs, and 2) the REFILL or DRAIN button on the tank control screen is selected. During a drain, the recirculation pump pulls liquid from both the inner tank and the outer weir. The pump starts when liquid falls below the tank's process level.



Typical Heated-Tank Draining Process

Cooling system specifications

- acid cooling system holds a minimum of 105% of total recirculation system volume
- two N_2 bubbler level sensors with operational interlocks (see table below)
- built-in coils circulate water for heat-exchange function
- gauge located in wet system module enables adjustment of cooling water inlet pressure (inlet pressure must not exceed 40 psi; flow ≅ 4 gpm)
- process tank volume cools 180°C to 70°C within 1 hour (based on 65°C cooling water)

One or multiple aspirators can be plumbed in parallel downstream of the acid cooling system. Each aspirator produces a specified dilution ratio (city water:process chemical), and cools the chemical.

Automatic Interlocks for Heated-Tank Drains	
Interlock	**Function of Interlock**
Cooling-tank overtemp	Acid cooling thermocouple interlock prevents the acid cooling drain valve from opening before desired drain temperature is achieved.
City water flow	Allows the city water flow valve to open only when the acid cooling system drain valve is open.
Drain overtemperature	Drain thermocouple downstream of the optional aspirator(s) shuts off acid cooling drain valve if temperature is too high.
Acid cooling system levels	**Full** shuts off heated tank drain. **Empty** shuts off cooling tank drain.

dryer

A device used to remove water from wafers. Common dryer types include IPA (isopropyl alcohol) dryer, SRD (spin rinser/dryer), and Marangoni dryer.

dummy load

A resistive test device capable of absorbing power or matching a device’s impedance. Used in testing device output.

E

ECR
Engineering Change Request. See document control.

edge exclusion
The outside edge of the wafer, which is reserve for handling, if necessary. No circuit printing takes place in this area.

EE
See robot end effector.

EE wash tank
See end-effector wash tank.

Emergency Action Plan
Designated actions employees and managers must take to ensure employee safety from fire and other emergencies.

Emergency Off
See EMO.

emergency modes
Wet systems have three emergency modes:

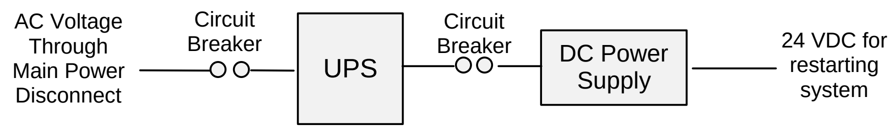
Emergency Mode	Cause	System Response
EMO	1. Fire 2. Emergency Stop button pressed 3. Exhaust Fail alarm	See EMO
Robot E-STOP	1. Robot E-STOP button pushed 2. Safety shield opened with keyswitch at AUTO position 3. Robot unable to move or to complete a move because of obstruction 4. Internal error	See Robot E-STOP
UPS	Main wet system power is lost	UPS engages. See GoToSafe.

EMO

Emergency Off (EMO). An EMO shutdown on a GFT wet system is caused by 1) pushing an Emergency Off pushbutton, 2) loss of exhaust, or 3) a fire.

During an EMO shutdown, electrical power is maintained through the UPS to a DC power supply, which provides a 24-VDC output. This voltage is necessary to restart the wet system. Recipes in progress cannot be resumed; product lots cannot be moved with the robot until the EMO condition is cleared.

EMO pushbuttons are red mushroom-type buttons located on both the front and back of wet systems. After an EMO button has been pushed, it must be manually pulled out before the wet system can be powered up.



Simplified schematic of electrical flow (left to right) after an EMO has occurred.

Responses to an EMO Shutdown	
Device or Function	**Response**
UPS (uninterruptible power supply)	• UPS retains power, but supplies only 24-VDC to a restart circuit.
Robot	• Loses power • Loses home position • Must be rehomed before it is used again
SRD (spin rinser/dryer)	• Loses operating power • Stops communicating with cell controller
Automatic valves	• All automatic valves go to default position
External DI water heater	• Operating power to the DI heater is **not** interrupted • Control and communication with heater are cut off • Heating stops
External chemical tank heater/chiller	• Operating power to the heater/chiller is cut off • Communication with VcS module stops • Heating/chilling functions stop
Cell controller and touchscreen	• Both lose power
Recipes in progress	• Immediately stop • Cannot be resumed • Product lots **cannot** be moved with the robot until wet system is restarted
Electrical circuits	• All circuits are disabled except 24-VDC startup circuit

end effector (EE)

See robot end effector.

end-effector (EE) wash tank

The EE wash tank rinses and dries the robot's end effectors (the grippers that hold the cassettes) to prevent contamination of the next chemical bath or the spin rinser/dryer (SRD). After removing process cassettes from any chemical tank, the robot places the cassettes in a rinse tank. While the wafers are in their rinse cycle, the empty robot automatically moves into the EE wash tank according to the rules in the following table.

The end-effector wash is a sequence of DI water rinses and N_2 drying that is permanently set in the wet system’s control system. However, each step is composed of various parameters and cycles that can be configured, including the duration and number of repetitions of each cycle in the step.

The EE Wash tank has an overflow function with a high/low flow feature. This allows the tank to fill at a high rate and overflow at a low rate. The EE Wash tank is filled from the bottom at a high flow rate until the DI-water level reaches the N_2 bubbler level sensor. The level sensor triggers the change from high to low flow rate.

N_2 spray bars are installed at the top of the tank to dry the end effectors as the robot rises to carry height.

EE Wash Tank Rules	EE Tank Sequence
1. Wash/dry before going to the input nest. (Wash is DI water; dry is N_2.) 2. Wash/dry before going to the SRD. 3. Wash if the next scheduled move is to a different chemical tank. 4. Wash if the next scheduled tank has the same chemical *and* if the control system determines there is enough time to complete a sequence before the next scheduled move.	1. EE tank is full and idle before the end effector enters. 2. Robot dips the end effector into the tank. **Wash Time** counter starts and the tank begins to overflow. 3. Wash time ends. **Drain Time** cycle starts and the tank empties. This completes one wash cycle. The wash cycle repeats for the number of times set in **Wash Cycles**. 4. **Drain Time** finishes. **Dry Cycle** starts for the amount of time set in **N_2 Spray Time**. 5. Robot lowers into tank, then raises. The N_2 spray is on. 6. **Dry Cycle** ends, then repeats for the number of times set in **Dry Cycles**. 7. Robot raises end effector to carry height and pauses for the time set in **Drip Time** before executing the next scheduled step in the recipe. The bolded items above are individually configured in the EE Wash tank configuration screen.

end mounting

See wet-system mounting.

endurance testing

Testing performed on the wet system before shipping to the customer; involves operating the wet system in standard mode with the intention of processing 5,000 wafers with assists but no failures.

Engineering Change Request (ECR) See document control.

Engineering Order (EO) See document control.

Engineering Work Order (EWO) See document control.

environment, product See product environment.

EO Engineering Order. See document control.

EPA Equipment purchasing agreement.

Epitaxial Method Method of growing an ingot of silicon by depositing crystals onto the seed from a gas.

EPROM See erasable programmable read-only memory.

erasable programmable read-only memory (EPROM) A read-only memory in which stored data can be erased and reprogrammed repeatedly.

ergonomics The science or study of the evaluation, planning, and adapting of equipment and tasks to promote the comfort of the human body for the health and efficiency of workers.

error Any deviation outside a specified tolerance range or value.

ESC Escape. A selection on the touchscreen and external keyboards and on the touchscreen menus.

ESD Electrostatic Discharge

E-STOP See Robot E-STOP.

Also see EMO.

etch See etching.

etchant The agent used to remove unwanted material from the product (etching). The most common etchants used in wet-chemical processing of semiconductors are mineral acids, particularly HF. By chemical action, the etchant removes all material that is not protected by resist.

etching

The process of removing (chemically dissolving) certain areas of layered materials on the wafer surface to leave the desired circuit pattern or to create the required thickness of the layer. Etch processes are typically named for the material being etched (for example, oxide etch and nitride etch). Etching is measured in Ångstrom units.

Also see stripping.

etch rate

Rate at which the surface of a wafer is etched (measured in Å/time, where time typically equals minutes).

ETFE

See Tefzel©

evaporation

Process where a metal capsule is heated in a chamber and becomes a vapor which solidifies as a metal film on exposed surfaces of semiconductor material. Also known as vapor deposition.

Evaporator Bell Jar

Chamber where the evaporation process occurs.

event

A detectable change in the condition of a system or equipment.

EWO

Engineering Work Order. See document control.

exhaust

Removal of gas, fumes, or vapor from the module.

Also see local exhaust system; exhaust alarm and control systems; exhaust flow patterns.

exhaust alarm and control systems

Every module in GFT wet systems can trigger two exhaust alarms: low-exhaust and exhaust fail. **Low-exhaust** warns that a module’s optimum exhaust velocity is lost and triggers an automated Runout response. **Exhaust fail** causes an EMO shutdown after an immediate GoToSafe and a configurable time delay. The delay allows recovery from a transient loss of exhaust flow without triggering an unnecessary EMO shutdown. Each of these exhaust alarms can be configured for different automated responses.

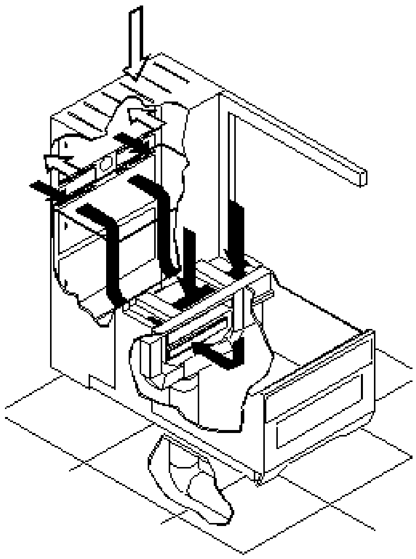
Also see *status beacon*.

exhaust and air-supply options

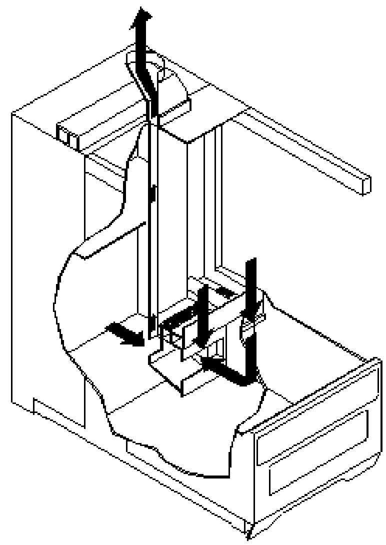
Three air-supply/exhaust options shall be available. A wet system can comprise modules that use different options.

Option	Hardware Used	Interlock Response
1	• Facility supplied air, air handlers, and filters • Air handlers controlled by the facility	• **EMO** – No control of air supply system. Standard EMO response. • **Low Exhaust** – Runout response after a 10-second time delay • **Exhaust Fail** – EMO is triggered after and immediate GoToSafe • **Fire** – EMO is triggered
2	• Air supplied from remote constant-speed air handlers through ULPA filters. These filters are assembled into filter plenum modules positioned over the wet system process area • 0.12-micron filters with 99.9995% efficiency • Aluminum perimeter framing and protective grill on the downstream side of the filter modules • Construction of 304, #4-finish stainless steel • Flex duct interconnect between blower and ULPA air plenum modules supplied by GFT	• **EMO** – Air handlers ***do not*** shut down or change speed. Air flow continues at current velocity. • **Low Exhaust** – Runout response after a 10-second time delay • **Exhaust Fail** – EMO is triggered after and immediate GoToSafe • **Fire** – Air handlers shut down and an EMO is triggered
3	• Same hardware as option 2, except air handlers are two-speed	• **Safety shield open** – Two-speed air handlers adjust to a reduced velocity maintenance-mode, which conforms to OSHA fpm safety requirement (currently 150 fpm). • **EMO** – Two-speed air handlers adjust to a reduced velocity maintenance-mode. • **Low Exhaust** – Runout response after a 10-second time delay • **Exhaust Fail** – EMO is triggered after and immediate GoToSafe • **Fire** – Air handlers shut down; EMO is triggered

exhaust flow patterns



**Bottom Exhaust
(Outline arrows indicate air returned to cleanroom.)**



Top Exhaust

exhaust collar

Facility-connection port.

exhaust monitoring options

Two options shall be available to monitor exhaust. Both can be used in the same wet system on a module-by-module basis and in conjunction with any air-supply option.

Option 1: Pitot tube / photohelic gauge	Option 2: Photohelic only
• One Pitot tube and photohelic for each module • Devices measure velocity pressure (inches of water) of the exhaust stream • Tubing connecting the Pitot to photohelic gauge on the back of each module shall be installed by facility personnel at the time of system facilitation	• Photohelic gauge, on the back of each module, shall indicate the difference between the ambient pressure where it is located and the exhaust duct.

exposure

A condition of being exposed, a position in relation to an unacceptable event, or an interaction between an employee and a hazard.

extender board

A de-bugging printed circuit board used by service personnel to temporarily extend the length of the installed PCB for more convenient monitoring purposes.

F

fab	Fabrication facility. See facility (preferred term).
facility	The customer's location; specifically, the site where wafers (or other product) are fabricated and the wet system is located. Also known as *fab*.
failure	Any interruption or variance from the specifications of equipment operation that requires the replacement of a component (other than specified consumables) because of degradation or failure. Also includes assists that interrupt operation and require more than 6 minutes. [From SEMATECH Official Dictionary, Rev. 5.0, 1995]
FARM	See filtered-acid recirculation module.
feedback	Electronic currents, coupled or directed from the circuit's output valve or amplitude back to the circuit that originated it. Normally used to control or compare.
FEM	Filtered etch module.
FEP	Fluorinated ethylene-propylene. Also see "Teflon."
filter bypass valve	See recirculation (heated tanks).
filtered-acid recirculation module (FARM)	A process module that has a chemical tank with an acid-recirculation system.
filtration	See recirculation (preferred term).
Fire Prevention Plan	Includes a list of major workplace fire hazards, procedures to control them, and the types of fire protection systems which can control potential fires.
fire-retardant polypropylene	FRPP.
fire suppression system	Typically uses CO_2 and/or water. See wet-system specification for details of fire detection and suppression system.
FLA	See full load amps.
flammable liquid	A liquid having a flash point below 100°F (37.8°C).
flash point	The temperature at which a liquid will give off enough flammable vapor to ignite.

fluorinated ethylene-propylene

FEP.

Also see “Teflon.”

FNPT

Female national pipe thread.

footprint

Physical dimensions (length and width) of a wet system.

force

Each tank control screen has a Forced/UnForced button that allows the direct control of individual valves, pumps, spray bars, and drains. In normal operation these buttons remain in the UnForced (automatic) mode. With the Forced button on, valves can be opened and closed, recirculation pumps can be operated, and other components individually controlled.

Tank control screens are accessed by selecting their icons on the main screen. Displaying control screens is not a password-protected operation. However, forcing and macro command functions require password permission.
A position in the password bit mask allows or denies operator permission to force wet-system components. This is a blanket permission, i.e., an operator may force any component on every control screen or force nothing at all.

The Forced function should be used only by trained technical personnel who have a thorough understanding of the wet-system operation. Also, it is extremely important to return the system to an **UnForced** condition before logging off or shutting down the control software.

To force a component:

1. Select a tank or device icon from the main screen.
2. Select the Forced/UnForced button on the displayed control screen. The button toggles between UnForced and Forced every time it is selected.
3. Select an ON/OFF or OPEN/CLOSED status box to toggle the status of a device such as a valve or pump.
   - Not all devices have forced capabilities.
   - On some control screens, devices do not have status boxes. In these cases select the icon itself to toggle its status.

When components are toggled to forced:

- Valves and other devices can be toggled ON/OFF or OPEN/CLOSED.
- The device will remain in a forced state until toggled again.
- Forcing overrides automatic control, preventing normal processing.

The wet system main control screen shows when a tank is in a forced condition.

fpm

Feet per minute (unit of velocity).

front-access module
A module in which the plumbing and electrical compartments can only be accessed from the front.

front mounting
See wet-system mounting.

FRPP
Fire-retardant polypropylene.

FRS
Filter recirculation system.

See recirculation

F_r
Resonant Frequency

frequency synthesizer PCB
Printed circuit board in GFT’s E-style Megasonics electronics packages. Used to produce a signal at Fr of transducer crystals that will drive the amplifier allowing the system to produce energy inside the process tank.

full load amps (FLA)
The peak load power requirement for a wet system or device (measured in amps). The FLA for each wet system is indicated on a label attached to the rear of the wet system near the main power disconnect switch.

G

GaAs Gallium arsenide.

Ge Germanium.

GEM Generic Equipment Model. SEMI International standard for communications and control of semiconductor equipment.

GEM Host-Cell Controller Interface See *GEM Specification*.

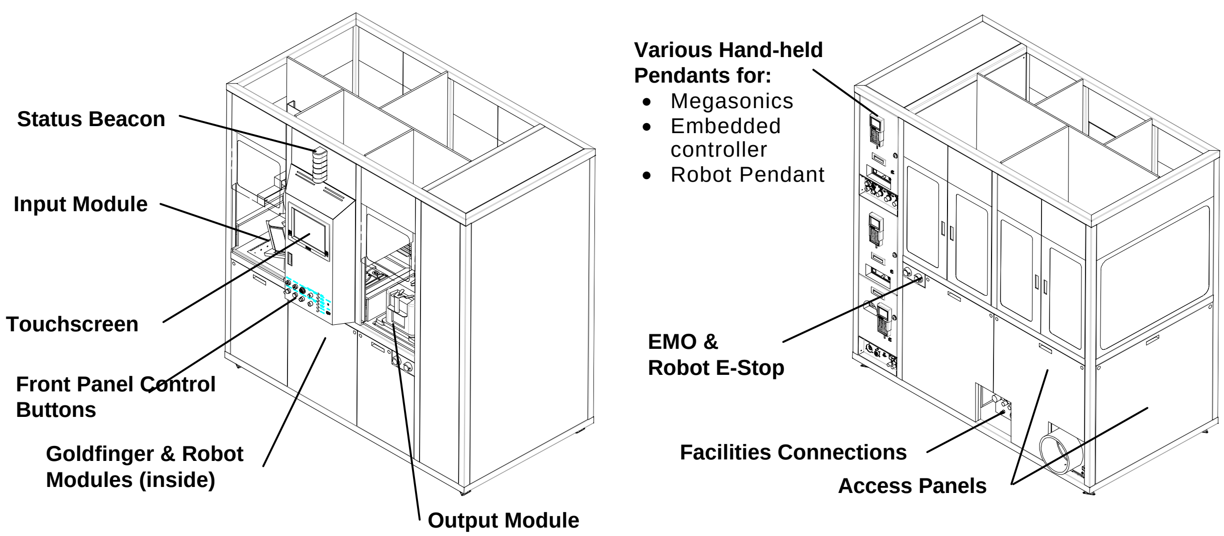
general safety rules General safe work practice rules adopted by GFT.

geometry The critical dimensions (CDs) and shape of the end product, measured in microns (µm).

GFI Ground Fault Interrupter.

g/L Grams per liter.

Goldfinger The Goldfinger Cleaning System is a post-CMP single-wafer based processing system designed to accommodate non-contact cleaning to remove organic, ionic, and particulate contaminants after the mechanical polishing of a wafer. The system is constructed with standardized modules for flexibility and variety in cleaning. A system may be manufactured to include any selection of modules, depending upon the requirements of the user. It may be arranged around a robot (if equipped) or another system so that every module is accessible.



GoToSafe

GoToSafe is an automated recovery sequence that ensures wafers are in, or moved into, safe tanks after a loss of main power to the wet system. GoToSafe is also response can be assigned to any alarm.

All GoToSafe responses have the features listed below.

- Audible and visual alarms
- New lots are not allowed until alarm is cleared
- Alarm message displayed on touchscreen and written to log file
- Lot is moved into or kept in a safe tank until problem is fixed

The scenario table below describes variations on the main GoToSafe theme.

GoToSafe Scenarios

	After Loss of Main Power	After an Alarm
Required Conditions	• Wet system has a powered-up UPS • Robot is functional and not experiencing an error • No obstruction, such as an open lid, prevents a robot move • Robot completes any move in progress, including moving a cassette into a chemical tank	• Alarm is configured for GoToSafe • Robot is functional and not experiencing an error • No obstruction, such as an open lid, prevents a robot move • Robot completes any move in progress, including moving a cassette into a chemical tank, before starting GoToSafe
Lot is in Safe (DI Water) Tank	• Lot stays in safe tank • Recipe is interrupted and cannot be resumed	• Lot remains in safe tank • Recipe timing function continues • If alarm is cleared before next scheduled move, recipe continues without a GoToSafe response • If alarm is *not* cleared before next scheduled move, lot stays in safe tank • Recipe can be continued by selecting **Resume** in the Scheduler menu after alarm condition is cleared
Lot is in Chemical Tank	• Robot *immediately* moves lot into safe tank (unless an error prevents robot movement) • Recipe in progress stops and cannot be resumed	• Lot completes the chemical tank step • Robot moves lot into safe tank • Recipe timing function continues • If alarm is *not* cleared before next scheduled move, lot stays in safe tank • Recipe can be continued by selecting **Resume** in the Scheduler menu after alarm condition is cleared

gpm

Gallons per minute.

gripper movement

See robot axes.

H

H_2O Water.

H_2O_2 Hydrogen peroxide.

H_2SO_4 Sulfuric acid.

H_3PO_4 Phosphoric acid. Used in nitride strip baths.

“Halar” Trademark for fluoropolymer (ECTFE) produced by Ausimont, USA, Inc.

“Halon” Trade name for a compressed gas used in fire-suppression systems. Used in and around electronics because it is a gas. Consumes oxygen in a room. Is hazardous to humans.

hardware The physical components or equipment that make up a computer or other system.

hazard An unsafe condition or practice that could cause injury or illness to an employee. Hazards are preventable.

Hazard Communication Program A written program designed to inform employees about hazardous chemicals and corresponding protective measures.

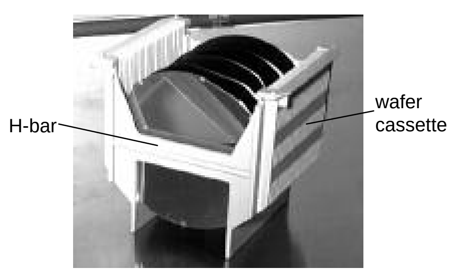
hazard control Reducing the probability of accidents by eliminating hazards, reducing exposure to hazards, or protecting employees from hazards.

hazard identification Noting the potential for accidents before they occur.

Hazcom Hazard communication program.

H-bar The narrow horizontal bar at one end of a wafer cassette (see photo). The vertical and horizontal reinforcing strips form an “H.” H-bar orientation is extremely important for secure mating with the robot’s end effector. Improper placement of cassette in the input queue can result in wafer damage.

Also see cassette placement.



Cassette H-bar Location

HCl Hydrochloric acid.

heater/chiller Unit used t heat or cool fluids; typically used in chemical processing to control the temperature of a specific bath or tank.

Also see temperature controls.

heating See temperature of process chemicals.

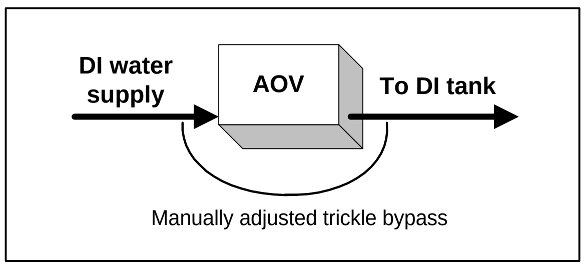
HEPA High-efficiency particulate air filter.

hertz (Hz) A unit of frequency equal to one cycle per second. Also known as *cycles per second*.

HF Hydrofluoric acid. See chemical process.

HF last If the HF-rinse combination is the last step before the wafers go into the dryer, the step is referred to as the *HF last*.

high/low flow plumbing (trickle bypass) DI water tanks fill at a high flow rate, then (to conserve water for the continuous overflow) change to a low flow rate when the tank has filled. During tank fills, an air-operated valve (AOV) opens automatically to provide high flow and fill the tank quickly. When the process level is reached, the AOV closes, but DI water continues flowing into the tank through a manually adjusted trickle bypass line.



High/Low DI Water Flow

HNO_3 Nitric acid.

home Mechanical location of the robot used as a reference position for the robot points. The robot must be homed (with the touchscreen or the robot joystick) each time the robot is powered up. When the robot is homing, if finds its home position for each axis, starting with the vertical axis and ending with the horizontal axis.

The robot’s home position for each axis is not taught; it is permanently encoded in the robot control system.

Also see robot points, robot axes, and robot control system.

hood See VLF hood. *Hood* is also an industry term for *wet system* (preferred term).

horizontal obstruction sensor (HOS) See obstruction sensor.

HOS Horizontal obstruction sensor. See obstruction sensor.

host computer

A remote computer (located at a distance from the wet system cell controller) that can:

- enter lots
- download recipes
- upload recipes
- request status
- communicate in numerous other ways with the cell controller

A host computer does not disable or override system-mounted pushbuttons or operations manually initiated from the touchscreen interface.

The GFT host/cell controller interface is GEM-compliant. See *GEM Specification*.

hot phos

Hot phosphoric acid. See chemical process.

HP

Hot phosphoric acid. See chemical process.

HPM

Hydrochloric peroxide mixture. See chemical process.

Huang 1

See chemical process.

Huang 2

See chemical process.

hydrochloric peroxide mixture (HPM)

See chemical process.

hydrofluoric acid (HF)

See chemical process.

hydrogen peroxide

H_2O_2.

hydrophobic

Lacking an affinity for, repelling, or failing to absorb or adsorb water (in the wet-processing industry, typically refers to materials such as wafers or filters).

Hydrophilic

Having a strong affinity for, attracting, absorbing, or adsorbing water (in the wet-processing industry, typically refers to wafers or filters).

Hysteresis

[ELECTRICAL]
An oscillator effect wherein a given value of an operation parameter may result in multiple values of output power of frequency.

This is a setting used to control OMEGA-type overtemperature controllers in the protection of Lufran In-Line heaters. It is the percentage of span which the temperature must fall or rise before the time changes state.

Hz

See hertz.

I

IC

See integrated circuit.

icon

An image representing a function on a touchscreen display. Icons change color in real-time to represent real-time operational conditions. See touchscreen colors used in touchscreen displays.

idle

The device is powered and ready for use but is not in use (for example, a tank has reached the level and temperature for processing, but no wafers are currently being processed in the tank).

Also see parked.

ILH

Inline heater. See temperature controls.

immersion heater

See temperature controls.

Impedance-matching transformer

A transformer used to match impedance between source and load. Required on all GFT Megasonic equipment.

implant

A method of semiconductor doping (adding impurities to an intrinsic material like silicon or germanium).

impurities

Materials used as dopants, e.g. boron, arsenic, and phosphorus. When these impurities are added to silicon or germanium they will produce P or N type materials.

incident

An unplanned, unwanted event that could or does degrade the efficiency of the business operation but does not include physical injury, illness, or property damage.

incident investigation

Inquiry to determine the root cause of an incident in order to prevent future incidents and accidents.

Ingots

The small piece left after a silicon crystal has been sliced into several wafers.

inline heater (ILH)

See temperature controls.

input/output (I/O)

Inputs are electrical signals from devices (such as the robot) that provide information about the status of the device to the cell controller or PLC. Outputs are electrical signals from the cell controller or PLC that turn devices on and off, open and close valves, and energize alarms, lights, and operator notifications.

Discrete I/O signals are 24 VDC, which are either on or off. *Analog input signals* are 4 to 20 mA, which correspond to measured resistivity, flow, pressure, and temperature values. *Analog output signals*, also 4 to 20 mA, drive heating systems from 0 to 100% capacity (depending on demand determined by PID loops).

Also see input/output module.

input/output (I/O) module
The module where the product enters and exits the wet system.

input/output (I/O) nest
See input/output queue (preferred term).

input/output (I/O) queue
Two or more sets of indented slots in the I/O module (module 1) for cassettes. Also known as I/O nest. (If the wet system has a WTU, the slots are for process cassettes only.)

insulator
A material or body that is a poor conductor of electricity.

integrated circuit (IC)
A complex electronic circuit fabricated on a substrate, usually a silicon chip.

interface
The connection between mechanical and/or electronic devices that allows them to function or pass information (data) back and forth between them (for example, the host/cell controller interface).

interlock
A device that prevents operation of a piece of equipment when an event exists. For example, an interlock causes the robot to stop when a safety shield is opened during processing.

ionic
Relating to, existing as, or characterized by means of ions.

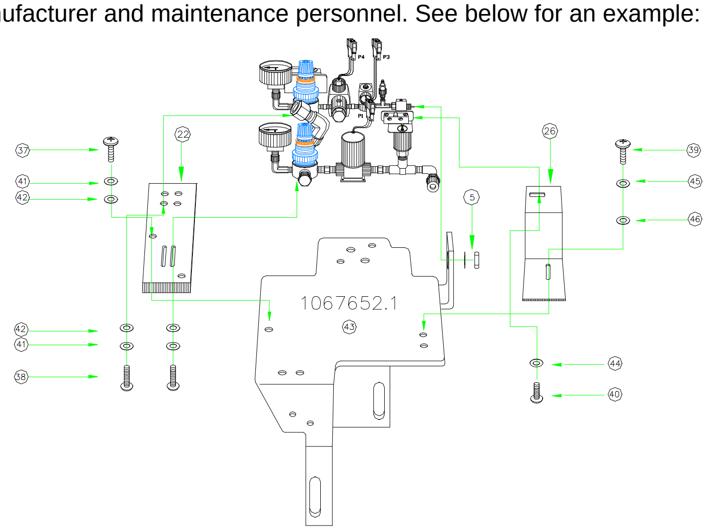
I/O
See input/output.

I/O Interface PCB
Used in Megasonics E-style electronics packages to communicate CPU commands to the 24VDC output board.

IPA
See isopropyl alcohol.

IPA dryer
Dryers that use isopropyl alcohol (IPA) to remove water from the surfaces of wafers and similar substrates.

IPB
Isometric Parts Breakdown, or Indented Parts BOM. Assembly instruction drawings used by the manufacturer and maintenance personnel. See below for an example:



Ironman — A program used to test equipment around the clock to identify and correct causes of failure. GFT uses endurance testing rather than Ironman testing.

island mounting — See wet-system mounting.

IsoDRY — GFT's IPA Vapor Drying System (generic term)

isopropyl alcohol (IPA) — $CH_3CHOHCH_3$. Also known as 2-Propanol.

isopropyl alcohol dryer — See IPA dryer.

J

joystick

See robot joystick.

K

k (kilo-)

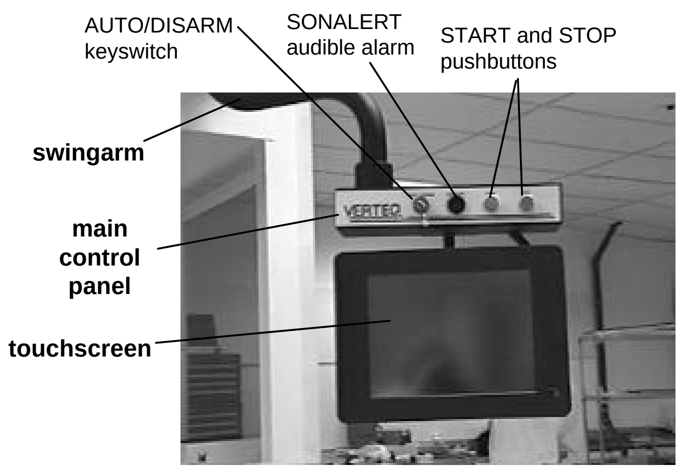
One thousand.

keyboard (external)

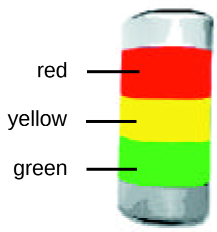
Typically located in the input module, this keyboard can be used to enter data and respond to touchscreen prompts. This keyboard is less convenient than the keyboards displayed on the touchscreen and is not normally used for wafer processing. The external keyboard, not the touchscreen keyboard, is used to install the wet system software.

keyswitch

Two-position AUTO/DISARM switch located on the main control panel. For normal wet-system operations the keyswitch is kept in the AUTO position. When the keyswitch is turned to the DISARM position, the safety shields can be opened without causing a robot E-STOP. *This is a safety override that must be used with great caution.*



Operator Interface Assembly

<table>
<tr><th colspan="2">Features and Interlocks when keyswitch is at DISARM</th></tr>
<tr><th>Status Beacon</th><th>Interlocks</th></tr>
<tr><td>

Status Beacon</td><td>
A safety shield can be opened without causing an E-STOP.
Yellow light on the status beacon flashes.
Robot will complete a move in progress but will not respond to any automatic commands until the keyswitch is moved back to AUTO.
The robot will not respond to manual and joystick commands unless 1) the logged-on operator has special password permission to override this interlock and 2) a touchscreen prompt is acknowledged.
Exhaust flow will increase (for systems with exhaust control systems).
New lots cannot be entered.
</td></tr>
</table>

kHz — See kilohertz.

kilohertz (kHz) — A unit of frequency equal to 1,000 hertz.

kinematics — Study of motion without regard for masses or forces.

KOH — Potassium hydroxide.

L

Labyrinth Seal Plate
Disc-shaped plate made of polypro material. Filtered nitrogen gas flows through small holes in the plate, forming a gaseous barrier that seals the bowl from outside contaminants and keeping air and water in the bowl from escaping.

laminar flow
Flow of liquid or gases in a smooth pattern without turbulence.

LCD
Liquid crystal display.

LED
Light-emitting diode.

Li
Lithium.

Lid
Pneumatically operated cover used on heated tanks. Lids open and close automatically during processing. Lids can also be opened manually when the tanks are not allocated by using the forcing or macro-command functions on the applicable tank control screen. Major lid safety interlocks include:

- lid cannot be opened or closed manually at any time during an automatic recipe, even if the tank is empty
- lid will not open if the robot is moving toward it
- robot will not deliver product lots into a tank if its lid is not fully open.

A lid can be configured to remain open during processing and to close at specified temperature conditions. See tank configuration.

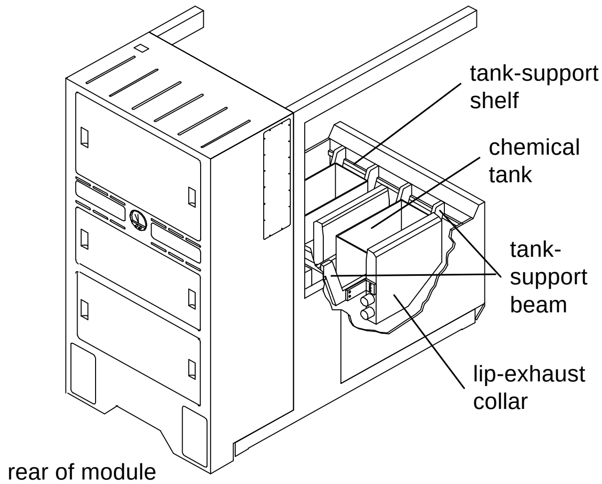
In semi-automated systems (in which the robot does not let go of cassettes during processing), an offset robot arm allows the effector to stay in the tank with the lid closed.

light point defect (LPD)
A feature (pit, particle, or peak) on a wafer's surface that causes light to be scattered from measurement tools that look for surface imperfections.

light tree
See status beacon (preferred term).

lip-exhaust collar
A mechanical structure mounted on the right and left sides of a chemical tank to create a local exhaust system. The lip exhaust system captures fumes from the process tank and draws them at an accelerated rate into the exhaust stream for removal from the module. The process localizes the chemical vapor and minimizes contamination of other components. When a lip-exhaust collar is present, a "deckless" system (a local exhaust system without a decktop) can be used.

Also see for exhaust flow patterns.



Typical Deck-less Module
(with local exhaust system)

lithium

Li.

Lithographic

A method of defining semiconductor patterns on wafers by use of a thin film of resistant material.

Load

Transducer.

local- and remote-mode operation

The wet system operates in either local or remote mode. The wet-system control system boots up in local mode, but remote-mode operation can be selected in the touchscreen Operations menu. Mode selection is a password-protected operation. In local mode, the wet system is controlled entirely through the touchscreen and external keyboard.

In remote-mode operation, the wet system is partially controlled through a host computer, which can:

- enter product lot IDs and select recipes
- monitor real-time touchscreen displays and log system events in automatically generated files
- receive "lot complete" messages
- add new recipes to control software

The wet system can be operated in only one mode at a time. Both local- and remote-mode processing typically involve a floor operator. In remote mode, the host-computer operator enters product lot IDs and recipes through the host computer; the floor operator monitors the process, acknowledges touchscreen prompts, and loads and unloads product lots.

Remote-mode operation requires a SEMATECH SECS-II compatible program on the host computer. For technical specifications, refer to *SECS-II Host-Cell Controller Interface*.

local exhaust system

An exhaust system that captures contaminants at or near their source for removal from the module.

Also see lip-exhaust collar; decktop.

local mode

See local- and remote-mode operation.

lockout box Mechanical box or device used as a safety precaution to prohibit a system being powered on by someone other than the service personnel.

Lockout / tag Program A program to protect employees from injury caused by the unexpected energization or startup of equipment or the unexpected release of stored energy.

lot See product lot.

lot threading Concurrent processing of multiple product lots. Automated wet systems have the lot-threading capability; manual and semi-automated wet systems do not.

Also see automated wet system; semi-automated wet system; manual wet system.

LPD See light point defect.

lpm Liters per minute (gpm x 3.786 = lpm).

LS byte Least Significant Byte

LSI Large Scale Integration

M

m

Meter. Also stands for milli, a prefix for one-thousandth.

mA

See milliampere.

macro command buttons

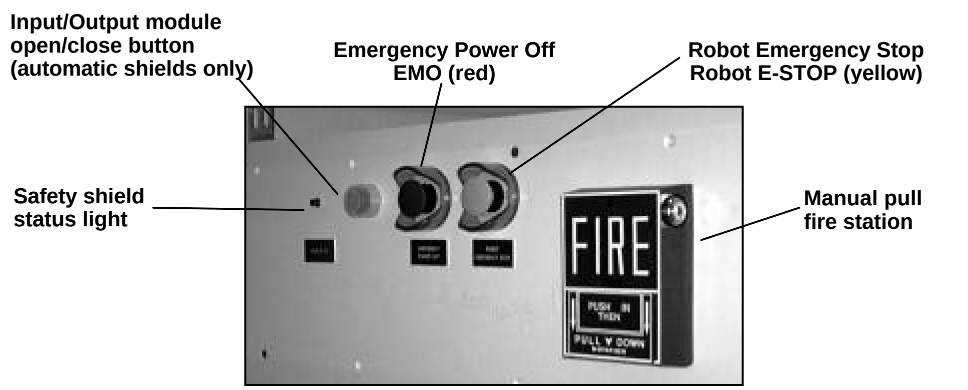
CAUTION
Macro commands override automatic operations and can cause serious operating errors. DO NOT use macro command buttons when the wet system is running an automatic recipe.

Macro commands launch operational sequences that are defined in tank configuration and recipe management, as well as default sequences set in the control system.

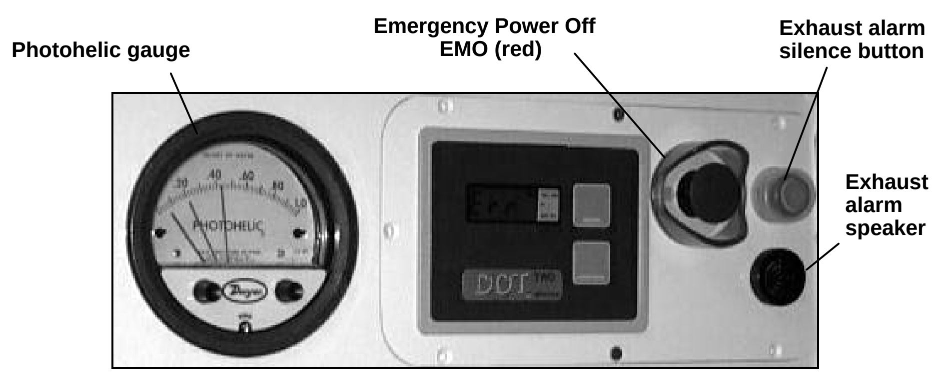
manifold

A pipe fitting with several lateral outlets used to connect one pipe with others.

manual controls (pushbuttons)



Typical Front Panel Controls



Typical Rear Panel Controls

manual fill

Requires an operator to pour chemical directly into a wet-system tank.

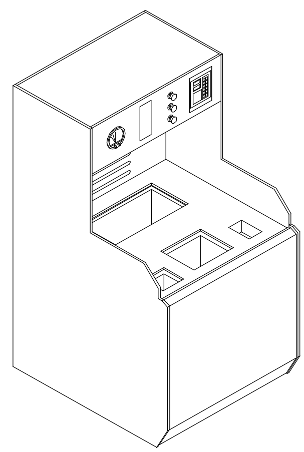
Also see bulk fill.

manual wet system (MWS)

Manual wet systems have the following features and capabilities:

- Manual wet systems are operated entirely by an operator. They have no robot or other independent automatic control systems. They may contain a touchscreen and a cell controller.
- The operator times the processes and transfers cassettes from one process to another.
- Tanks are arranged either end to end or in a front-to-rear arrangement.
- The product lot begins in a dry state and ends in a wet state. The wet system has **no** dry in-dry out capability (the operator removes the cassette from the final rinse tank and transfers it to the spin rinser/dryer (SRD) as the final processing step).
- Only one product lot is processed at a time. The operator transfers cassettes through all processing steps.

Also see wet system; automated wet system; semi-automated wet system.



Typical Manual Module

Manufacturing Engineering Order (MEO)

See document control.

manufacturing resource planning II (MRPII)

A computerized system of controls and planning techniques for all of manufacturing.

Also see material requirements planning.

Marangoni dryer

A drying technique that uses isopropyl alcohol (IPA) and the surface tension of DI water to dry wafers.

mask

A thin sheet of metal foil perforated with holes, used to protect specific areas of the product during a deposition process.

Also see photomask; etching.

material requirements planning (MRP)
A computerized planning system used by manufacturing for production control. MRP is one part of a larger manufacturing resource planning system, manufacturing resource planning II (MRPII).

material safety data sheet (MSDS)
The primary written means of conveying information concerning chemical hazards. Includes information on the properties and hazards of the chemical.

Max Metering Pump Count
The pump counter tracks the pump's operational cycles. Trebor pumps use a pressure sensor, mounted on the pump's exhaust side, to sense the movement of the pump bellows. Iwaki pumps use a proximity sensor to sense the pump's strokes.

MCS
See megasonic cleaning system.

megahertz (MHz)
A unit of frequency equal to 1,000,000 hertz.

megasonic cleaning system (MCS)
The cleaning system inside a process tank that uses the action of megasonic waves to force particles off wafers (or other substrates). Also known as megasonics.

The system cleans by vibrating a transducer crystal at its resonant frequency, which generates waves of sonic energy through a liquid solution. The high-energy waves repeatedly strike both sides of the wafers immersed in the cleaning solution. Liquid diffuses between particle and device and acts as a wedge, lifting particles and suspending them in the cleaning solution.

The system cleans with no moving parts. The quartz lens disperses high-frequency energy through the cleaning solution and across the face of the wafers, making chain drive, stepper motor, and other transport systems unnecessary.

megasonics
See megasonic cleaning system.

megohm (W)
A unit of resistance equal to 1,000,000 ohms.

menu
Options displayed on a screen.

MEO
Manufacturing Engineering Order. See document control.

metallic element
An element that is distinguished from a nonmetallic one by its iridescent and reflective properties, malleability, ability to conduct electricity, and ability to form positive ions.

metallurgical fabrication
The fabrication of semiconductors, employing the science and technology of metals as conductors.

metering
See metering pump.

metering pump
A metering pump is used in the wet system for two purposes: (1) to release a specified amount of chemical into a chemical bath during initial fill (*metering*), and (2) to add a specified amount of chemical to the chemical bath to maintain chemical concentration during processing (*spiking*).

mho (u)
A unit of electrical conductance. Reciprocal of ohm.

MHz

See megahertz.

micron (μ)

Unit of length equal to one millionth of a meter (10^{-6} m), one thousandth of a millimeter, and 0.000039 inch. Used for measuring size of particles. Also known as *micrometer* (μm).

milliampere

A unit of current equal to one-thousandth of an ampere (10^{-3} ampere). Abbreviated mA or milliamp.

mini-environment

An enclosed-system process environment that has controlled temperature, relative humidity, differential pressure, and exhaust flow.

Also see local exhaust system; exhaust alarm and control systems; exhaust flow patterns.

MIS

Management information system.

MK Safe

Make Safe

mm

Millimeter. To convert millimeters to inches, multiply by 0.0394.

MNPT

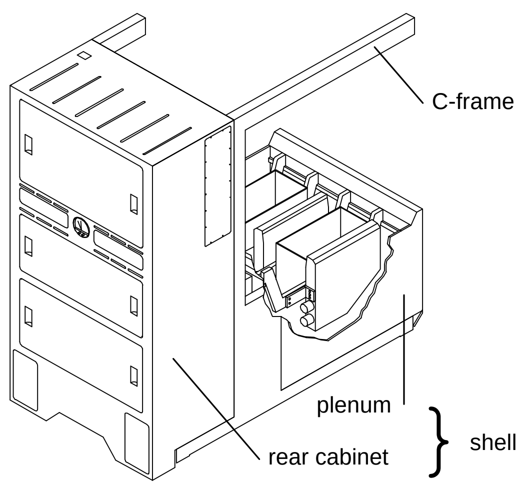
Male national pipe tread.

module

A group of interconnected wet-system devices that perform a process unit-operation (for example, an SRD module spins, rinses, and dries wafers). Several modules are connected to form a complete wet system.

A typical module (see drawing) is composed of a shell (rear cabinet plus plenum), C-frame, and internal equipment associated with the specific module.

Also see process module.



Typical Module

module, front access

See front-access module.

module, process	See process module.
module, rear access	See rear-access module.
monitor wafer	A control wafer used as a starting foundation.
mounting, robot	See robot mounting.
mounting, wet-system	See wet-system mounting.
mouse	Used for the *optional* screen editor utility, and in the timing diagram in recipe management for VcS wet systems.
MRP	See material requirements planning.
MRPII	See manufacturing resource planning II.
MS	Magnetic switch.
MS Byte	Most Significant Byte
MSDS	See material safety data sheet.
MTBA	Mean time between assists.
MTBF	Mean time between failures.
MTTR	Mean time to repair.
MV2	Metering Valve number 2
MWS	See manual wet system.
MWSF	Manual wet system, front access.
MWSR	Manual wet system, rear access.

N

N_2

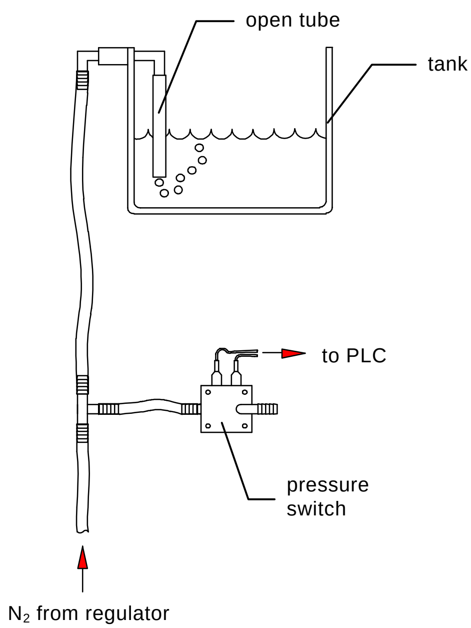
See nitrogen gas.

N_2 bubbler level sensors

The device that senses liquid level in a tank (see drawing).

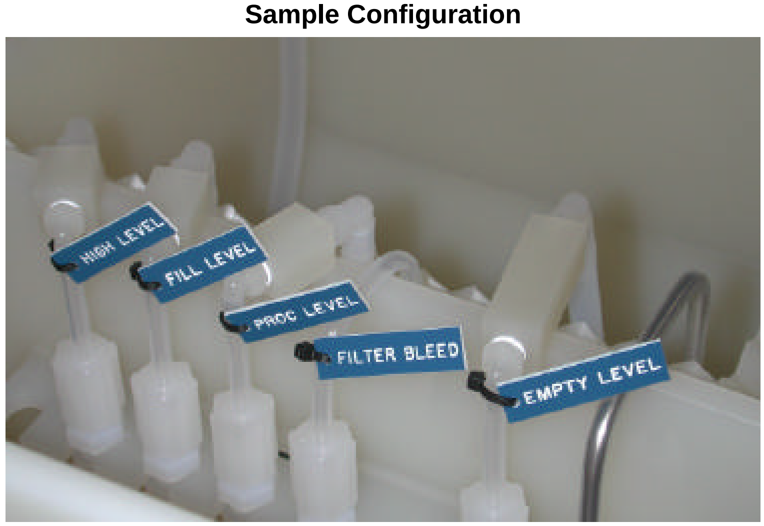
The N_2 bubbler senses liquid level in the following manner: The pressure switch monitors the pressure differential (ΔP) between the hydrostatic fluid pressure in the tank and the ambient atmospheric pressure in the plenum.

When fluid covers the open end of the tube, the switch senses backpressure of the fluid and closes. If the fluid is not present, there is no backpressure and the switch opens.



N_2 Bubbler Level Sensing

Sample Configuration



Available Level Sensors and Functions

EMPTY LEVEL
- Used in PLC logic *drain sequence*
- Used for hardware interlock for external *heater/chiller*
- Needed for every type of chemical tank (not QDR's or VcS tanks)

LOW LEVEL
- Used for hardware interlock for *Megasonic* transducer (chemical or QDR tanks)
- Used for hardware interlock for quartz tank *blanket heater*

PROCESS LEVEL
- Minimal level for *wafer coverage*
- Used for software interlock for recirc pump
- Used for software interlock for in-line heater (including external heater/chiller); in-line heater hardware interlock is capacitance sensor in recirc fluid path
- Combined with LOW LEVEL in static quartz tank to cover wafers and blanket heater

FILL LEVEL
- Used with *bulkfill* in PLC logic prep sequence (also used for manual pour systems)
- Used as *topoff* level (for DI or chemical)

MAX LEVEL
- Used only with *HF concentration* monitoring & control

HIGH LEVEL
- Used as *overfill* level – alarm condition
- Used with every type of chemical tank (not QDR's or VcS tanks)

Level Sensors Baseline Configurations

Process Tank Type	**Levels Used**
APM with: • Bulkfill • Recirc • Megasonic • 0°C to 100°C • PVDF	**Empty** **Low** **Process** **Fill** **High**
HF with: • Bulkfill • Recirc • Concentration Monitor • 0°C to 100°C • PVDF	**Empty** **Process** **Fill** **Max** **High**
HP or **SPM** with: • Bulkfill • Recirc • High Temperature >100°C • Quartz	**Empty** **Low** **Process** **Fill** **High**
HP or **SPM** with: • Bulkfill • Static • High Temperature >100°C • Quartz	**Empty** **Low** (can serve as Process Level if using only four levels) **Fill** **High**
QDR with: • Megasonic	**Low** **Process**

N_2 Flowmeter Cylindrical-shaped device with a metal bead inside that moves on a graduated scale.

N_2O Nitrous oxide.

NaCl Sodium chloride.

NAK Information has been received but is incorrect.

NAN Nano strip. See chemical process.

nano strip See chemical process.

NaOH Sodium hydroxide.

native oxide Thin oxide layer grown during wafer processing.

native oxide etch (NOE) See chemical process.

NEC National Electrical Code.

nest, product See product nest.

NFPA National Fire Protection Association.

NH_3 Ammonia.

NH_4Cl Ammonium chloride.

NH_4F Ammonium fluoride.

NH_4OH Ammonium hydroxide.

$NH_4S_2O_2$ Ammonium persulfate.

NIOSH National Institute for Occupational Safety and Health.

nitric acid HNO_3.

nitride Compound of metal with nitrogen; formed by passing nitrogen over heated metal. Used in semiconductors to cause hardening or to form insulating layers.

nitride etch Chemical process that removes part of the nitride layer on a wafer. This process uses the same chemistries as nitride strip, but for shorter process times. See chemical process.

nitride strip Chemical process that removes all of the nitride layer on a wafer. See chemical process.

Also see temperature control for nitride-strip processes.

nitrogen gas (N_2)	A very clean inert gas.
nitrous oxide	N_2O.
NOE	Native oxide etch. See chemical process.
NOSPR (SRD)	Number of steps per recipe.
NPP	Natural polypropylene.
NVR	Nonvolatile residue.

O

O_2 Oxygen.

O_3 Ozone.

obstruction sensor (OS) A sensor on the robot arm that detects an object in the robot's path (when the object touches the arm), and stops the robot. The obstruction sensor, which is wired in series with the robot E-STOP circuit, helps assure that robot operation is safe.

Types of obstruction sensors include:

- *vertical obstruction sensor (VOS)*, which detects objects in the robot's vertical path,
- *horizontal obstruction sensor (HOS)*, which detects objects in the robot's horizontal path, and
- *obstruction sensor (OS)*, which detects objects in both the vertical and horizontal path of the robot.

OEM Original Equipment Manufacturer.

OFA Oil Free Air.

OFR Overflow rinse. See chemical process.

ohm (W) A unit of electrical resistance.

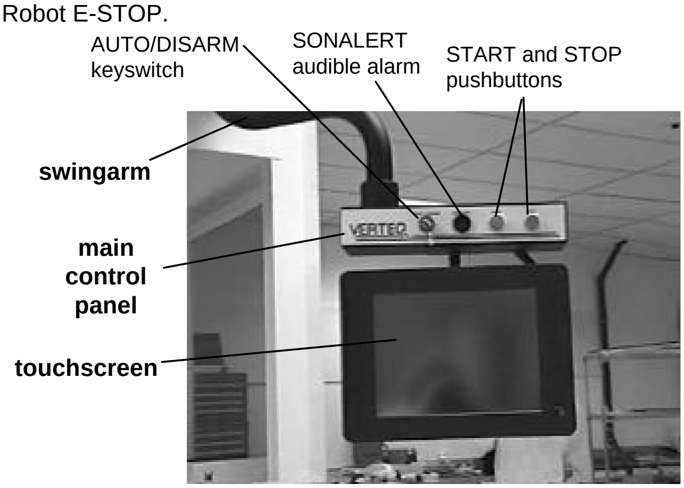
OIA See operator interface assembly.

operator controls See operator interface assembly.

Operator interface assembly (OIA) The main operator controls on a typical wet system are located on the operator interface assembly.

The operator interface assembly usually includes the *main control panel* (with keyswitch, audible alarm, and start and stop pushbuttons), and the *touchscreen* (see photo).

Also see interface; other operator controls: EMO, robot joystick, keyboard (external), mouse, and Robot E-STOP.



operator interface panel (OIP)

See operator interface assembly (OIA).

operator interface touchscreen

See touchscreen (preferred term).

opto-isolator

A solid-state relay with no moving parts; a light-emitting diode focused at the base of the photo transistor to control current flow.

organics

Chemical compounds based on carbon rings or chains and containing hydrogen.

organics strip

A chemical process used to strip organics.

OR-OSHA

Oregon Occupational Safety and Health Administration.

OS

See obstruction sensor.

oscilloscope

Electronic test device used to display voltage vs. time, signals, or waveforms for identification and accuracy

OSHA

U.S. Occupational Safety and Health Administration.

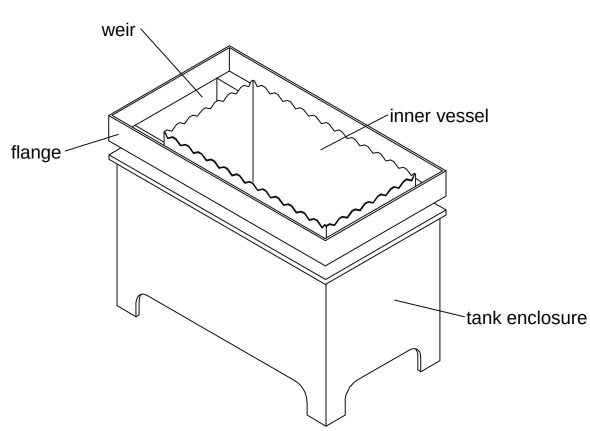
OT

Overtemperature controller.

overflow

Liquid that flows over the top of a tank.

- In a chemical tank, the liquid flows over the top of the inner vessel into the weir (see drawing). *Input overflow* occurs when a loaded cassette is placed in the tank. *Recirculation overflow* occurs during normal recirculation.
- In a rinse tank, the liquid flows over the top of the tank directly into the plenum. The durations of pre-, process-, and post-overflow for a rinse tank are set in the recipe configuration.
- Rinse tanks can be equipped with high-and low-flow rates. High flow is used in filling the tank; low flow is used to conserve DI water after the tank is filled.



Chemical Tank (showing weir)

overflow rinse (OFR)
DI water is added to the tank at the bottom in a single-pass rinse until it runs over the edge of the tank and into the plenum. No megasonics and no quick dumps are involved.

Also see overflow; chemical process.

overtravel switch(es)
Switches located on the far ends of each robot axis rail. When contacted by the robot, the robot stops moving.

oxidation
A reaction with oxygen that forms an oxide, such as nitrous oxide (N_2O), carbon dioxide (CO_2), or silicon dioxide (SiO_2).

oxide
Binary compound of oxygen.

oxide etch
See etching; chemical process.

oxide layer
A layer of oxide on or in the wafer.

oxygen
O_2.

ozone
O_3.

P

PAN
Phosphoric acetic nitric etch. See chemical process.

parked
1. A device is powered but is not ready for use, and all physical movement is stopped (for example, a tank is powered but is not prepped, and no wafers are currently being processed in the tank).
2. Robot is raised to the carry height and is not moving.

particle
An unwanted impurity that contaminates the wafer's surface.

particle count
The number of particles in a particular location in the cleanroom or on the wafer.

Also see cleanroom classification.

PCB
Printed circuit board.

PEC
Process enhanced cassette.

Also see cassette.

PEEK
Polyetheretherketone.

PEL
Permissible exposure limit.

perfluoroalkoxy (PFA)
See "Teflon."

personal protective equipment (PPE)
Equipment such as goggles, gloves, and respirators that are necessary to protect employees from hazards.

PFA
Perfluoroalkoxy. See "Teflon."

pH
The scale (0-14) used to measure acidity and alkalinity. (<7 = acidity; 7 = neutral; >7 = alkalinity)

phos
Hot phosphoric acid. See chemical process.

phosphoric acetic nitric etch (PAN)
See chemical process.

phosphoric acid
See H_3PO_4.

photolithography
The process in which a thin layer of photographic chemicals (photoresist) is applied to the surface of a semiconductor substrate. A pattern is optically reproduced on film and transferred from the film to the wafer, later becoming the physical circuits.

photomask

A film or glass negative or positive used as a template for projecting an image onto a substrate. Light patterns projected through this mask onto the substrate produce subtle changes which, when exposed to specific chemicals, corrode and are washed away, leaving layers of metal that form electronic circuits.

photoprocess

A process that uses light to cause a chemical reaction.

photoresist

The light-sensitive, organic material deposited on the wafer surface during photoprocessing, certain portions of which may be dissolved after exposure to light to form a patterned mask.

PID parameter setup

Proportional-integral-derivative (PID) control systems. Also see scaling factors.

NOTE
Conventional PID control systems include **p**roportional, **i**ntegral, and **d**erivative functions. GFT uses a modified PID control system, which includes *only* the proportional and integral functions. However, GFT documentation uses the full acronym, PID, because it is commonly recognized in manufacturing industries.

The temperature in process tanks is controlled by a proportional-integral loop within the PLC program.

The PID Parameter screen defines the default values for controlling process temperatures. The values entered are used by the PID in a mathematical formula that determines an **output value**. The output value is a combination of:

- error (proportional value of the actual temperature relative to the process-temperature setpoint) and
- integral (accumulation of the error over time).

This output value, derived from the mathematical formula is used in one of two ways:

- **Standard** PID loop
- **Inverse** PID loop

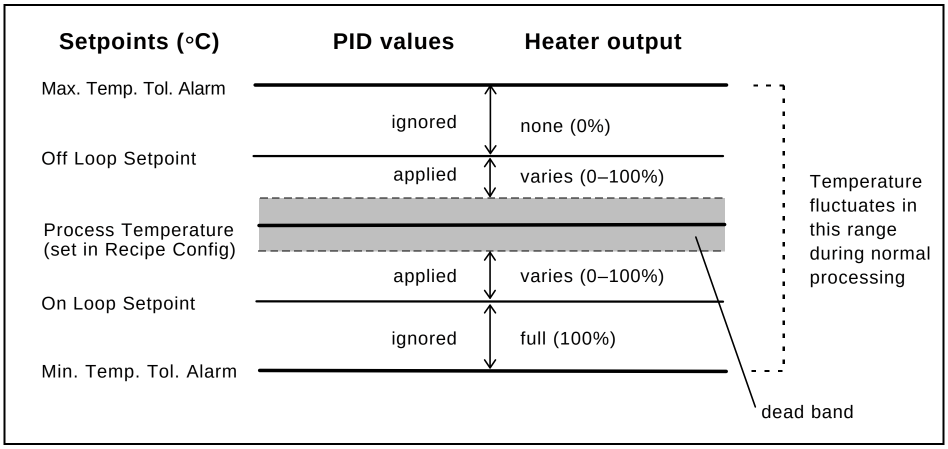
Standard PID Loop

The output value, through the PLC program, is converted to a control signal which drives the heater from 0 to 100% capacity, depending upon how close the current temperature is to the process-temperature setpoint. The process temperature (set in recipe configuration) is monitored and reported to the PID in real time, from a scaled input.

Inverse PID Loop

In this approach, used in nitride-etch processes, the heater is fully off when the tank content temperature is at or above the recipe setpoint. When the temperature of tank contents drops below the process setpoint, the heater comes on at 100%. The output value is subtracted from the whole integer **1** (1 - (output value) = the inverse output value). This inverse value, through the PLC program, is converted to a control signal which drives the DI inject devices to maintain the process temperature. The process temperature is monitored and reported to the PID in real time, from a scaled input. (Also see *temperature control for static-bath nitride-strip processes.*)

The remaining PID discussion is true for both PID loop versions.



PID-loop adjustments minimize over- and under heating to help stabilize tank temperature as rapidly as possible.

PID Parameters are described below:

Max Integral/Min Integral is used in calculations to determine the heater's reaction speed to PID outputs. The default values shown are usually adequate for tank heating and should be changed only by qualified personnel with an understanding of PID operation (see "Tips" below).

Integral Time is the time period at which the PID makes temperature corrections. When the current temperature is within the deadband range, no significant corrections take place. In the setup screen example shown above, the PID will make temperature corrections every 4.5 seconds. (Note that the Integral Time shown on the PID Setup screen is 45, which is equivalent to 4.5 seconds. To convert integral time into seconds, multiply the value for Integral Time as shown on the PID Setup screen by 0.1; in this example, 45 x 0.1 = 4.5 seconds).

Integral Value is the amount the PID output value is adjusted at each temperature correction when it is measuring temperatures between the On Loop and Off Loop setpoints (excluding the dead band).

Proportional Gain is a sensitivity factor used in the PID calculation. The Proportional Gain value is set at the factory and fine-tuned during on-site installation. It should not require adjustment unless the heater is replaced or the system is modified.

On Loop Setpoint. Below this temperature, the heater comes on at 100% output and the PID values are ignored.

Off Loop Setpoint. Above this temperature, the heater's output is 0% and the PID values are ignored.

NOTE
Between On Loop Setpoint and Off Loop Setpoint, the PID values are used to proportionally adjust the heater output, or for the Inverse PID loop, DI water inject.

Dead Band is the range of plus and minus values around the process temperature in which the PID makes no changes to the heater (or DI water inject) output.

Rcp. Tolerance (recipe tolerance). This parameter is used only on PID setups for staging tanks. This temperature of chemical in a staging tank must be at the chemical tank's process temperature, plus or minus the Rcp.Tolerance value (±°C), before it can be released to the process tank.

NOTE
The Min./Max. Temp. Tol. Alarm must be greater than the Temperature Tolerance parameters set in recipe management. For example, if the Temperature Tolerance is set at 5°C, and the PID Min./Max. Temp. Tol. Alarm is set at <5°C, a temperature error can occur even when the temperature of tank contents is within the recipe's allowable range.

Min./Max. Temp. Tol. Alarm is the allowable range in which the temperature can fluctuate without causing an alarm. In the example shown above, an error is generated if the temperature is 5°C above or below the process temperature. This function becomes operable *after* the process temperature is initially reached, to prevent unnecessary errors during startup.

Typical PID settings

These values are typically set at the factory before on-site installation adjustments.

Parameter	DHF Tank	HP Tanks	APM Tank
Max Integral (1-100)	80	80	80
Min Integral (1-100)	20	20	20
Integral Time (0.1 sec)	150	250	250
Integral Value	2	10	10
Proportional Gain	100	2	2
On Loop Setpoint (C)	0.30	2.50	2.50
Off Loop Setpoint (C)	0.20	0.50	0.50
Dead Band (C)	0.20	0.50	0.50
Min. Temp. Tol. Alarm	0.50	3.00	3.00
Max. Temp. Tol. Alarm	0.50	3.00	3.00

Tips for Setting PID Parameters

The typical values should be adequate for initial chemical testing. Proportional Gain and Integral Time are usually the only values that need adjustment. In general, when configuring process temperature, measure the actual temperature over time to understand the physical limitations of the environment. If adjustments are needed, change only one parameter at a time. Slight changes may have large effects over long periods of time. It is a bad idea to change too many parameters in a short time span.

Proportional Gain: A value of one (1) is usually adequate for all tanks. To increase PID reaction time, increase this value by one whole number at a time and observe the response. A slow-acting PID works best with low- to high-temperature recipes.

Integral Time: Values between 45 and 60 (4.5 to 6 seconds) cause slow integral control. Adjustments to Integral Time are the best way to narrow the temperature's oscillation around the process temperature.

piranha strip

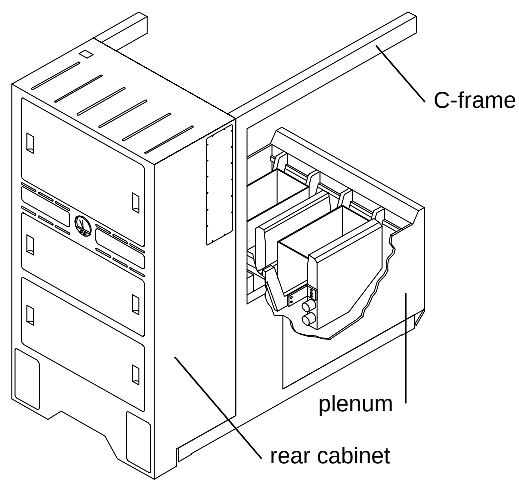
See chemical process.

PLC

Programmable logic controller. Controls individual devices (valves, pumps, process monitoring equipment) through input/output signals; provides timing and counting for process controls; and provides real-time information to the cell controller.

plenum

The area of the module around and beneath the process tanks or process plumbing. Sometimes refers to the floor of the module. See drawing.



plenum float

A level indicator inside the plenum that detects liquid height or volume.

PM

Preventive maintenance.

PMs

Particle monitors.

polypropylene

A hard, resinous material that resists moisture, oils, and solvents and can withstand temperatures up to 170°C. Transport cassettes and the wet-system shell are typically made of polypropylene.

polytetrafluoroethylene

PTFE.

Also see "Teflon."

port

An opening, such as the QDR drain port.

postmetallic strip A chemical process that removes excess metals after a metal-deposition process.

potassium hydroxide KOH.

POU, POUG Point of use, point-of-use generator.

pounds per square inch absolute (psia) Pressure measurement that utilizes a complete vacuum as a reference, or zero point.

pounds per square inch differential (psid) The difference in pressure between two points in a fluid-flow system, measured in pounds per square inch.

pounds per square inch gauge (psig) Pressure measurement that utilizes ambient (surrounding) pressure as a reference, or zero point. Ambient pressure is 14.7 psia, which would be 0 psig.

power tune Function performed in Megasonic applications where algorithmic power table is written in addresses of battery-backed RAM.

PP Peak to peak

ppb Parts per billion.

PPE See personal protective equipment.

PPID Recipe number

ppm Parts per million.

ppt Parts per trillion.

prediffusion clean A cleaning process that cleans the wafers before the diffusion process is performed. Typical cleaning agents are SPM, DHF, APM, and HPM.

PREP Prepare. A selection on the touchscreen that automatically prepares tanks (fill level, temperature, and related process conditions) and other devices for processing wafer lots.

pressure, differential See differential pressure.

process, processing

1. (noun) In semiconductor manufacturing, any series of operations used to strip, etch, clean, rinse, and dry the product (typically silicon wafers) by moving it through chemical baths, DI-water rinses, and drying cycles.
2. (verb) To perform the series of operations listed in no. 1.

Also see wet processing; chemical process; rinse process.

process area

See cleanroom, bay-and-chase.

process bath

See chemical bath (preferred term).

process cassette

See cassette.

process chemical

The chemical used during chemical processing. Some typical process chemicals include hydrofluoric acid (HF), hydrochloric acid (HCl), and nitric acid (HNO3).

Also see rinse chemical.

process enclosure

The enclosure around the process modules. This enclosure isolates the process environment from the operators and core (gray areas) of the cleanroom.

process environment

The environment inside the wet system where the wafers are processed (stripped, etched, cleaned, rinsed, and dried).

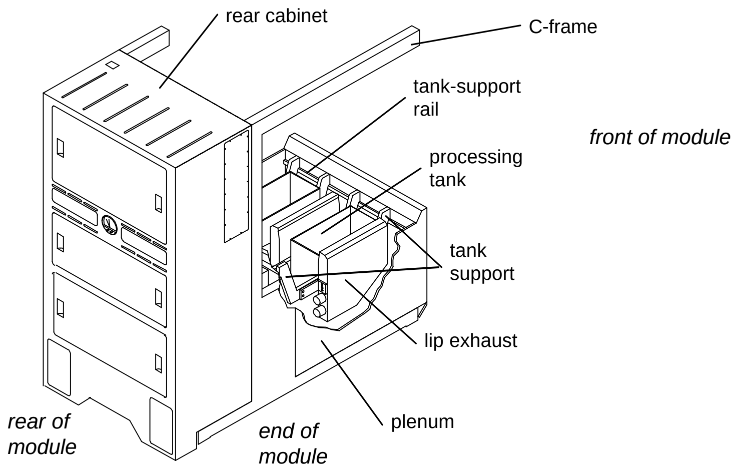
Also see product environment.

process liquid

See chemical.

process module

A module in which the product is chemically processed and rinsed.



process start/advance pushbutton

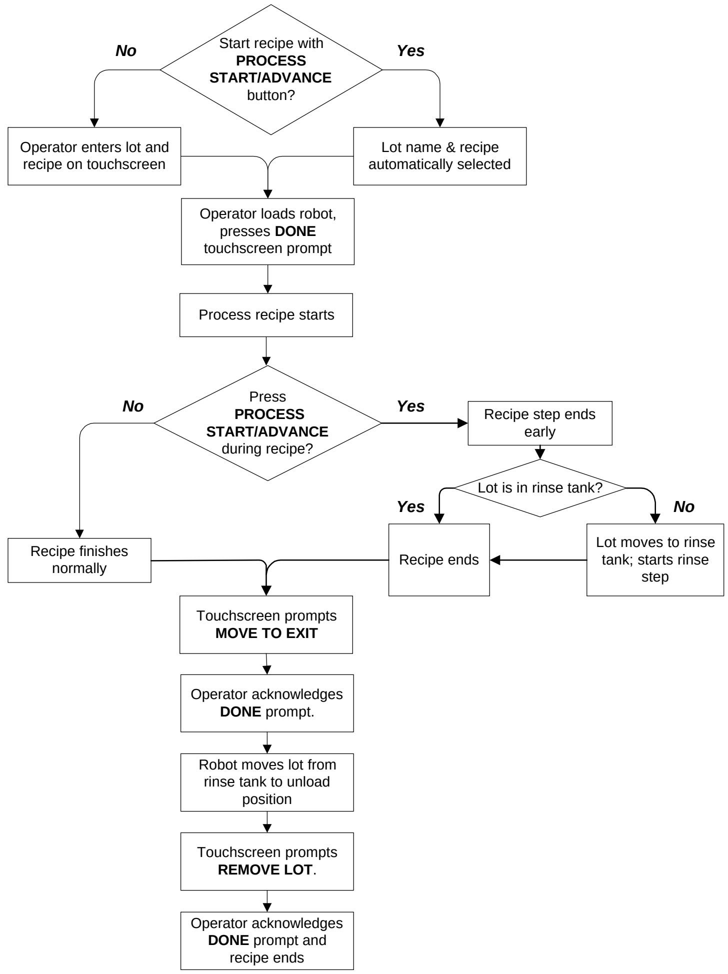
Optional pushbutton used on some semi-automated system. When pushed during an automated recipe, the step in progress finishes and the recipe advances to the next scheduled step. See operational sequences below for details.

Operational Sequences

Detailed flow charts and explanations of operational sequences for various wet system configurations. Specific operational sequences and associated control features are discussed below.

- Systems with PROCESS START/ADVANCE Button
- Systems without PROCESS START/ADVANCE Button
- Systems with In-Process Wafer View Capability

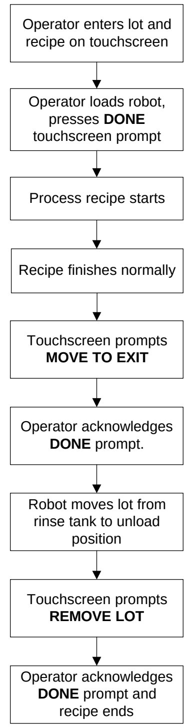
Semi-automated Wet Systems *with* PROCESS START/ADVANCE Button Operational Sequence



Semi-automated Wet Systems *with* (PROCESS START/ADVANCE Button) Control Features

Control Feature	Function
Touchscreen **DONE** prompt	Must be acknowledged to proceed to the next step. Operator may: • press the manual go button or • select DONE on the touchscreen.
PROCESS START/ADVANCE button	• Starts a recipe (automatically names lot and selects last recipe run). • Interrupts a step in progress and skips to the next step. • Acknowledges a touchscreen **DONE** prompt.
Indicator light on control assembly	• Flashes when **DONE** is displayed on touchscreen. • Steady illumination during a step in progress.
NOTE: Systems may be configured to end a recipe by acknowledging the **MOVE TO EXIT** prompt, bypassing the last **REMOVE LOT** prompt.	

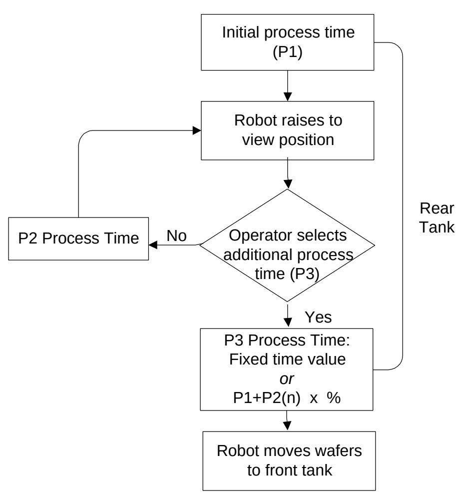
Semi-automated Wet Systems *without* PROCESS START/ADVANCE Button Operational Sequence



Semi-automated Wet Systems *without* PROCESS START/ADVANCE Button

Control Feature	Function
Touchscreen **DONE** prompt	Must be acknowledged to proceed to the next step.
Indicator light on control assembly	• Flashes when **DONE** is displayed on touchscreen. • Steady illumination during a step in progress.
NOTE: Systems may be configured to end a recipe by acknowledging the **MOVE TO EXIT** prompt, bypassing the last **REMOVE LOT** prompt.	

Semi-automated Wet Systems with In-Process Wafer View Capability Operational Sequence



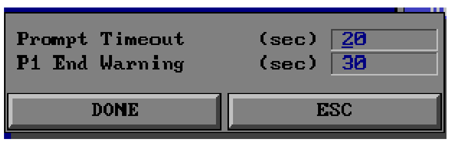
Operational Sequence (In-Process Wafer View)

1. Robot agitates wafers (moves vertically in and out) in rear tank for length of time set in P1.
2. Before P1 times out, operator is alerted that P1 is about to expire.
3. When P1 times out, robot raises above rear tank and pauses for operator to visually inspect wafers. The next step is operator-dependent (see following table).

If operator selects P3:	If operator *does not* select P3 within preset time (Prompt Timeout):
• robot moves back into rear tank for P3 • when P3 finishes, robot moves wafers into front tank	• robot moves back into rear tank for time set in P2 • when P2 finishes, robot raises above rear tank and pauses for visual inspection of wafers • this sequence repeats until operator selects P3

Configurable Recipe Timing Parameters

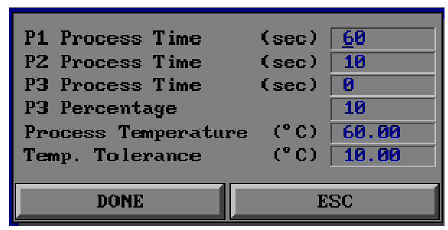
Tank Configuration Menu



Prompt Timeout: Length of time robot pauses above tank 1 for wafer inspection. If operator does not select P3, P2 occurs after this timeout. This automatic P2 selection repeats until the operator selects P3.

P1 End Warning: Time when a notification alerts operator that PI is about to finish.

Recipe Configuration Menu



P1 Process Time: Process time in tank 1.

P2 Process Time: Additional process time in tank 1.

P3 Process Time: Fixed process time. This supersedes P3 Percentage when any value other than zero is entered here. If both this item and P3 Percentage are set at zero, P3 process time defaults to 1 second.

P3 Percentage: Sets P3 process time as a function of total tank 1 process time. The value entered here sets a % multiplier:

$P3 = P1+P2_{(n)}$ %

---

process unit-operation

Physical transformation of the material (for example, etch or dry).

product

1. The substance (typically wafers) that is processed in the wet system.
2. The merchandise (such as wet systems and SRDs) GFT sells to its customers.

product environment

The environment immediately surrounding the product (typically wafers).

Also see process environment.

product lot

The group of wafers (or other product) inside a cassette that are processed in the wet system using a particular recipe. Also known as *lot*; *wafer lot*.

product nest

Area inside a tank where the cassette containing the product is placed. The nest holds the cassette to keep it from moving.

production summary

Wafer production summaries of log files can be viewed on the OIP and/or copied to a DOS disk and printed out using a standard word processor. Wet system **entry** and **exit** times of wafer lots and **alarms** during a 24-hour period are recorded by date and stored with ***.prd*** filename extensions in log files. See the Files section of the operations manual for a sample of the summary and how to view or print it out.

proportional-integral-derivative setup

See PID parameter setup.

psi

Pounds per square inch.

psia

See pounds per square inch absolute.

psid

See pounds per square inch differential.

psig

See pounds per square inch gauge.

PSW

Pressure switch

PTFE

Polytetrafluoroethylene.

Also see "Teflon."

pump counters

Pump counters track operational cycles of recirculation and staging tank pumps. Trebor pumps use a pressure sensor, mounted on the pump's exhaust side, to sense the movement of the pump bellows. Iwaki pumps use a proximity sensor to sense pump strokes. In both cases, a **Pump cycle count exceeded -- service required.** message is displayed on the touchscreen when the pump has operated for the configured number of cycles. This event may be configured as a Runout alarm, in which case the wet system will finish the lot(s) in process, but new lots cannot be entered until the alarm is cleared.

Pump cycles are shown in real time on the tank control screen. As the pump operates, the displayed number increments. All pump counters are set in tank configuration.

Pump counters are reset to zero by selecting **RESET** on the tank control screen. (It is also necessary to select **CANCEL** if this message is configured as an alarm.)

purge

purge3

A preprogrammed procedure (see *macro command buttons*) that drains and flushes a chemical tank with recirculating DI water in order to remove traces of chemical and contaminants from the tank and any associated recirculation system. Chemical tanks are purged before performing maintenance tasks to protect personnel from exposure to any residual chemical.

A tank will have one of two purge routines: PURGE or PURGE3. Their operational sequences differ according to their plumbing hardware. Both can use cold, ambient, or heated DI water. View the tank's control screen to find out which type of purge routine is used. The PURGE macro command button indicates the tank is using the standard purge routine for standard plumbing hardware. The PURGE3 button indicates the tank is using the “three-way” valve purge routine for multiple-valve plumbing hardware.

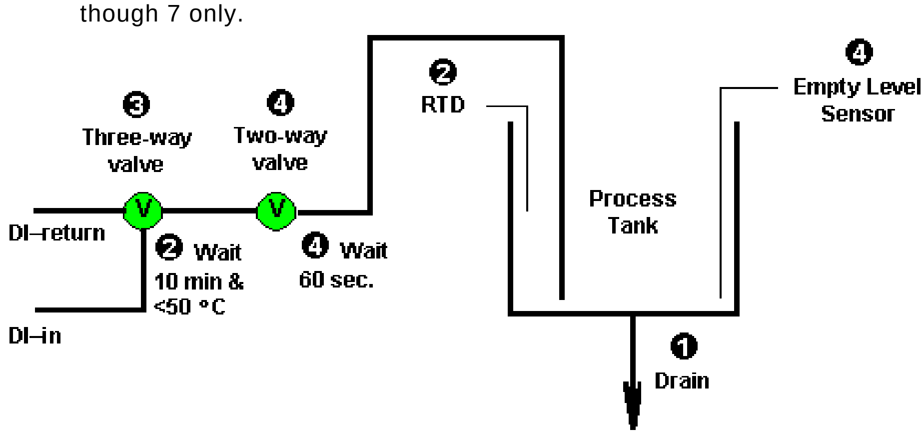
Pressing the PURGE (or PURGE3) macro command button on the tank control screen initiates the purge routine. Each routine is detailed below. The configuration items (such as length of time a pump operates or the number of times the purge routine repeats) of both purge routines are defined in Section 5 of the operations manual.

Standard PURGE routine:

1. Tank drains, if it contains any liquid.
2. Tank refills with DI water to its upper level (fill or process level).
3. Recirculation pump operates for a configurable length of time (see Section 5 for the *Purge Time* configuration item).
4. Tank drains.
5. Standard purge routine repeats for a configurable number of times (see Section 5 (AWS and SAWS) or Section 4 (MWS) for the *Purge Cycles* configuration item).

Three-way PURGE3 routine (see figure below)**:**

1. Tank drains, if it contains any liquid.
2. The purge3 routine waits for ten (10) minutes and monitors the tank temperature RTD to report a temperature of less than 50°C.
3. When 10 minutes have elapsed and the tank temperature reported is less than 50°C, a closed three-way valve opens and delivers DI water to a closed two-way valve.
4. The purge3 routine waits an additional 60 seconds, and:
   - At the end of this 60 second period, the two-way valve opens and delivers DI water to the tank.
   - During the 60 second period, if the Empty level sensor in the tank is triggered an alarm is sent and it is assumed that the two-way valve is leaking. Regardless of alarm status, the purge3 routine continues.
5. Tank refills with DI water to its upper level (fill or process level).
6. Recirculation pump operates for a configurable length of time (see Section 5 for the *Purge Time* configuration item).
7. Tank drains.
8. Three-way purge routine repeats for a configurable number of times (see Section 5 (AWS and SAWS) or Section 4 (MWS) for the *Purge Cycles* configuration item), but in the remaining purge cycles repeats steps 5 though 7 only.



PVDF

Polyvinyl difluoride or polyvinylidine fluoride.

Q

QA See quality assurance.

QC See quality control.

QD Quick dump. See quick dump rinse.

QDR Quick dump rinse. See chemical process.

QDR tank Tank that uses DI water to rinse wafers after treatment with chemicals. A large drain port in the bottom of the tank quickly opens to dump tank contents. DI water is sprayed on wafer lots during dumps.

QGS See quality gain share.

QNX The UNIX-based operating system used on GFT wet-system computers. This is a multitasking, micro-kernel operating system, designed specifically for message-passing functions, with its own complete command structure.

QTF See quality task force.

qualification Procedure to accept a wet-system product.

quality Product and service performance that result in customer satisfaction.

quality assurance (QA) A planned and systematic pattern of all actions necessary to provide adequate confidence that a product will conform to established requirements.

quality control (QC) A management function that includes estimating overall quality of the product and determining any changes needed to achieve or maintain the required level of quality.

quality gain share (QGS) A program established by GFT in 1991 that embraces various Total Quality Management (TQM) principles. The program is continually changing and is refined as a result of employee involvement and empowerment. Enables GFT to provide its customers with superior process solutions, products, and services. GFT employees: For complete details, obtain QGS packet from Human Resources.

quality task force (QTF) Various cross-functional committees established by QGS that concentrate on improving areas such as on-time shipments, supplier quality, and safety.

quartz lens Disperses high frequency energy through the cleaning solution.

queue The particular order in which cassettes are lined up for processing.

queue deck The platform inside the wet system where cassettes are placed in a particular order while awaiting processing, and where cassettes are placed after processing.

quick dump rinse (QDR) A rinse process in which a large drain port in the bottom of the tank quickly opens to dump tank contents. Also see QDR tank; chemical process.

R

RAM

See random-access memory.

random-access memory (RAM)

Computer memory that can be read from and written to. RAM is the main internal storage available to the user for programs and data; RAM files may be accessed in any desired order.

RCA1

See chemical process

RCA2

See chemical process

RCD

Rinse Clean Dryer. A Vendor Supplied device. This is a process tank in which the wafers are rinsed and dried. The tank is a dual-contained vessel with an integrated dump-drain valve. Included in the RCD system is an anti-static generator, liquid level and cassette proximity sensors. A lid is positioned on top. Both the IPA and N_2 gas injector nozzles are mounted underneath the lid. The lid is closed and opened by a pneumatic operated lever, which is controlled by the wet system’s cell controller, or can be manually opened from the wet system’s RCD tank control screen.

The RCD can use up to a 20-step recipe process. Each step defines one function. The function of each step is selectable, but only one function can be selected per step. The time, in seconds, to run each step is associated with the selected function.

read-only memory (ROM)

Computer memory that can be read from but not written to.

rear-access module

A module in which the plumbing and electrical compartments can only be accessed from the rear.

recipe

A sequence of processing steps with associated parameters (such as time, temperature, and fill level) used to process a product.

recirc

See recirculation.

recirc pump

See recirculation pump.

recirculation and draining of heated tanks

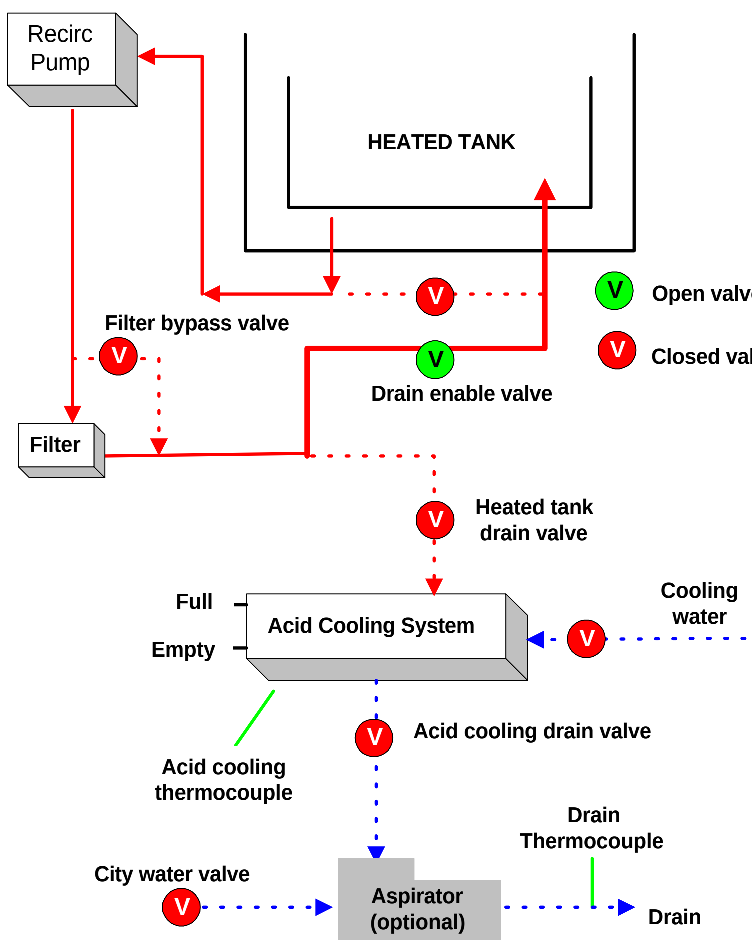
The process of removing contaminants (particles) from fluid by pumping liquid out of the tank's weir, through a filter, and back into the tank.

The process chemical in heated tanks recirculates continuously whenever it reaches the Process Level, regardless of whether a product lot is in the tank. The recirculation loop is shown by the solid lines in drawing to the left.

The filter bypass valve diverts chemical from the filter until it has reached an acceptable temperature. This feature is included if the unheated chemical has a high viscosity (is very thick). Without the bypass, chemical may barely flow through the filter until the heated chemical bath approaches process temperature. This function is configured in tank configuration.

During recirculation, the recirculation pump simultaneously pumps process chemical from the tank's inner vessel and the weir. The recirculation pump starts when the chemical falls below the Process Level. When the Low Level N2 bubbler trips, the drain timer starts.

Also see draining (heated tanks).



recirculation pump

The pump that recirculates liquid in the tank.

Also see recirculation; pump counter.

reclaim

To retrieve DI water normally destined for drainage and filtered and reprocessed. Reduces cost of DI production.

refill

To fill again.

REL
Recommended exposure limit.

remote mode
See local- and remote-mode operation.

Reset


Returns equipment to a specified state after a configured value (e.g. pump, SRD, or WTU cycle) has been reached. Touchscreen buttons on tank and device control screens enable quick resetting.

Also see *pump counters*.

resist
Coating placed on the wafer surface to prevent etching.

resistivity
The ability of a material (typically liquid when referring to wet processing) to resist passage of electrical current either through its bulk or on a surface; usually measured in megohms (MΩ).

resistivity probe
A device that measures resistivity of DI water for rinsing.

resist strip
See chemical process.

Respiratory Protection Program
Program to control occupational diseases caused by breathing air contaminated with harmful substances.

RET
Return. A command on a touchscreen menu.

reverse osmosis (RO)
The second step in the process of purifying water for use in semiconductor manufacturing. RO removes the bulk of ions, organics, bacteria, and particulates by forcing pretreated water under pressure through a semi-permeable membrane.

RF
Radio frequency.

rinse, cascade
See cascade rinse.

rinse chemical
Chemical (typically DI water or IPA) used in the rinse process. Also see process chemical.

rinse process
The process used to rinse the product. Typically performed after each chemical process. Also known as rinse, rinsing.

rinse, rinsing
Immersing the product in a rinse chemical, typically DI water or IPA, usually after each chemical process. Also known as rinse process. Also see quick dump rinse; overflow rinse.

rinse tank
Container in which the product is rinsed. Also see chemical tank.

rinse to resistivity
Resistivity monitors located on rinse tank exteriors measure the resistivity of overflowing DI water. Impurities increase conductivity. As chemical contaminants in the rinse water decrease, the resistivity rises. When a specified resistivity is reached, the rinse ends and the robot then transfers the product lot to the next position. Rinse to resistivity values are configurable on the touchscreen.

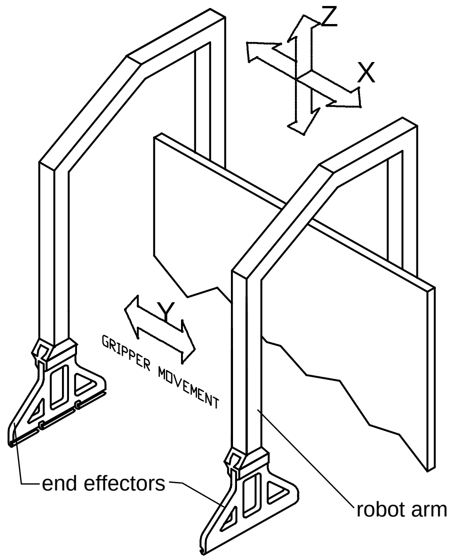
RO
See reverse osmosis.

robot axes

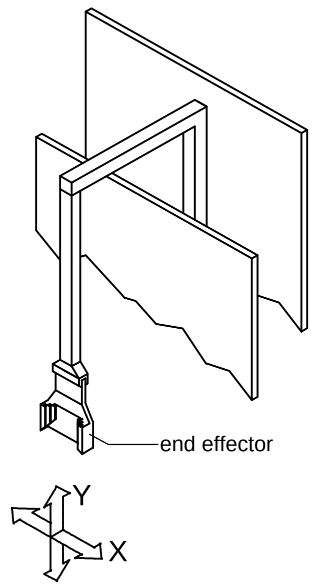
When referring to GFT wet systems, axes refers to the directional movement of the robot arms (X, Y, and Z axes).

On two-arm robots, the robot moves horizontally (X axis) and vertically (Z axis), and the arms move in and out to grip and release cassettes (Y axis). The in and out movement of the robot arms is called gripper movement.

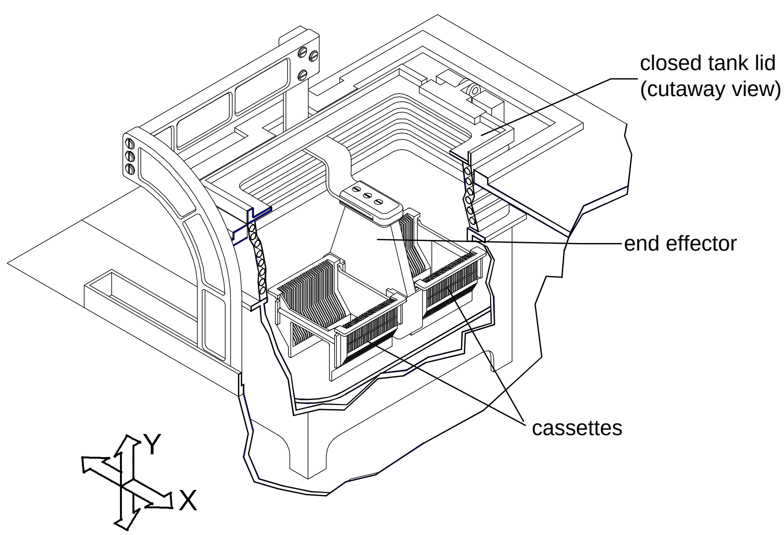
On one-arm robots, the robot moves horizontally (X axis) and vertically (Y axis), and there is no gripper movement. See drawings below.



Two-Arm, Three-Axis Robot
(used in automated wet systems)



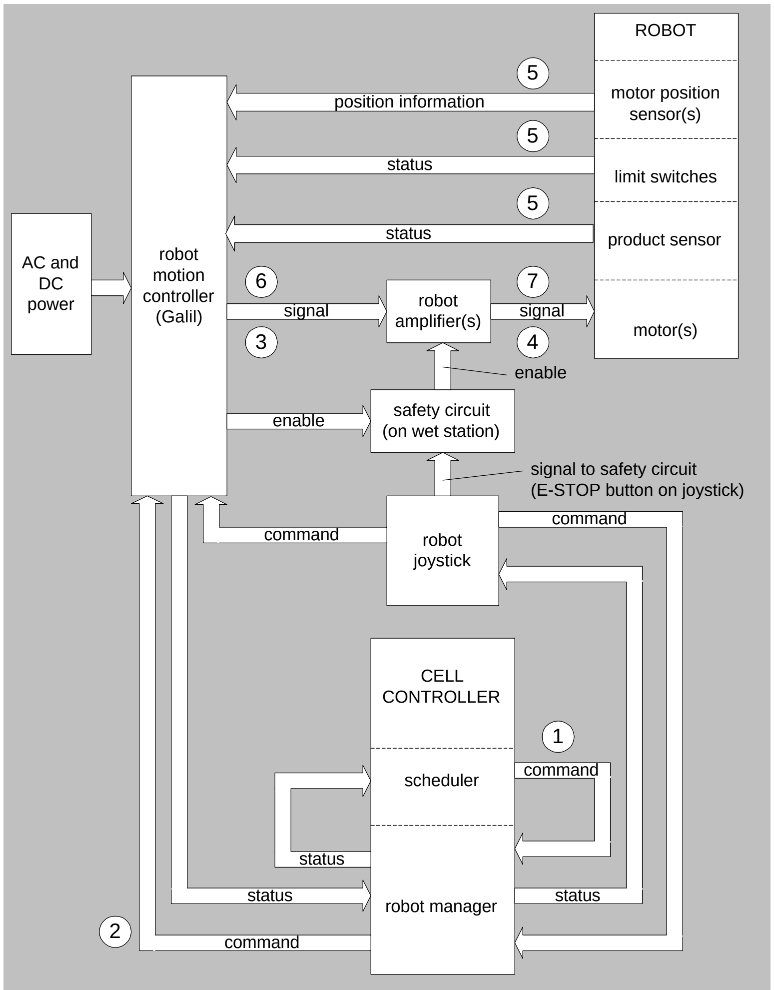
One-Arm, Two-Axis Robot
(used in semi-automated wet systems)



One-Arm, Two-Axis Robot with Lid Adapter
(used in semi-automated wet systems)

robot control system

The software and hardware that controls and monitors the robot (see drawing below). An explanation of the robot control system follows the drawing.



Robot Control System (simplified)

1. Based on a selected recipe, the scheduler (in the cell controller) sends a command to the robot manager (also in the cell controller).
2. The robot manager interprets the command, adds information as necessary, and sends it to the robot motion controller.
3. The motion controller sends a signal to an amplifier.
4. The amplifier sends a signal to the appropriate motor, which moves the robot. (Robots that have more than one axis will have a like number of amplifiers and motors.)
5. As the robot begins to move, the robot's motor-position sensor(s), limit switches, and product sensor send messages regarding the robot's status and position to the motion controller.
6. Using the information obtained in step 5, the motion controller sends a signal to the robot amplifier.
7. The amplifier sends a signal to the appropriate robot motor, which controls the movement of the robot.

During normal wet-system operations, the scheduler controls the robot. During maintenance and homing, the operator controls the robot manually using the robot joystick. The joystick can control the robot either by sending commands to the robot manager or to the motion controller.

The safety circuit, which can be activated by pressing a Robot E-STOP button (on the wet system or joystick) can immediately stop the robot movement by removing the enable signal. Also see robot controller; robot manager software; robot joystick; robot points; home.

robot controller

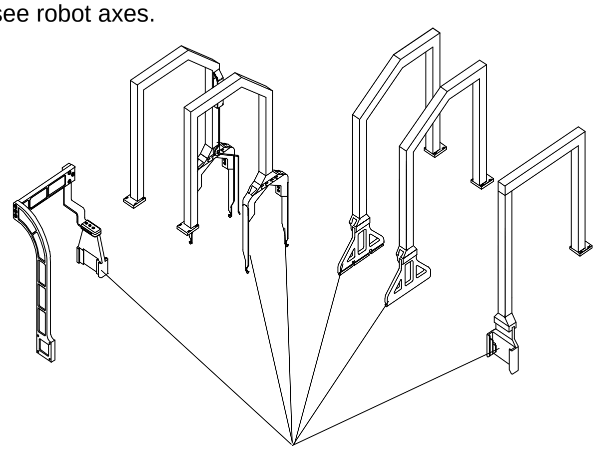
Consists of a multi-axis robot motion controller, amplifier(s), position sensor(s), safety circuit, and motion controller software. The robot controller interacts with the cell controller and robot joystick to activate the robot motors, which move the robot between taught points and at specific speeds and acceleration levels. Also see robot control system.

Robot Emergency Stop

See Robot E-STOP.

robot end effector (EE)

An accessory device attached to the robot-arm mounting plate that enables the robot to perform the intended task; specifically, the device used to pick up and hold the cassette of wafers. The following drawing shows the standard robot end effectors used in GFT wet systems. Also see robot axes.



Standard End Effectors

Robot E-STOP (emergency stop)

This hard-wired safety circuit removes power from the robot and immediately stops all robot movement. A robot E-STOP can be triggered by one or more of the following:

- A safety shield is opened during automatic processing.
- Any E-STOP pushbutton on the wet system or robot joystick is pushed.
- An obstruction prevents the robot from moving or reaching a destination (in automatic, joystick, or manual modes of operation).
- Robot motor overheats.
- Robot control system reports a position error or internal problem.

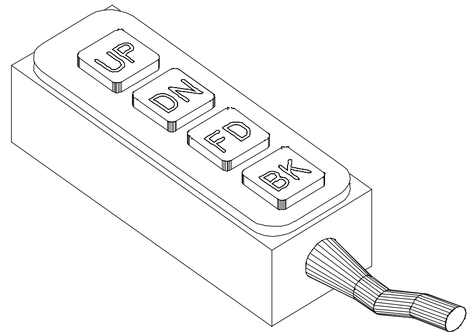
Automatic processing can continue uninterrupted after a robot E-STOP if:

1. the robot is not in motion when the error occurs, and
2. the problem is corrected before the next scheduled move.

robot joystick

A handheld, interactive terminal used to home the robot and teach points, control individual robot motors, recover from errors, and work with the robot during maintenance. The joystick can move the robot to taught positions or to any position within the overtravel limits. When the joystick is enabled, all automatic processing and manual moves from the robot control screen are disabled.

Robot Joystick for Automated Wet Systems



Robot Joystick for VcS and Semi-automated Wet Systems

Joysticks for automated systems include the following:

- point teaching capability
- robot E-STOP pushbutton
- move, home, teach, and gripper-movement controls
- instructions and prompts
- readout of exact robot position in real time
- onscreen help messages

Joysticks for VcS and semi-automated systems control robot movement along the horizontal and vertical axes.

Also see robot control system.

robot manager software

The software in the cell controller that interprets and coordinates commands and status messages to and from the scheduler, the robot joystick, and the robot motion controller. Also see robot control system.

robot mounting

The location of the robot in the wet system in relation to the tanks. Robots may be mounted behind the tanks (rear mounted), in front of the tanks (front mounted), or at the side of a tank (side mounted).

robot points

The exact locations in the wet system where the robot will pick up and put down cassettes containing the product. An operator "teaches" the points to the robot before processing begins. There is one taught point for each tank or device. Also see robot control system.

robot shield

The physical barrier(s) between the process tanks and the robot. Robot shields protect the robot from chemical damage and help keep particulates out of the process environment. One-arm robots typically have a lower robot shield; two-arm robots typically have an upper and a lower robot shield.

ROM See read-only memory.

root cause (of an accident) Weaknesses in the safety and health management system that have allowed the surface causes to exist. The underlying reason for an accident or incident.

rpm Revolutions per minute.

RS-232C An industry standard 25-pin connector for asynchronous serial data communications.

RTD Resistance temperature device. A device used to measure the temperature of process chemicals based on a change in resistivity proportional to the temperature. A small platinum coil (the resistance temperature detector) is the most common resistive medium used in the device.

Also see temperature controls.

RTP Rapid thermal processing.

S

safe location

A position for the robot, before HOME is initiated, from which the robot can be moved without hitting an obstruction. The robot end effectors must not be in a tank or holding product.

safe tank

A DI water tank that can hold a cassette in case of a processing error or alarm. In automated wet systems, the control software ensures the availability of a safe tank for every product lot in process.

Also see GoToSafe.

Safety and Health Committee

Employee/manager group that advises management on improvements to the safety program, participates in accident investigations, and inspects the workplace for hazards.

safety shield

Clear-plastic sliding "window" across the front and sometimes the ends of the wet system. Safety shields provide a safety barrier between personnel and the robot and process chemicals. They also maintain cleanliness in the wet system.

Safety shields may be automatic or manual. A hardwired interlock causes a Robot E-STOP when a manual safety shield is opened during wet-system operation. Automatic safety shields may be opened for specified periods of time during wet system operations without causing an E-STOP. Check the operating manual for specific procedures.

Also see keyswitch.

SC1

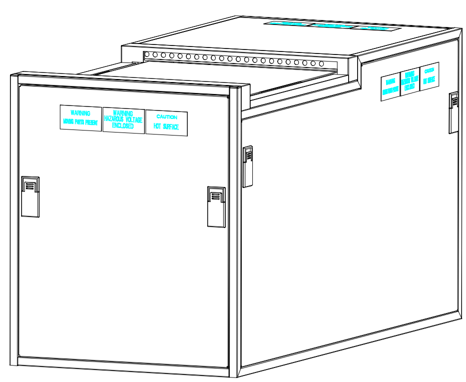
Standard clean type 1. See chemical process.

SC2

Standard clean type 2. See chemical process.

SC200

The SuperClean SC200 Spin Rinser Dryer is a horizontal top-loading programmable rinser/dryer used to clean semiconductor substrates such as wafers, photomasks, and other wafer manufacturing devices up to 8 inches (200mm) in diameter, and is compatible with front and rear 2-axis robotics.



scaling factor

Proportional term used in converting a milliamp (mA) input signal from a monitoring device into a physical measurement (engineering unit). A mA signal is an analog input because it corresponds proportionally to a measurable physical condition: the higher the amperage the device generates, the greater the physical reading.

Tank Temp Scaling and Resist Scaling factors are used in converting milliamp input signals to degrees Celsius and megaohms, respectively. These calculated values are:

1. displayed on the tank control screen for the operator to view
2. recorded in log and lot files
3. input to the heating control PID calculation

The milliamp-to-engineering unit conversion occurs in three major steps:

1. **Analog Signal**. A monitoring device sends a mA signal to the PLC.
2. **Analog-to-Digital Conversion**. The PLC converts the mA signal to a corresponding number based on 32,000 digital units.
3. **Engineering Unit**. The PLC uses the scaling factor (the ratio of the monitored range to the digital units) to calculate temperature, flow, or resistivity.

Calculating a Scaling Factor

NOTE
The scaling factor will not, in itself, ensure accurate monitoring. The monitoring device (thermometer, flowmeter, resistivity monitor) must be calibrated properly according to manufacturer's specifications.

To calculate a scaling factor, divide the PLC's digital unit value (32,000) into the device's maximum input range as follows:

- Find the high number of the device's monitored range and multiply it by the appropriate precision scaling value (see below).
- Divide 32,000 into that number.
- Enter the answer in the touchscreen configuration screen.

Precision Scale

A multiplier is used to calibrate the precision of the measure output. A 100,000 multiplier provides a 0.1 precision; a 100,000,000 multiplier produces a 0.01 precision. The following examples show how this function works.

For temperature if the monitor has a 0-200°C range:

200 x 100,000 / 32,000 = 625

In this example, entering 625 in the configuration screen will yield temperature monitoring with a 0.1 precision.

For resistivity if the monitor has a 0-18 megaohm range:

18 x 100,000,000 / 32,000 = 56,250

In this example, entering 56,250 in the configuration screen will yield resistivity monitoring with a 0.01 precision.

scfh

Standard cubic feet per hour (unit of volumetric flow rate).

scfm

Standard cubic feet per minute (unit of volumetric flow rate).

scheduler

The GFT scheduler is designed to orchestrate the movement of multiple lots safely through various process scenarios in an efficient fashion. A recipe is a series of process steps at various stations. Some of these steps are at locations where the lot must be removed immediately upon process completion. Others, called safe havens, may hold product beyond the completion of process without harm. Moves from stations where product must be removed on process completion are called critical moves, and moves from safe havens are called safe moves. Transport resources, usually one or more robots, must be allocated for these movements.

Each recipe is broken down into a series of process segments, each of which ends at a safe haven. The segments from various work orders are interleaved for efficiency. Each work order contends for process and transport resources, and begins a process segment when all resources necessary to insure safe movement through the segment have been acquired. All process devices must be available and prepped to recipe parameters before product delivery.

The robot is a critical scheduling element, since it must be prepped(washed and/or dried) differently for different transfers. These preparations are time-consuming, and must be complete before the transfers can be made. The robot is typically a resource for multiple concurrent work orders, more than one of which may have critical moves scheduled, so accurate forecasting of process completion is essential so that these critical transfers can be prepared for and made on time. This may sometimes require the robot to stand idle rather than begin a safe transfer which could not be completed before the critical transfer time arrives.

SCR

Silicon-controlled rectifier. A device that controls electrical power.

scrap wafer

A wafer that has no commercial value, typically caused by a processing error.

SECS

SEMI Equipment Communications Standard. Note: GEM - Host Communications is a separate standard.

SECS-I and SECS-II

SEMI industry-standard protocol used for communications between devices and control computers.

selectivity

The ability of a substance to etch another substance (expressed as a ratio, usually a phosphoric acid etch rate ratio of Si_3N_4:SiO_2 of 100:1).

SEMI

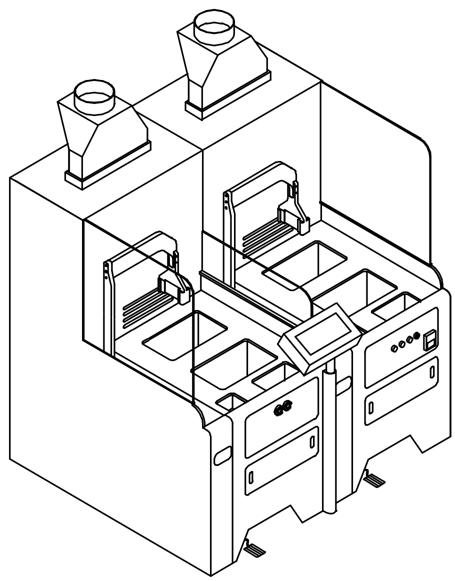
Semiconductor Equipment and Materials International.

semi-automated wet system (SAWS)

Semi-automated wet systems have the following features and capabilities:

- The operator manually loads and unloads cassettes from the robot's end effector, which does not release cassettes during processing.
- A one-arm, two-axis robot transfers cassettes from one tank to another and to the input position.
- The control software schedules cassette transfers, tank prepping, and wafer processing.
- Tanks are arranged from the front to the rear of the wet system (*front-to-rear* arrangement).
- The product lot begins in a dry state and ends in a wet state. The wet system has **no** dry in-dry out capability (the operator removes the cassette from the final rinse tank and transfers it to the spin rinser/dryer (SRD) as the final processing step).
- With exceptions; only one product lot is processed at a time. The robot does not release the cassette until the entire recipe has been completed.

Also see wet system; automated wet system; manual wet system.



semiconductor

A material that has a resistivity between that of metals and insulators. May or may not conduct depending on source.

semiconductor die

A slice of semiconductor material from a rod or ingot.

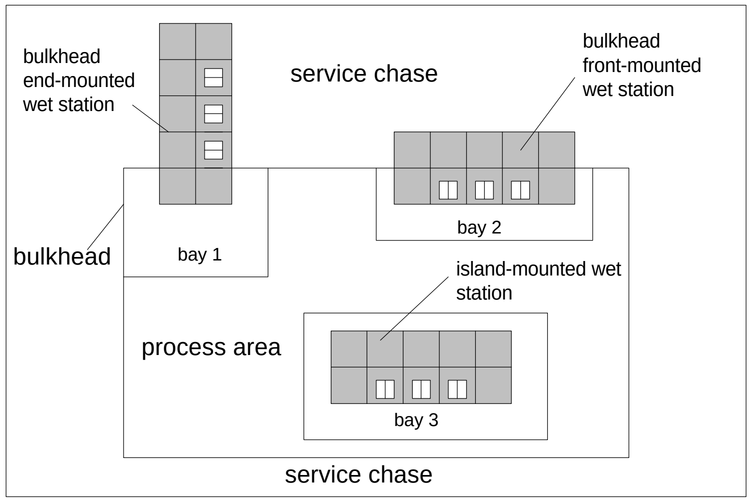
SEMI International Standards 1995

International standards for the semiconductor industry.

SEMI S2-93 “Safety Guidelines for Semiconductor Manufacturing Equipment,” chapter in *SEMI International Standards 1995*.

SEMI S6-93 “Safety Guidelines for Ventilation,” chapter in *SEMI International Standards 1995*.

service chase The area of the cleanroom surrounding (or behind) the process area. This area allows access to the plumbing and electrical cabinets of process equipment for servicing. Also known as *chase*; *core*; *service core*.

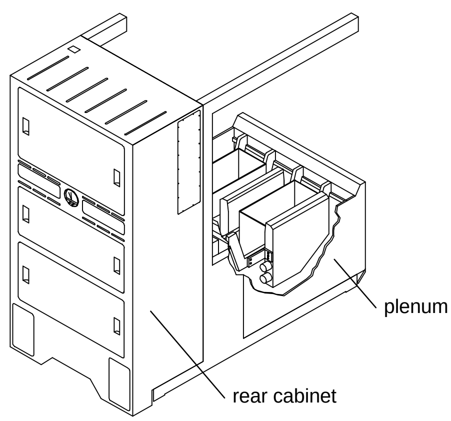


service core See service chase (preferred term).

servo motor Motor used in robotics applications where motor speed or rotation are both controlled by a corrective signal that is amplified and fed to a motor circuit.

shared memory region (SMR) A designated block of memory for data exchange between the PLC and cell controller.

shell, module The rear cabinet plus the plenum.



shield, robot See robot shield.

Si See silicon.

Si_3N_4 Silicon nitride. Used as a mask.

signal generator Electronic testing device used to supply a standard voltage of known amplitude and frequency.

SiH_4 Silane gas.

silicon (Si) A semi-metallic element used in the manufacture of integrated circuits. Next to oxygen, silicon is the most abundant element in the Earth's crust and is widely found in sand and clay. Silicon grows with a native oxide on its surface, and is perfect for delivering and protecting an exact wiring pattern of millions of integrated circuits that make up a chip.

silicon dioxide SiO_2. Used as a mask.

silicon nitride Si_3N_4. Used as a mask.

SiO_2 Silicon dioxide. Used as a mask.

slope etch See chemical process.

SLV Solvent. chemical process.

SMIF Standard mechanical interface.

SMR See shared memory region.

Smart DI Ultra Pure Water Heating System Rippey DI heating unit.

sodium chloride NaCl.

sodium hydroxide NaOH.

software Programs or instructions used to control the operations of a computer.

solvent See chemical process.

SPC Statistical process control.

spiking pump See metering pump (preferred term).

SPM Sulfuric peroxide mixture. See chemical process.

sputtering Process similar to evaporation.

SRD Spin rinser/dryer.

SRD module The module in which the product is rinsed and dried using the SRD (spin rinser/dryer).

SRF Surfactant. See chemical process.

SSQA Standardized supplier quality assessment.

SSR Solid-state relay.

staging tank Reservoirs of chemical for release to the process tank. These tanks can be configured for several different functions:

- heating the chemical
- Initial filling of the process tank to a specified concentration
- replenishing the process tank to maintain liquid levels
- spiking the process tank to maintain chemical concentration

Staging tanks are located in their module's plumbing compartment. These small service tanks automatically dispense preset quantities of chemical to the module's chemical tank. The volume, frequency and number of dispense cycles are programmable.

Manual fill staging tanks are located in the plumbing compartment of the applicable modules. On manual-fill systems, chemical is poured into the staging-tank fill port (a funnel mounted on the front of the module) until the level of the liquid can be seen in the feed tube. The staging tank can then dispense preset quantities of chemical automatically. The volume, frequency and number of dispense cycles are set in each recipe.

Two level sensors, empty and low level, are mounted on the side of the staging tank. When the liquid level drops below the low-level sensor, a warning message appears on the touchscreen to notify the operator that the staging tank requires filling soon. If the tank is not refilled before the level drops to the empty-level sensor, the operator is alerted to refill the tank immediately.

Bulkfill staging tanks receive chemicals directly from the facility's chemical bulkfill system.

Three level indicators, low, process (or fill), and high, are mounted on the side of the staging tank. When liquid level drops below the low-level sensor, the tank fills automatically to the fill-level sensor. If chemical reaches the high-level sensor, the main fill valve closes immediately.

During wafer processing, staging tanks automatically release chemical to the process tank to (1) maintain chemical consistency, or (2) replenish the liquid to the process level. The liquid is delivered to the process tank by way of a metering pump or dispense valve. Metering (spiking) pumps precisely control the volume of chemical added to the process tank. Dispense valves are gravity fed. Because the flow rate to the process tank is greater than through a metering pump, the tanks fills more rapidly. However, the volume of fluid cannot be as accurately controlled.

Stage Tanks (Fixed-Volume Dispensing)

In fixed dispensing, the chemical bath operates at a particular chemical ratio set by a process engineer. Each of the bath's associated stage tanks is manually calibrated and configured to dispense a given volume. For example, to achieve a bath ratio of 10:2:1, the system would need to dispense 7000 ml of one chemical and 3500 ml of the second chemical. (The first value, 10, is DI water, which is not delivered to the bath via a stage tank.) The Fill level sensor on each stage tank is calibrated with graduated cylinders and set to dispense those volumes. A change in bath ratio requires adjustment and recalibration of the stage tank level sensors.

Level-Sensing Functions of Staging Tanks	
Manually-Filled Staging Tanks	
Low	When liquid level drops below this sensor, the operator is alerted to refill the tank immediately.
Process	When liquid level drops below the process-level sensor, a warning message appears on the touchscreen notifying operator that the staging tank requires filling soon.
Automated Bulkfill Staging Tanks (Fixed-Volume Dispense)	
Low	When liquid level drops below the low-level sensor, the bulkfill valve opens automatically, then closes when the process-level sensor is reached.
Fill or Process	When liquid reaches this level, the bulkfill valve closes.
High	Hardwired to a second fill valve plumbed in series with the primary fill valve. When chemical reaches this sensor, both fill valves close. This is a redundant valve for safety.
Automated Bulkfill Staging Tanks (Variable-Volume Dispense)	
Low	When liquid level drops below the low-level sensor, the bulkfill valve opens automatically, then closes when the A, B, or C level sensor is reached.
A, B, C	Three levels replace the single Process or Fill sensor used in a fixed-dispense system. When liquid reaches one of these levels, the bulkfill valve closes. The level to be reached is automatically determined to meet a configured chemical ratio. See the variable-volume dispensing example below.
High	Hardwired to a second fill valve plumbed in series with the primary fill valve. When chemical reaches this sensor, both fill valves close. This is a redundant valve for safety.

3-Level Stage Tanks (Variable-Volume Dispensing Of Dilute Chemistries)

Variable dispense schemes enable a bath ratio to be changed without adjusting and recalibrating stage tank level sensors. These schemes use five level sensors on the stage tank. Three variable level sensors, labeled A, B, and C, replace the single-variable Fill or Process level sensor. The desired chemistry ratio is specified in recipe management (**Chem [#] Ratio** line item).

There are two variable-dispense schemes. The first is for a process bath with a single dispense of a prediluted chemical (typically HF).The second is for a bath that uses two chemicals without predilution. In both schemes, a cell controller script derives chemical volume values (CHEMVOLs) from parameters that are set in tank configuration. These parameters include stage tank levels A, B, C, bath volume, and predilution ratios from. (See 3-Level Stage Setup in *Tank configuration*.)

NOTE
Chemical ratios can be changed in tank configuration only *after* the tank has been drained.

Example of Variable-Volume Dispensing of Two Chemicals

Desired ratio	10:02:01	**Stage level C**	4000 ml
Bath volume	49.1 liters	**Stage level B**	1200 ml
Chem1VOL	7538	**Stage level A**	135 ml
Chem2VOL	3769	**Pump volume**	8 ml per stroke

From the desired ratio and total bath volume, a cell controller subscript determines Chem1 volume is 7,538 ml, then sends this to the PLC as parameter CHM1VOL. The PLC uses a subroutine called BEAKER2 to compare CHM1VOL with stage tank levels, then dispenses 4000 ml on the first cycle, subtracts 4000 ml from CHMVOL, and adds it to BKRVOL, ending the first cycle. The new CHMVOL value is again compared with the stage tank level sensor volumes, and the greatest volume possible is dispensed—in this case 1200 ml. This cycle repeats until the CHMVOL value is less than the value of the stage tank Level A.

The metering pump dispenses the remaining volume, at 8 ml per stroke, until the volume dispensed equals or exceeds CHMVOL. Because the metering pump dispenses in 8-ml increments, it is possible for the total chemical to exceed the configured value by as much as 7 ml. When the dispense sequence for Chem1 is complete, the dispense sequence for Chem2 begins, using the same sequence described above.

Increments of chemical dispensing. All values are in milliliters.

Chem1			Chem2		
Dispense	**CHMVOL**	**BKRVOL**	**Dispense**	**CHMVOL**	**BKRVOL**
0	7538	0	0	3769	0
4000	3538	4000	1200	2569	1200
1200	2338	5200	1200	1369	2400
1200	1138	6400	1200	169	3600
135	1003	6535	135	34	3735
135	868	6670	8	26	3743
135	733	6805	8	18	3751
135	598	6940	8	10	3759
135	463	7075	8	2	3767
135	328	7210	8		
135	193	7345			
135	58	7480			
8	50	7488			
8	42	7496			
8	34	7504			
8	26	7512			
8	18	7520			
8	10	7528			
8	2	7536			
8					

standard clean type 1 (SC1)

See chemical process.

standard clean type 2 (SC2)

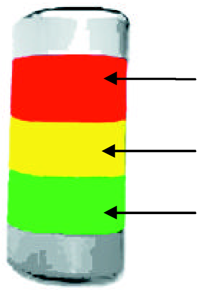
See chemical process.

static

Without movement or change.

static eliminator Device used to neutralize non-conductive materials by producing a region of ionized gas through which charged materials can pass.

status beacon Also known as *light tree*. A three-light indicator that reveals wet-system status.



Red: (*blue* in European systems) Failure (alarm), abort, immediate assistance required.

Yellow: Keyswitch is in DISARM position.

Green: Equipment is enabled and running product.

Also see *critical alarms* and *exhaust alarms*.

Color	Condition	Wet System Condition	Operator Action	Example
RED or BLUE	**Flashing**	Emergency.	Immediate action; e.g. correct alarm condition or push EMO.	Robot malfunction; pressure exceeds safe limit
YELLOW	**Flashing**	Abnormal and/or hazardous.	Careful monitoring and/or intervention	Keyswitch is in **DISARM** position.
	Off	Normal.	No operator action indicated	Keyswitch is in **AUTO** position.
GREEN	**Steady On**	Powered on. No alarms or problems.	None required.	Wet system is processing normally.
	Flashing	Operator notification.	Mandatory operator action.	Operator prompted to enter or remove cassette.
	Off	Powered down.	None	

NOTES:
1. Blue is used in place of red in European countries. (See *European Standard EN-60204-1*).
2. Multiple lights may be lit simultaneously when multiple conditions are present.

Stepper motor A compact DC motor with high torque used to transport a wafer load across an ultraclean Megasonic energy beam.

strip See stripping.

stripping The process of removing (chemically dissolving) and entire surface layer of the water, in contrast to etching, which removes only selected material. Stripping processes are typically named for the material being stripped (for example, oxide strip and nitride strip). Stripping is measured in Ångstrom units.

Also see etching.

subambient See temperature of process chemicals.

subfab The area below the cleanroom that contains auxiliary equipment such as DI water heaters, facility fire-suppression system, and bulk-chemical dispensers.

substrate	The physical material (sapphire, silicon, or ceramic) upon which an electronic circuit is fabricated. Used for mechanical support.
sulfuric acid	H_2SO_4.
sulfuric peroxide mixture (SPM)	See chemical process.
Sunburst Meg	Sunburst Megasonics.
surface cause (of an accident)	A readily apparent reason for an accident or incident that usually appears early in an accident/incident investigation, but is not the root cause. Usually a pre-existing unsafe condition or practice (a hazard).
surfactant	Detergent-like additive used in wet-system processes to clean wafers. Also see chemical process.
SV	Solenoid valve.
swingarm	Curved pole mounted to the wet system upon which the operator interface assembly is attached. See operator interface assembly.
SWS	See semi-automated wet system.
SWSF	Semi-automated wet system, front access.
SWSR	Semi-automated wet system, rear access.

T

tachometer
Measuring device for rotations / revolutions per minute.

TDC
Transducer Dead Center

tank, chemical
See chemical tank (preferred term).

tank configuration
Programming the control system, through a series of touchscreen displays, to define:

- hardware devices present on each tank
- process values to enforce (times, flows, resistivities, and other process limits that define recipes)

Tank configuration is password-protected and should be performed only by process engineers or other personnel with advanced understanding of wet-system operations and process chemistry.

tank draining
See recirculation.

tank heating and cooling
See temperature controls.

tank levels
Every wet system tank has at least one level sensor. Process and rinse tanks use N_2 bubbler sensors; staging tanks use capacitance sensors. Inputs from these sensors are interlocked to automated alarms, safety interlocks, and filling-draining functions. See the table below for more details.

Level Interlocks for Wet System Tanks		
Levels	**Interlocks**	
Process Tanks		
High	Activates a **Main tank is overfull** alarm.	
Fill	During a tank prep, when this level is reached chemical stops dispensing into the tank. This level is above the Process level to compensate for filling the plumbing lines in the recirculation system.	
Process	Normal processing level. If the liquid level falls below this level during automatic processing, a Process Level Lost alarm occurs.	
Low	**With PREFILL LOW LEV**	**Without PREFILL LOW LEV**
	• Stops DI water prefill at this level during tank PREP. • The heater starts when this level is reached, and turns off whenever this level is lost to protect the heater and Megasonic.	The heater starts when this level is reached, and turns off whenever this level is lost to protect the heater and Megasonic.
Empty	Starts the drain timer. Tells the control system when the tank is empty following a drain command.	
Rinse Tanks		
Process	• Triggers an alarm if liquid drops below this process level (set high enough to ensure complete coverage of wafers during rinsing). • Triggers change from high to low flow rate. The tank fills at a high flow rate, then (to conserve water) changes to a low flow rate when this sensor level is reached.	
Low	Used in rinse tanks equipped with Megasonic units to ensure that they are covered with DI water when they are active.	
Manually-filled Staging Tanks		
Process	When liquid level drops below the process-level sensor, a warning message appears on the touchscreen notifying operator that the staging tank requires filling soon.	
Low	When liquid level drops below this sensor, the operator is alerted to refill the tank immediately.	
Bulk-filled Staging Tanks		
High	Hardwired to a second fill valve plumbed in series with the primary fill valve. When chemical reaches this sensor, both fill valves close. This is a redundant valve for safety.	
Process	When liquid reaches this level, the bulk-fill valve closes.	
Low	When liquid level drops below the low-level sensor, the bulk-fill valve opens automatically, then closes when the process-level sensor is reached.	
EE-Wash Tank		
Process	The EE wash tank has an overflow function. The tank fills from the bottom at a high flow rate, then (to conserve water) changes to a low flow rate when this sensor level is reached.	

tank, process

See chemical tank.

tank, rinse

See rinse tank.

tank, safe

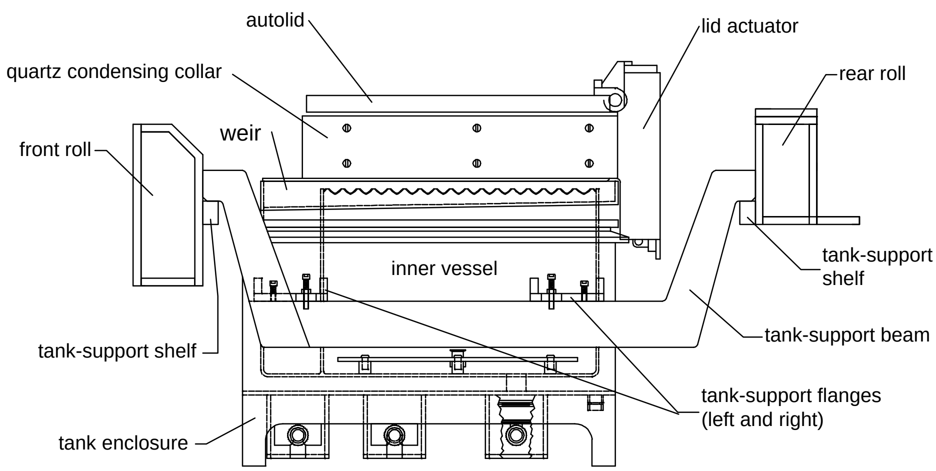
See safe tank.

tank, staging

See staging tank.

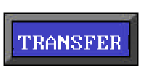
tank-support beam

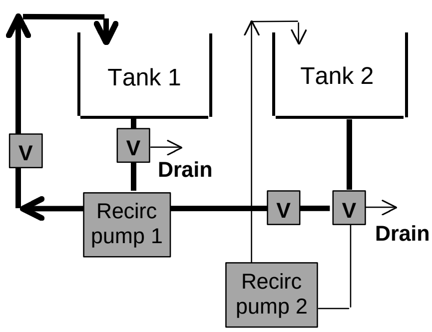
Supports the chemical tank and the lip-exhaust collar (if present). The tank-support beam rests on the tank-support shelf. See drawing below.



Chemical Tank (side view)

tank-to-tank chemical transfer





This automated sequence moves chemical from one chemical tank to another in the same module (not between different modules). This sequence, typically used in a two-step process that uses the same chemical, allows the cleaner chemical in tank 2 to be reused in tank 1 before being drained from the wet system. This sequence is often used at regular bath changeouts, but can be used whenever the tanks are not allocated.

The automated transfer sequence starts by selecting TRANSFER in the tank 2 control screen:

1. Tank 1drains.
2. When tank 1 level lowers to Empty, the tank 2 drain valve opens, and routes the flow through the tank 1 recirculation pump.
3. Tank 1 recirculation pump starts, directing chemical into tank 1.
4. When tank 2 level lowers to Empty, the transfer continues for the time set in Transfer Drain Timer (see Section 5.2.6 in the Operations Manual).
5. Tank 2 automatically reset to allow a new PREP sequence.
6. Tank 1 is topped-off with appropriate chemical, if so configured.

tank, VcS See VcS tank.

TC See thermocouple.

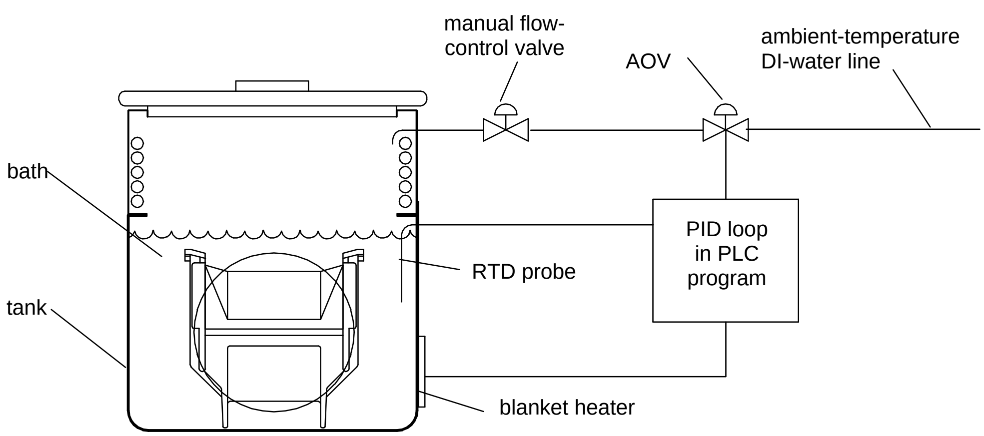
TDR Time-delay relay.

teaching points See robot points.

“Teflon” Family of fluoropolymers (including FEP, PFA, and PTFE) produced from resins manufactured by the DuPont Company.

Tefzel ã A Du Pont copolymer product of ethylene and TFE used for coating stainless steel robot end effectors

temperature control for static-bath nitride-strip processes Nonrecirculated nitride strip processes use the injection of ambient-temperature DI water to control bath temperature. See drawing below.



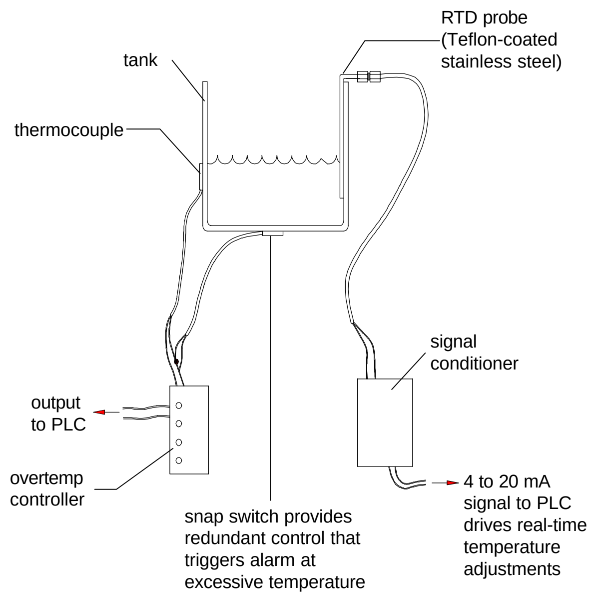
Temperature Control for Nitride-Strip Processes (simplified view)

The bath is heated by a blanket heater and cooled by injection of ambient-temperature DI water (see drawing). The blanket heater and an air-operated valve (AOV) in the DI water line are both controlled by a proportional-integral-derivative (PID) loop within the PLC program.

When the bath temperature is below the recipe's setpoint, the PID loop turns on the heater to 100% capacity and closes the AOV. When the temperature exceeds an upper tolerance, the heater turns off and the DI water valve opens, cooling the bath. A manual flow-control valve is adjusted to add enough DI water to (1) lower bath temperature, and (2) replace the DI water boiled from the bath, without significantly changing the phosphoric acid to-DI-water ratio. (This "on or off" function is different from the variable output usually associated with PID controls.)

This control scheme maintains nitride process bath temperature at 165± 2°C.

temperature controls Control the temperature of chemicals in chemical tanks, or DI water in hot-rinse tanks. Temperature-control components in GFT wet systems include. See drawing below.



Standard Temperature-Control System

1. Heaters; heater/chillers:

   - Heater/chiller—device typically used with HF process to maintain near-ambient process temperature (usually about 20-35°C) by heating or cooling the fluid as it flows through coils in the recirculation loop heat exchanger.
   - Inline heater—device typically used with APM process to maintain a medium process temperature (about 60°C) by heating the process chemicals in a recirculation loop.
   - Blanket heater (also called integral heater)--device typically used with hot phosphoric process to maintain a high process temperature (above 100°C) by heating the outside of the tank with an electric coil.
   - Immersion heater--same as blanket heater except that the heater coils contact the process chemical in the tank.
   - External DI heater--device outside the wet system heats DI water for a hot-rinse process. Used when facility-supplied heated DI water is not available. A hot rinse reduces the thermal shock to wafers after hot chemical processing and quickly removes residual chemical.

2. Temperature monitors and controls:

   - Thermocouples measure the temperature of the heater elements. The output is sent to the PLC by way of an overtemperature controller.
   - RTD (resistance temperature device) probe monitors chemical temperatures in the tanks and sends signals to a signal conditioner. The signal conditioner, in turn, sends the signals to PID loops (within the PLC) that drive real-time temperature adjustments.

An RTD probe may be used to monitor the DI-water temperature in a rinse tank during a hot-rinse process but, in this case, it is used for information only and the signals bypass the control system.

3. Overtemperature control. Snap switches and overtemperature controls, hardwired to the heater contactor, trigger alarms and shut off the heater if a heater element reaches excessive temperature.

Also see temperature of process chemicals; temperature control for nitride-strip processes.

temperature of process chemicals

Temperature	Range (°C)	Tolerance (°C)	Control Device
Non-heated	N/A	N/A	Uncontrolled
Heated–Chilled	15-35	+/- 0.5	Heater/chiller
Heated (medium)	>36-100	+/- 1.0	Inline, blanket, immersion, or external DI heater
Heated (high)	>100	+/- 2.0	Inline, blanket, or immersion heater

TFE
See PTFE.

thermocouple (TC)
Used to measure temperature. Two dissimilar metals are welded together to develop a galvanic potential. The voltage output changes proportionally to the temperature.

three-axis robot
Also known as *two-arm robot*. See robot axes.

throughput
Processing capability of a wet system; that is, the number of wafers per hour a particular wet system can process using a particular recipe. Throughput is calculated using a formula that assumes the availability of a safe tank for every product lot in process

Ti strip
Titanium strip. APM is the preferred term. See chemical process

timers
See debounce timers.

TLV
Threshold limit value. The airborne concentration of a material to which nearly all persons can be exposed day after day without adverse effects.

TLV-C
Threshold limit value-ceiling. The ceiling exposure limit. The concentration that should not be exceeded even instantaneously.

TLV-STEL
Threshold limit value-short-term exposure limit. The short-term exposure limit or maximum concentration for a continuous 15-minute exposure period (maximum of four such periods per day, with at least 60 minutes between exposure periods) and provided that the TLV-TWA is not exceeded.

TLV-TWA
Threshold limit value-time weighted average. The allowable time-weighted average concentration for a normal 8-hour workday or 40-hour work week.

TOC
Total organic carbon.

tool
See wet system (preferred term).

topoff
An automated chemical fill sequence used to prevent unnecessary Process level lost alarms during processing. See topoff in tank configuration.

torque
(noun) A force that tends to produce rotation or twisting; used for large loads.

(verb) To tighten to a specific level.

total organic carbon
TOC.

touchscreen

A touch-sensitive computer screen used for operator interface, allowing input to the CPU by touching menu items and icons on the screen. The operator uses the touchscreen to perform wet-system control functions and view color graphics. Also known as *operator interface touchscreen*. Also see operator interface assembly.

The color of the icons on the touchscreen indicates the status of the corresponding wet-system components. Icon color on the touchscreen display indicates the status of the wet-system components.

transducer

1. A piezoelectric crystal bonded to a quartz lens; used to convert RF energy into acoustical energy. All GFT Sunburst and Ultraclean cleaning systems use them.

2. Converts a physical measurement (such as pressure, flow, or temperature) to an electrical signal.

transport cassette

See cassette.

trickle bypass

See high/low flow plumbing.

two-axis robot

Also known as *one-arm robot*. See robot axes.

U

UF Ultrahigh filtration.

ULPA Ultra-low particulate air.

UNC United national coarse (threads).

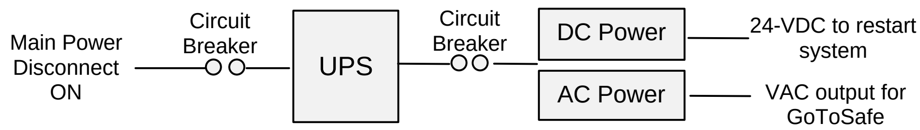
UNF United national fine (threads).

uniformity Consistent surface topography across a wafer's surface.

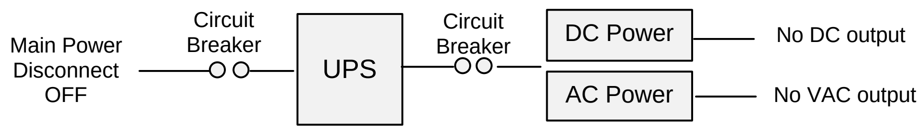
uninterruptible power supply (UPS) Supplies electric power to the wet system as follows:

Responses to Power Loss		
Power Loss Type	**UPS Response**	**Wet System Response**
Power outage	Supplies AC power to robot, touchscreen/cell controller, PLC, and 24-VDC power supply.	• Recipes in progress stop and cannot be recovered • Automated GoToSafe response
Main disconnect lever at OFF	All electrical input to and output from UPS are cut off.	• All automatic valves close • All physical movement and operations powered by wet system are disabled • All UPS output is cut off
EMO pushbutton engaged	Input VAC to UPS is not cut off but UPS supplies only a 24-VDC startup circuit.	• All automatic valves go to default position • All physical movement is disabled • Exhaust system response is configurable. See *Exhaust* in AWS Specification for details.

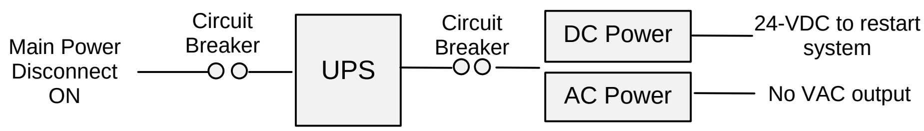
uninterruptible power supply (UPS) ***continued***



UPS function in response to a power outage.



UPS function when primary power main disconnect is at OFF



UPS function in response to EMO shutdown.

UPS See uninterruptible power supply.

uptime The time during which a piece of equipment or the wet system is functioning or able to function.

UV/IR Ultraviolet/infrared.

V

VAC Volts alternating current.

VcS VerteqcleanSystem

VLSI Very Large Scale Integration

vapor deposition see evaporation

variable dip Enables the Full-auto robot to hold onto a cassette, rather than release it, during a short step in a process recipe. The threshold can be set at any time value, but it is often used for a recipe step of <30 seconds, when the robot does not have enough time to complete another action before removing the cassette. Typically used in HF processes, this function is set by GFT software engineers, not on the touchscreen interface.

VDC Volts direct current.

VERTEQ (old style logo)

VER	Versatility
T	Technology
E	Equipment
Q	Quality

Old Style Definition

Old Style

Old Style

Verteq becomes Goldfinger Technologies, LLC in 2004

vertical obstruction sensor (VOS) See obstruction sensor.

VLF hood Vertical laminar flow hood. A protective covering on the wet system that provides ventilation by removing fumes, dusts, and gases. Also known as hood.

Also see laminar flow.

VOS Vertical obstruction sensor. See obstruction sensor.

W

wafer

A thin circular disk (typically made from silicon) on which many integrated circuits are fabricated and subsequently diced up into individual chips.

wafer lot

See product lot (preferred term).

wafer processing

See process.

watts

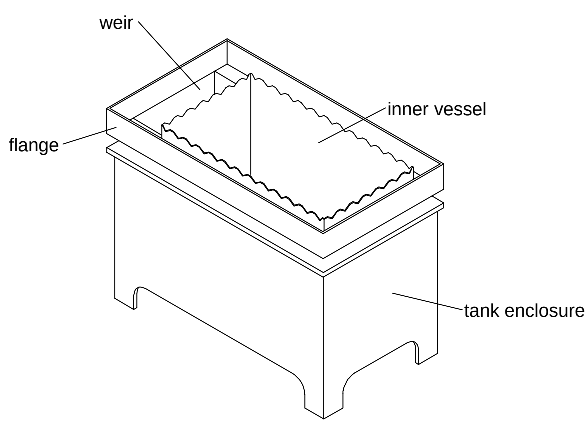
Unit of power; 1/746 horsepower

waveform

Graphic display of voltage (amplitude) vs. time (frequency); relationship of voltage, current, power vs. time.

weir

The area of the chemical tank between the inner vessel and the tank enclosure that accepts input overflow and normal recirculation overflow (see drawing). The weir also isolates overflow liquid for heating and cooling.



wet processing

The application of chemicals in a liquid state in the cleaning, etching, and stripping of the semiconductor-fabrication cycle. The principal challenge is to remove organic, ionic, and particulate contaminants from the wafer surface prior to the many manufacturing steps, without increasing wafer surface roughness.

Also see process.

wet system

An immersion-processing system that cleans, etches, and strips silicon wafers and other substrates by combining wet chemistry, rinse tanks, dryers, robotics, and control software.

Also see automated wet system; semi-automated wet system; manual wet system.

A typical GFT wet system (Automated or Semi-Automated) with major parts labeled is shown in the foldout drawings. Note that the wet-system drawings were prepared for training purposes; consequently, they include parts from more than one type of wet system. A wet system sold at a customer's facility would not contain all of the parts shown in the drawings. Also, parts on an actual wet system may be in different locations than those shown on the drawings.

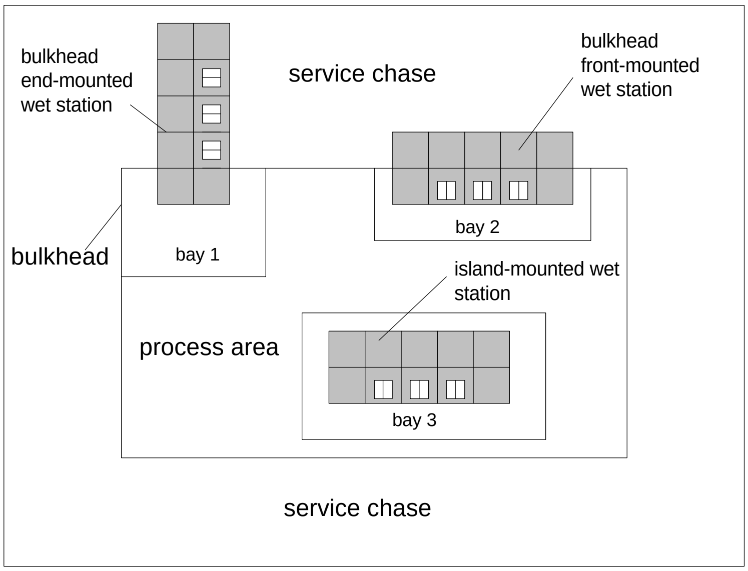
wet-system control system

The software and hardware that interact to control the wet system. See the foldout drawings.

wet-system mounting

Refers to the location and manner of placement of the wet system in the cleanroom. Types of wet-system mounting include the following (see drawing):

- *Bulkhead mounted:* The wet system is enclosed in a wall either transversely or longitudinally. Types of bulkhead mounting include:
  - *end mounted*—the operator I/O portion at the end of the wet system is accessible from the process area
  - *front mounted*—the front of the wet system is accessible from the process area
- *Island mounted:* The entire wet system is inside the process area of the cleanroom, not attached or surrounded by a wall.



WG

Water gauge. Used for measuring air pressure.

WIP

Wafers in process. Also known as work in process.

WPP

White polypropylene.

WTU

Wafer transfer unit.

X

x-ray lithography
A process similar to photolithography except that x-rays rather than light are used to expose the film coating.

Y

yield
Count of successful circuits at completion of a semiconductor manufacturing process, expressed as a percent of the total.

Z

There are no entries for **Z**.