

# CBJT-2W

900-1200 HP



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## FEATURES AND BENEFITS

The CBJT-2W firetube boiler is designed, manufactured, and packaged by Cleaver-Brooks. All units are factory fire tested and shipped as a package, ready for quick connection to utilities. In addition to the features provided on all Cleaver-Brooks Firetube boilers, the following features apply to the CBJT-2W.

### ***Two Pass Design:***

- The packaged boiler offers high efficiency, flexibility, reliability, safety and ease of operation.

### ***Front and Rear Access:***

- Davited front doors, all sizes.
- Provides access to front tube sheet and tubes.
- Large rear access plug for turnaround, tubes, and furnace access.

### ***Natural Gas, No. 2 Oil, or Combination Burners Available:***

- Combination gas/oil burners provide quick fuel changeover without burner adjustment.

## PRODUCT OFFERING

Cleaver-Brooks CBJT-2W Boilers are available in 150-250 psig steam designs. Burners are available to fire natural gas, No. 2 oil, or a combination of oil and gas. Standard product offering is:

- 900-1200 hp.
- Two pass waterback design.
- Full modulation, all sizes.

Available options include the following (contact your local Cleaver-Brooks authorized representative for option details).

- Boiler Options:
  - Additional screwed or flanged tappings.
  - Blowdown valves.
  - Non-return valves.
  - Feedwater valves and regulators.
  - Surface blowdown systems.
  - Surge load baffles.
  - Seismic design.
- Burner/Control Options:
  - Flame safeguard controllers.
  - Lead/lag system.
  - Special insurance and code requirements (e.g., FM, NFPA-85).
  - Alarm bell/silence switch.
  - Special motor requirements (TEFC, high efficiency).
  - Special indicating lights.
  - Main disconnect.
  - Elapsed time meter.
  - NEMA enclosures.
  - Remote emergency shut-off (115V).
  - Circuit breakers.

Day/night controls.

Special power requirements.

Low NOx Equipment.

- Fuel Options:

Gas strainer.

Gas pressure gauge.

Future gas conversion.

Oversized/undersized gas trains.

Optional Oil Pumps.

## DIMENSIONS AND RATINGS

Dimensions and ratings are shown in the following tables and illustrations. The information is subject to change without notice.

- Table 1 - CBJT-2W Steam Boiler Ratings
- Figure 1, Table 2 - CBJT-2W Steam Boiler Dimensions 900-1200 HP



**Table 1: CBJT-2W 900-1200 Ratings**

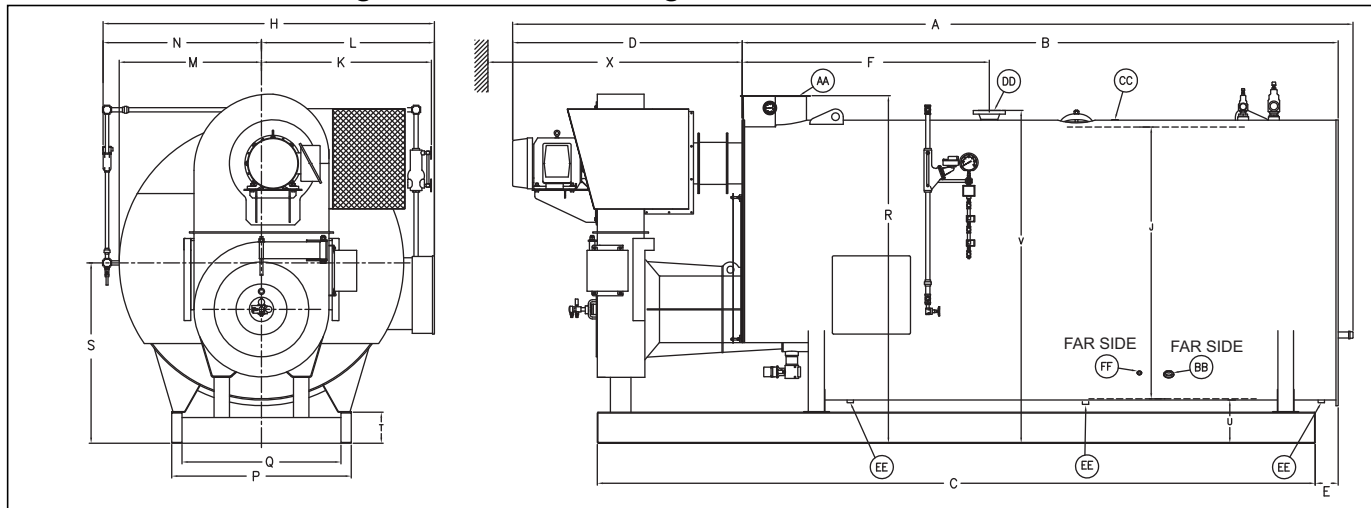
BOILER H.P.	900	1000	1100	1200
Burner Model (Standard)	XL-1	XL-1	XL-1	XL-1
Burner Model (30 ppm)	LNXL-1	LNXL-1	LNXL-1	LNXL-1
RATINGS - SEA LEVEL TO 700 FT.				
Rated Capacity (lbs-steam/hr from and at 212 OF)	31050	34500	37950	41400
Btu Output (1000 Btu/hr)	30128	33475	36823	40170
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY BASED ON NOMINAL 80% EFFICIENCY				
Light Oil gph (140,000 Btu/gal)	269.0	298.9	328.8	358.7
Gas CFH (1000 Btu)	37659	41844	46028	50213
Gas (Therm/hr)	376.6	418.4	460.3	502.1
POWER REQUIREMENTS - SEA LEVEL TO 700 FT. (60 HZ)				
Blower Motor hp (Standard) <sup>A</sup>	30	40	50	60
Blower Motor hp (30 ppm) <sup>A</sup>	40	50	60	75
Circulating Oil Pump Motor hp <sup>B</sup>	1 1/2	1 1/2	1 1/2	1 1/2
Oil Metering Pump Motor hp <sup>B</sup>	n/a	n/a	n/a	n/a
Air Compressor Motor hp <sup>B</sup>	15	15	40	<del>40</del>
BOILER DATA				
Heating Surface sq-ft. (Fireside)	2810	2810	2955	2955

NOTES:

- A. Blower motor size for boiler operating pressures 125 psig and less, contact your local Cleaver-Brooks authorized representative for higher pressures and altitude.
- B. Required for #2 Oil Firing.
- C. All fractional hp motors will be single phase voltage except oil metering pump motors which are three phase. Integral hp motors will be three phase voltage.

15 HP

**Figure 1. Dimension Diagram, CBJT-2W 900-1200 HP**



**Table 2: CBJT-2W 900-1200 Dimensions**

BOILER H.P.	DIM	900	1000	1100	1200
<b>LENGTHS</b>					
Overall Length	A	354	354	364	364
Shell	B	256	256	266	266
Base Frame	C	305.5	305.5	315.5	315.5
Burner Extension	D	92	92	92	92
Rear Ring Flange to Base	E	11.25	11.25	11.25	11.25
Shell Flange to Steam Nozzle	F	134	134	140	140
<b>WIDTHS</b>					
Overall Width	H	130.5	130.5	130.5	130.5
I.D. Boiler	J	106	106	106	106
Center to Water Column	K	68	68	68	68
Center to Panel	L	67.5	67.5	67.5	67.5
Center to Lagging	M	56	56	56	56
Center to Auxiliary LWCO	N	63	63	63	63
Base Outside	P	74.75	74.75	74.75	74.75
Base Inside	Q	61.75	61.75	61.75	61.75
<b>HEIGHTS</b>					
Base to Vent Outlet (Overall Height)	R	138	138	138	138
Base to Boiler Centerline	S	71	71	71	71
Height of Base Frame	T	12	12	12	12
Base to Bottom of Boiler	U	17.5	17.5	17.5	17.5
Base to Steam Outlet	V	131	131	131	131
<b>BOILER CONNECTIONS</b>					
Feedwater Inlet	BB	3	3	3	3
Surface Blowoff	CC	1	1	1	1
Steam Nozzle (300# ANSI Flange)	DD	10	10	10	10
Blowdown-Front & Rear	EE	2	2	2	2
Chemical Feed	FF	0.75	0.75	0.75	0.75
<b>VENT STACK</b>					
Vent Stack Diameter (Flanged)	AA	32	32	32	32
<b>MINIMUM CLEARANCES</b>					
Tube Removal - Front Only	X	181	181	192	192
<b>MINIMUM BOILER ROOM LENGTH ALLOWING FOR TUBE REMOVAL:</b>					
Thru Window or Door		396	396	406	406
Front of Boiler		473	473	494	494
<b>WEIGHTS IN LBS</b>					
Normal Water Weight		34,430	34,430	32,670	32,670
Approx. Shipping Weight - (150psig)		47,000	47,000	49,000	49,000

**NOTES:**

Accompanying dimensions, while sufficiently accurate for layout purposes, must be confirmed for construction by certified dimension diagram/drawing.

All connections are threaded unless otherwise indicated.

## PERFORMANCE DATA

### Efficiency

Tables 8-9 show predicted fuel-to-steam efficiencies (including radiation and convection losses) for Cleaver-Brooks CBJT-2W Firetube boilers. For specific efficiencies on firetube boiler offerings not listed here, contact your local Cleaver-Brooks authorized representative.

Cleaver-Brooks offers an industry leading fuel-to-steam boiler efficiency guarantee for CBJT-2W Firetube Boilers. The guarantee is based on the fuel-to-steam efficiencies shown in the efficiency tables and the following conditions. The efficiency percent number is only meaningful if the specific conditions of the efficiency calculations are clearly stated in the specification (see Cleaver-Brooks publication CB-7767 for a detailed description of efficiency calculations).

The boiler manufacturer shall guarantee that, at the time of startup, the boiler will achieve fuel-to-steam efficiency (as shown in the tables listed above) at 100% firing rate (add efficiency guarantees at 25%, 50%, and 75% of rating, if required). If the boiler(s) fail to achieve the corresponding guaranteed efficiency as published, the boiler manufacturer will rebate, to the ultimate boiler owner, five thousand dollars (\$5,000) for every full efficiency point (1.0%) that the actual efficiency is below the guaranteed level. The specified boiler efficiency is based on the following conditions.

1. Fuel specification used to determine boiler efficiency:

- Natural Gas

Carbon,% (wt) = 69.98

Hydrogen,% (wt) = 22.31

Sulfur,% (wt) = 0.0

Heating value, Btu/lb = 21,830

- No. 2 Oil

Carbon,% (wt) = 85.8

Hydrogen,% (wt) = 12.7

Sulfur,% (wt) = 0.2

Heating value, Btu/lb = 19,420

2. Efficiencies are based on ambient air temperature of 80 °F, relative humidity of 30%, and 15% excess air in the exhaust flue gas.
3. Efficiencies are based on the following radiation and convection losses. Firing rate of 25% - 1.2%, 50% - 0.6%, 75% - 0.4%, and 100% - 0.3%.

## ENGINEERING DATA

The following engineering information is provided for CBJT-2W Boilers. Additional detail is available from your local Cleaver-Brooks authorized representative.

### Boiler Information

Table 3 lists quantity and outlet size for safety valves supplied on CBJT-2W boilers. Table 4 gives steam volume and disengaging area.

Table 5 shows recommended steam nozzle sizes for CBJT-2W boilers.

Table 6 gives recommended non-return valve sizes for CBJT-2W Boilers.

### Blowdown Water Requirements

Some local codes require blowdown tanks to be constructed in accordance with recommendations of the National Board of Boiler and Pressure Vessel Inspectors.

The National Board's recommendations base the size of the blowdown tank on the removal of at least 4 inches of water from the boiler.

Table 13 lists the approximate quantity of water represented by 4 inches of water at normal operating level for Cleaver-Brooks CBJT-2W Boilers.

## **Burner/Control Information**

### ***Burner Characteristics***

Note that altitude correction and burner changes are required for higher altitudes which may alter dimensions, motor hp and gas pressures. Also 50 Hz applications and low NOx options should be reviewed by the Cleaver-Brooks authorized representative.

### ***Fuel Connections - Gas***

The local gas company should be consulted for requirements and authorization for installation and inspection of gas supply piping. Installation of gas supply piping and venting must be in accordance with all applicable engineering guidelines and regulatory codes. All connections made to the boiler should be arranged so that all components remain accessible for inspection, cleaning and maintenance.

A drip leg should be installed in the supply piping before the connection to the gas pressure regulator. The drip leg should be at least as large as the inlet fitting supplied with the boiler. Consideration must be given to both volume and pressure requirements when choosing gas supply piping size. Refer to the boiler dimension diagram provided by Cleaver-Brooks for the particular installation. Connections to the burner gas train should be made with a union, so that gas train components or the burner may be easily disconnected for inspection or service. Upon completion of the gas piping installation, the system should be checked for gas leakage and tight shutoff of all valves.

### ***Fuel Connections - Oil***

Oil-fired burners are equipped with an oil pump, which draws fuel from a storage tank and supplies pressurized oil to the burner nozzle(s). The burner supply oil pump has a greater capacity than the burner requires for the maximum firing rate. Fuel not delivered to the nozzle is returned to the storage tank. A two-pipe (supply and return) oil system is recommended for all installations. Oil lines must be sized for the burner and burner supply oil pump capacities.

The burner supply oil pump suction should not exceed 10" Hg. If a transfer pump is used, it must have a pumping capacity at least equal to that of the burner pump(s). Supply pressure to the burner pump should not exceed 3 psig.

A strainer must be installed in the supply piping upstream of the burner supply pump in order to prevent entry of foreign material into the pump, fuel control valves, or burner nozzle(s). The strainer must be sized for the burner supply pump capacity. A strainer mesh of 150 microns (0.005") is recommended.

Install a check valve in the line to prevent draining of the oil suction line when the burner is not in operation. Location of the check valve varies with the system, but usually it is located as close as possible to the storage tank.

Installation of a vacuum gauge in the burner supply line between the burner oil pump and the strainer is recommended. Regular observation and recording of the gauge indication will assist in determining when the strainer needs servicing.

Upon completion of the oil piping installation, the system should be checked for oil or air leakage and tight shutoff of all valves.

## **Boiler Room Information**

Table 13 shows typical boiler room width requirements.

### **Stack Support Capabilities**

CBJT-2W boilers can support up to 2000 lbs. without additional support.

CBJT-2W boilers can be reinforced to support up to 3000 lbs.

## Boiler Room Combustion Air

When determining boiler room air requirements, the size of the room, air flow, and velocity of air must be reviewed as follows:

1. Size (area) and location of air supply openings in boiler room.
  - A. Two (2) permanent air supply openings in the outer walls of the boiler room are recommended. Locate one (1) at each end of the boiler room, preferably below a height of 7 feet. This allows air to sweep the length of the boiler.
  - B. Air supply openings can be louvered for weather protection, but they should not be covered with fine mesh wire, as this type of covering has poor air flow qualities and is subject to clogging by dust or dirt.
  - C. A vent fan in the boiler room is not recommended, as it could create a slight vacuum under certain conditions and cause variations in the quantity of combustion air. This can result in unsatisfactory burner performance.
  - D. Under no condition should the total area of the air supply openings be less than one (1) square foot.
  - E. Size the openings by using the formula:

$$\text{Area (sq-ft)} = \text{CFM/FPM}$$

2. Amount of air required (cfm).
  - A. Combustion Air = Rated bhp x 8 cfm/bhp.
  - B. Ventilation Air = Maximum bhp x 2 cfm/bhp or a total of 10 cfm/bhp - up to 1000 feet elevation. Add 3 percent more per 1000 feet of added elevation.
3. Acceptable air velocity in Boiler Room (fpm).
  - A. From floor to (7) foot height - 250 fpm.
  - B. Above (7) foot height - 500 fpm.

Example: Determine the area of the boiler room air supply openings for (1) 1000 hp boiler at 800 feet altitude. The air openings are to be 5 feet above floor level.

- Air required:  $1000 \times 10 = 10000$  cfm (from 2B above).
- Air velocity: Up to 7 feet = 250 fpm (from 3 above).
- Area Required:  $\text{Area} = \text{cfm/fpm} = 10000/250 = 40$  Sq-ft total.
- Area/Opening:  $40/2 = 20$  sq-ft/opening (2 required).

*Consult local codes, which may supersede these requirements.*

## Stack/Breeching Size Criteria

The design of the stack and breeching must provide the required draft at each boiler flue gas outlet. Proper draft is critical to burner performance.

Although constant pressure at the flue gas outlet of the CBJT-2W is not required, it is necessary to size the stack/breeching to limit flue gas pressure variation. The allowable pressure range is  $-0.50''$  W.C. to  $+0.50''$  W.C. The maximum pressure variation at any firing rate for the boiler is  $0.50''$  W.C.

The low NO<sub>x</sub> option allowable pressure range is  $-0.25''$  W.C. to  $+0.25''$  W.C. The maximum pressure variation at any firing rate for the boiler is  $0.25''$ W.C.

Stack and breeching sizes should always be provided by a reputable stack supplier who will design the stack and breeching system based on the above criteria. Your local Cleaver-Brooks authorized representative is capable of assisting in your evaluation of the stack/breeching design.

**Table 3: CBJT-2W Steam Boiler Safety Valve Outlet Size**

BOILER HP	VALVE SETTING					
	150 PSIG STEAM		200 PSIG STEAM		250 PSIG STEAM	
	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)
900	3	2-1/2	3	(2) 2-1/2 (1) 1-1/2	2	2-1/2
1000	4	(3) 2-1/2 (1) 2	3	(2) 2-1/2 (1) 2	2	2-1/2
1100	4	(3) 2-1/2 (1) 2	3	2-1/2	3	(2) 2-1/2 (1) 1-1/2
1200	4	2-1/2	3	2-1/2	3	(2) 2-1/2 (1) 2

NOTE: Valve manufacturers are Kunkle, Consolidated or Conbraco, depending on availability.

**Table 4: Model CBJT-2W Steam Volume and Disengaging Areas**

BOILER HP	STEAM VOLUME CU-FT	STEAM RELIEVING AREA SQ-IN
	HIGH PRESSURE	HIGH PRESSURE
	(A)	(A)
900	140.2	18605
1000	140.2	18605
1100	160.5	19901
1200	160.5	19901

**Table 5: CBJT-2W Recommended Steam Nozzle Size**

OPERATING PRESSURE PSIG	BOILER HP			
	900	1000	1100	1200
50	12	12	14	14
75	10	10	12	12
100	10	10	10	10
125	8	8	10	10
150	8	8	8	8
200	8	8	8	8
250	6	6	6	6

NOTES:

1. Steam nozzle sizes given in inches.
2. Recommended steam nozzle sizes based on 4000 to 5000 fpm steam velocity.

**Table 6: Model CBJT-2W Recommended Non-Return Valve Size**

BOILER HP	BOILER CAPACITY (LBS/HR)	OPERATING PRESSURE (PSIG)							
		50	75	100	125	150	175	200	250
900	31050	8	8	8	6	6	6	6	6
1000	34500	8	8	8	6	6	6	6	6
1100	37950	10	8	8	8	6	6	6	6
1200	41405	10	8	8	8	6	6	6	6

NOTE: Valve sizes (300 psig flanges) given in inches.

**Table 7: Altitude Correction for Gas**

ALTITUDE (FT)	CORRECTION FACTOR	ALTITUDE (FT)	CORRECTION FACTOR
1000	1.04	6000	1.25
2000	1.07	7000	1.3
3000	1.11	8000	1.35
4000	1.16	9000	1.4
5000	1.21	-	-

To obtain minimum required gas pressure at altitudes above 700 feet, multiply the pressure by the listed factors:

Inches WC x 0.577 = oz/sq-in.

oz/sq-in x 1.732 = inches WC.

Inches WC x 0.0361 = psig.

oz/sq-in x 0.0625 = psig.

psig x 27.71 = Inches WC.

psig x 16.0 = oz/sq-in.

**Table 8: Predicted Fuel-to-Steam Efficiencies - Natural Gas**

BHP	OPERATING PRESSURE = 125 psig			
	% OF LOAD			
	25%	50%	75%	100%
900	82.7	82.2	81.5	80.7
1000	82.6	82.1	81.3	80.5
1100	82.7	82.2	81.5	80.8
1200	82.6	82.1	81.4	80.6

**Table 9: Predicted Fuel-to-Steam Efficiencies - No. 2 Oil**

BHP	OPERATING PRESSURE = 125 psig			
	% OF LOAD			
	25%	50%	75%	100%
900	86.0	85.5	84.8	84.1
1000	85.9	85.4	84.6	83.8
1100	86.0	85.5	84.8	84.1
1200	86.0	85.4	84.7	83.9

**Table 10: CBJT-2W Natural Gas Estimated Emissions**

POLLUTANT	UNITS	UNCONTROLLED	30 PPM SYSTEM
CO	ppm <sup>A</sup>	50	50
	lb/MMBTU	0.037	0.037
NOx	ppm <sup>A</sup>	120	30
	lb/MMBTU	0.1214	0.364
SOx	ppm <sup>A</sup>	-	-
	lb/MMBTU	0.001	0.001
HC/VOC	ppm <sup>A</sup>	-	-
	lb/MMBTU	0.0055	0.0055
PM	ppm <sup>A</sup>	-	-
	lb/MMBTU	0.0076	0.0076

**Table 11: CBJT-2W Boilers: No. 2 Oil, Estimated Emissions**

POLLUTANT	UNITS	UNCONTROLLED	30 PPM SYSTEM
CO	ppm <sup>A</sup>	50	50
	lb/MMBTU	0.039	0.039
NOx	ppm <sup>A</sup>	160	90
	lb/MMBTU	0.2047	0.12
SOx	ppm <sup>A</sup>	55	55
	lb/MMBTU	0.1	0.1
HC/VOC	ppm <sup>A</sup>	-	-
	lb/MMBTU	0.0021	0.0021
PM	ppm <sup>A</sup>	-	-
	lb/MMBTU	0.0089	0.0089

A. ppm levels are given on a dry volume basis and corrected to 3% oxygen (15% excess air)

A. ppm levels are given on a dry volume basis and corrected to 3% oxygen (15% excess air)

BASED ON THE FOLLOWING CONSTITUENT LEVELS:  
 Fuel-bound Nitrogen content = 0.02% or less by weight.  
 Sulfur content = 0.1% by weight.  
 Ash content = 0.01% by weight.

**Table 11: Turndown**

BHP	Natural Gas		#2 Oil	
	Uncontrolled NOx	30 ppm NOx	Uncontrolled-Natural gas system	30 ppm NOx -Natural gas system
900	10:1	8:1	8:1	8:1
1000	10:1	8:1	8:1	8:1
1100	10:1	8:1	8:1	8:1
1200	10:1	8:1	8:1	8:1

**Table 12: Min. required gas pressure at entrance to C-B supplied regulator/gas valve**

BOILER HP	Combination Regulator and Gas Valve Size (in)	PRESSURE REQUIRED ("WC)
900	4	50
1000	4	63
1100	4	64
1200	4	59

Note: For undersized or oversized gas trains or altitudes above 700 feet, contact your local Cleaver-Brooks representative.

**Table 13: Blowdown Tank Sizing**

BOILER HP	WATER (GAL)
900	336
1000	336
1100	358
1200	358

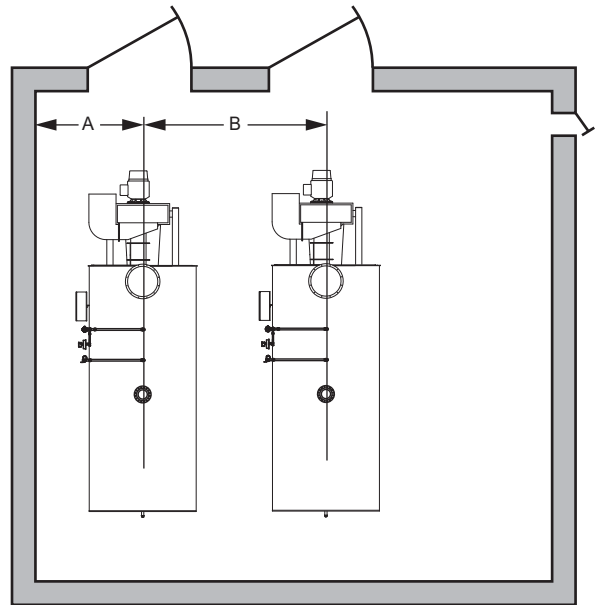
NOTE: Quantity of water removed from boiler by lowering normal water line 4".

**Table 14: Boiler Room Width (Typical Layout) - Model CBJT-2W**

BOILER HP	900-1200
DIM. "A" <sup>1</sup>	110"
DIM. "B" <sup>2</sup>	180"

NOTES:

1. Recommended minimum distance between boiler and wall. Dimension "A" allows for a "clear" 42" aisle between the water column on the boiler and the wall. If space permits, this aisle should be widened.
2. Recommended minimum distance between boilers.

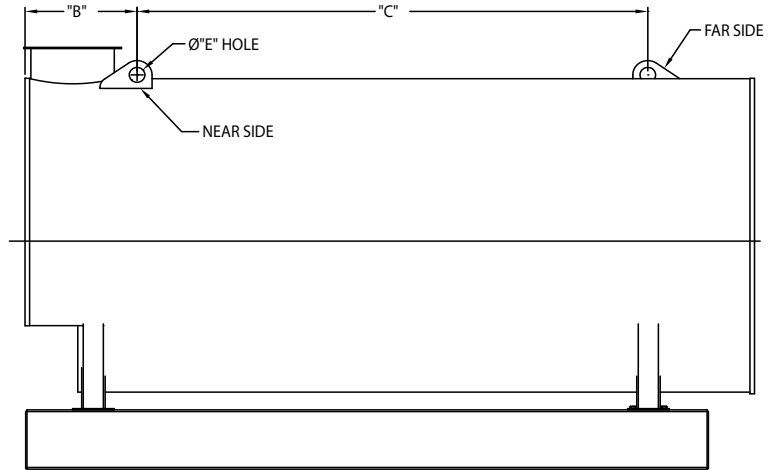
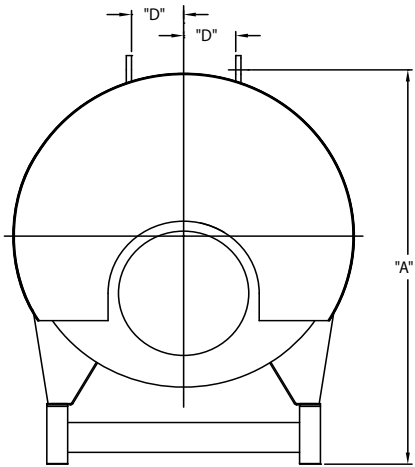




**Table 15: CBJT-2W Boilers Lifting Lug Location**

BOILER HP	ALL DIMENSIONS IN INCHES				
	A	B	C	D	E
900	128	48.375	188.25	12	3
1000	128	48.375	188.25	12	3
1100	128	48.375	198.25	12	3
1200	128	48.375	198.25	12	3

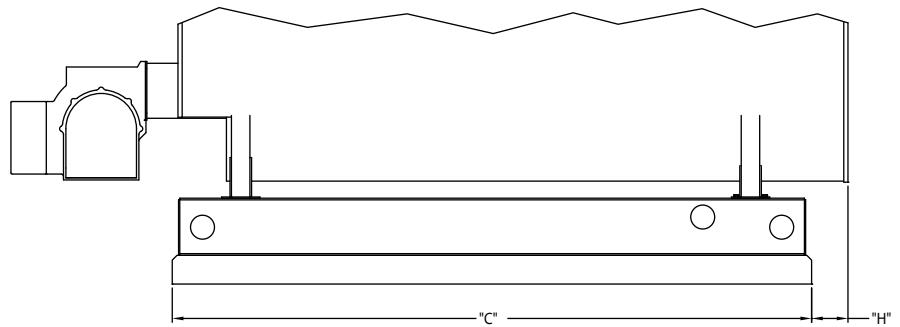
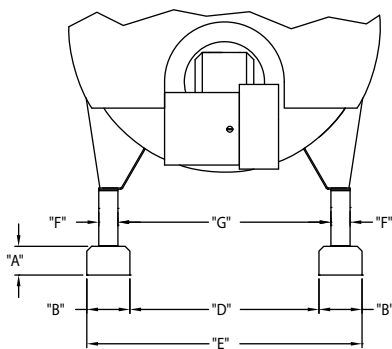
NOTE: Dimensions A, B, and C may vary by 1 inch.



**Table 16: CBJT-2W Boiler Mounting Piers**

BOILER HP	ALL DIMENSIONS IN INCHES							
	A	B	C	D	E	F	G	H
900	6	12	318	56.25	80.25	6.5	61.75	5
1000	6	12	318	56.25	80.25	6.5	61.75	5
1100	6	12	328	56.25	80.25	6.5	61.75	5
1200	6	12	328	56.25	80.25	6.5	61.75	5

NOTE: 6-inch high mounting piers recommended for use beneath the boiler base frame. The use of these piers provides increased inspection accessibility to the boiler and added height for washing down the area beneath the boiler.





**INTEGRATED, INTELLIGENT**

# **HAWK**

**CONTROL SYSTEM**

**Hawk 1000-4500 Series**



**FOR MAXIMUM**

**INTEGRATION**

**EFFICIENCY**

**SAFETY**

**RELIABILITY**

**COMMUNICATIONS**

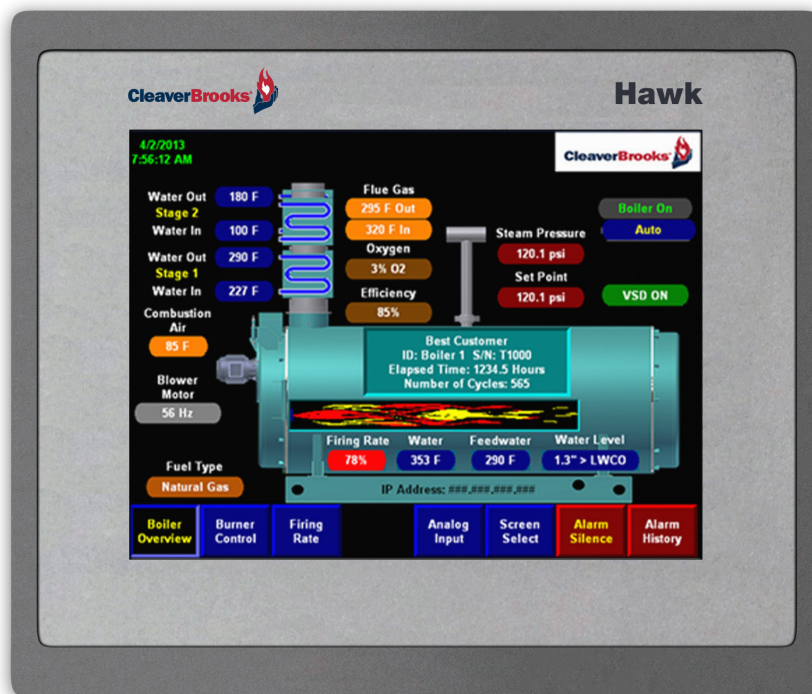


# Hawk

## INTELLIGENT, INTEGRATED BOILER ROOM CONTROL SOLUTION

For over 80 years, Cleaver-Brooks has been packaging boiler room equipment. Today, we integrate the boiler/burner/controls and heat recovery for the most efficient heating or process solution possible.

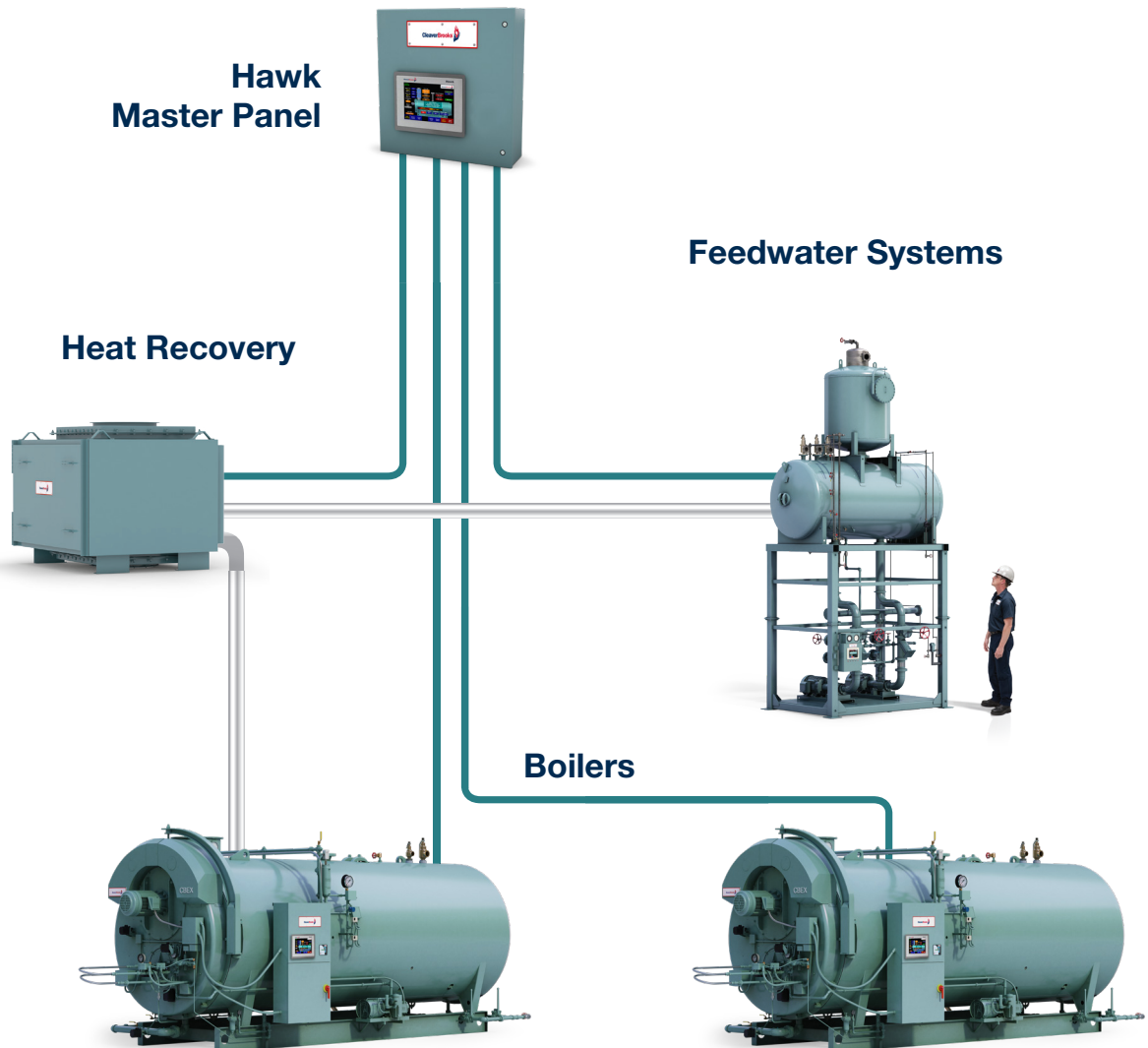
Since we engineer the core components of our equipment, we can ensure everything is made to work together for maximum efficiency, safety and reliability with a seamless, easy-to-use, human-to-machine interface.



# SINGLE SOURCE INTEGRATED BOILER ROOM CONTROL FOR MAXIMUM EFFICIENCY

The Hawk is a complete boiler room solution. It not only integrates the boiler/burner, heat recovery and feedwater systems, but provides complete boiler room data to remote communication systems such as building automation systems, SCADA packages and other remote monitoring systems. While integrated, the combustion and burner management are maintained as separate devices to meet NFPA85 and other safety codes.

Because the Hawk comes preprogrammed for boiler/burner applications, commissioning your boiler system can save you time to get your customer on line.





# NEW OR RETROFIT APPLICATIONS



Upgrade options give your old boiler state-of-the-art performance. Employing industrially hardened PLC technology, user-friendly touch-screen operation and advanced operating and diagnostic messaging, the Hawk offers unmatched functionality.



*Retrofit your boiler's dated control system with virtually any boiler or system*

## Why upgrade?

- ▶ Update your boiler's controls to the Best Acceptable Control Technology (BACT)
- ▶ Increase efficiency
- ▶ Fuel savings
- ▶ Allow variances to reduce resource utilization with data reporting and communications
- ▶ Reduce emissions with burner update and Hawk control
- ▶ Monitoring, communication and optional reporting capabilities

## POWERFUL COMMUNICATIONS

The Hawk is one of the most flexible control systems available in the industry. Control options provide easy access to information to the end users Building Automation System, C-B SCADA and other remote monitoring systems. The Hawk has the ability to monitor and control multiple aspects of boiler control such as fuel usage and hours of use, O<sub>2</sub> levels, stack temperature, lead/lag sequencing, boiler efficiency, water level, temperature/pressure, hot standby, combustion control and more.

The Hawk's user friendly interface has robust local HMI trending and data trending, up to 300,000 points, allowing the operator to continually tune the system for optimum performance.

You can be alerted by e-mail, text messaging, internal network or Internet of boiler status and alarms, and this same data can be shared with smartphones or the latest mobile device.

# HAWK CONTROL SYSTEM PACKAGES



## Hawk 1000 Control

The Hawk 1000 is a complete package that comes standard for precise fuel-to-air ratio O<sub>2</sub> trim & VSD control, in one integrated system. Optional single-point and Lo-Hi-Lo control allows flexibility for commercial-type boilers requirement.

### Hawk 1000 Features

- ▶ Standard Honeywell (CB780E) integrated burner management system or Fireeye (CB120E) as an option
- ▶ Allen-Bradley Panelview Plus 6" color touch screen HMI for setup, monitoring, and data acquisition
- ▶ Rockwell/Allen-Bradley PLC platform
- ▶ UL Listed



## Hawk 4000 Control

The Hawk 4000 includes complete boiler room control integration including fuel-to-air ratio controls (parallel positioning), O<sub>2</sub> trim, variable speed drive control on the combustion blower, economizer monitoring, draft control, 1, 2 and 3 element control, user defined analog inputs, 3 independent fuels supported, advanced troubleshooting and help screens, and more.

### Hawk 4000 Features

- ▶ Standard Honeywell (CB780E) integrated burner management system or Fireeye CB120E as an option
- ▶ Rockwell/Allen-Bradley PLC platform
- ▶ Allen-Bradley Panelview Plus 7" color touch screen HMI for setup, monitoring, and data acquisition
- ▶ Optional upgrade to a 10" screen
- ▶ UL Listed



## Hawk 4500 Control

The Hawk 4500 package includes the same features and flexibility as the Hawk 4000, but is ideal for smaller capacity Industrial Watertube applications requiring single-point positioning or parallel positioning.

### Hawk 4500 Features

- ▶ Fireeye (CB120E)-based integrated burner management system or Honeywell (CB780E) an option
- ▶ Rockwell/Allen-Bradley PLC platform
- ▶ Allen-Bradley PanelView Plus™ 10" color touch screen HMI for setup, monitoring, and data acquisition

# Hawk Standard and Optional Features



All Hawk packages come standard with parallel positioning, stack temperature with high cutoff set point, thermal shock protection, dual set points, Ethernet, touch screen HMI, hot standby, remote stop/start, PLC-based combustion control, flash card reader and alarm monitoring and historical monitoring.

OPTIONAL FEATURES FOR HAWK PACKAGES			
	Hawk 1000	Hawk 4000	Hawk 4500
Processor	L24ER	L33ER	L36ERM
6" color touch screen	Standard	N/A	N/A
7" Panel View Plus color touch screen	N/A	Standard	N/A
10" Panel View Plus color touch screen	N/A	Optional	Standard
UL Listed	Yes	Yes	N/A
Honeywell CB780	Standard	Standard	Optional
Fireye CB120E	Optional	Optional	Standard
O <sub>2</sub> trim	Standard*	Standard*	Standard*
Parallel positioning	Standard*	Standard*	Standard*
3rd Fuel Parallel Positioning	N/A	Standard*	Custom
Variable speed drive	Standard*	Standard*	Standard*
Draft Control	N/A	Standard*	Standard*
Single point positioning/jackshaft	Optional	Optional	Optional
Hi-Low-Off control	Optional	N/A	N/A
Revert to pilot (Using Fireye CB120 only)	Optional	Optional	Custom
Full metering capabilities	N/A	Custom	Standard
Stack Temp with High Cutoff Set Point	Standard	Standard	Standard
Thermal Shock Protection	Standard	Standard	Standard
Economizer flue gas outlet temperature input	N/A	Optional	Optional
Economizer feedwater inlet temperature input	N/A	Optional	Optional
Economizer feedwater outlet temperature input	N/A	Optional	Optional
Additional user analog inputs	N/A	Optional	Optional
Expanded annunciation	Optional	Optional	Standard*
Combustion air/ambient temperature monitoring	Optional	Optional	Optional
Dual Set Points	Standard	Standard	Standard
Stack loss boiler efficiency reading	Standard	Standard	N/A
Hot Stand By	Standard	Standard	Standard
E-mail, text messaging via internet	Standard	Standard	Standard
Building Automation Interface	Optional	Optional	Optional
Remote monitoring SCADA system	Optional	Optional	Optional
Water Level Display Capabilities	Optional	Standard*	Standard*
2 boiler lead/lag	Standard*	Standard*	N/A
MasterPanel lead/lag (See system specs for specific use)	Optional	Optional	Optional
Local on Screen Trending	N/A	Standard	Standard
Alarm History	Standard	Standard	Standard
Water Level Control 1, 2 or 3 Element	N/A	Standard*	Standard*
Two-Stage Economizer Control Single Boiler	N/A	Standard*	N/A

Note: See specific Hawk system specifications for complete details for each options allowance or use.

\*Hardware required

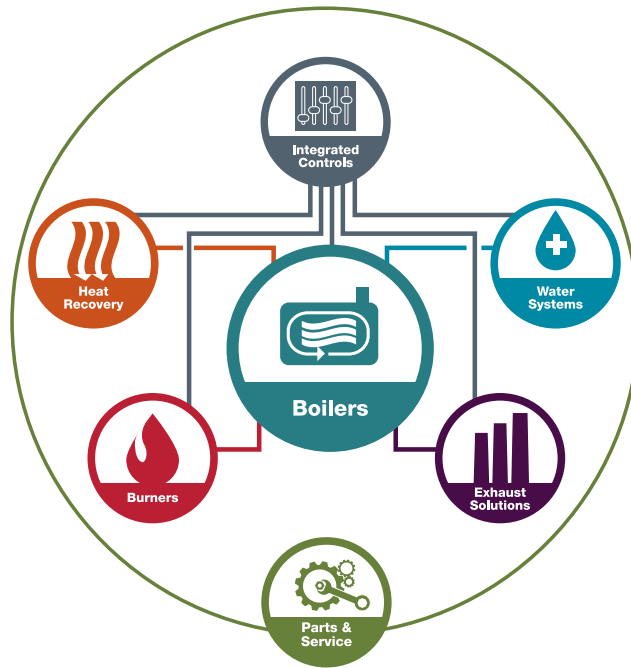
Oxygen trim



Variable speed drive







# Providing energy-efficient, environmentally friendly boiler room solutions

Cleaver-Brooks is one of only a few boiler room solution providers in the world to operate a dedicated research and development facility. Having pioneered several industry-leading technologies, we remain just as committed today to introducing technology and products that enable a more energy-efficient and environmentally friendly generation of steam and hot water.

We distribute our products through the Cleaver-Brooks Representatives Association, or CBRA, an alliance of independently owned and operated companies that provide boiler room products and service. CBRA companies can be counted on to provide Cleaver-Brooks products and parts, engineering support, customer training, technical service and system maintenance. To find a CBRA representative near you, please visit [cleaverbrooks.com/reps](http://cleaverbrooks.com/reps).



221 Law Street • Thomasville, GA 31792 USA  
 229-226-3024 • 800-296-4110 • [info@cleaverbrooks.com](mailto:info@cleaverbrooks.com)  
[cleaverbrooks.com](http://cleaverbrooks.com)



MAJOR COMPONENTS	
1	Control Panel <b>15 HP, 460/3/60</b>
2	Entrance Panel
3	Blower Motor - 75 HP
4	Air Compressor - <del>40 HP</del> (Shipped Loose)
5	Combustion Safeguard Control - CB-780E
6	Flame Scanner - Infrared
7	Pressure Control - Operating Limit
8	Pressure Control - High Limit (Manual Reset)
9	Steam Pressure Transmitter
10	Main Low Water Column - McDM-193-7B
11	Auxiliary Low Water Cutoff - McDM-1575
12	Steam Gauge
13	N/A
14	Stack Temperature Transmitter
15	Safety Valve (4) Set @ 150# (Shipped Loose)
16	Gas Train
17	Fuel Oil Piping Terminal
18	Fuel Oil Pump Assembly (Shipped Loose)
19	Manway 12" x 16"
20	Variable Speed Drive

SERVICE CONNECTIONS	
A	Electric - Main Power Supply - 460 / 3 / 60
B	N/A
C	Exhaust Vent Pipe - 32" OD
D	Vent Flange (See Detail)
E	Steam Outlet - 10" 300# R.F. Flange
F	N/A
G	N/A
H	Feedwater - (1) 3.0 NPT Piping - 2.5 NPT
I	Bottom Blowdown - (3) 2.0 NPT
J	Water Column Blowdown - 0.75 NPT
K	Gauge Glass Blowdown - 0.25 NPT
L	Surface Blowoff - 1.0 NPT (With Collector Pipe) Piping - 0.75 NPT
M	Gas Pilot - 0.5 NPT
N	Main Gas - 3.0 NPT
O	Min.-Max. Inlet Gas Pressure Required is 5.4-10 PSI Approx. Regulator Setpoint: 65" W.C. Maximum Gas Flowrate - 50,213 SCFH
P	Oil Inlet - 0.75 NPT Rating - 358.7 GPH
Q	Oil Outlet - 0.75 NPT
R	Chemical Feed - 1.0 NPT
S	Safety Valve - (4) Kunkle 6010JHE 2.0 x 2.5 FPT (Outlet)
T	N/A

**NOTES**

- \* Boiler is Designed and Constructed in Accordance with the ASME Boiler and Pressure Vessel Code - Section 1 High Pressure Boiler
- \* This Unit Complies with Insurance Underwriters Requirement for Factory Mutual & GE Global Asset Protection
- \* The Boiler Package is painted with High Temperature Light Blue Enamel
- \* The Burner Operation is Full Modulating

This Boiler Is Provided with:

1. Control Circuit Transformer
2. Welded End Caps on Basereils
3. Hawk 1000 Package
4. TEFC Rated Blower, Air Compressor, & Oil Pump Motor
5. All Panels Included Contain U.L. Label
6. Reflex Gauge Glass Provided
7. Water Column Vacuum Breaker Provided

BOILER SPECIFICATIONS	
Boiler Designation - CBJT-2W 200 1200	
Design Pressure - 150ST	
Design Rating - 1200 hp	
Emissions - 30 ppm	
Fuel(s) - No. 2 Oil & Natural Gas	
Steam Capacity - 41,400# stm/hr @212 deg F	
Fireside Heating Surface - 2,955 Sq. Ft.	
Dry Weight - 49,000 LB	
Water Weight - 32,670 LB	
Gallons (Operating) - 3917	
Code Compliance - FM, GE-GAP (NFPA-85)	

**BOILER CLEARANCES**

Tube Removal - Front Only: 192"

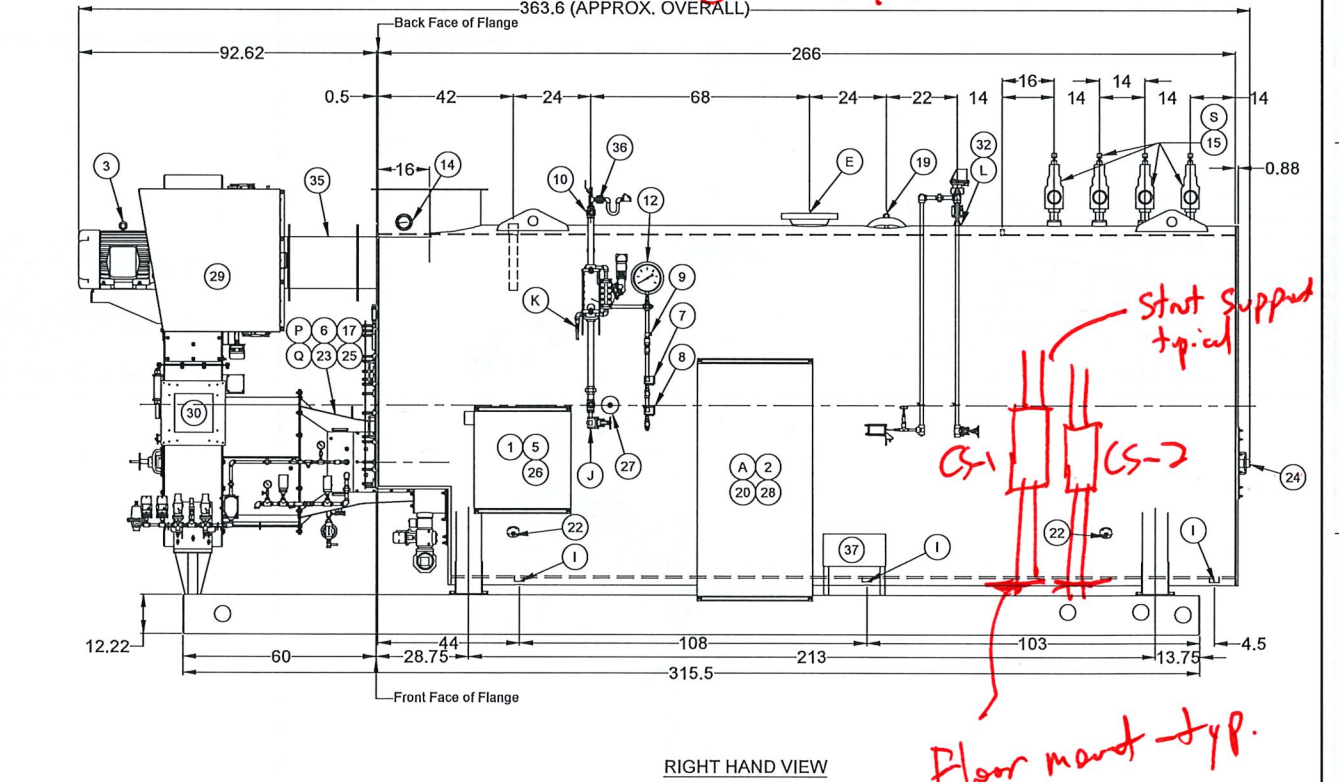
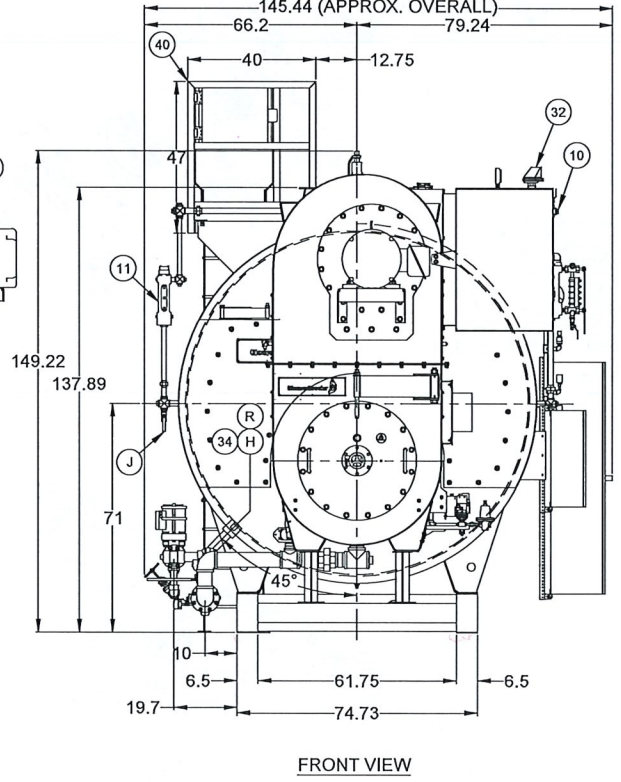
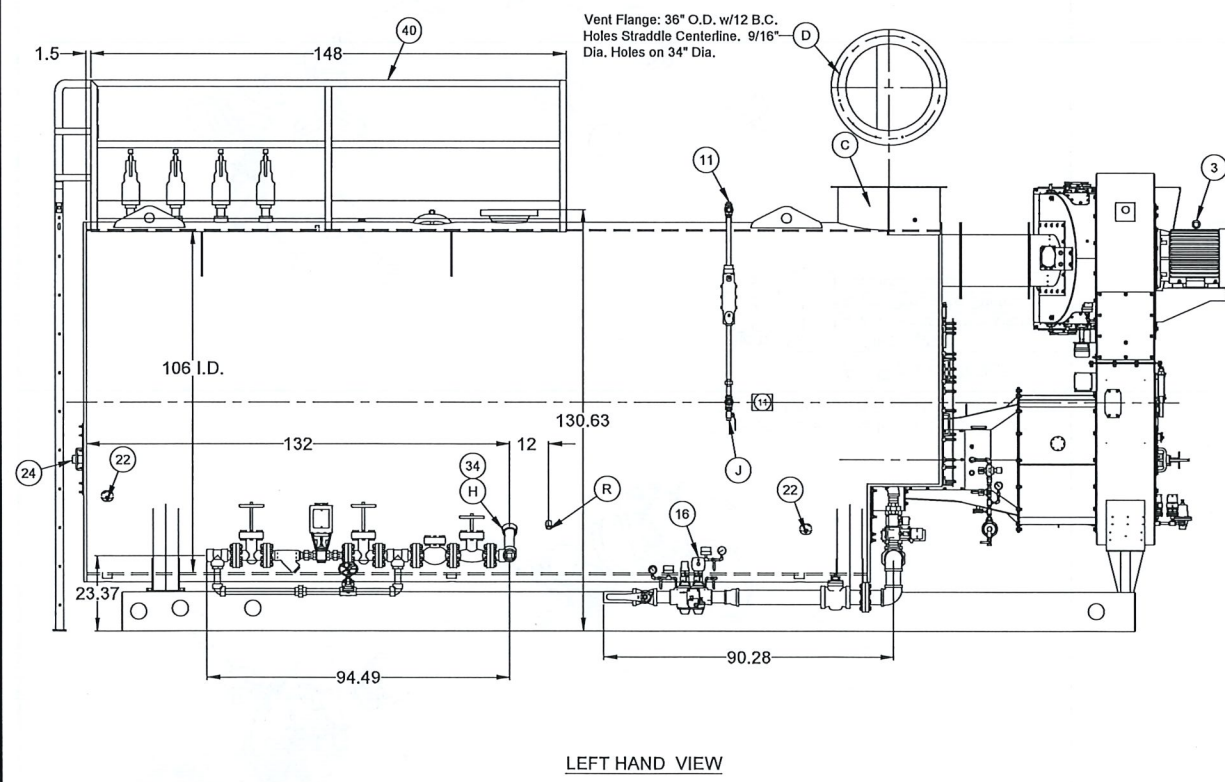
MINIMUM BOILER ROOM LENGTH ALLOWING FOR TUBE REMOVAL:

Thru Window or Door : 406"  
Front of Boiler: 494"

1) Provide 40/3 Breaker @ Panel PH1 (PH1-13/15/16) for Boiler Air Compressor. Provide Provide Hema Size 2 FVNR Combination (CS-1) Motor starter (Hema 1 enclosure) and mount on boiler adjacent to boiler main disconnect

2) Provide 15/3 Breaker @ Panel PH1 (PH1-19/21/23) for Boiler Oil Pump. Provide Hema Size 0 FVNR Combination motor starter (Hema 1 enclosure) and mount on boiler adjacent to boiler main disconnect (CS-2) Humerun 3#12, #12G, 1/4" C to Panel PH-1.  
Humerun 3#10, #10G, 1" C to Panel PH-1.

3) Revise Boiler Breaker @ Panel PH1 to be 150/3MT Breaker. Revise Boiler feeder to be 3#2#10G, 1 1/2" C (PH1-1/3/5)



REVISIONS	DATE	BY	DESCRIPTION
1	05/26/21	TDL	USED BOILER NOTES

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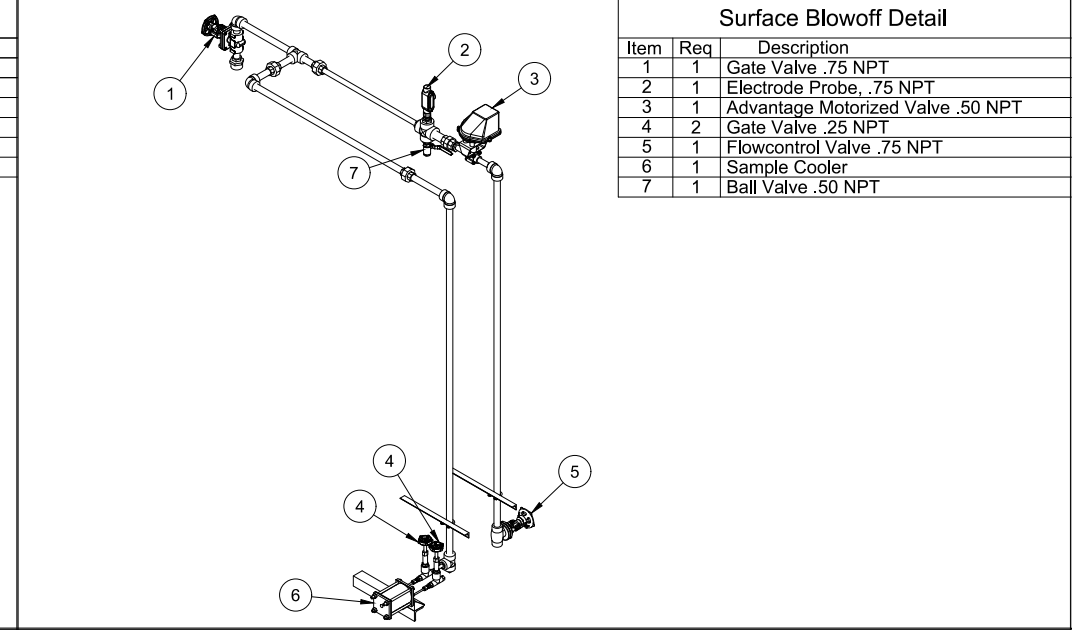
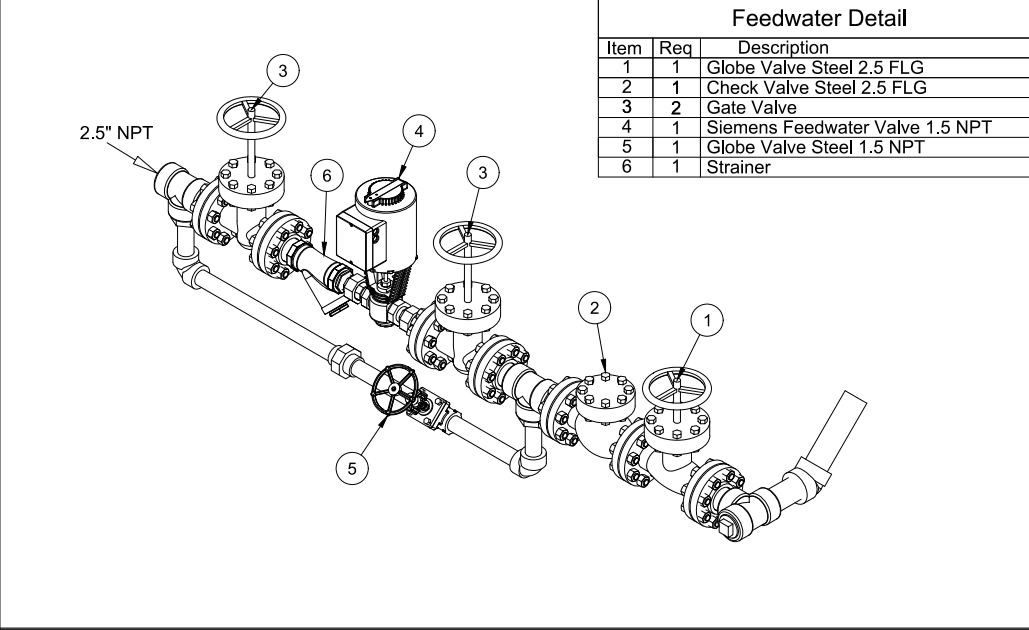
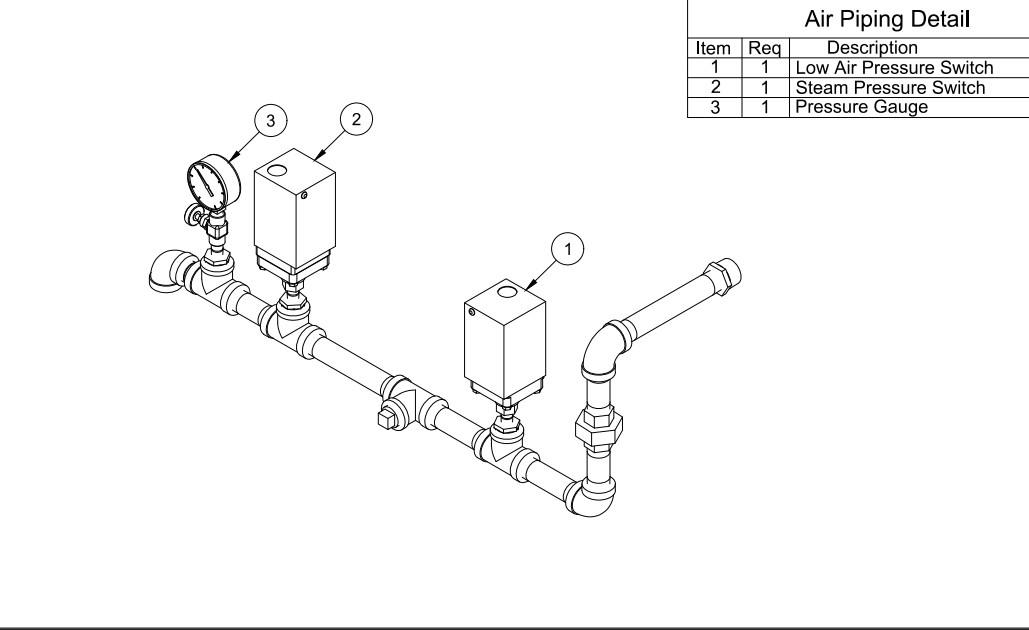
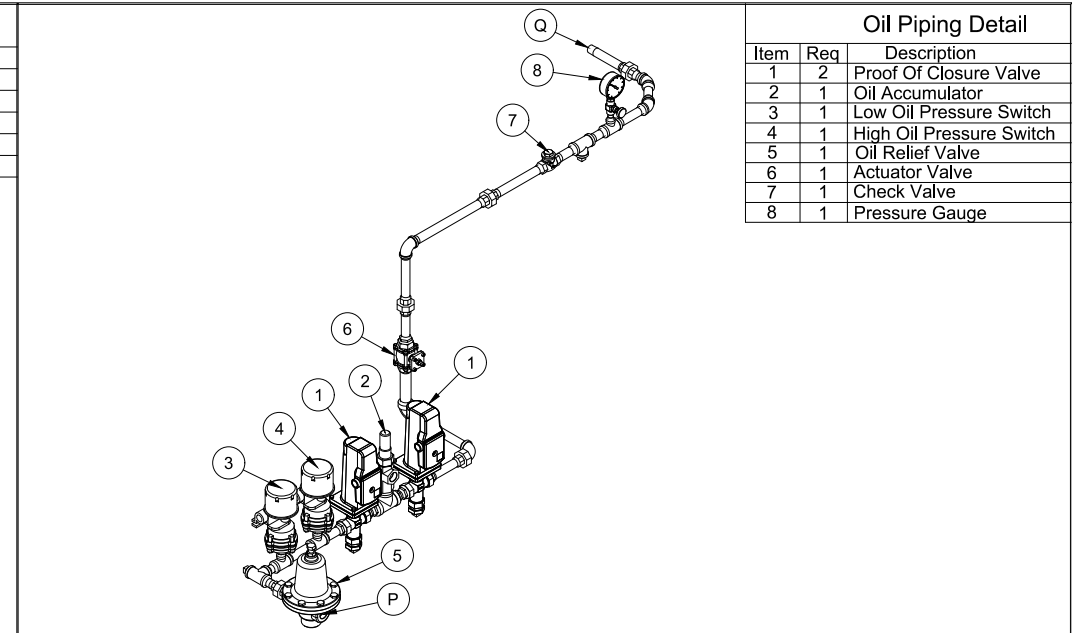
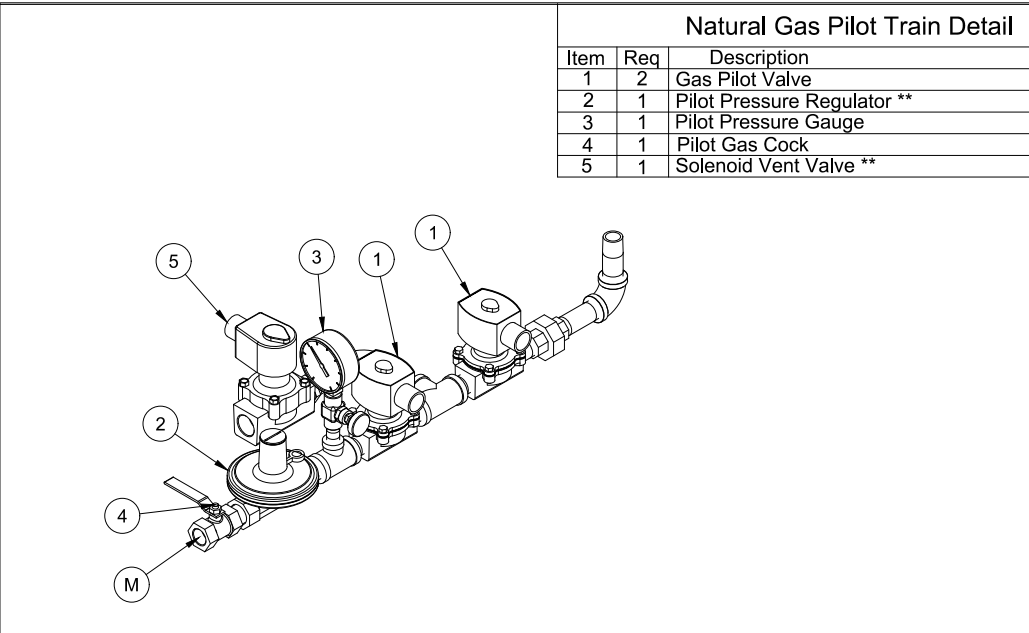
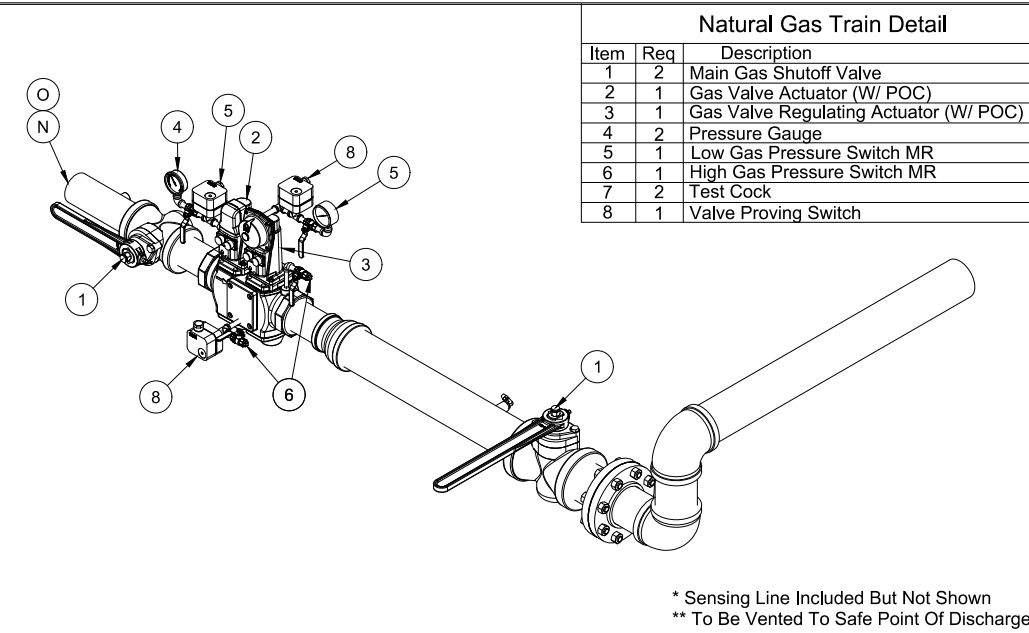
**DIMENSIONAL DIAGRAM**

SCALE: N.T.S.  
DATE: 04/19/21  
DRAWN: TDL

**CleaverBrooks**

MODEL	CBJT-2W	200	1200	150ST	CAPACITY
FUEL	460	3	60	3	FM&GAP
VOLTS		PHASE	HERTZ	WIRE	INSURANCE





**Ship Loose**  
These Items Are Shipped Loose For Installation By Others

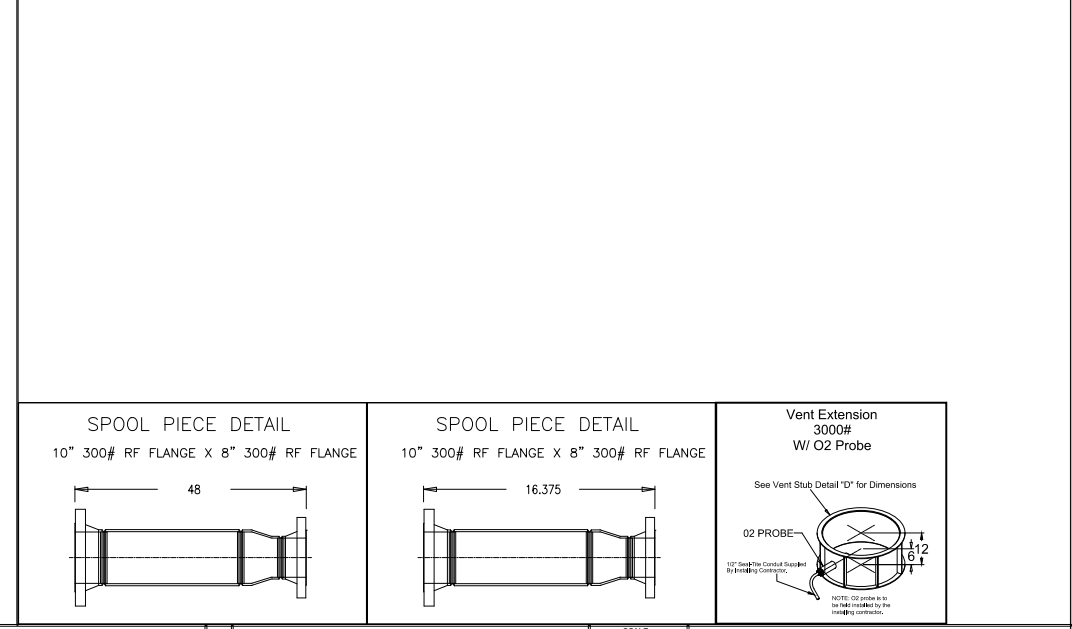
Safety Valve - (4) Set At 150#  
 Steam Header Spool Piece - 10x8x48  
 Second Steam Header Spool Piece - 8x10x16.375  
 Steam Header Valve - Cast Steel 10" 300# FLG  
 Stop Check Valve - Cast Steel 8" 300# Angle Pattern Model 1A W/ Free Blow Drain Valve  
 Vent Extension - 3000# W/ Connection for CB Type O2 Probe  
 CB O2 Probe  
 Feedwater 3-Valve Bypass Assembly  
 Platform & Ladder Assembly  
 Fuel Oil Pump Set  
 Surface Blow Off - Automatic Conductivity Controller  
 Air Compressor  
 RC Panel

**FUEL OIL PUMP SET - VIKING**

MODEL: GG-4195-D MOTOR: 1.5 HP CAPACITY: 330 GPH RPM: 1750

**460/3/60**

**NOTES:**  
 Pump assembly includes suction strainer & H-O-A starter.  
 Assembly will be shipped loose for installation close to oil storage tank.



REV	DATE	DESCRIPTION
01	05/26/21	TDL

REVISED BOILER NOTES

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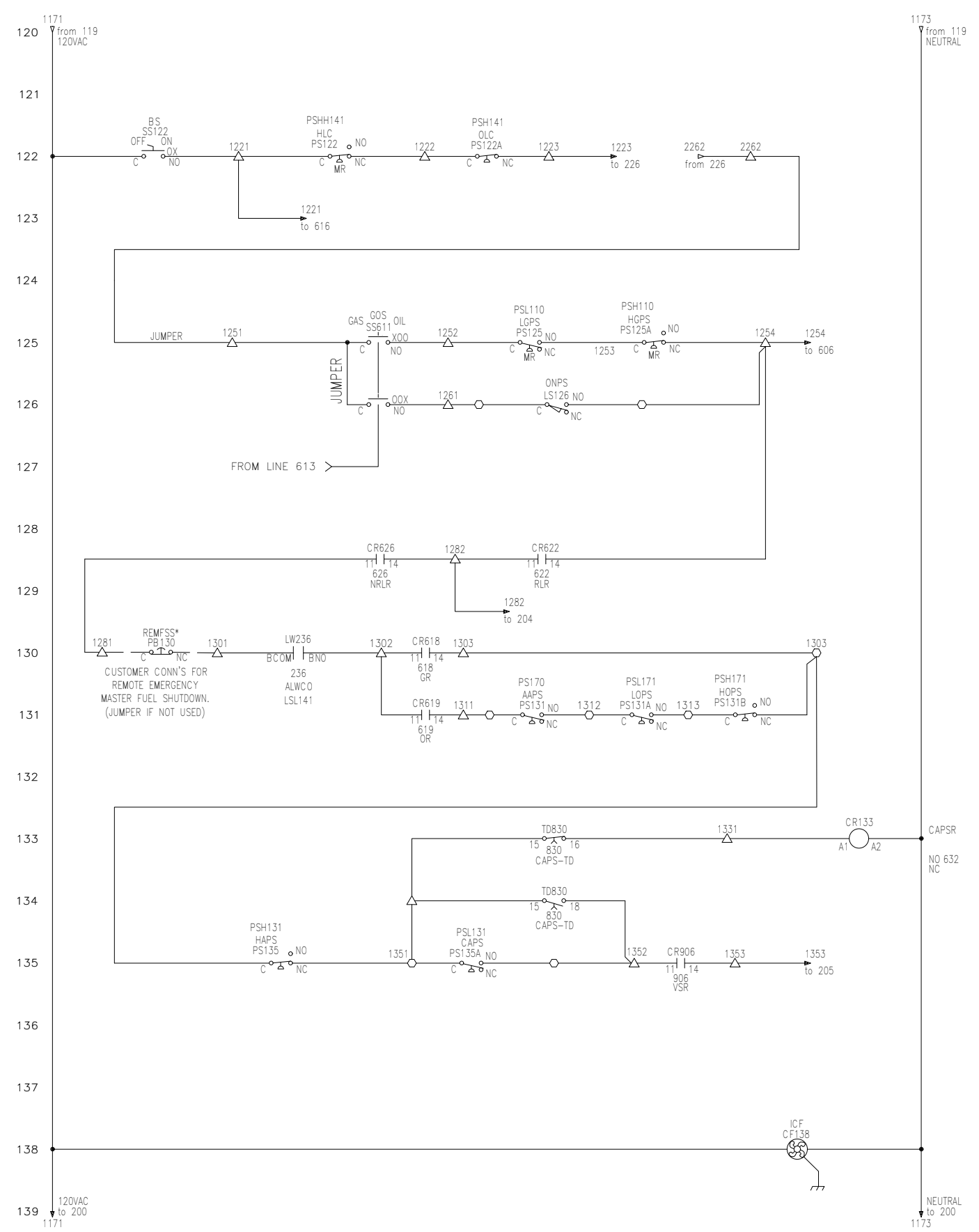
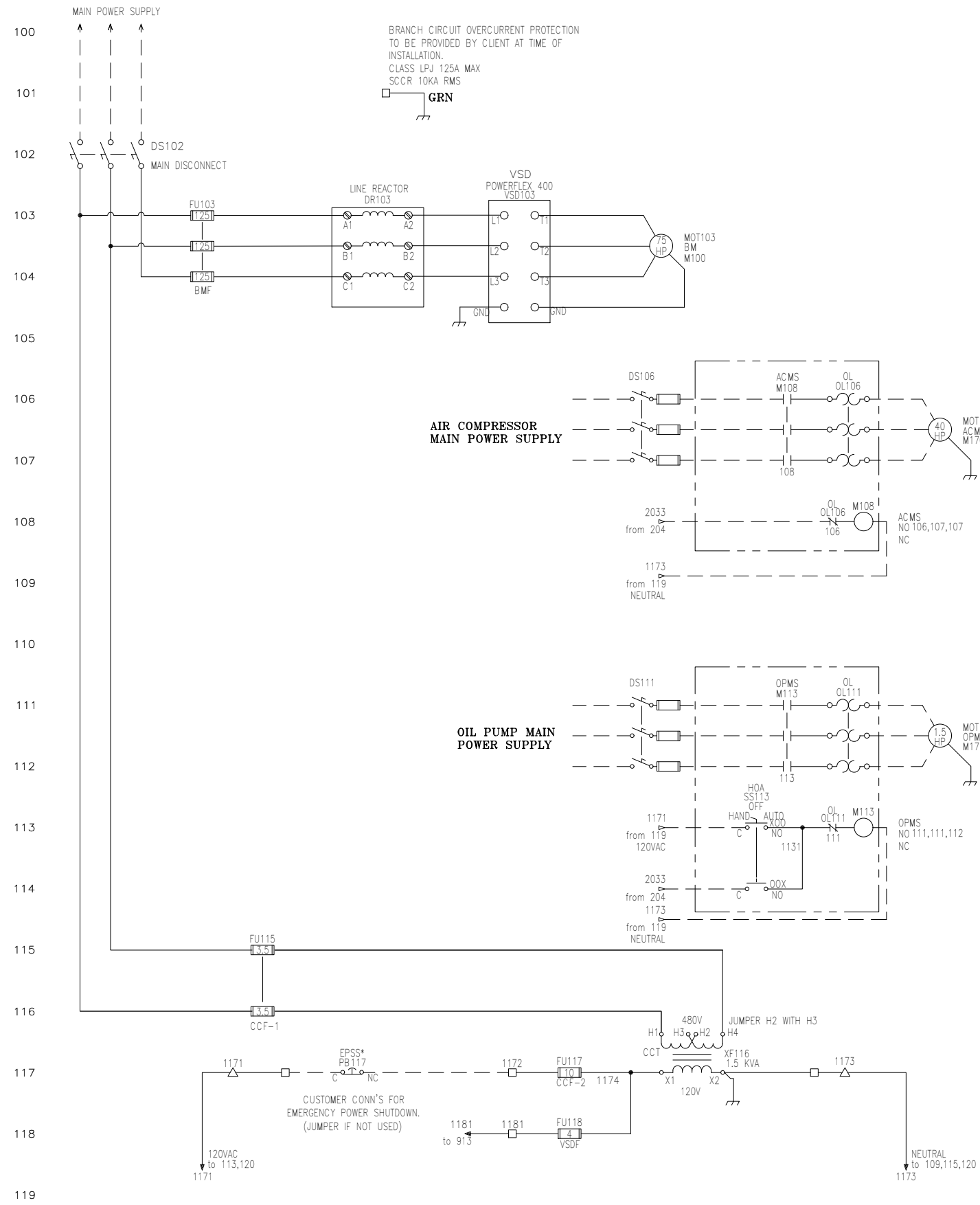
**DIMENSIONAL DIAGRAM**

SHT 02 OF 02

SCALE <b>N.T.S.</b>	DATE 04/19/21	<b>CleaverBrooks</b>			
DRAWN <b>TDL</b>	CHECKED BY <b>JMP</b>				
MODEL CBJT-2W	FUEL 460	SIZE 3	1200 60	150ST 3	CAPACITY FM&GAP
DRWG. NO. <b>T8433-1-1DD</b>		<b>01</b>			

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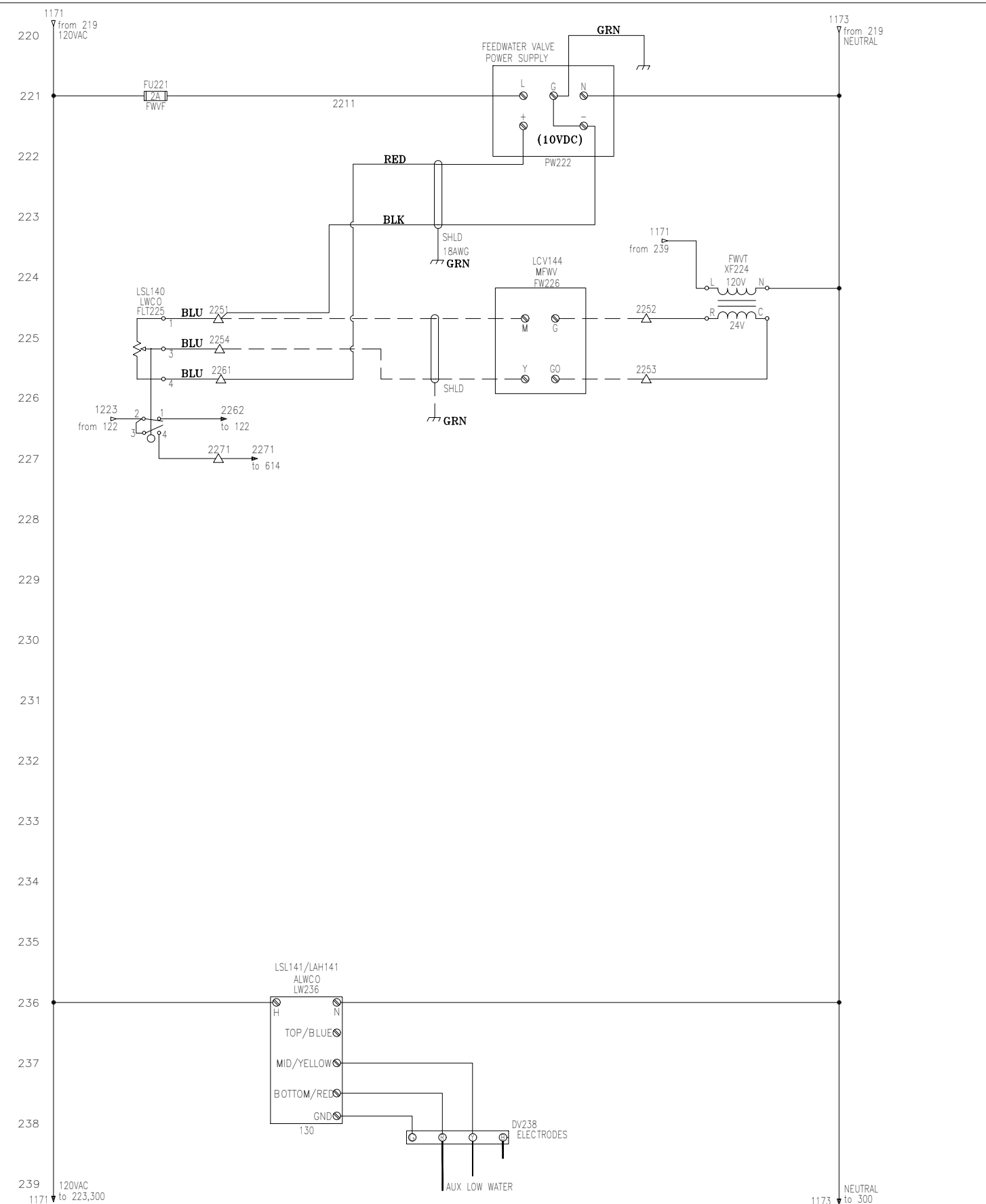
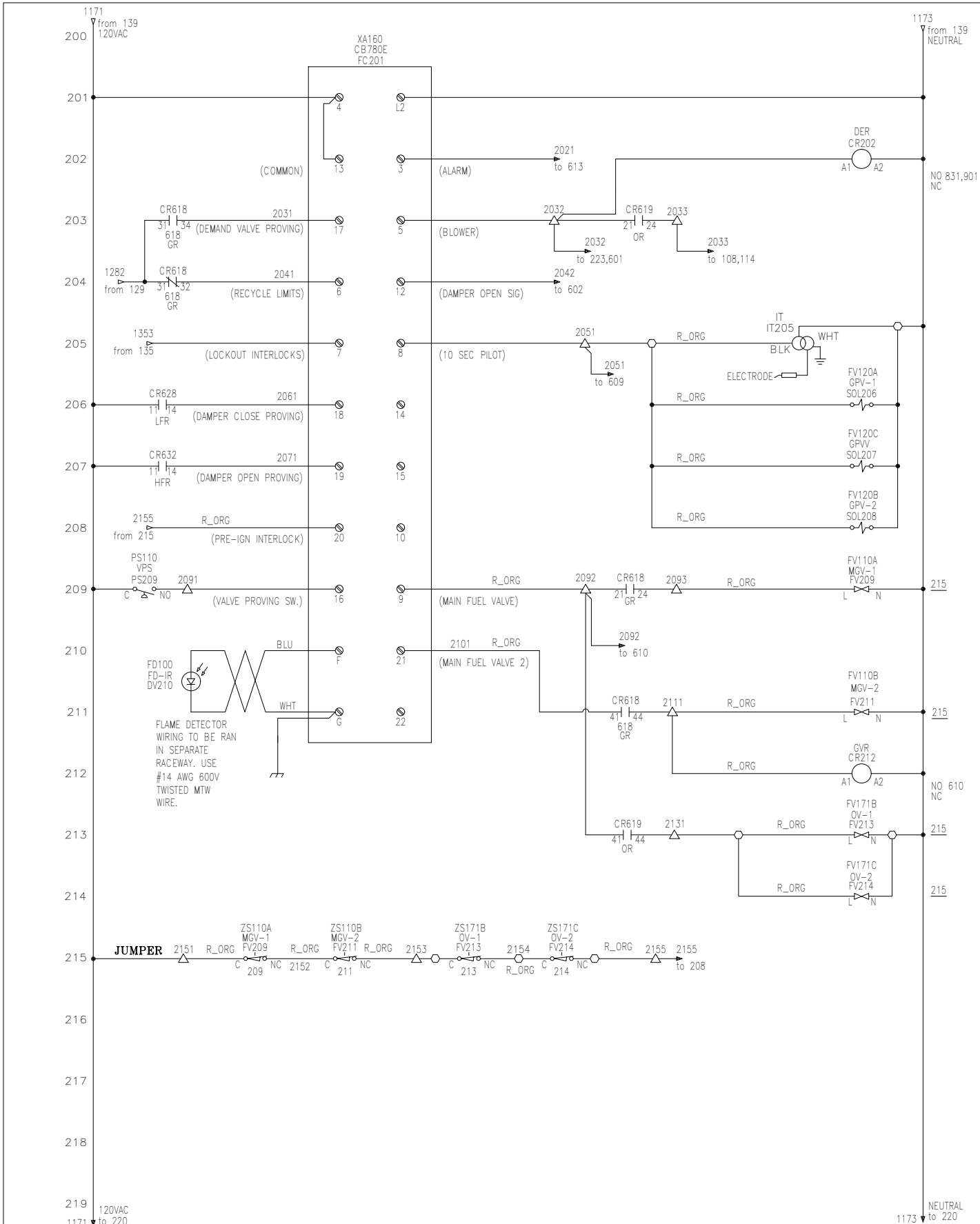
REVISIONS  
SEE FINAL PAGE

HAWK 1000	WIRE COLOR	SYMBOL
	YELLOW	Y
	GREEN	GRN
	RED	R
	BLUE	BL
	WHITE	W
	BLACK	B
	BLUE/WHITE	BLU/WHT
	YELLOW/GREEN	YEL/GRN
	GREEN/YELLOW	GRN/YEL

**HAWK 1000\_200**  
**ELGIN MENTAL HOSPITAL**  
**ELGIN, IL**  
**T8433**  
**WIRING DIAGRAM**  
 SHEET NO. 1 OF 9

SCALE	CleaverBrooks			
N.T.S.	MODEL	FUEL	SIZE	INSURANCE
DATE	CBJT-2W 200	1200	150ST	F&G-GAP
04/15/21	CMH	460	3	124
DRAWN	460	3	60	3
CMH	VOLTS	PHASE	HERTZ	WIRE
SIZE	D	DRWG. NO.	T8433-1-1WD	00

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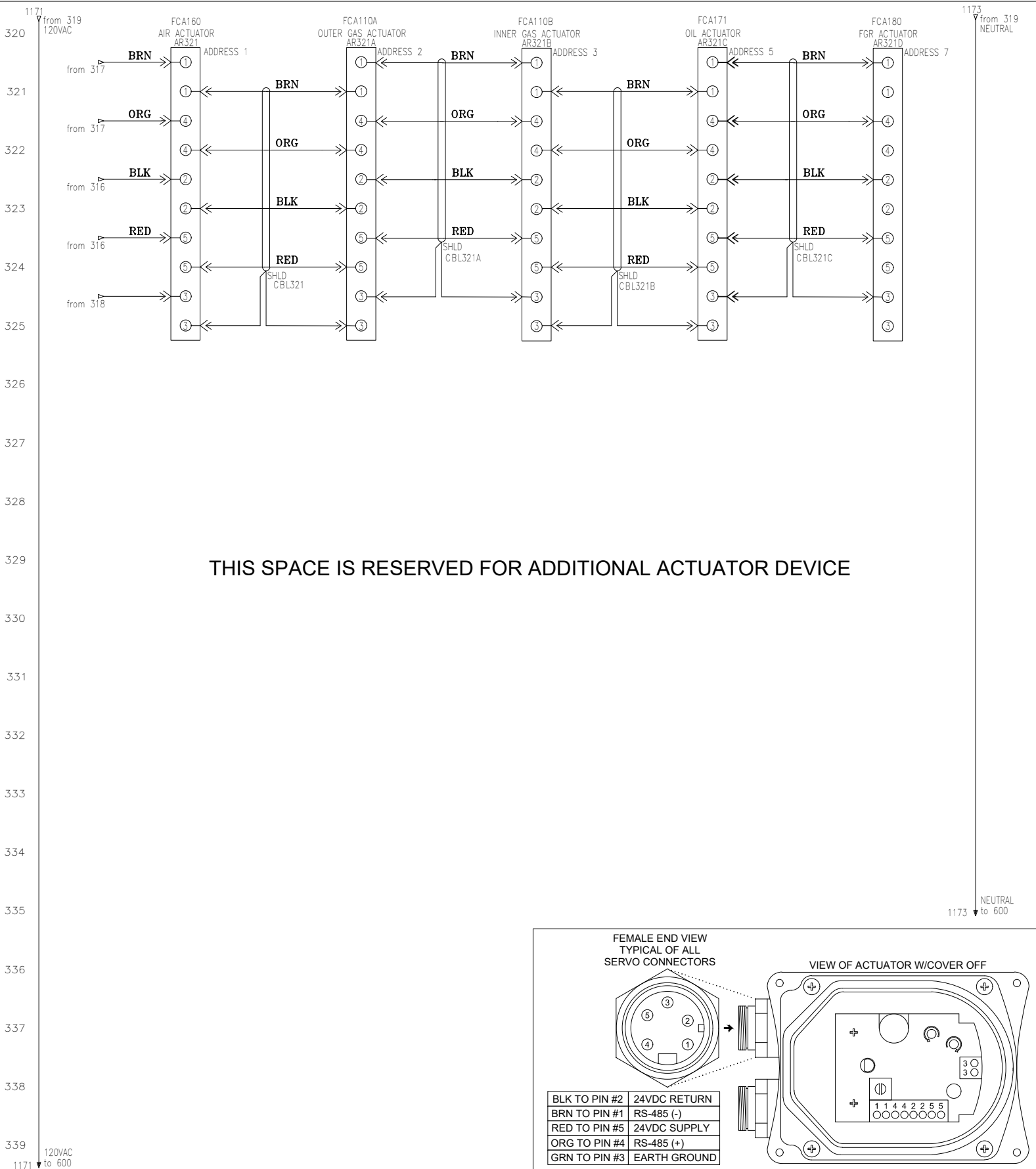
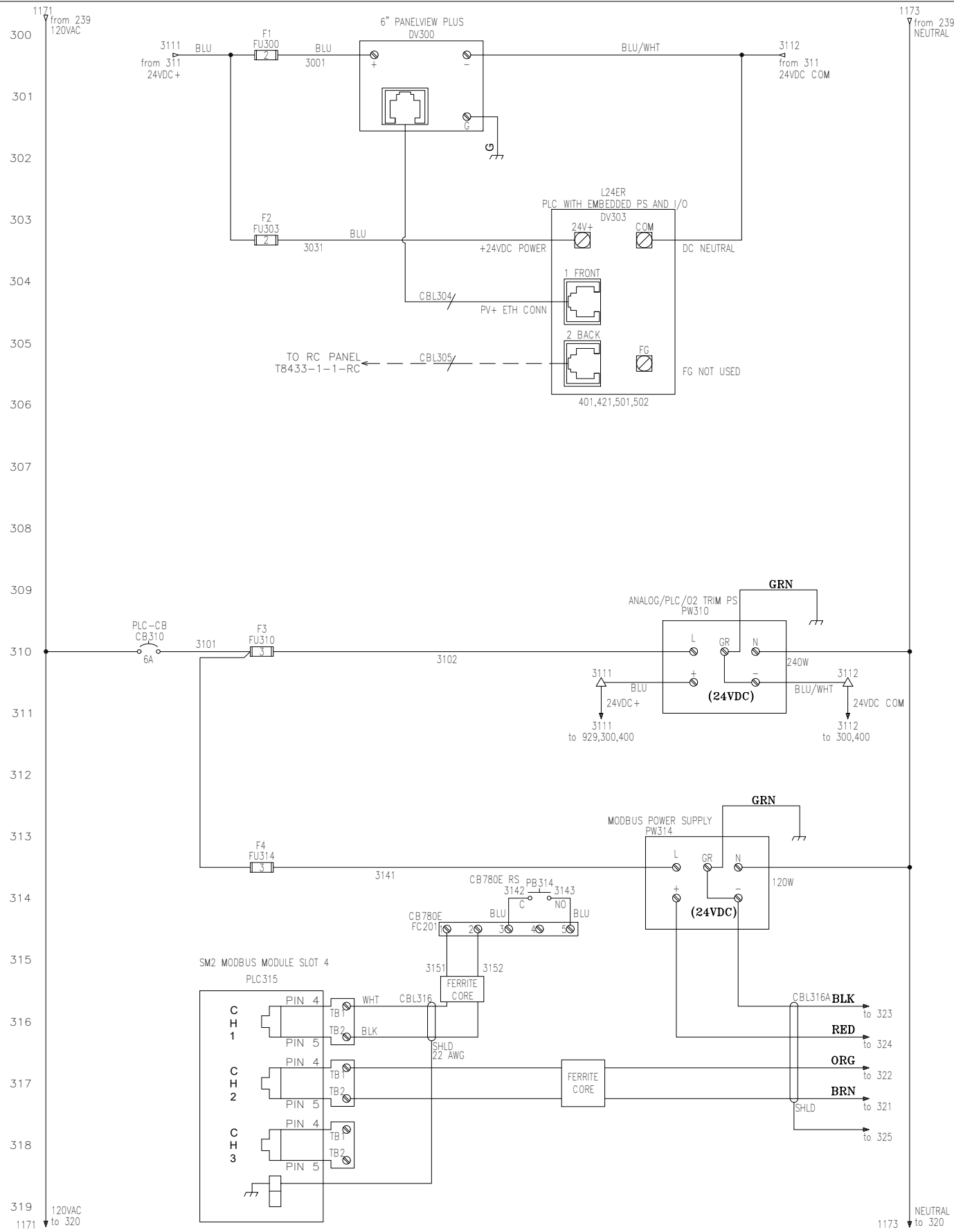
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HAWK 1000	WIRE COLOR	SYMBOL
HMI: 98500670_002	YELLOW	Y
PLC: 98500509_001_012	GREEN	GRN
CHECKED BY: JMP	RED	R
	BLUE	BL
	WHITE	W
	BLACK	B
	BLUE/WHITE	BLU/WHT
	YELLOW/GREEN	YEL/GRN
	GREEN/YELLOW	GRN/YEL

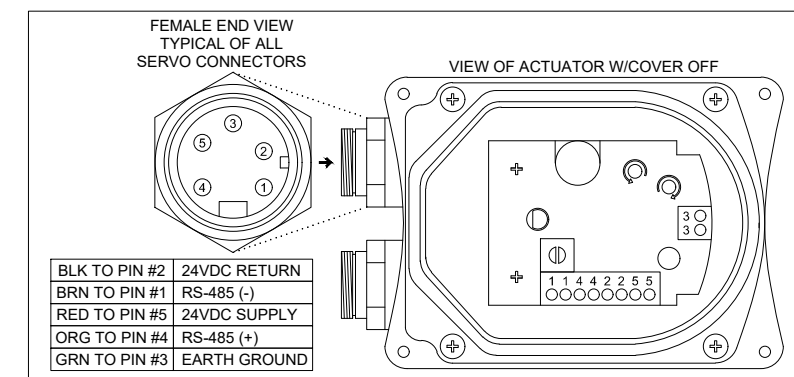
HAWK 1000\_200  
ELGIN MENTAL HOSPITAL  
ELGIN, IL  
T8433  
WIRING DIAGRAM  
SHEET NO. 2 OF 9

SCALE N.T.S.	<b>CleaverBrooks</b>			
DATE 04/15/21	MODEL CBJT-2W 200	FUEL SIZE 1200	PRESSURE 150ST	INSURANCE F&GE-GAP
DRAWN CMH	VOLTS 460	PHASE 3	HERTZ 60	WIRE 124
SIZE D	DRWG. NO.	T8433-1-1WD		00

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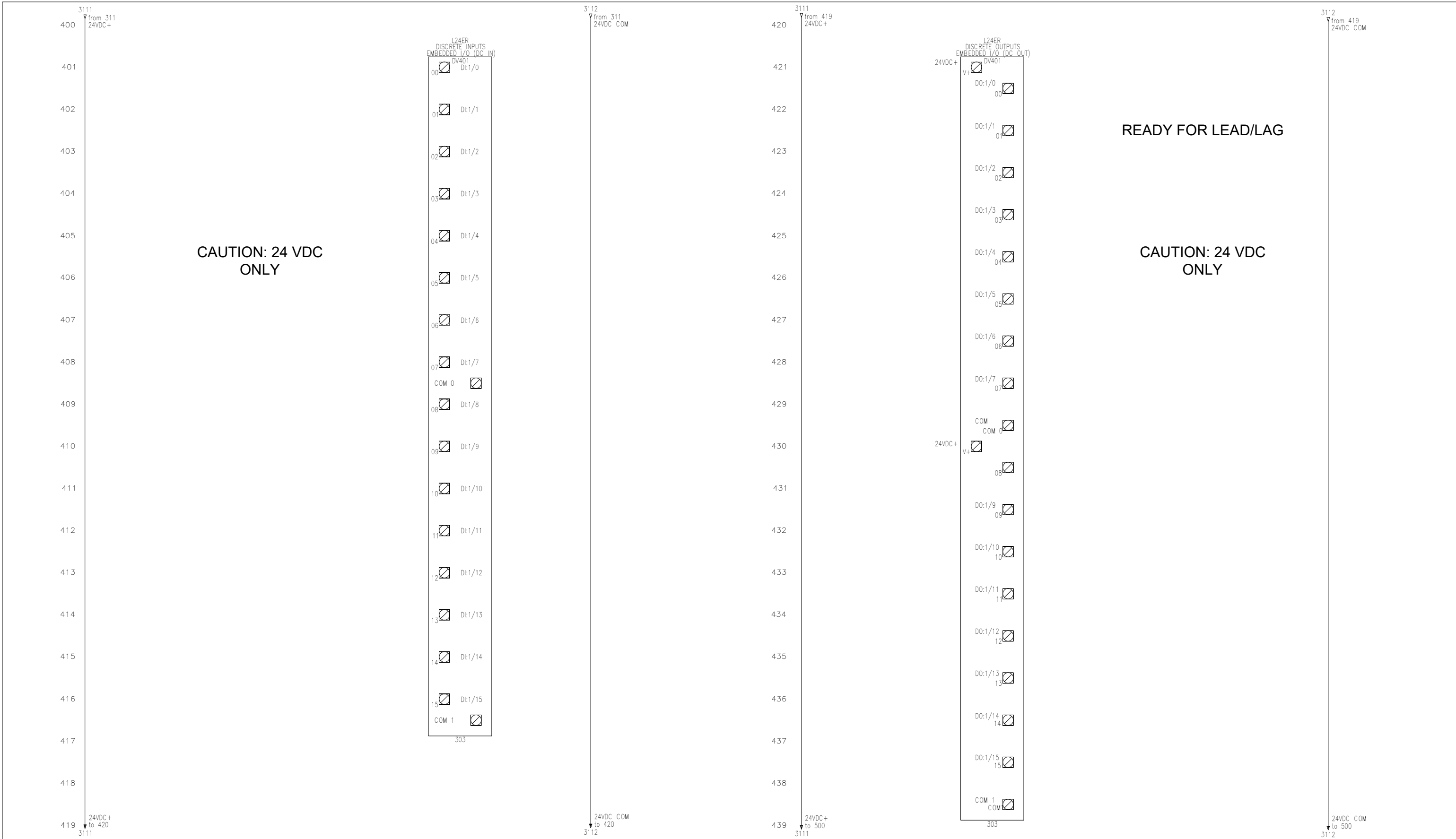


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REVISIONS SEE FINAL PAGE

HAWK 1000	WIRE COLOR	SYMBOL	SCALE N.T.S.			
HMI: 98500670_002	YELLOW	Y	ELGIN MENTAL HOSPITAL			
PLC: 98500509_001_012	GREEN	GRN	ELGIN, IL			
CHECKED BY: JMP	RED	R	T8433			
	BLUE	BL	WIRING DIAGRAM			
	WHITE	W	SHEET NO. 3 OF 9			
	BLACK	B	DATE 04/15/21			
	BLUE/WHITE	BLU/WHT	DRAWN CMH			
	YELLOW/GREEN	YEL/GRN	MODEL CBJT-2W 200			
	GREEN/YELLOW	GRN/YEL	FUEL SIZE 1200			
			PRESSURE 60			
			INSURANCE 150ST F&GE-GAP			
			VOLTS 460			
			PHASE 3			
			HERTZ 60			
			WIRE 3			
			MCA 124			
			SIZE D			
			DRWG. NO. T8433-1-1WD			
			00			

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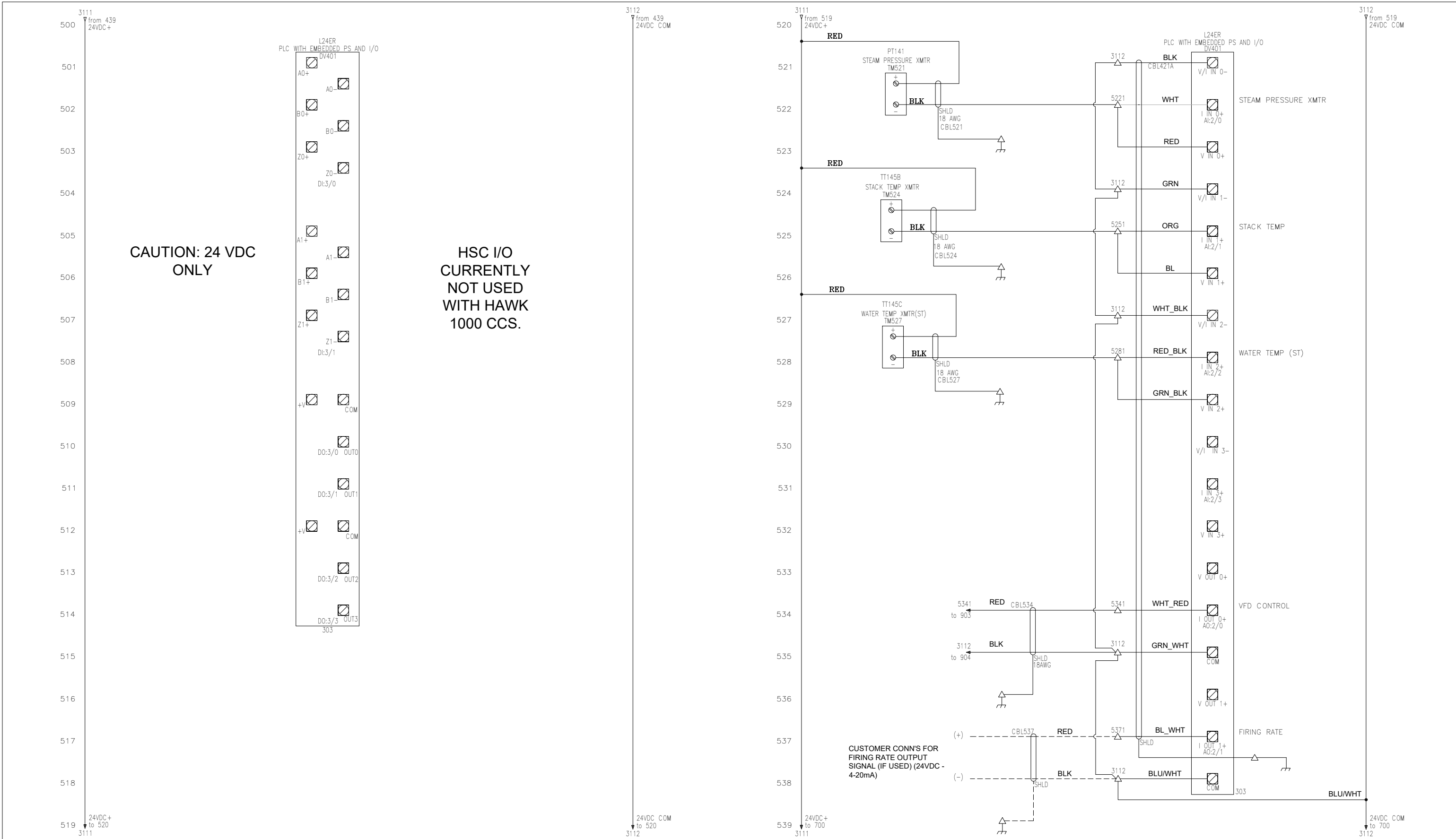


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HAWK 1000		WIRE COLOR		SYMBOL		ELGIN MENTAL HOSPITAL		SCALE N.T.S.		<b>CleaverBrooks</b>	
HMI: 98500670_002		YELLOW		Y		ELGIN, IL		DATE	04/15/21	MODEL	CBJT-2W 200
PLC: 98500509_001_012		GREEN		GRN		T8433		FUEL	1200	SIZE	150ST
CHECKED BY: JMP		RED		R		WIRING DIAGRAM		PRESSURE	3	INSURANCE	F&GE-GAP
		BLUE		BL		SHEET NO. 4 OF 9		INSURANCE	124		
		WHITE		W				DATE	04/15/21	MODEL	460
		BLACK		B				FUEL	3	FUEL	3
		BLUE/WHITE		BLU/WHT				SIZE	D	SIZE	60
		YELLOW/GREEN		YEL/GRN				HERTZ	3	HERTZ	3
		GREEN/YELLOW		GRN/YEL				WIRE	124	WIRE	124
								MCA	00		
								DRWG. NO.	T8433-1-1WD		

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**CAUTION: 24 VDC ONLY**

**HSC I/O CURRENTLY NOT USED WITH HAWK 1000 CCS.**

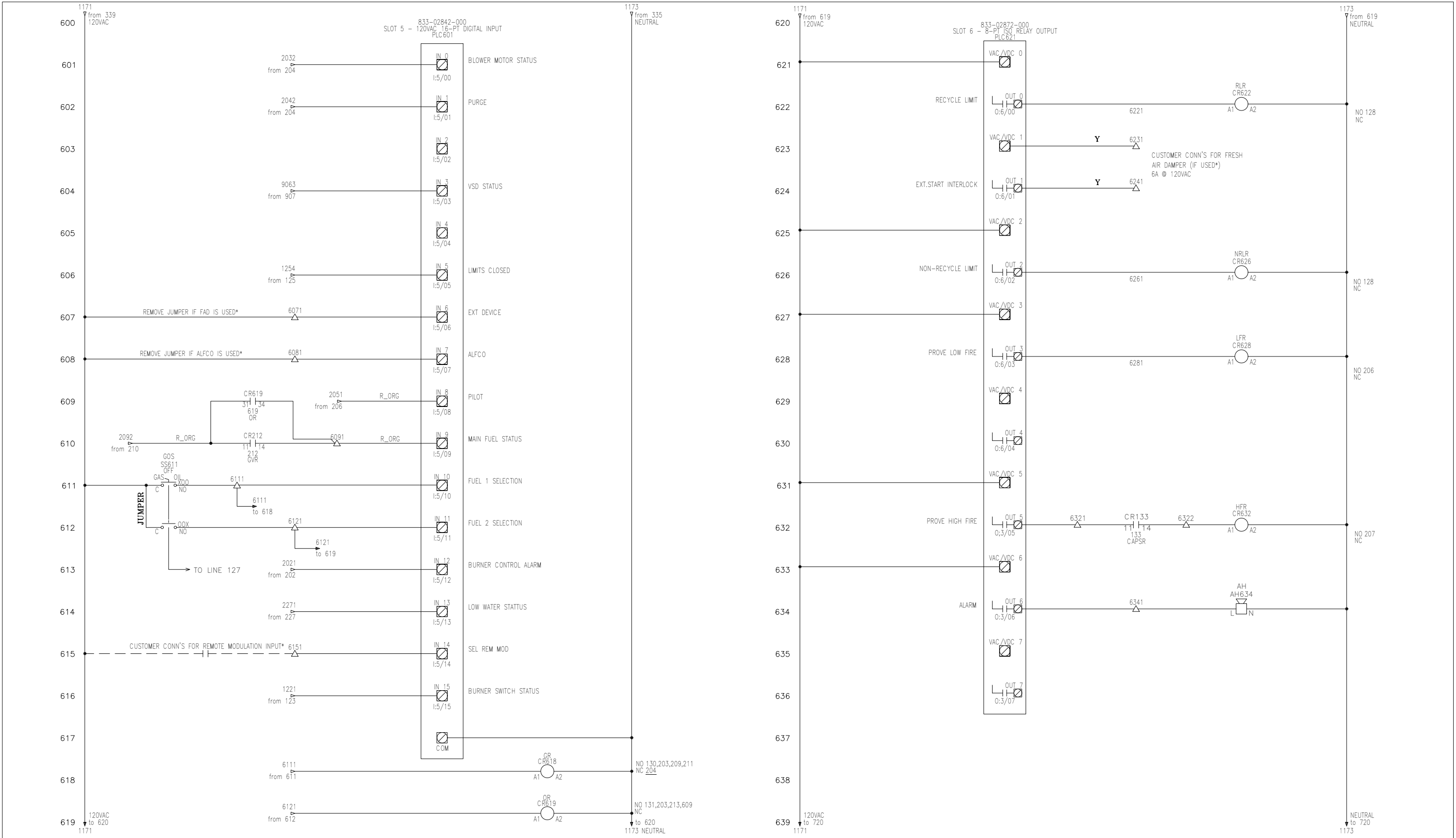
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HAWK 1000	WIRE COLOR	SYMBOL	ELGIN MENTAL HOSPITAL		SCALE	<b>CleaverBrooks</b>	
HMI: 98500670_002	YELLOW	Y	ELGIN, IL		N.T.S.	MODEL	F&GE-GAP
PLC: 98500509_001_012	GREEN	GRN	T8433		DATE	1200	150ST
CHECKED BY: JMP	RED	R	WIRING DIAGRAM		04/15/21	SIZE	PRESSURE
	BLU	BL	SHEET NO. 5 OF 9		DRWN	3	INSURANCE
	WHT	W			CMH	60	124
	BLK	B			SIZE	3	MCA
	BLU/WHT	BLU/WHT			D	HERTZ	WIRE
	YEL/WGRN	YEL/GRN			DRWG. NO.	PHASE	INSURANCE
	GRN/YEL	GRN/YEL				HERTZ	INSURANCE
						WIRE	INSURANCE



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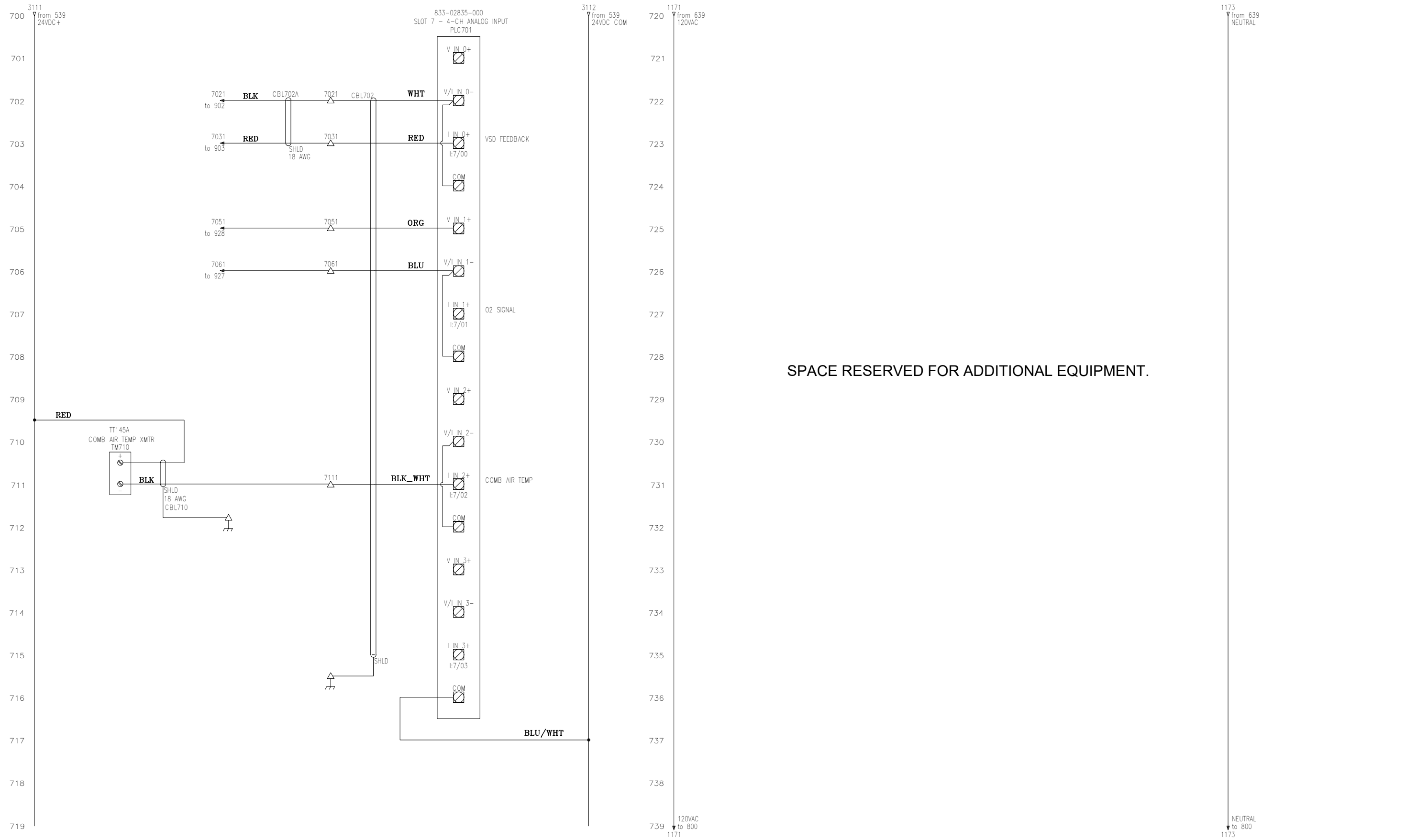


REVISIONS  
SEE FINAL PAGE.

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HAWK 1000		WIRE COLOR		SYMBOL		HAWK 1000_200		ELGIN MENTAL HOSPITAL		SCALE N.T.S.		<b>CleaverBrooks</b>		
HMI: 98500670_002		YELLOW		Y		ELGIN, IL		DATE 04/15/21		MODEL CBJT-2W 200	SIZE 1200	150ST	F&GE-GAP	
PLC: 98500509_001_012		RED		R		T8433		DRAWN CMH		460	3	60	3	124
CHECKED BY: JMP		BLUE		BL		WIRING DIAGRAM		SIZE D		VOLTS	PHASE	HERTZ	WIRE	MCA
		WHITE		W		SHEET NO. 6 OF 9		DRWG. NO. T8433-1-1WD						00
		BLACK		B										
		BLUE/WHITE		BLU/WHT										
		YELLOW/GREEN		YEL/GRN										
		GREEN/YELLOW		GRN/YEL										

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SEE FINAL PAGE.

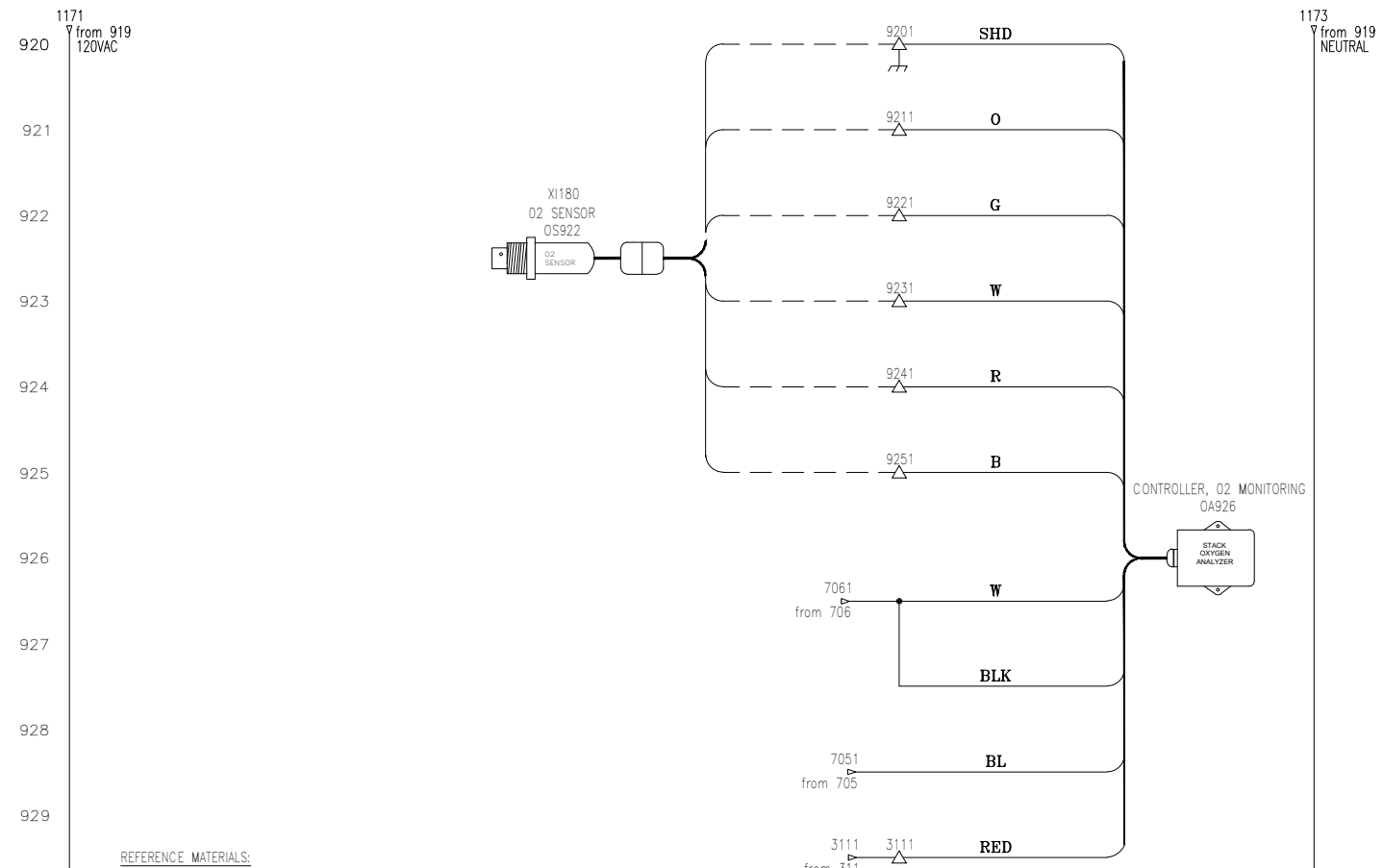
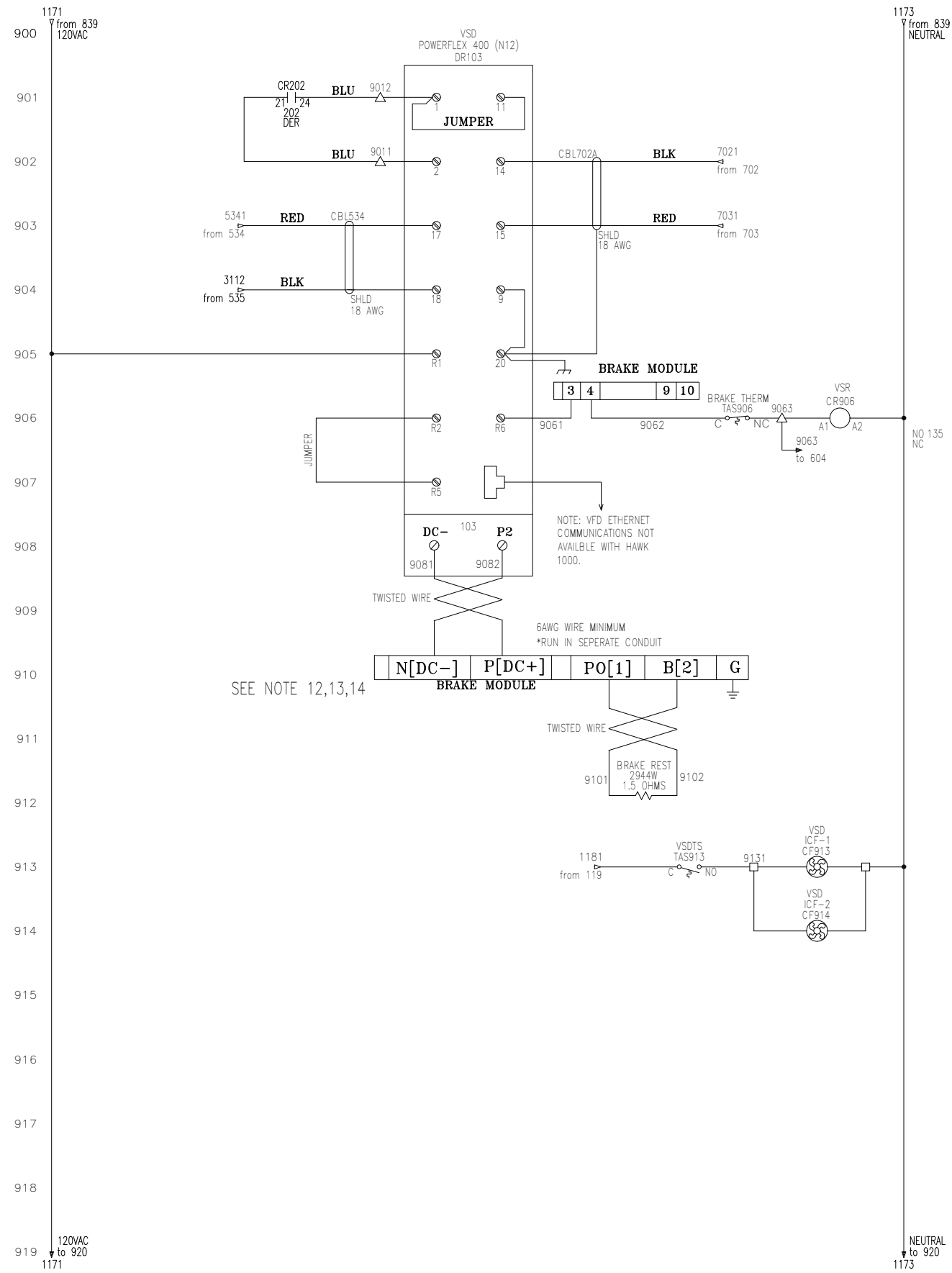
HAWK 1000	WIRE COLOR	SYMBOL
HMI: 98500670_002	YELLOW	Y
PLC: 98500509_001_012	GREEN	GRN
CHECKED BY: JMP	RED	R
	BLUE	BL
	WHITE	W
	BLACK	B
	BLUE/WHITE	BLU/WHT
	YELLOW/GREEN	YEL/GRN
	GREEN/YELLOW	GRN/YEL

HAWK 1000\_200  
ELGIN MENTAL HOSPITAL  
ELGIN, IL  
T8433  
WIRING DIAGRAM  
SHEET NO. 7 OF 9

SCALE N.T.S.	<b>CleaverBrooks</b>			
DATE 04/15/21	MODEL CBJT-2W 200	FUEL 1200	SIZE 150ST	INSURANCE F&GE-GAP
DRAWN CMH	VOLTS 460	PHASE 3	HERTZ 60	WIRE 3 124 MCA
SIZE D	DRWG. NO. T8433-1-1WD	00		



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- REFERENCE MATERIALS:**
- FOR FURTHER INFORMATION REGARDING THE HAWK 1000 REFER TO MANUALS 750-366.
  - FOR FURTHER INFORMATION ON THE HAWK ICS O2 TRIM SYSTEM SEE MANUAL 750-224.
  - FOR FURTHER INFORMATION REGARDING THE CB780E BURNER CONTROL REFER TO MANUAL 750-234.
  - FOR FURTHER INFORMATION REGARDING THE VARIABLE SPEED DRIVE CONTROL REFER TO MANUAL 750-198
  - THE VARIABLE SPEED DRIVE GROUND CONFIGURATION IS SET AS SOLID GROUND, IF HIGH RESISTANCE GROUND IS REQUIRED REFER TO MANUFACTURER MANUAL.
  - FOR INFORMATION ON THE CONTROLLOGIX 5370 L2 CONTROLLER SEE USER MANUAL 1769-UM021-EN-P.
- GENERAL NOTES:**
- PRIMARY CIRCUIT PROTECTION FOR THE IGNITION TRANSFORMER HAS BEEN PROVIDED BY CLEAVER BROOKS. SEE CCCB OR CCF-2 FOR CURRENT RATING.
  - THERE ARE TO BE NO PENETRATIONS IN THE TOP OF THE CONTROL PANEL.
  - USE CONDUIT HUBS WITH SAME ENVIRONMENTAL RATING AS ENCLOSURE.
  - COMPACTLOGIX COMPONENTS REQUIRE A MINIMUM OF 2" CLEARANCE ABOVE AND BELOW.
  - MAXIMUM SETPOINT ON ADJUSTABLE OVERLOAD RELAYS TO BE 115% OF MOTOR FLA.
- JOB SPECIFIC NOTES:**
- CONTROL WIRING IS #16 AWG (105° C) UNLESS OTHERWISE NOTED.
  - TWO WIRE SHIELDED CABLE IS #18 AWG BELDEN 9318 UNLESS OTHERWISE NOTED.
  - TWO WIRE SHIELDED CABLE FROM FSG TO SM2 MODULE IS #22 AWG BELDEN 8761 OR EQUIVALENT.
  - THREE WIRE SHIELDED CABLE IS #18 AWG BELDEN 9365 OR EQUIVALENT.
  - WATER COLUMN WIRING SHALL BE RATED 200°C.
  - WIRING COLOR CODE PER UL508A.
  - LEVELMASTER SENSOR CABLE IS TO BE GENERAL CABLE C02543.
- WIRING COLOR CODE:**
- BLACK: THREE PHASE AND VOLTAGES ABOVE 120VAC.
  - RED: UNGROUND (HOT) AC CONTROL CIRCUITS THAT DE-ENERGIZE WITH MAIN DISCONNECT.
  - WHITE: GROUNDED (NEUTRAL) AC CURRENT-CARRYING CONTROL CIRCUIT CONDUCTOR REGARDLESS OF VOLTAGE.
  - BLUE: UNGROUND (POSITIVE) DC CONTROL CIRCUIT.
  - BLUE/WHITE: GROUNDED (NEGATIVE) DC CURRENT-CARRYING CONTROL CIRCUIT CONDUCTOR.
  - YELLOW: UNGROUND (HOT) AC CONTROL CIRCUITS THAT DO NOT DE-ENERGIZE WITH MAIN DISCONNECT.
  - YELLOW/WHITE: GROUNDED (NEUTRAL) AC CONTROL CIRCUIT CURRENT-CARRYING CONDUCTORS THAT DO NOT DE-ENERGIZE WITH MAIN DISCONNECT.
  - RED/ORANGE: REPRESENTS A CRITICAL FUEL CIRCUIT.
  - GREEN: GROUND.

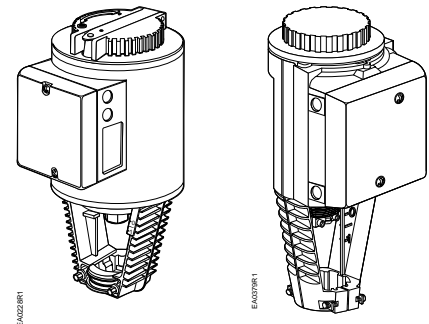
REVISIONS			
REV	DATE	DESCRIPTIONS	INITIALS
1			
2			
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HAWK 1000	WIRE COLOR	SYMBOL	ELGIN MENTAL HOSPITAL		SCALE	<b>CleaverBrooks</b>		
HMI: 98500670_002	YELLOW	Y	ELGIN, IL	T8433	N.T.S.	DATE	04/15/21	CBJT-2W 200
PLC: 98500509_001_012	RED	GRN	WIRING DIAGRAM		DRAWN	MODEL	FUEL	1200
CHECKED BY: JMP	BLUE	BL	SHEET NO. 9 OF 9		CMH	VOLTS	3	60
	WHITE	W			SIZE	HERTZ	3	150ST
	BLACK	B			D	PHASE	3	F&G-GAP
	BLUE/WHITE	BLU/WHT			DRWG. NO.	INSURANCE	124	MCA
	BLACK/WHITE	BLK/WHT						
	YELLOW/GREEN	YEL/GRN						
	GREEN/YELLOW	GRN/YEL						

## Flowrite™ EA 599 Series

### SKB/C/D 62UA Series Electronic Valve Actuator 24 Vac Proportional Control Advanced Features



SKB/C

SKD

#### Description

The Flowrite EA 599 Series SKB/C/D62UA Electronic Valve Actuator requires a 24 Vac supply and receives a 0 to 10 Vdc or a 4 to 20 mA control signal to proportionally control a valve. This actuator is designed to work with Flowrite VF 599 Series valves and Siemens Building Technologies, Inc. standard valves with a 3/4-inch (20 mm) stroke.

#### Features

- Direct-coupled installation requires no special tools or adjustments
- Visual and electronic stroke indication
- Die-cast aluminum housing
- Manual override
- Spring return to fail-safe position
- Automatic stroke calibration
- Direct or reverse acting
- Adjustable start and span
- Stroke limit control
- Selectable operation direction (direct-acting/reverse acting)
- Choice of linear or equal-percentage flow characteristic
- Maintenance-free

#### Application

These electronic actuators are designed to be used with Flowrite VF 599 Series valves with either 3/4-inch (20 mm) stroke (SKB/D) or a 1-1/2 inch (40 mm) stroke (SKC) in liquid service and steam service applications; or other manufacturer's valves with appropriate Universal Valve Linkage Kit.



#### Product Numbers

Table 1. Product Numbers

Actuator Stroke	Order Number
3/4-inch (20 mm)	SKB62UA
	SKD62UA

1-1/2 inch (40 mm)	SKC62UA
--------------------	---------

### Warning/Caution Notations

<b>WARNING:</b>		Personal injury/loss of life may occur if a procedure is not performed as specified.
<b>CAUTION:</b>		Equipment damage, or loss of data may occur if the user does not follow a procedure as specified.

### Specifications

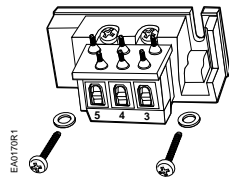
<b>Power Supply</b>	Operating voltage (SELV, PELV)	24 Vac $\pm$ 20%		
	Frequency	50 or 60 Hz		
	Power consumption	SKB62UA	17 VA/ 12W	
		SKC62UA	28 VA/ 20W	
		SKD62UA	17 VA/ 12W	
<b>Operating</b>	Type of control (proportional)	0 to 10 Vdc; 4 to 20 mA; or 0 to 1000 ohm		
	Running time		<u>Opening:</u>	<u>Closing:</u>
		SKB62UA	120 sec	15 sec
		SKC62UA	120 sec	20 sec
		SKD62UA	30 sec	15 sec
	Spring-return time	Closing:		
		SKB62UA	15 sec	
		SKC62UA	20 sec	
		SKD62UA	15 sec	
	Nominal stroke	SKB62UA	3/4-inch (20 mm)	
SKC62UA		1-1/2-inch (40 mm)		
SKD62UA		3/4-inch (20 mm)		
Position force	SKB/C 62UA	2800N		
	SKD62UA	1000N		
<b>Signal Inputs</b>	Terminal Y			
	Voltage	0 to 10 Vdc		
	Input impedance	100K ohm		
	Current	4 to 20 mA		
	Input impedance	240 ohm		
	Signal resolution	<1%		
	Hysteresis	<1%		

	Terminal Z Resistance	0 to 1000 ohm
	Override control functions Z not connected Z connected directly to G Z connected directly to G0 Z connected to M via 0 to 1000 ohm	No function (priority at Terminal Y) Maximum stroke 100% Minimum stroke 0% Linear or equal percentage
<b>Signal Inputs, continued</b>	Terminal U Voltage Load impedance Current Load impedance	0 to 9.8 Vdc $\pm$ 2% >500 ohm 4 to 19.6 mA $\pm$ 2% <500 ohms
<b>Ambient Conditions</b>	Maximum admissible temperature of medium in the connected valve: Ambient temperature Media temperature	$\leq$ 284°F (140°C) 5°F to 130°F (-15°C to 55°C) 14°F to 300°F (-10°C to 150°C)
	Operation Environmental conditions Temperature Humidity	To IEC 721-3-3 Class 3K5 5°F to 122°F (-15°C to 50°C) 5% to 95% rh
	Transport Environmental conditions Temperature Humidity	To IEC 721-2-1 Class 3K5 22°F to 149°F (-5°C to 65°C) <95% rh
	Storage Environmental conditions Temperature Humidity	To IEC 721-3-1 Class 1K3 5°F to 122°F (-15°C to 50°C) 5% to 95% rh
<b>Agency Certification</b>		UL listed to UL873 C-UL certified to Canadian standard C22.2 No. 24-93
	Meet CE requirements: EMC Directive	89/336/EEC
	C-tick	N474
	Protection standard Protection Class	IP54 to EN 60 529 III to EN 60 730
<b>Miscellaneous</b>	Materials Actuator housing and bracket Housing box and manual adjustor Conduit opening Dimensions Weight SKB62UA SKC62UA SKD62UA	Die-cast aluminum Plastic 1/2-inch NPSM See Figures 25 and 26 18.9 lbs (8,60 kg) 22.5 lbs (10,00 kg) 8.5 lbs (3,85 kg)
<b>Housing</b>	NEMA Rating	NEMA 1 (Interior only) See <i>Accessories</i>

**Advanced Features**

Direction of Operation	Direct acting / reverse acting	0 to 10 Vdc; 10 to 0 Vdc 4 20 mA; 20 to 4 mA 0 to 1000 ohm / 1000 to 0 ohm
Stroke Limit Control	Range of lower limit	0% to 45% adjustable
	Range of upper limit	100% to 55% adjustable
Sequence Control	Starting Point of Sequence (Start)	0 to 15V adjustable
	Operating Range of Sequence (Span)	3 to 15V adjustable

**Accessories**

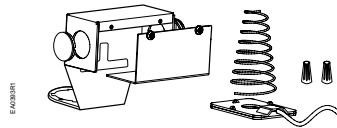


**Figure 1. Auxiliary Switch.**

**ASC1.6** Auxiliary switch

- Sends a signal to indicate that the valve is in the 0% stroke position.
- The switching point is fixed at the 0% stroke position.

Switching capacity	24 Vac 4A resistive, 2A inductive
Lowest recommended current	10 mA

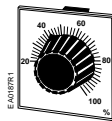


**Figure 2. Packing Heating Element.**

**599-00417** Packing heating element for SKD  
**599-00418** Packing heating element for SKB/C

This heater allows the stem to move freely in valves that control fluids at temperatures below 32°F (0°C). It reduces ice crystal formation on the stem which may damage the packing.

Operating Voltage	24 Vac
Heating Output	20 W

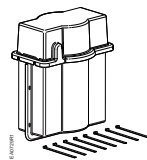


**Figure 3. Remote Setting Unit.**

**FZA21.11** Remote setting unit.

Potentiometer is used for manual control or remote setting of minimum positions of controlled devices. Suitable for flush panel mounting only.

Control Input	0 to 1000 ohms
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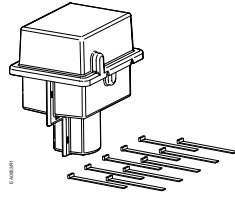


**Figure 4. SKB/C Weather Shield.**

**599-10065** The SKB/C actuator is UL listed to meet NEMA Type 3R requirements (a degree of protection against rain, sleet, and damage from external ice formation) when installed with this weather shield and outdoor-rated conduit fittings in the vertical position. See *Service Kits* for replacement Ultraviolet resistant cable ties.

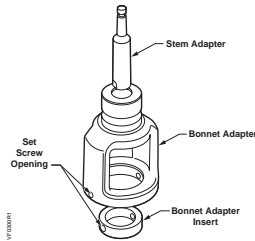


**Accessories,  
 continued**



**Figure 5. SKD Weather Shield.**

**599-10071** The SKD actuator is UL listed to meet NEMA TYPE 3R requirements (a degree of protection against rain, sleet, and damage from external ice formation) when installed with this weather shield and outdoor-rated conduit fittings in the vertical position. See *Service Kits* for replacement UV resistant cable ties.



**Figure 6. Valve Retrofit Kit.**

**Universal Retrofit Kit**

Kit contains the parts needed to adapt a valve to the following Siemens 599 Series Flowrite actuators: SKB, SKC, SKD, SQX. Selected valves from the following manufacturers can also be accommodated: Honeywell, Johnson Controls and Siebe. See your local Siemens representative for details.

**Service Kits**

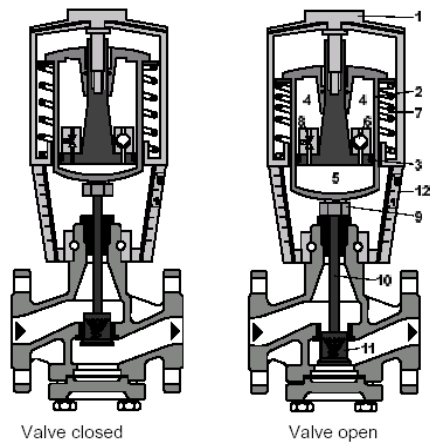
Circuit board replacement	4 668 5751 8
Manual override kit	4268 5510 8
Plastic wiring compartment cover	4 104 5582 8
Stem retainer kit	
Contains one stem nut (Figure 7, Item 6) and one stem retainer clip.	
2-1/2 and 3-inch valves	599-10048
4, 5, and 6-inch valves	599-10049
Retainer clamp kit	599-10200
Ultraviolet (UV) resistant cable ties (pkg. of 8)	538-994



**WARNING:**

This product contains a spring under high compression. Do not attempt to disassemble the actuator.

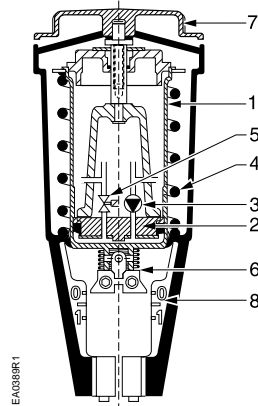
**Valve Details**



1. Manual Adjuster
2. Pressure Cylinder
3. Piston
4. Reservoir
5. Pressure Chamber
6. Pump
7. Return Spring
8. Bypass Valve
9. Coupling
10. Valve Stem
11. Inner Valve
12. Position Indicator (0 to 1)

**Figure 7. SKB/C Valve Parts.**

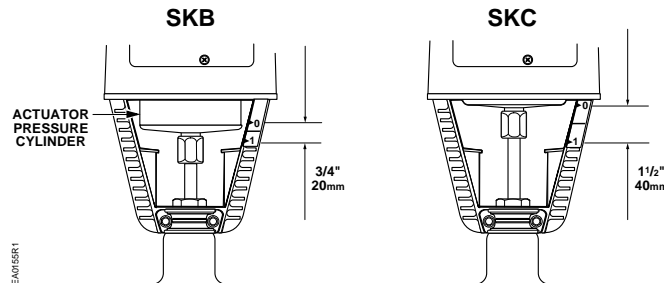
**Valve Details,  
 continued**



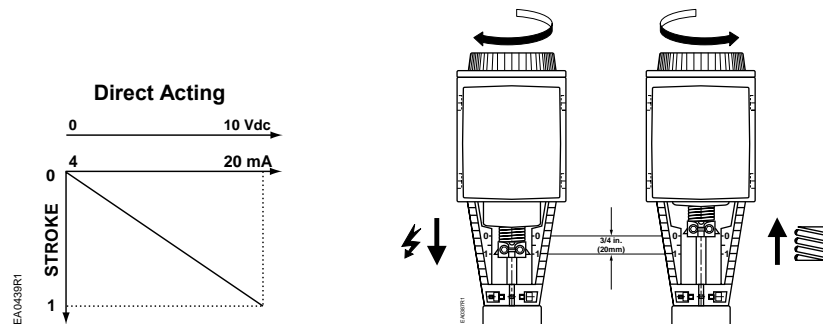
1. Pressure cylinder
2. Piston
3. Oscillating pump
4. Return spring
5. Bypass valve
6. Valve stem retainer
7. Manual override knob
8. Position indicator

**Figure 8. SKD Valve Parts.**

**Standard Operation**



**Figure 9. SKB\C Valve Stem Travel Indication.**

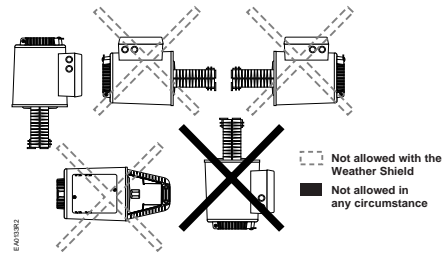


**Figure 10. SKD Valve Stem Travel Indication.**

The actuator accepts a 0 to 10 Vdc or a 4 to 20 mA control signal. The actuator mounted on a valve produces a stroke proportional to the input signal. When power is turned off or in the event of a power failure, the actuator spring returns the valve to its normal position.

**Mounting and Installation**

The vertical position is the recommended position for mounting and the only position for NEMA Type 3R rating with the Weather Shield. Acceptable mounting positions are shown in Figure 11.



**Figure 11. Acceptable Mounting Positions.**

Allow four inches (100 mm) around the sides and back of the actuator and eight inches (200 mm) above and to the front of the actuator.

See dimensions in Figure 25 and Figure 26.

Detailed installation instructions for field mounting are shipped with the actuator.



**CAUTION:**

When removing the knockout do not damage the circuit board. Use the top knockout position, if possible.

**Start-up**

Check the wiring for proper connections.

**NOTE:** The valve body assembly determines the complete assembly action.

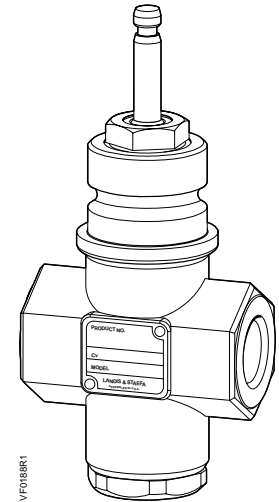
**Spring Return Function**

All SKB/C/D62UA actuators are factory-fitted with a spring-return function. If the control signal or power supply fails, the actuator will return to the 0% stroke position (stem fully retracted).

## Flowrite™ VF 599 Series

### Two-Way Valves

### 1/2 to 2-inch Bronze Body



#### Description

The Flowrite VF 599 Series two-way valves are designed to work with either a pneumatic or electronic actuator with a 3/4-inch (20 mm) stroke. They are available in ANSI Class 250 for normally closed or normally open action.

#### Features

- Direct coupled universal bonnet
- Choice of two flow characteristics
- Choice of brass or stainless steel trim
- ANSI Leakage Class IV (0.01% of Cv)
- Cartridge type packing

#### Application

Flowrite valves are generally recommended for water, steam, and glycol solutions to 50%.

#### Product Numbers

See Tables 1 and 2.

#### Ordering a Valve Plus Actuator Assembly

To order a complete valve plus actuator assembly from the factory, combine the actuator prefix code with the suffix of the valve assembly product number. See *TB 249 Flowrite 599 Series Valve and Actuator Assembly Selection Technical Bulletin* (155-304P25) for selection procedure and ordering codes.

Valve assemblies can be ordered using the numbers in Tables 1 and 2.

**Table 3. Maximum Water Capacity - U.S. Gallons per Minute.**

Valve Size in inches	Pressure Differential - psi															
	Cv/1	2	3	4	5	6	8	10	15	20	25	30	40	50	60	75
1/2	1.0	1.4	1.7	2.0	2.2	2.5	2.8	3.2	3.9	4.5	5.0	5.5	6.3	7.1	7.8	8.7
	1.6	2.3	2.8	3.2	3.6	3.9	4.5	5.1	6.2	7.2	8.0	8.8	10.1	11.3	12.4	13.9
	2.5	3.5	4.3	5.0	5.6	6.1	7.1	7.9	9.7	11.2	12.5	13.7	15.8	17.7	19.4	22
	4	5.7	7	8.0	8.9	10	11.3	12.6	15.5	17.9	20.0	21.9	25	28	31	35
3/4	6	8.9	10.9	12.6	14.1	15.4	17.8	20	24	28	32	35	40	45	49	55
1	10	14.1	17.3	20	22	24	28	32	39	45	50	55	63	71	77	87
1-1/4	16	23	28	32	36	39	45	51	62	72	80	88	101	113	124	139
1-1/2	25	35	43	50	56	61	71	79	97	112	125	137	158	177	194	217
2	40	57	69	80	89	98	113	126	155	179	200	219	253	283	310	346

**Table 4. Maximum Water Capacity - Cubic Meters per Hour (m<sup>3</sup>/hr).**

Valve Size inches mm	Pressure Differential - kPa														
	1	10	20	30	40	50	60	80	Kvs/100	150	200	300	400	500	
15	0.09	0.3	0.4	0.5	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.5	1.7	1.9	
	0.14	0.4	0.6	0.8	0.9	1.0	1.1	1.2	1.4	1.7	1.9	2.4	2.7	3.1	
	0.2	0.7	1.0	1.2	1.4	1.5	1.7	1.9	2.2	2.6	3.0	3.7	4.3	4.8	
	0.3	1.1	1.5	1.9	2.2	2.4	2.7	3.1	3.4	4.2	4.9	6.0	6.9	7.7	
20	0.5	1.7	2.4	3.0	3.4	3.8	4.2	4.9	5.4	6.7	7.7	9.4	10.9	12.1	
25	0.9	2.7	3.8	4.7	5.4	6.1	6.7	7.7	8.6	10.5	12.2	14.9	17.2	19.2	
32	1.4	4.4	6.2	7.6	8.7	9.8	10.7	12.3	13.8	16.9	19.5	23.9	27.6	30.9	
40	2.2	6.8	9.6	11.8	13.6	15.2	16.7	19.2	22	26	30	37	43	48	
50	3.4	10.9	15.4	18.8	22	24	27	31	34	42	49	60	69	77	

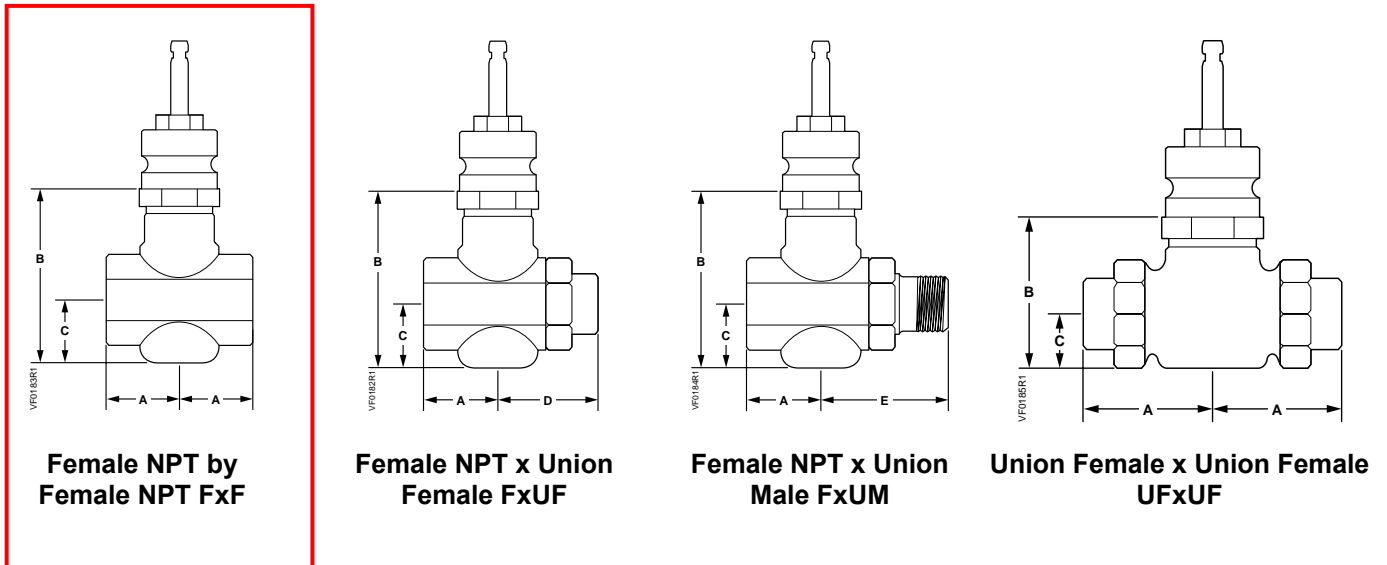
**Table 5. Steam Capacity - Pounds per Hour.**

Line Size inches	Inlet Pressure - psig																							
	2			5			10			15			50			75			100					
	1	2	3	4	5	6	8	10	12	15	20	30	32.5	40	45	50	60	70	80	90	100			
1/2	12.0	16.6	22	25	28	34	38	42	45	50	54	65	72	87	115	118	119	141	157	163	183	199	209	
	19.1	27	35	40	44	54	61	67	72	80	86	104	116	139	183	188	109	225	251	261	292	318	334	
	30	42	55	62	69	85	96	104	112	125	135	163	181	217	287	294	296	351	392	408	457	497	522	
3/4	48	67	88	100	110	136	153	167	179	200	216	261	289	348	459	471	474	562	627	653	731	796	835	
	75	105	138	157	174	213	241	263	282	316	341	411	455	548	722	742	747	886	988	1029	1152	1253	1315	
	120	166	219	250	275	339	382	417	447	501	541	653	723	870	1147	1178	1186	1406	1568	1633	1828	1989	2088	
1-1/4	191	266	351	400	441	542	611	667	716	801	865	1044	1156	1392	1835	1884	1897	2249	2509	2612	2599	2925	3182	3340
	299	416	549	625	689	847	955	1042	1118	1252	1351	1632	1806	2175	2867	2944	2964	3515	3920	4081	4061	4570	4972	5219
	478	666	878	1000	1102	1356	1529	1667	1789	2003	2162	2611	2890	3480	4587	4710	4743	5624	6272	6530	6497	7311	7956	8350

**Table 6. Steam Capacity - Kilograms per Hour.**

Line Size mm	Inlet Pressure - kPa														
	100			150			200			500			500		
	10	20	50	15	30	75	20	40	100	50	100	250	100	250	500
15	6.04	8.54	13.50	9.07	12.8	20.2	12.11	17.13	27.08	30.3	42.9	67.8			
	9.66	13.6	21.61	14.5	20.5	32.4	19.37	27.40	43.32	48.51	68.60	108.47			
	15	21	34	23	32	51	30	43	68	76	107	169			
20	24	34	54	36	51	81	48	69	108	121	172	271			
	38	54	85	57	81	128	76	108	171	191	270	427			
	25	60	85	135	91	128	203	121	171	271	303	429	678		
32	97	137	216	145	205	325	194	274	433	485	686	1085			
	40	151	214	338	227	321	507	303	428	677	758	1072	1695		
	50	242	342	540	363	513	812	484	685	1083	1213	1715	2712		

**Dimensions,  
 Continued**



**Table 11. 2-Way Valve Dimensions.**

Valve Action	Valve Size Inches	A		B	C	D FxUF	E FxUM
		FxF, FxUF, and FxUM	UFxUF				
Normally Closed	1/2 (15)	1-7/16 (36)	—	3-13/16 (97)	2-3/16 (55)	2-5/16 (59)	2-7/8 (73)
	3/4 (20)	1-11/16 (43)	—	3-13/16 (97)	2-3/16 (55)	2-5/8 (67)	3-3/16 (81)
	1 (25)	2 (50)	—	3-13/16 (97)	2-3/16 (55)	3 (76)	3-1/2 (89)
	1-1/4 (32)	2-1/2* (62)*	3-3/4 (95)	3-13/16 (97)	2-3/16 (55)	—	—
	1-1/2 (40)	2-9/16* (65)*	3-15/16 (99)	3-7/8 (99)	2-1/4 (58)	—	—
	2 (50)	3-1/8* (79)*	4-9/16 (115)	4-1/2 (114)	2-9/16 (65)	—	—
Normally Open	1/2 (15)	1-7/16 (36)	—	2-15/16 (74)	1-1/4 (31)	2-5/16 (59)	2-7/8 (73)
	3/4 (20)	1-11/16 (43)	—	3-15/16 (99)	1-7/16 (36)	2-5/8 (67)	3-3/16 (81)
	1 (25)	2 (50)	—	3-3/4 (96)	1-1/4 (32)	3 (76)	3-1/2 (89)
	1-1/4 (32)	2-1/2* (62)*	3-3/4 (95)	4-1/4** (108)**	2** (51)**	—	4-3/8 (111)
	1-1/2 (40)	2-9/16* (65)*	3-15/16 (99)	4-1/4** (108)**	2** (51)**	—	—
	2 (50)	3-1/8* (79)*	4-9/16 (115)	4-9/16** (116)**	2-1/4** (57)**	—	—

\* FxUF is not available as standard in 1-1/4, 1-1/2, and 2-inch valves.

FxUM is not available as standard in 1-1/2, and 2 inch-valves.

\*\* This dimension is determined by the union nut.

**Service Kit NOTE:** To select the service kit, know your valve body assembly number, model number and the type of connection. Read down the *Connection* column until you find the valve body assembly number and then read to the far right to identify the correct kit. The valve body assembly number and model number are stamped on the tag on the valve body.

**Table 14. Rebuild/Repack Service Kits Part Numbers. See Table 12 for Items in Kit.**

Connection				Valve Description	Model 1 Kit No.	Model 2 Kit No.
FxF	FxUF	UFxUF	FxUM			
599-03000	599-03009	—	599-03216	NO 1/2" Linear SS 1.0 Cv O-ring	599-03300	—
599-03001	599-03010	—	599-03217	NO 1/2" Linear SS 1.6 Cv O-ring	599-03301	—
599-03002	599-03011	—	599-03218	NO 1/2" Linear SS 2.5 Cv O-ring	599-03302	—
599-03003	599-03012	—	599-03219	NO 1/2" Linear SS 4.0 Cv O-ring	599-03303	—
599-03004	599-03013	—	599-03220	NO 3/4" Linear SS O-ring	599-03304	—
599-03005	599-03014	—	599-03221	NO 1" Linear SS O-ring	599-03305	—
599-03006	—	599-03015	—	NO 1-1/4" Linear SS O-ring	599-03306	599-09201
599-03007	—	599-03016	—	NO1-1/2" Linear SS O-ring	599-03307	599-09202
599-03008	—	599-03017	—	NO 2" Linear SS O-ring	599-03308	599-09203
599-03018	599-03027	—	599-03225	NC 1/2" Linear SS 1.0 Cv O-ring	599-03309	—
599-03019	599-03028	—	599-03226	NC 1/2" Linear SS 1.6 Cv O-ring	599-03310	—
599-03020	599-03029	—	599-03227	NC 1/2" Linear SS 2.5 Cv O-ring	599-03311	—
599-03021	599-03030	—	599-03228	NC 1/2" Linear SS 4.0 Cv O-ring	599-03312	—
599-03022	599-03031	—	599-03229	NC 3/4" Linear SS O-ring	599-03313	—
599-03023	599-03032	—	599-03230	NC 1" Linear SS O-ring	599-03314	—
599-03024	—	599-03033	—	NC 1-1/4" Linear SS O-ring	599-03315	599-09213
599-03025	—	599-03034	—	NC 1-1/2" Linear SS O-ring	599-03316	599-09214
599-03026	—	599-03035	—	NC 2" Linear SS O-ring	599-03317	599-09215
599-03054	599-03063	—	599-03234	NO 1/2" Linear SS 1.0 Cv Steam	599-03318	—
599-03055	599-03064	—	599-03235	NO 1/2" Linear SS 1.6 Cv Steam	599-03319	—
599-03056	599-03065	—	599-03236	NO 1/2" Linear SS 2.5 Cv Steam	599-03320	—
599-03057	599-03066	—	599-03237	NO 1/2" Linear SS 4.0 Cv Steam	599-03321	—
599-03058	599-03067	—	599-03238	NO 3/4" Linear SS Steam	599-03322	—
599-03059	599-03068	—	599-03239	NO 1" Linear SS Steam	599-03323	—
599-03060	—	599-03069	—	NO 1-1/4" Linear SS Steam	599-03324	599-09204
599-03061	—	599-03070	—	NO 1-1/2" Linear SS Steam	599-03325	599-09205
599-03062	—	599-03071	—	NO 2" Linear SS Steam	599-03326	599-09206
599-03072	599-03081	—	599-03243	NC 1/2" Linear SS 1.0 Cv Steam	599-03327	—
599-03073	599-03082	—	599-03244	NC 1/2" Linear SS 1.6 Cv Steam	599-03328	—
599-03074	599-03083	—	599-03245	NC 1/2" Linear SS 2.5 Cv Steam	599-03329	—
599-03075	599-03084	—	599-03246	NC 1/2" Linear SS 4.0 Cv Steam	599-03330	—
599-03076	599-03085	—	599-03247	NC 3/4" Linear SS Steam	599-03331	—
599-03077	599-03086	—	599-03248	NC 1" Linear SS Steam	599-03332	—
599-03078	—	599-03087	—	NC 1-1/4" Linear SS Steam	599-03333	599-09216
599-03079	—	599-03088	—	NC 1-1/2" Linear SS Steam	599-03334	599-09217
599-03080	—	599-03089	—	NC 2" Linear SS Steam	599-03335	599-09218



**Series 6000 and Models 6933-6935** ASME Section I and VIII, Steam, 'V' and 'UV', ASME Section VIII, Air/Gas 'UV' National Board Certified. Models 933, 934, and 935 are ASME Section IV, 'Steam', 'HV' National Board Certified



#### Pressure and Temperature Limits

##### **Models 6010, 6021, 6182, 6283, 6221** Section I Steam

15 to 250 psig [1.0 to 17.2 barg]  
-60° to 406°F [-51° to 208°C]

##### **Non-code and Section VIII Steam** Air/Gas

3 to 250 psig [0.2 to 17.2 barg]  
-60° to 406°F [-51° to 208°C]

##### **Models 6030, 6130, 6230** Section I Steam

15 to 300 psig [1.0 to 20.7 barg]  
-60° to 425°F [-51° to 208°C]

##### **Non-code and Section VIII Steam** Air/Gas

3 to 300 psig [0.2 to 20.7 barg]  
-60° to 425°F [-51° to 218°C]

#### Applications

- Steam Boilers and Generators.
- Air/Gas Compressors - reciprocating or rotary - portable or stationary, intercoolers and aftercoolers.
- Pressure Vessels - containing steam, air or non-hazardous gas. Including tanks, receivers, sterilizers and autoclaves.
- Pressure Reducing Stations - protection of the discharge or low pressure side of system.

#### Features and Benefits

- **O-ring seats available** for exceptional leak-free performance, reduced maintenance cost, multiple cycles with tight shutoff, improved seating integrity.
- **Wide hex on valve nozzle** provides wrenching service clearance for easy installation.
- **Dual control rings offer easy adjustability** for precise opening with minimum preopen or simmer and exact blowdown control.
- **Ball bearing pivot between disc and spring** corrects misalignment and compensates for spring side thrust.
- **Grooved piston model disc** reduces sliding area and friction.

#### Model Descriptions

**Model 6010:** Side outlet. Full nozzle design with bronze/brass trim. Available with O-ring seats. For exceptional leak-free performance.

**Model 6021:** Same as Model 6010 with Teflon® (PFA) disc insert. For exceptional leak-free performance (use on steam only).

**Model 6030:** Same as Model 6010 except SS trim (nozzle and disc). Available with O-ring seats for exceptional leak-free performance.

**Model 6182:** Top outlet. Full nozzle design with bronze/brass trim. O-ring seat available for exceptional leak-free performance.

**Model 6121:** Same as Model 6182 with Teflon® (PFA) disc insert. For exceptional non-leak performance (use on steam only).

**Model 6130:** Same as Model 6182 except SS trim (nozzle and disc). O-ring seat available for exceptional leak-free performance.

**Model 6186:** Top outlet. Full nozzle design with bronze/brass trim. 150 psig [10.3 barg] maximum set pressure. Replaces Model 86 (original equipment only).

**Model 6283:** Side outlet. Full nozzle design bronze/brass trim.

**Model 6221:** Same as Model 6283 with Teflon® (PFA) disc insert. For exceptional leak-free performance (use on steam only).

**Model 6230:** Same as Model 6283 except SS trim (nozzle and disc).

**Model 6933:** Same as Model 6010 except certified for ASME code Section IV. Low pressure steam heating boilers set at 15 psig [1.0 barg] only.

**Model 6934:** Same as Model 6021 except certified for ASME code Section IV. Low pressure steam heating boilers set at 15 psig [1.0 barg] only.

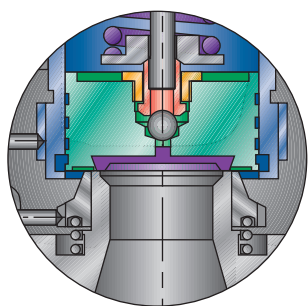
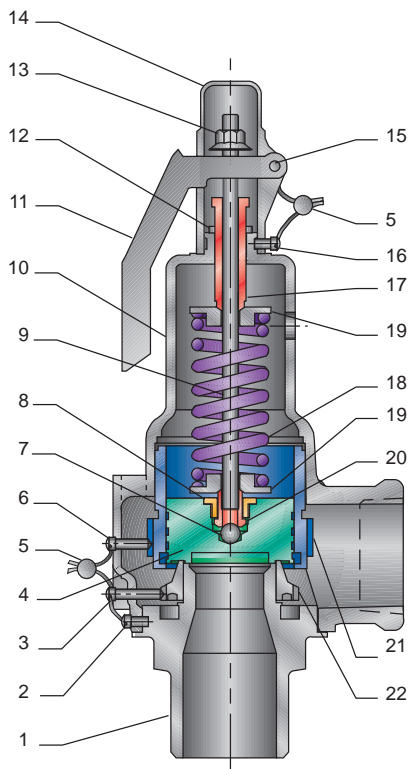
**Model 6935:** Same as Model 6030 except certified for ASME code Section IV. Low pressure steam heating boilers set at 15 psig [1.0 barg] only.

#### Note

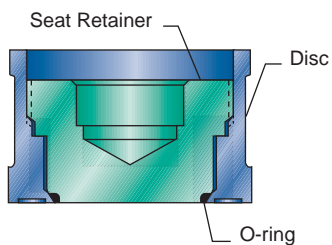
1. Resilient seats determine temperature range. (see page 112)

**Series 6000 and Models 6933-6935** ASME Section I and VIII,  
Steam, ASME Section VIII, Air/Gas, National Board Certified

**Parts and Materials - Models 6010, 6021, 6030, 6221, 6230, 6283, 6933, 6934, 6935**



**Models 6021, 6121, 6221**



**Model 6010V (Optional Soft Seat)**

No.	Part Name	Materials 6010, 6021, 6221, 6283, 6933, 6934	Materials 6030, 6230, 935
1	Nozzle	Bronze	SS
2	Body Set Screw	SS	SS
3	Warn Ring Set Screw	SS	SS
4	Disc	B21 Alloy 485,	SS
5	Wire and Seal	SS Wire and Lead seal	SS/Lead
6	Guide Set Screw	SS	SS
7	Ball	SS, A756-440C	SS
8	Retainer Nut	Brass, B16	Brass
9	Stem	SS, A582-416	SS
10	Body	Bronze	Bronze
11	Lever	Steel	Steel
12	Jam Nut	Brass, B16	Brass
13	Lift Nut	Steel	Steel
14	Cap	Brass	Brass
15	Lever Pin	Steel	Steel
16	Cap Set Screw	SS, Commercial 18-8	SS
17	Compression Screw	Brass, B16	Brass
18	Spring	SS	SS
19	Spring Step	Brass, B16	Brass
20	Stem Retainer	Brass, B16	Brass
21	Guide	Brass/Bronze	Brass/Bronze
22	Warn Ring	Brass/Bronze	Brass/Bronze
23	Seat <sup>1</sup>	1, 2	1, 2

**Note**

- Models 6021, 6121, 6221 and 6934 Teflon®, optional O-ring seat available for all others except Models 6933 and 6935.

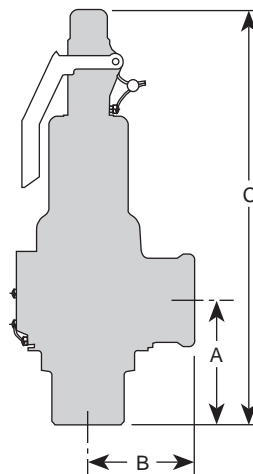
**Series 6000 and Models 6933-6935** ASME Section I and VIII, Steam, ASME Section VIII, Air/Gas  
National Board Certified. Models 6933-6935 is ASME Section IV, 'Steam,' National Board Certified

**Specifications**

Model Number <sup>1</sup>	Orifice	Connections ANSI Standard		Valve Dimensions			Approximate Weight	
		Inlet in [mm]	Outlet in [mm]	A	B	C	lb	[kg]
60**DC#	D	1/2" [12.7]	3/4" [19.0]	2 1/8 [54]	1 5/8 [41]	6 1/2 [165]	1 1/2	[0.7]
60**DD#	D	3/4" [19.0]	3/4" [19.0]	2 1/8 [54]	1 5/8 [41]	6 1/2 [165]	1 3/4	[0.8]
61**DC#	D	1/2" [12.7]	—	—	—	6 1/2 [165]	1 1/4	[0.6]
60**ED#	E	3/4" [19.0]	1" [25.4]	2 3/8 [60]	1 3/4 [44]	7 1/2 [191]	2 1/2	[1.1]
60**EE#	E	1" [25.4]	1" [25.4]	2 1/2 [64]	1 3/4 [44]	7 5/8 [194]	2 3/4	[1.2]
61**ED#	E	3/4" [19.0]	—	—	—	7 1/2 [191]	2 1/4	[1.0]
62**ED#	E	3/4" [19.0]	1 1/4" [31.75]	2 7/8 [73]	1 3/4 [44]	7 1/2 [191]	2 3/4	[1.2]
60**FE#	F	1" [25.4]	1 1/4" [31.8]	2 5/8 [67]	2 [51]	8 1/2 [216]	3 1/2	[1.6]
60**FF#	F	1 1/4" [31.8]	1 1/4" [31.8]	2 7/8 [73]	2 [51]	8 3/4 [222]	3 3/4	[1.7]
61**FE#	F	1" [25.4]	—	—	—	8 1/2 [222]	3 1/4	[1.5]
62**FE#	F	1" [25.4]	1 1/2" [38.0]	2 7/8 [73]	2 [51]	8 1/2 [222]	3 3/4	[1.7]
60**GF#	G	1 1/4" [31.8]	1 1/2" [38.0]	3 1/8 [79]	2 3/8 [60]	9 5/8 [244]	5 1/2	[2.5]
60**GG#	G	1 1/2" [38.0]	1 1/2" [38.0]	3 3/8 [86]	2 3/8 [60]	10 [254]	5 3/4	[2.6]
61**GF#	G	1 1/4" [31.8]	—	—	—	9 5/8 [244]	5	[2.3]
62**GF#	G	1 1/4" [31.8]	2" [51.0]	3 3/8 [86]	2 1/4 [57]	9 5/8 [244]	5 3/4	[2.6]
60**HG#	H	1 1/2" [38.0]	2" [51.0]	3 5/8 [92]	2 3/4 [70]	10 5/8 [270]	7 3/4	[3.5]
60**HH#	H	2" [51.0]	2" [51.0]	4 1/8 [105]	2 3/4 [70]	11 1/8 [283]	8	[3.6]
61**HG#	H	1 1/2" [38.0]	—	—	—	10 5/8 [270]	7 1/4	[3.3]
62**HG#	H	1 1/2" [38.0]	2 1/2" [64.0]	3 7/8 [98]	3 [76]	10 5/8 [270]	8	[3.6]
<b>60**JH#</b>	J	2" [51.0]	2 1/2" [64.0]	4 1/4 [108]	3 3/8 [86]	13 5/8 [346]	15 1/2	[7.0]
60**JJ#	J	2 1/2" [64.0]	2 1/2" [64.0]	4 1/2 [114]	3 3/8 [86]	14 [356]	15 3/4	[7.2]
61**JH#	J	2" [51.0]	—	—	—	13 5/8 [346]	15	[6.8]
62**JH#	J	2" [51.0]	3" [76.0]	4 5/8 [117]	3 3/8 [86]	13 5/8 [345]	15 1/2	[7.0]

**Notes**

1. Replace asterisks with desired model number. Replace # with desired seat material.
2. Model 6030 available only 1/2 x 3/4-inch [12.7 x 19 mm], 3/4 x 1-inch [19 x 25.4 mm], 1 x 1 1/4-inch [25.4 x 31.8 mm], 1 1/4 x 1 1/2-inch [31.8 x 38 mm], 1 1/2 x 2-inch [38 x 51 mm] and 2 x 2 1/2-inch [51 x 64 mm].
3. Models 933, 934 and 935 have same dimensions as Model 6010.



**Series 6000**

**ASME Section I Steam (English, lb/h)**

Set Pressure (psig)	Orifice Area, in <sup>2</sup>					
	D (0.1213)	E (0.2157)	F (0.3369)	G (0.553)	H (0.864)	J (1.415)
15	173	309	484	793	1236	2025
20	201	358	560	918	1431	2344
25	228	407	637	1044	1626	2664
30	255	456	713	1169	1821	2983
35	283	504	789	1294	2015	3302
40	310	553	866	1419	2210	3622
45	337	602	942	1544	2405	3941
50	365	651	1018	1669	2600	4260
55	392	700	1095	1794	2795	4580
60	419	748	1171	1919	2990	4899
65	447	797	1247	2045	3185	5219
70	474	847	1325	2172	3384	5544
75	503	897	1404	2301	3585	5873
80	531	947	1483	2430	3785	6202
85	559	998	1561	2559	3986	6531
90	587	1048	1640	2688	4187	6860
95	615	1098	1718	2817	4388	7189
100	643	1148	1797	2946	4588	7518
105	671	1199	1876	3074	4789	7847
110	700	1249	1954	3203	4990	8176
115	728	1299	2033	3332	5191	8505
120	756	1349	2112	3461	5392	8834
125	784	1400	2190	3590	5592	9163
130	812	1450	2269	3719	5793	9492
135	840	1500	2348	3848	5994	9821
140	869	1550	2426	3977	6195	10150
145	897	1601	2505	4105	6395	10479
150	925	1651	2583	4234	6596	10808
160	981	1751	2741	4492	6998	11466
170	1037	1852	2898	4750	7399	12123
180	1094	1952	3055	5008	7801	12781
190	1150	2053	3212	5265	8202	13439
200	1206	2153	3370	5523	8604	14097
210	1263	2254	3527	5781	9005	14755
220	1319	2354	3684	6039	9407	15413
230	1375	2455	3842	6297	9808	16071
240	1432	2555	3999	6554	10210	16729
250	1488	2656	4156	6812	10612	17387
260	1544	2756	4313	7070	11013	18045
270	1600	2857	4471	7328	11415	18703
280	1657	2957	4628	7585	11816	19360
290	1713	3058	4785	7843	12218	20018
300	1769	3158	4942	8101	12619	20676

## Series 6000 and Models 6933-6935

### Service Recommendations for Resilient Seat/Seal Materials

Seat/Seal Materials <sup>1</sup>	Service Recommendation
Viton® A (-10 to 406°F) [-23 to 208°C]	Acetone, Air, Amyl Alcohol, Aniline, Benzene, Butane, Carbon Disulphide, Carbon Tetrachloride, Dowtherm 'A' and 'E', Ethyl Chloride, Ethylene, Ethylene Glycol, Ethyl Alcohol, Gasoline, Hexane, Hydrogen Sulphide, Isobutyl Alcohol, JP - 4 Fuel, JP - 5 Fuel, Kerosene, Lube Oil, Natural Gas, Naphtha, Nitrogen, Propane, Propylene, Propyl Alcohol, Sulphur Dioxide, Toluene, Trichloroethylene, Turpentine, Water, Xylene
Ethylene Propylene (-70 to 400°F) [-57 to 205°C]	Steam, Hot Water

ASME Section I and VIII, Steam, ASME Section VIII, Air/Gas National Board Certified.  
Models 6930, 6933, 6935 ASME Section IV, National Board Certified

### Model Number/Order Guide

**Model Number Position**

1	2	3	4	5	6	7	7	8	9	10	11	12	13	14	15
---	---	---	---	---	---	---	---	---	---	----	----	----	----	----	----

**Example**

6	0	1	0	H	G	M	0	1	—	A	M	0	1	5	0
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

**Model**

<b>6010</b>	6130	6230
6021	6186	6933
6030	6283	6934
6182	6221	6935
6121		

**Orifice**

D	G
E	H
F	<b>J</b>

**Inlet Size**

C - 1/2-inch	[12.7]	G - 1 1/2-inch	[38.1]
D - 3/4-inch	[19.0]	<b>H - 2-inch</b>	[50.8]
E - 1-inch	[25.4]	J - 2 1/2-inch	[63.5]
F - 1 1/4-inch	[31.8]		

**Seat Material**

M - Metal	<b>E - EPR</b>
V - Viton®	

**Variation (01 through 99)**

- 01 - Plain lever**
- 02 - Plain lever with vibration dampener
- 03 - Plain lever with gag
- 06 - BSP Threads

**Design Revision**

Indicates non-interchangeable revision. Dash (-) if original design.

**Valve Service**

- A - Steam ASME Section I**
- K - Air/Gas ASME Section VIII
- L - Steam ASME Section VIII
- G - Steam ASME Section IV (Models 933, 934, 935 only)
- P - Steam, Non-code
- N - Air, Non-code

**Spring Material**

M - SS

**Set Pressure**

0015 - 15 psig [1.0 barg] only for Models 6933, 6934, 6935

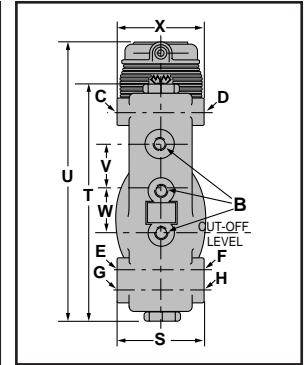
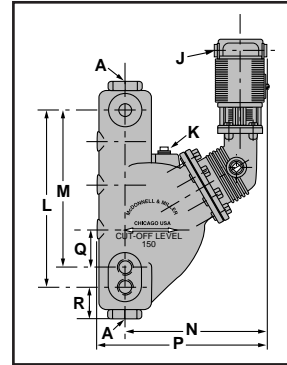
# Low Water Cut-Offs – Mechanical Combination Low Water Cut-Off/Pump Controllers for Steam Boilers

## Series 193



### Low Water Cut-Off/Pump Controllers

- For commercial and industrial low or high pressure steam boilers
- Maintains consistent water level regardless of pressure
- Water column with integral tapplings for gauge glass and tri-cock installations
- For boilers of any steaming capacity
- No. 5 Switch included
- Magnetic repulsion eliminates need for bellows
- Optional features
  - Manual reset
  - On/Off or proportional control switch to maintain constant boiler output
- 1" NPT connections
- Maximum pressure 150 psi (10.5 kg/cm<sup>2</sup>)



**SERIES 193**

### Ordering Information

Model Number	Part Number	Description	Weight lbs. (kg)
193	163400	Combination low water cut-off/pump controller w/No. 5 switch	52.5 (23.8)
193-A	163500	193 w/alternate tapplings	52.5 (23.8)
193-A-7B	164500	193-A w/No. 7B switch	52.5 (23.8)
193-A-7BM	164600	193-A-7B w/manual reset	52.5 (23.8)
193-A-M	164200	193-A w/manual reset	52.5 (23.8)
193-B	163600	193 w/alternate tapplings	52.5 (23.8)
193-B-M	164300	193-B w/manual reset	52.5 (23.8)
193-B-7B	164700	193-B w/No. 7B switch	52.5 (23.8)
193-D	163900	193 w/alternate tapplings	52.5 (23.8)
193-D-7B	163903	193-D w/No. 7B switch	52.5 (23.8)
193-M	164100	193 w/manual reset	52.5 (23.8)
193-7B	164400	193 w/No. 7B switch	52.5 (23.8)
193-7BM	164525	193-7B w/manual reset	52.5 (23.8)
193-D-M	163902	193-D w/manual reset	52.5 (23.8)
193-G	164760	193 w/alternate tapplings	52.5 (23.8)

### Electrical Ratings

345 VA at 120 or 240 VAC

### Dimensions, in. (mm)

Model	A NPT	B NPT	C NPT	D NPT	E NPT	F NPT	G NPT	H NPT	J NPT	K NPT
193	1	1/2	1/2	1/2	–	–	1/2	1/2	1/2	3/4
193-A	1	1/2	1/2	1/2	1/2	1/2	–	–	1/2	3/4
193-B	1 1/4	3/4	3/4	3/4	–	–	3/4	3/4	1/2	3/4
193-D	1	1/2	1	1/2	1	1/2	–	–	1/2	3/4
193-G	1	1/2	–	1/2	1	1/2	–	–	1/2	3/4

Model	L	M	N	P	Q	R
193	12 3/4 (324)	–	10 13/16 (274)	13 (330)	–	2 7/8 (73)
193-A	–	11 1/2 (292)	10 13/16 (274)	13 (330)	2 1/4 (57)	–
193-B	12 3/4 (324)	–	10 13/16 (274)	13 (330)	–	2 7/8 (73)
193-D	–	11 1/2 (292)	10 13/16 (274)	13 (330)	2 1/4 (57)	–
193-G	–	11 1/2 (292)	10 13/16 (274)	13 (330)	2 1/4 (57)	–

Model	S	T	U	V	W	X
193	6 3/4 (171.4)	17 1/2 (445)	20 1/2 (521)	3 1/2 (89)	3 1/2 (89)	6 (152)
193-A	6 3/4 (171.4)	17 1/2 (445)	20 1/2 (521)	3 1/2 (89)	3 1/2 (89)	6 (152)
193-B	6 3/4 (171.4)	17 1/2 (445)	20 1/2 (521)	3 1/2 (89)	3 1/2 (89)	6 (152)
193-D	6 3/4 (171.4)	17 1/2 (445)	20 1/2 (521)	3 1/2 (89)	3 1/2 (89)	6 (152)
193-G	6 3/4 (171.4)	17 1/2 (445)	20 1/2 (521)	3 1/2 (89)	3 1/2 (89)	6 (152)

BOILER CONTROLS

# Series 1575

## Conductance Probe

## Low Water Cut-Offs & Pump Controllers

The **Series 1575** controller provides reliable control of burner circuits, pumps, motor starters and electric valves for low water protection and pump control in commercial and industrial steam boilers. The control uses conductance probes and solves many of the inherent limitations of float operated controls such as sensitivity to boiler operating pressure. The combination of higher pressure and wider differential capabilities, the Series 1575 expands the functionality of the M&M LWCO/Level Control product line.

### Typical Applications

- Primary low water fuel cut-off protection and pump control for commercial and industrial steam boilers
- Motorized valve controller, low water cut-off, high water cut-off and alarm actuator for boilers, vessels and tanks

### Features

- Set points and differentials remain constant throughout pressure range
- Auto reset
- Probe operation diagnostics
  - Sensitivity monitor
  - Sequence monitor
  - Wetted probe monitor
- Adjustable 60-second burner-off time delays
- Adjustable pump differentials by cutting probe to desired set points
- Redundant low-water and pump-off circuitry
- 1 Hp burner and pump relays
- Control unit can be mounted in any convenient location
- Test button standard
- Probe chamber with 3 probes and gauge glass tapings
- 4th probe can be added for high water control



**Control Unit**  
(For remote mounting)



**Probe Chamber**  
(With 3 probes standard)

For over 85 years, McDonnell & Miller has been a name you can trust and rely on for boiler safety controls.



**McDonnell & Miller**  
a xylem brand



## Specifications

- NEMA 1 electrical enclosure
- NEMA4X chamber enclosure
- Maximum operating pressure 250 psi (17.3 kg/cm)
- Maximum ambient temperature 135° F (57° C)
- Maximum operating temperature 406° F (208° C) (at probes)

## Electrical Ratings

### Electrical Rating and Switch Ratings

Supply Voltage	Probe Voltage	(Amps) NO (NC) VAC	Locked Rotor (Amps) NO (NC) VAC	Pilot Duty (VA) NO (NC) VAC	Motor (HP) NO (NC) VAC
120 VAC 50/60Hz	5VAC	16 (5.8), 120	96 (34.8), 120	470 (290), 120	1 (1/4), 120
	Maximum	8 (2.9), 240	48 (17.4), 240	470 (290) 240	1 (1/4), 240

## Ordering Information

Part Number	Model	Description	Weight lbs. (kg)
171907	1575	Combination low water cut-off/pump controller	30 (13.6)
<b>Replacement Parts</b>			
310490	150E-CU	Control unit for 1575 or 150E or 157E	2.7 (1.2)
176319	PA-750-HP	High Pressure Probe	0.5 (.23)
179530	PS-1-SS	12" (305mm) Sensing Probe w/PTFE	0.5 (.23)



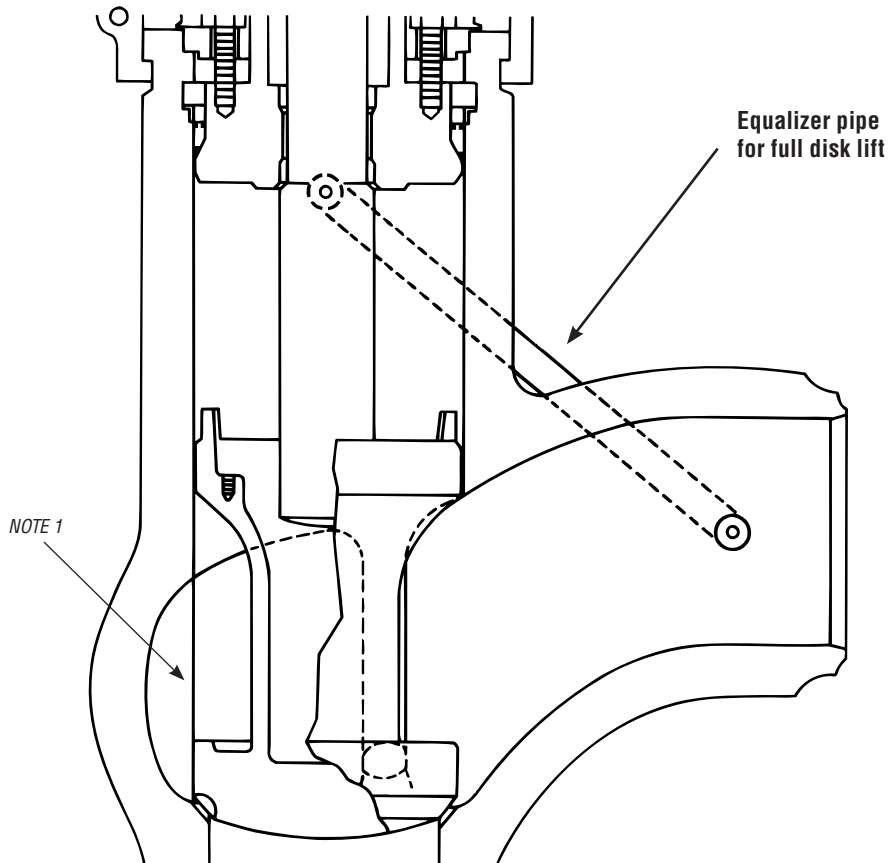
Xylem Inc.  
8200 N. Austin Avenue  
Morton Grove, Illinois 60053  
Phone: (847) 966-3700  
Fax: (847) 965-8379  
www.mcdonnellmiller.com





## Features and Description of Edward Stop-Check (Non-Return) Valves

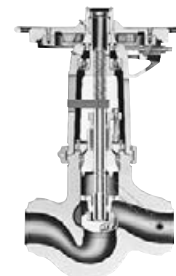
Edward stop-check (non-return) valves offer the same tight-sealing performance as Edward stop valves and, at the same time, give check valve protection in the event of fluid back flow. Edward stop-check valves are commonly used to prevent back flow from a header fed from two or more sources when there is a loss of pressure in one of the sources — for example, the boiler outlet to a common header or at the feedwater heater outlets.



Flite-Flow®



Angle



Globe

### Equalizer

All Edward cast steel stop-check valves are equipped with an Equalizer pipe. Acting as an external pressure balancing pipeline, the Equalizer connects the zone above the disk with the lower pressure area in the valve outlet (See drawing above.) This reduces pressure above the disk and, as a result, causes the higher pressure below the disk to raise the disk to full lift. The Equalizer helps reduce pressure drop and disk-piston movement and wear.

**All other features are the same as those defined on page 17 for stop valves.**

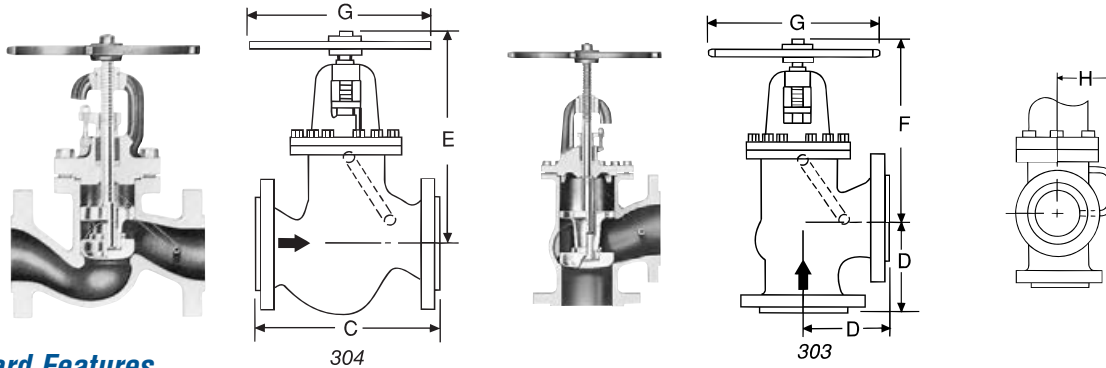
*NOTE 1: Guide ribs are hardfaced on Flite-Flow and some angle pattern valves.*



Elbow Down

# Stop-Check (Non-Return) Valves

## Class 300 740 PSI @ 100°F (51.1 BAR @ 38°C)



### Standard Features

- Bodies and bonnets are cast steel (WCB & WC6).
- Bolted Bonnet, OS & Y.
- Globe & angle design.
- Integral Stellite seat, disk and backseat.
- Body-guided disk piston.
- 13% chromium stainless steel stem.
- Asbestos-free graphitic packing.
- Gasket:
  - Size 2½ – asbestos-free, spiral wound.
  - All others – Long Terme<sup>#</sup> steel.
- Equipped with equalizer.

### Pressure Class 300 (PN 50)

Fig. No.	Type	Ends	NPS (DN)
304	Globe	Flanged	3 (80) thru 12 (300)
304Y	Globe	Buttwelding	
<b>303</b>	<b>Angle</b>	<b>Flanged</b>	2½ (65) thru 12 (300)
303Y	Angle	Buttwelding	

### Dimensions – Globe & Angle

Black numerals are in inches and pounds  
Colored numerals are in millimeters and kilograms

Figure No. 303/303Y, 304/304Y	NPS	2½	3	4	5	6	<b>8</b>	10	12
	DN	65	80	100	125	150	250	250	300
C - Face to Face, Globe*	—	—	12.5	14	15.76	17.5	22	24.5	28
	—	—	<b>318</b>	<b>356</b>	<b>400</b>	<b>445</b>	<b>559</b>	<b>622</b>	<b>711</b>
D - Center to Face, Angle*	5.75	6.25	7	7.88	8.75	11	12.25	14	—
	<b>146</b>	<b>159</b>	<b>178</b>	<b>200</b>	<b>222</b>	<b>279</b>	<b>310</b>	<b>356</b>	—
E - Center to Top, Globe	—	16.2	16.7	20.1	24.8	28.4	34.3	39.7	—
	—	—	<b>411</b>	<b>424</b>	<b>510</b>	<b>630</b>	<b>721</b>	<b>871</b>	<b>1008</b>
F - Center to Top, Angle	13.6	14.4	14.6	17.7	21.4	24.2	28.8	32.9	—
	<b>345</b>	<b>366</b>	<b>371</b>	<b>450</b>	<b>544</b>	<b>615</b>	<b>731</b>	<b>836</b>	—
G - Handwheel/Handle Diameter*	11	11.5	11.5	15	18	22	22	26	—
	<b>279</b>	<b>292</b>	<b>292</b>	<b>381</b>	<b>457</b>	<b>559</b>	<b>559</b>	<b>660</b>	—
H - Equalizer Clearance	5.9	8.7	8.5	10	9.6	11	13.7	15	—
	<b>150</b>	<b>221</b>	<b>216</b>	<b>254</b>	<b>244</b>	<b>279</b>	<b>348</b>	<b>381</b>	—
Weight, Globe (Flanged)	—	100	110	230	370	525	920	1525	—
	—	—	<b>45</b>	<b>50</b>	<b>104</b>	<b>168</b>	<b>238</b>	<b>417</b>	<b>692</b>
Weight, Globe (Welding)	—	75	95	175	295	400	765	1365	—
	—	—	<b>34</b>	<b>43</b>	<b>79</b>	<b>134</b>	<b>181</b>	<b>327</b>	<b>619</b>
<b>Weight, Angle (Flanged)</b>	66	100	130	200	300	450	700	1250	—
	<b>29</b>	<b>45</b>	<b>59</b>	<b>91</b>	<b>136</b>	<b>204</b>	<b>318</b>	<b>567</b>	—
Weight, Angle (Welding)	51	70	90	152	215	325	560	970	—
	<b>23</b>	<b>32</b>	<b>41</b>	<b>69</b>	<b>98</b>	<b>147</b>	<b>254</b>	<b>440</b>	—

\* Regular handwheel standard on all sizes except size 12 has an impactor handwheel and size 2½ has an impactor handle.

• Center-to-end or end-to-end dimensions for welding end valves same as center-to-contact face or contact-face to contact-face dimensions for flanged end valves.

**28** # Long Terme Steel is a product coated by immersion in molten terne metal. Terne Metal is an alloy of lead and a small amount (about 3%) of tin.

# CB780E/CB784E

## Relay Modules with Valve Proving

### Installation and Operating Instructions

#### PRODUCT DATA



## APPLICATION

The Clever-Brooks CB780E/CB784E is a microprocessor based integrated burner control for automatically fired gas, oil, or combination fuel single burner applications. The CB780E consists of a Relay Module and Keyboard Display Module. The CB784E consists of the Relay Module only. A subbase, Amplifier, and Purge Card are required to complete the system. Options include Personal Computer Interface, DATA CONTROLBUS MODULE™, Remote Display Mounting, First-Out Expanded Annunciator and COMBUSTION SYSTEM MANAGER™ Software.

The CB780E/CB784E is programmed to provide a level of safety, functional capability, and features beyond the capacity of conventional controls.

Functions provided by the CB780E/CB784E include automatic burner sequencing, flame supervision, system status indication, system or self-diagnostics, and troubleshooting.

The CB780E/CB784E offer the Valve Proving test feature.

Using the 833-2727 Keyboard Display (standard on the CB780E), the following features can be set-up:

- **Post Purge time—Up to 60 minutes—Device shipped with 15 seconds Post purge**
- **Valve Proving features include:**
  - VPS test time
  - When (Never, Before, After, Split or Both)

See the 833-2727 Instructions (750-248) for its features. Series 5 can be programmed for ModBus communication.

At commissioning time, the Valve Proving System may be scheduled to occur at one of five different times:

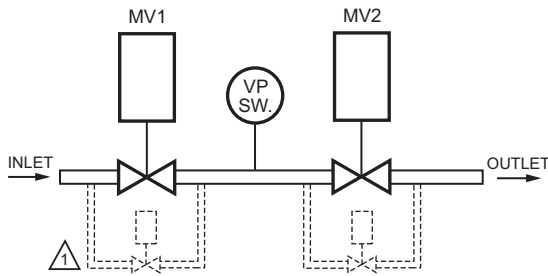
- **Never—Device default as received—Valve proving does not occur.**
- **Before—Valve proving before run concurrent with Pre-Purge.**
- **After—Valve proving occurs after the Run state, before the device goes to Standby (Concurrent with Post-Purge, if selected.)**
- **Both—Valve proving occurs at both times Before and After, noted above.**
- **Split—The main valve 2 (MV2) (high pressure) seat test is performed at the Before time and the main valve 1 (MV1) (low pressure) seat test is performed during the After time.**

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The following assumptions apply when using the CB780E/CB784E:



**CAUTION:** VALVE ENERGIZING TIMING IS BASED ON VALVE OPENING TIMES OF 13 SECONDS MAXIMUM.  
 - FOR VALVES WITH TIMINGS GREATER THAN 13 SECONDS OR THOSE THAT DO NOT OPEN THE ACTIVE VALVE WITHIN THE ENERGIZED TIME, A SAFETY SHUTOFF SOLENOID VALVE (1/4", 120 VAC) IS REQUIRED TO OBTAIN THE PROPER TEST PRESSURES.  
 - THE VALVE WILL BE WIRED IN PARALLEL TO THE VALVE IT IS BYPASSING (TERMINAL 9 FOR MV1 OR TERMINAL 21 FOR MV2).

M24788

**Fig. 1. The valve proving system.**

MV1—Wired to terminal 9. It is located in the most upstream position of the main gas valve train.

VPS—Valve Proving Switch: Setpoint at 1/2 of Main Valve inlet pressure.

MV2—Wired to terminal 21. It is the main valve located closest to the burner.

The PII—Pre-Ignition Interlock (or Proof of Closure Switch) for terminal 20 can be installed on MV1, MV2, or as a series connection through both valves.

## FEATURES

- **Safety features:**
  - Safety interlock.
  - Closed loop logic test.
  - Dynamic AMPLI-CHECK™.
  - Dynamic input check.
  - Dynamic safety relay test.
  - Dynamic self-check logic.
  - Expanded safe-start check.
  - High Fire Purge Switch test.
  - Internal hardware status monitoring.
  - Low Fire Start Switch test.
  - Tamper-resistant timing and logic.
- Access for external electrical voltage checks.
- Application flexibility.
- Communication interface capability.
- Dependable, long-term operation provided by microcomputer technology.

- First-out annunciation and system diagnostics provided by a 2-row by 20-column Vacuum Fluorescent Display (VFD) located on the Keyboard Display Module.
- First-out expanded annunciation with 26 Light Emitting Diodes (LEDs) for limits and interlocks (optional).
- Five function Run/Test Switch.
- Interchangeable plug-in flame amplifiers.
- Local or remote annunciation of operation and fault information.
- Nonvolatile memory for retaining history files and sequencing status after loss of power.
- Remote reset (optional).
- Report generation (optional).
- Five sequence information LEDs
- Burner controller data:
  - Sequence status.
  - Sequence time.
  - Hold status.
  - Lockout/alarm status.
  - Flame signal strength.
  - Expanded annunciation status.
  - Total cycles of operation.
  - Total hours of operation.
  - Fault history of six most recent faults:
    - Cycles of operation at time of fault.
    - Expanded annunciator data at time of fault.
    - Fault message and code.
    - Hours of operation at time of fault.
    - Sequence status at time of fault.
    - Sequence time at time of fault.
  - Diagnostic information:
    - Device type.
    - Flame amplifier type.
    - Flame failure response time.
    - Manufacturing code.
    - On/Off status of all digital inputs and outputs.
    - Selected prepurge time.
    - Software revision and version of CB780E/CB784E and Keyboard Display Module.
    - Status of configuration jumpers.
    - Status of Run/Test Switch.

## SPECIFICATIONS

### Electrical Ratings (see Table 1):

Voltage and Frequency: 120 Vac (+10/-15%), 50 or 60 Hz (±10%).

Keyboard Display Module: 13 Vdc peak full wave rectified (+20/-15%).

Power Dissipation:

CB780E/CB784E: 10W maximum.

Display Module: 3W maximum.

Maximum Total Connected Load: 2000 VA.

Fusing: 15A maximum, Type SC or equivalent—fast blow.

**Table 1. Terminal Ratings.**

Terminal No.	Description	Ratings (120 Vac)
G	Flame Sensor Ground <sup>a</sup>	—
Earth G	Earth Ground	—
L2(N)	Line Voltage Common	—
3	Alarm	1A pilot duty
4	Line Voltage Supply (L1) <sup>b</sup>	120 Vac (+10%/-15%), 50 or 60 Hz (±10%).
5	Burner Motor	9.8AFL, 58.ALR (inrush)
6	Burner Controller and Limits Demand (Not Valve Proving)	1 mA.
7	Lockout/Running Interlock	8A run, 43A inrush
8	Pilot Valve/Ignition	c
9	Main Fuel Valve	c
10	Ignition	c
F(11)	Flame Sensor	60 to 220 Vac, current limited
12	Firing Rate High Fire	75VA pilot duty
13	Firing Rate Common	75VA pilot duty
14	Firing Rate Low Fire	75VA pilot duty
15	Firing Rate Modulate	75VA pilot duty
16	Valve Proving Switch	1 mA
17	Demand—Valve Proving	1 mA
18	Low Fire Switch Input	1 mA
19	High Fire Switch Input (7800/40L only)	1 mA
20	Pre-Ignition Interlock Input	1 mA
21	Interrupted First Stage Oil Valve or MV2	c
22	Shutter	0.5A

<sup>a</sup> The relay module must have a good earth ground providing a connection between the subbase and the control panel or the equipment. The earth ground wire must be capable of conducting the current to blow the 15A fuse (or breaker) in event of an internal short circuit. The relay module requires a low impedance ground connection to the equipment frame, which, in turn, requires a low impedance connection to earth ground.

<sup>b</sup> 2000 VA maximum connected load to relay module assembly.

<sup>c</sup> See Table 2 and 3.

**Table 2. Combinations for Terminals 8, 9, 10, and 21.**

Combination No.	Pilot Fuel #	Main 9	Ignition 10	Valve 21
1	C	F	No load	No load
2	B	F	No load	No load
3	No load	F	No load	B
4	F	F	A	No load
5	No load	F	A	F
6	D	F	A	No load
7	No load	D	A	D
8	D	D	A	No load
9	No load	D	A	D

**Table 3. Explanation of Each Combination**

A	B	C	D	E
4.5A ignition	50 VA Pilot Duty <sup>a</sup> plus 4.5A ignition.	180 VA ignition plus motor valve with: 660 VA inrush, 360 VA, open, 260 VA hold.	2A Pilot Duty. <sup>a</sup>	64 VA Pilot Duty. <sup>a</sup> plus motor valves with: 3850 VA inrush, 700 VA open, 250 VA hold.

**Table 4. Valve Proving Combinations.**

	Pilot Valve	Main Valve 1	Ignition	Main Valve 2
Combination	Terminal 8	Terminal 9	Terminal 10	Terminal 21
10 <sup>a</sup>	--	D	A	D
11	--	D	A	F
12	--	F	A	D
13	--	F	A	F
14 <sup>b</sup>	C	D	--	D
15	C	D	--	F
16	C	F	--	D
17	C	F	--	F
18	B	D	--	D
19	B	D	--	F
20	B	F	--	D
21	B	F	--	F
22	D	D	A	D
23	D	D	A	F
24	D	F	A	D
25	D	F	A	F

<sup>a</sup> JR2 intact - Direct Spark

<sup>b</sup> ED - Pilot System

**Environmental Ratings:**

Ambient Temperature:

Operating: -40°F to +140°F (-40°C to +40°C).

Storage: -40°F to +150°F (-40°C to +66°C).

Humidity: 85% RH continuous, noncondensing.

Vibration: 0.5G environment.

**Dimensions:**

Refer to Fig. 2 and 3.

**Weight:**

CB780E/CB784E: 1 pound 10 ounces, unpacked.

Keyboard Display Module: 4 ounces, unpacked.

**IMPORTANT:**

*Flame Detection System available for use with CB780E/CB784E. To select your Plug-in Flame Signal Amplifier and matching Flame Detector, see Table 5.*

**Table 5. Flame Detection Systems (Fig. 4, 5, 6)**

Plug-In Flame Amplifiers				Applicable Flame Detectors			
Type	Color	Self-Checking	Part Number	Flame Failure Response Time	Fuel	Type	Part Number
Infrared	Red/White	No	833-3495	3 sec.	Gas, oil, coal	Infrared (Lead Sulfide)	817-4133
		Dynamic AMPLI-CHECK™	833-3496 <sup>a</sup>				
Ultraviolet	Purple	No	833-2724		Gas, oil	Ultraviolet	817-1743 <sup>b</sup>
Ultraviolet Self-Check	Green	Dynamic Self-Check	833-2741 <sup>c</sup>		Gas, oil, coal	Ultraviolet (Purple Peeper®)	817-1121

<sup>a</sup> Circuitry tests the flame signal amplifier 12 times a minute during burner operation and shuts down the burner if the amplifier fails.

<sup>b</sup> The 817-1743 Flame detector should be used only on burners that cycle on-off at least once every twenty-four hours. Appliances with burners that remain on for twenty-four hours continuously or longer should use the 817-1121 Flame Detector with 833-2741 Amplifier as the ultraviolet flame detection system.

<sup>c</sup> Circuitry tests all electronic components in the flame detection system (amplifier and detector) 12 times a minute during burner operation and shuts down the burner if the detection system fails. Series 4 amplifiers check 60 to 120 times per minute.

**Approvals:**

Underwriters Laboratory, Inc., listed, File No. MP268,

Guide No. MCCZ.

Canadian Standards Association certified, LR9S329-3.

IRI acceptable.

Federal Communications Commission, Part 15,

Class B—Emissions

**Required Components:**

CB780E: 120 Vac, 50/60 Hz, 833-03517.

CB784E: 120 Vac, 50/60 Hz, 833-03518.

Wiring Subbase 833-2725

Plug-in Flame Signal Amplifier: see Table 5.

Plug-in Purge Timer Cards: selectable:

833-2730—30 sec.

833-2731—60 sec.

833-2732—90 sec.

833-2733—2 1/2 min.

NOTE: The CB780E and CB784E are identical, except for the Keyboard Display Module, which is standard with the CB780E and optional with the CB784E.

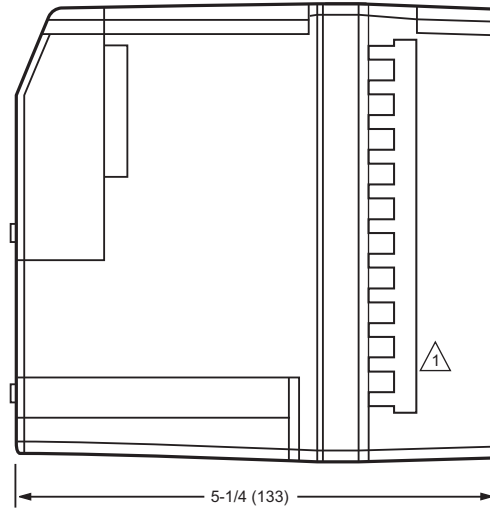
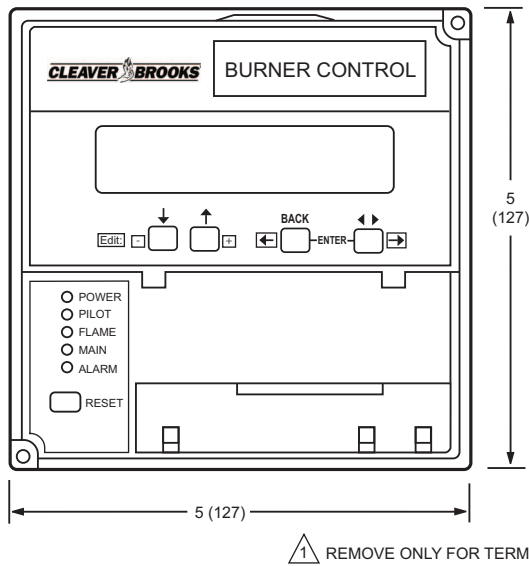
**Accessories:**

Optional:

DATA CONTROLBUS MODULE—part no. 833-2729. Provides communication and remote reset capabilities on CB780E; remote display capabilities on CB780E and CB784E.

CB783 Expanded Annunciator—part no. 833-2726.  
 Keyboard Display Module—part no. 833-2727.  
 Remote Mounting Kit for the Keyboard Display, NEMA 4—  
 part no. 833-2740.

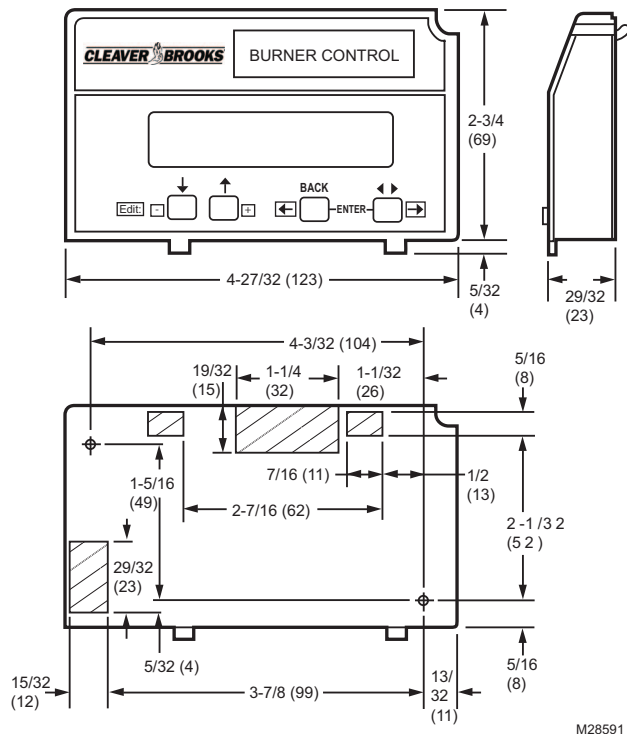
Tester—part no. 626-5050.  
 833-2760 5-Wire Connector for the Keyboard Display Module.  
 Required any time the KDM is used for remote reset or  
 when using the CB783 Expanded Annunciator.



1 REMOVE ONLY FOR TERMINAL TEST ACCESS.

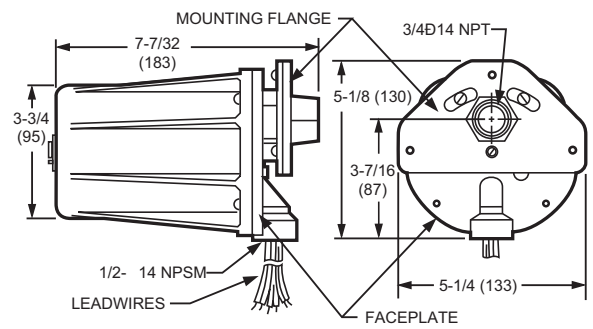
M28590

Fig. 2. Mounting dimensions of CB780E/CB784E Relay Module and 833-2725 Subbase, in inches (mm).



M28591

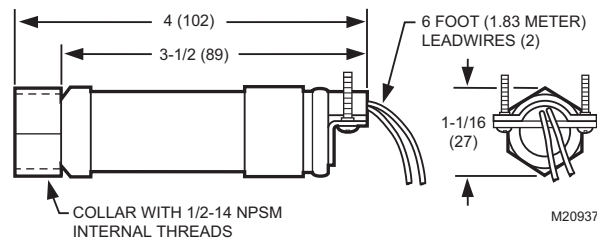
Fig. 3. Mounting dimensions of Keyboard Display Module, in inches (mm).



817-1121

M20935

Fig. 4. Ultraviolet Self-Check detector, mounting dimensions in inches (mm).



817-1743

M20937

Fig. 5. Ultraviolet detector, mounting dimensions in inches (mm).



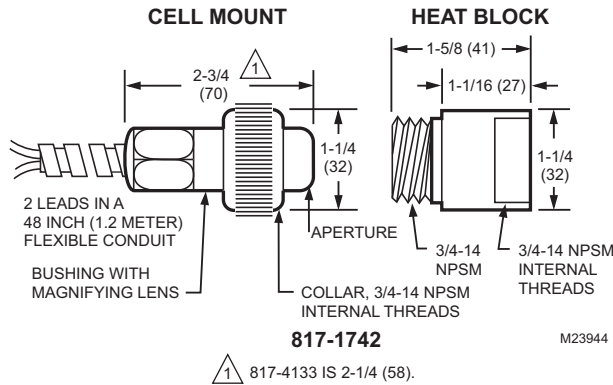


Fig. 6. Infrared detector, mounting dimensions in inches (mm).

## PRINCIPAL TECHNICAL FEATURES

The CB780E/CB784E provides all customary flame safeguard functions while providing significant advancements in the areas of safety, annunciation and system diagnostics.

### Safety Shutdown (Lockout) Occurs If Any of the Following Occur During the Indicated Period:

1. Anytime:
  - a. Purge card is not installed or removed.
  - b. Purge card is bad.
  - c. Configuration jumpers were changed (after 200 hours of main valve operation).
  - d. Internal system fault.
  - e. Demand present at terminals 6 and 17 at the same time.
  - f. Failure of the Valve Proving test
  - g. Demand on terminal 17 and device at default "Never".
2. INITIATE Period
  - a. AC line power errors occurred. See Operation section.
  - b. Four minute INITIATE period has been exceeded.
3. STANDBY Period
  - a. Flame signal is present after 240 seconds.
  - b. Pre-Ignition Interlock is open an accumulative time of 30 seconds.
  - c. Interlock check feature is enabled (only with JR3 clipped) and the Interlock String (including the airflow switch) is closed for 120 seconds with controller closed.
  - d. Ignition/pilot valve terminal is energized.
  - e. Main valve terminal is energized.
  - f. Internal system fault occurred.
4. PREPURGE Period
  - a. Pre-Ignition Interlock opens anytime during PREPURGE period (except during Valve Proving test).
  - b. Flame signal is detected after first ten seconds during PREPURGE.
  - c. High Fire Switch fails to close within four minutes, and fifteen seconds after firing rate motor is commanded to drive to high fire position at start of PREPURGE.

- d. Low Fire Switch fails to close within four minutes, and fifteen seconds after firing rate motor is commanded to drive to low fire position at end of PREPURGE.
  - e. Lockout Interlock does not close within 10 seconds.
  - f. Lockout Interlock opens during PREPURGE.
  - g. Ignition/pilot valve terminal is energized.
  - h. Main valve terminal is energized (except during Value Proving testing).
  - i. Internal system fault.
5. PILOT FLAME ESTABLISHING Period (PFEP)
    - a. Low Fire Switch opens.
    - b. Lockout Interlock opens.
    - c. Ignition/pilot valve terminal is not energized.
    - d. Early Spark Termination terminal is energized after five seconds.
    - e. No flame is present at end of PFEP.
  6. MAIN FLAME ESTABLISHING Period (MFEP)
    - a. Low Fire Switch opens.
    - b. Lockout Interlock opens.
    - c. Ignition/pilot valve terminal is not energized.
    - d. Main valve terminal is not energized.
    - e. No flame is present at end of MFEP.
  7. RUN Period
    - a. No flame is present.
    - b. Lockout Interlock opens.
    - c. Interrupted pilot valve terminal is energized.
    - d. Main valve terminal is not energized.
  8. POSTPURGE Period
    - a. Pre-Ignition Interlock does not close in five seconds and opens after five-second time period (except during Value Proving testing).
    - b. Ignition/pilot valve terminal is energized.
    - c. Main valve terminal is energized (except during Valve Proving testing)

## SAFETY PROVISIONS

### Internal Hardware Status Monitoring

The CB780E/CB784E checks the purge card for correct parity to prevent purge timing shifts and circuitry failures. It also analyzes the integrity of the configuration jumpers and internal hardware. The POWER LED blinks every four seconds, signifying an internal hardware check.

### Closed Loop Logic Test

The test verifies the integrity of all safety critical loads, terminals 8, 9, 10 and 21. If the loads are not energized properly; i.e., the main valve terminal is powered during PREPURGE, the CB780E/CB784E will lockout on safety shutdown. The CB780E/CB784E must react to input changes but avoid the occurrence of *nuisance* shutdown events. Signal conditioning is applied to line voltage inputs to verify proper operation in the presence of *normal* electrical line noise such as transient high voltage spikes or short periods of line dropout. Signal conditioning is tolerant of synchronous noise (line noise events that occur at the same time during each line cycle).

### Dynamic Ampli-Check™

Dynamic AMPLI-CHECK™ circuitry tests the flame signal amplifier during burner operation and shuts down the CB780E/CB784E if the flame amplifier fails.

## Dynamic Flame Amplifier and Shutter Check

Self-checking circuitry tests all electronic components in the flame detection system and amplifier 10 to 12 times per minute and shuts down the CB780E/CB784E if the detection system fails.

## Dynamic Input Check

All system input circuits are examined to verify that the CB780E/CB784E is capable of recognizing the true status of external controls, limits and interlocks. If any input fails this test, a safety shutdown occurs and the fault is annunciated.

## Dynamic Safety Relay Test

Checks the ability of the dynamic safety relay contacts to open and close. It also verifies that the safety critical loads, terminals 8, 9, 10 and 21, can be de-energized, as required, by the Dynamic Self-Check logic.

## Dynamic Self-Check Safety Circuit

The microcomputer tests itself and related hardware while at the same time the safety relay system tests the microcomputer operation. If a microcomputer or safety relay failure occurs and does not allow proper execution of the self-check routine, safety shutdown will occur and all safety critical loads will be de-energized.

## Expanded Safe-Start Check

The conventional safe-start check, which prevents burner start-up if flame is indicated at start-up, is expanded to include a flame signal check during STANDBY, a preignition interlock check, an interlock check, and a safety critical load check.

## High Fire Purge and Low Fire Start Switch Tests

*High Fire Purge Switch Test* examines the Purge Position Interlock Switch at the moment the firing rate motor is commanded to the high fire position. If the switch is bypassed, welded or otherwise closed prematurely, the system will automatically add 30 seconds to allow additional drive time for the firing rate motor to reach or near the open position before starting the purge timing; otherwise, purge timing starts when the High Fire Switch is closed. This switch will also cause a hold (four minutes, fifteen seconds) condition when the switch is open before purge or opens during purge. The CB780E/CB784E will lockout and annunciate an alarm if the switch fails to close within the hold time period.

*Low Fire Start Switch Test* examines the Low Fire Start Switch at the moment PREPURGE is completed. If the switch is bypassed, welded or otherwise prematurely closed, the system automatically adds 30 seconds to allow the firing rate motor additional time to reach or near the low fire start position before ignition trials; otherwise, ignition trials start after the Low Fire Switch closes. The test also is used to prove that the firing rate motor is at low fire position throughout the ignition trial period. This switch will also cause a hold (four minutes, fifteen seconds) condition if the switch opens after purging is complete. The CB780E/CB784E will lockout and annunciate an alarm if the switch fails to close within the hold time period.

## Mandatory Purge

If lockout occurs after the initiation of ignition trials, (or at anytime during a sequence when the fuel valves may have been energized), a mandatory POSTPURGE period is imposed.

## Off Cycle (STANDBY or PREPURGE) Flame Signal Check

The flame detection subsystem (flame detector and amplifier) is monitored during STANDBY. If a flame simulating condition or an actual flame exists, a system hold occurs and start-up is prevented. If the flame signal exists at any time after the first 40 seconds of STANDBY, a safety shutdown will occur and be annunciated. A shutter-check amplifier and self-checking detector are energized for the first 40 seconds during STANDBY and the last two seconds before exiting STANDBY. If a flame exists, a safety shutdown occurs. An AMPLI-CHECK™ Amplifier is energized continually through STANDBY and PREPURGE to detect any possibility of a runaway detector or a flame. If either situation happens, a safety shutdown occurs. A standard amplifier is energized continually through STANDBY and PREPURGE. If either situation happens, a safety shutdown occurs.

## Preignition Output Circuit Check

At the end of PREPURGE, the Dynamic Safety Relay operation is checked. Also, all safety critical loads, terminals 8, 9, 10 and 21 are checked to verify the terminals are not powered. If the Dynamic Safety Relay operation is faulty, or if any of the safety critical loads are powered, safety shutdown occurs and is annunciated.

## Tamper-Resistant Timing and Logic

Safety and logic timings are inaccessible and cannot be altered or defeated.

## Verified Spark Termination

The ignition terminal is monitored to verify early spark termination (five seconds ignition and pilot and five seconds *pilot only*).

## First-Out Annunciation and Self-Diagnostics

*Sequence Status Lights* (LEDs) provide positive visual indication of the program sequence: POWER, PILOT, FLAME, MAIN and ALARM. The green POWER LED blinks every four seconds to signify the CB780E/CB784E hardware is running correctly.

*Multi-function Keyboard Display Module* (standard with CB780E, optional with CB784E) shows elapsed time during PREPURGE, PILOT IGN, MAIN IGN, and POSTPURGE. As an additional troubleshooting aid, it provides sequence timing, diagnostic information, historical information and expanded annunciator information when a safety shutdown or hold or normal operation occurs.

*First-out Annunciation* reports the cause of a safety shutdown or identifies the cause of a failure to start or continue the burner control sequence with an English text and numbered code via the Keyboard Display Module. It monitors all field input circuits, including the Flame Signal Amplifier and Firing

Rate Position Switches. The system distinguishes 118 modes of failure and detects and annunciates difficult-to-find intermittent failures.

*Self-Diagnostics* adds to the First-out Annunciation by allowing the CB780E/CB784E to distinguish between field (external device) and internal (system related) problems. Faults associated within the flame detection subsystem, CB780E/CB784E or plug-in Purge Card, are isolated and reported by the Keyboard Display Module, see Troubleshooting section and CB780E/CB784E System Annunciation Diagnostics and Troubleshooting, Bulletin Number CB-7803.

## Interlock Requirements

The following interlock inputs are provided:

### Low Fire Interlock

This interlock verifies the firing rate motor is in the low fire position before and during ignition trials.

### High Fire Interlock

This interlock verifies the firing rate motor is in the high fire position prior to and during PREPURGE.

### Lockout Interlock

This interlock (ILK) input signifies a Lockout Interlock. If the Lockout Interlock is open for more than ten seconds into PREPURGE, the CB780E/CB784E will lockout. After entering PREPURGE, if the Lockout Interlock opens during the first ten seconds, the purge timer will be reset. This provides a continuous PURGE to occur without interruption before the Pilot Flame Establishing Period. If a Lockout Interlock opens anytime after ten seconds into PURGE, during the Ignition Trials or Run, it causes a lockout.

A typical Lockout Interlock string contains an airflow switch (see Fig. 8). The Interlock Check is a site configurable option (see Table 7). If this feature is enabled, the CB780E/CB784E will lockout after 120 seconds whenever control terminal 6 is energized, and the Lockout Interlock string (including airflow switch) is closed during STANDBY.

### Preignition Interlock

The Preignition Interlock input is typically connected to proof-of-closure switches for fuel valve(s). The Preignition Interlock must be energized throughout PREPURGE. If the Preignition Interlock opens during STANDBY, it causes a hold (30 seconds). The CB780E/CB784E will lockout if the interlock does not close within 30 seconds during STANDBY. If the Preignition Interlock opens during PREPURGE, it will lockout. If the Preignition Interlock is open after five seconds into

POSTPURGE, the CB780E/CB784E will lockout. The Preignition Interlock is ignored during the ignition trials state and during RUN.

## INSTALLATION

### WARNING

**Fire or Explosion Hazard.**

**Can cause severe injury, death or property damage.**

To prevent possible hazardous burner operation, verification of safety requirements must be performed each time a control is installed on a burner.

### When Installing This Product...

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings given in the instructions and marked on the product to make sure the product is suitable for the application.
3. Installer must be a trained, experienced, flame safeguard technician.
4. After installation is complete, check out the product operation as provided in these instructions.

### WARNING

**Electrical Shock Hazard.**

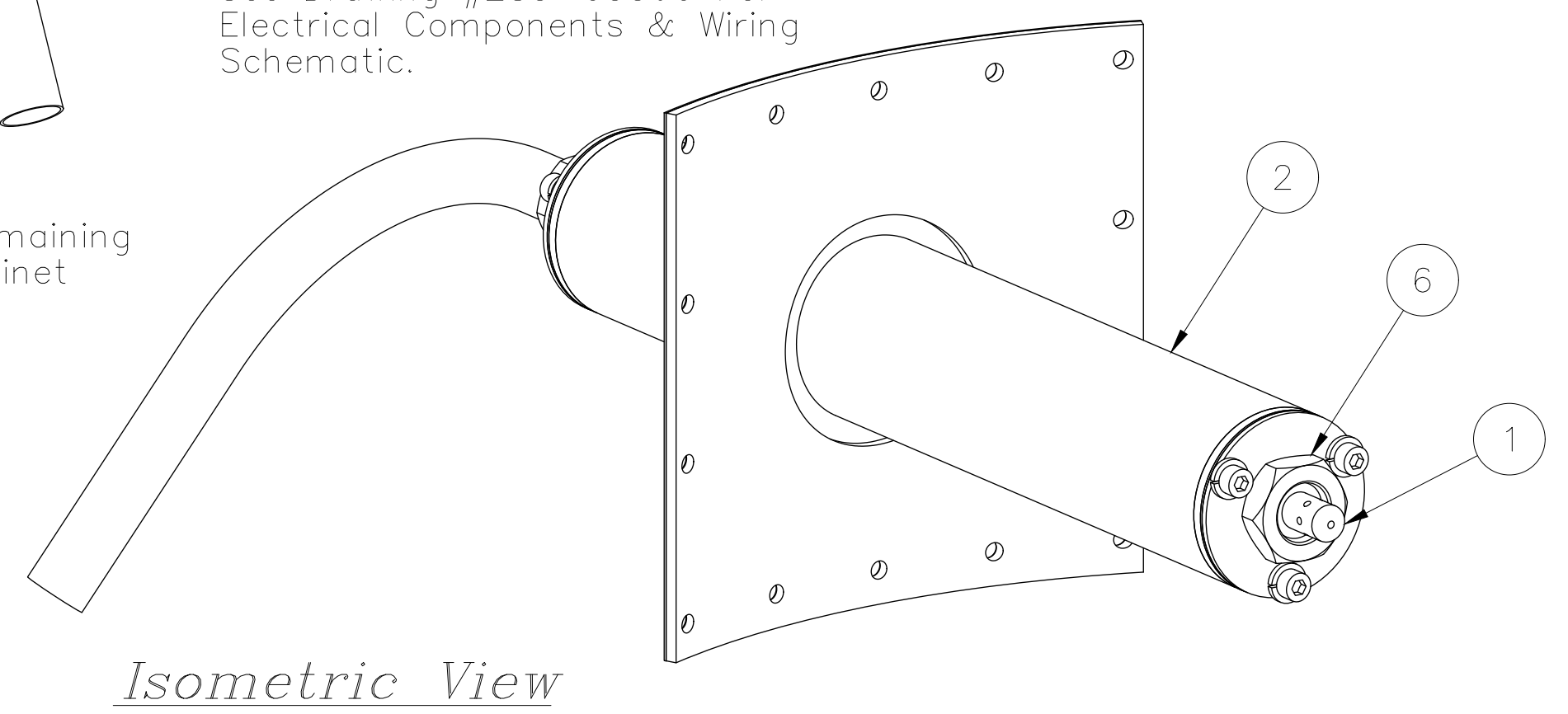
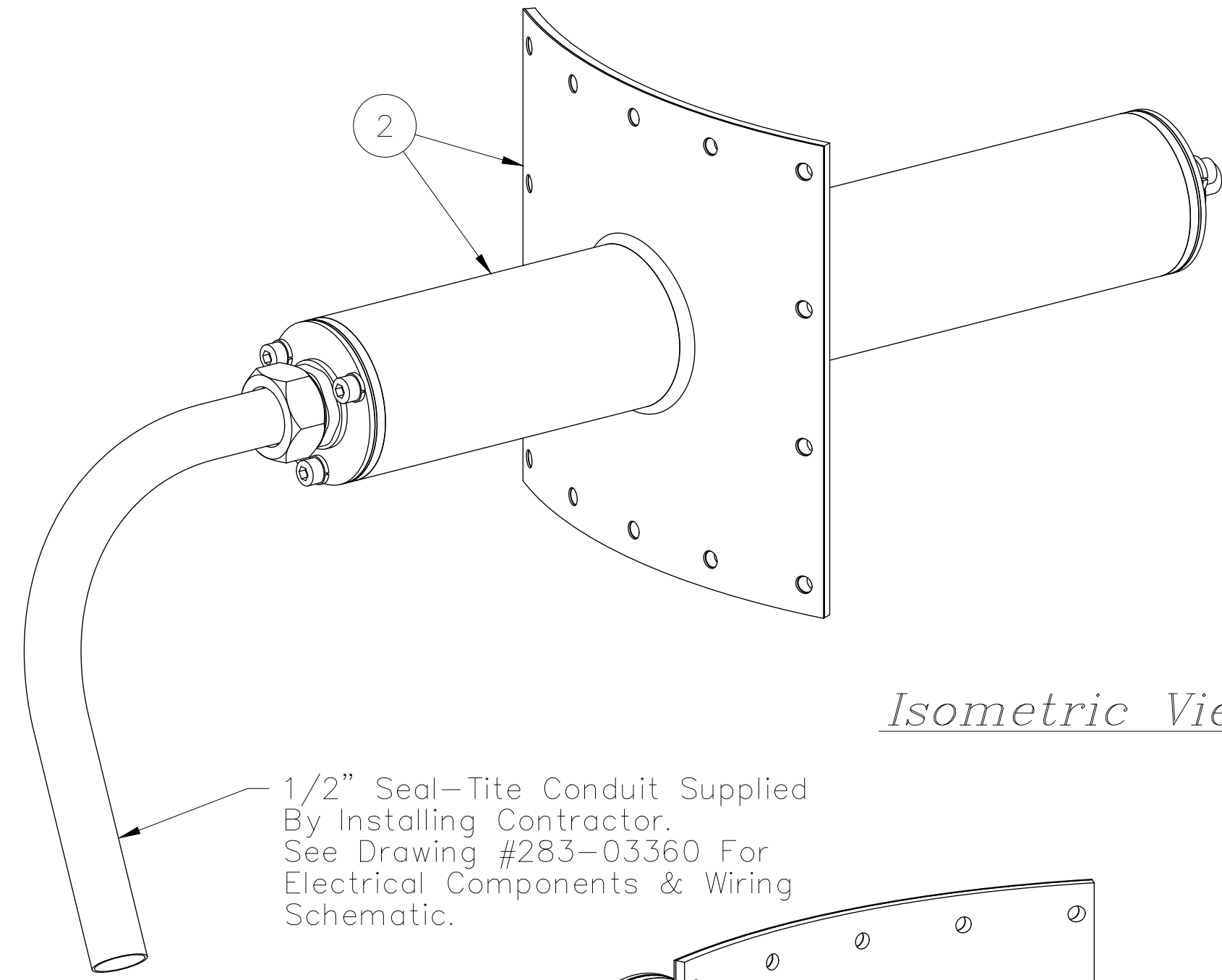
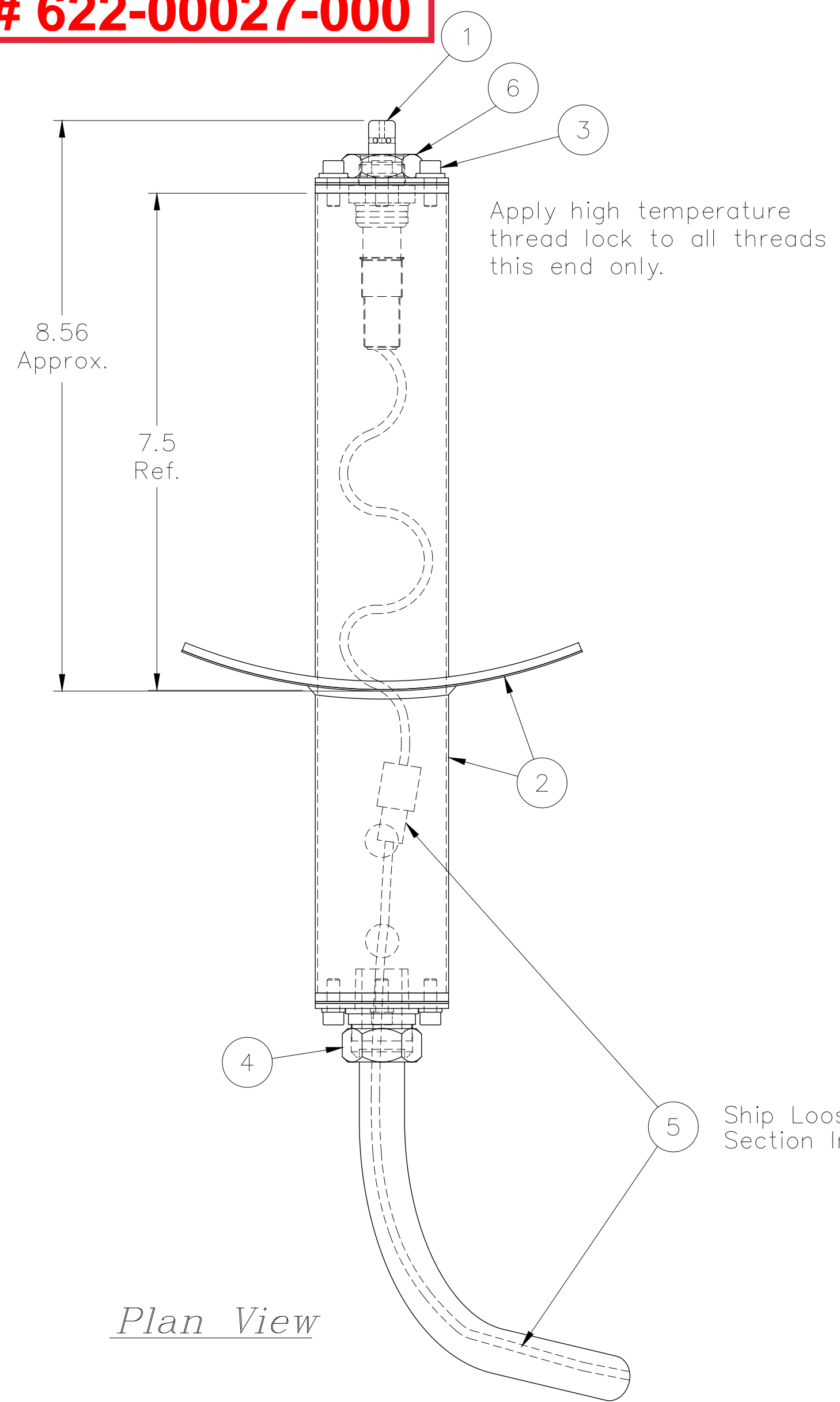
**Can cause severe injury, death or property damage.**

Disconnect the power supply before beginning installation to prevent electrical shock, equipment and control damage. More than one power supply disconnect may be involved.

### Wiring Information

1. Wiring connections for the CB780E/CB784E are unique; therefore, refer to Fig. 7–12 or the correct Specifications for proper subbase wiring.
2. Wiring must comply with all applicable codes, ordinances and regulations.
3. Wiring, where required, must comply with NEC Class 1 (Line Voltage) wiring.
4. Loads connected to the CB780E/CB784E must not exceed those listed on the CB780E/CB784E label or the Specifications, see Table 1.
5. Limits and interlocks must be rated to simultaneously carry and break current to the ignition transformer, pilot valve, and main fuel valve(s).
6. All external timers must be listed or component recognized by authorities who have jurisdiction for the specific purpose for which they are used.

**CB# 622-00027-000**



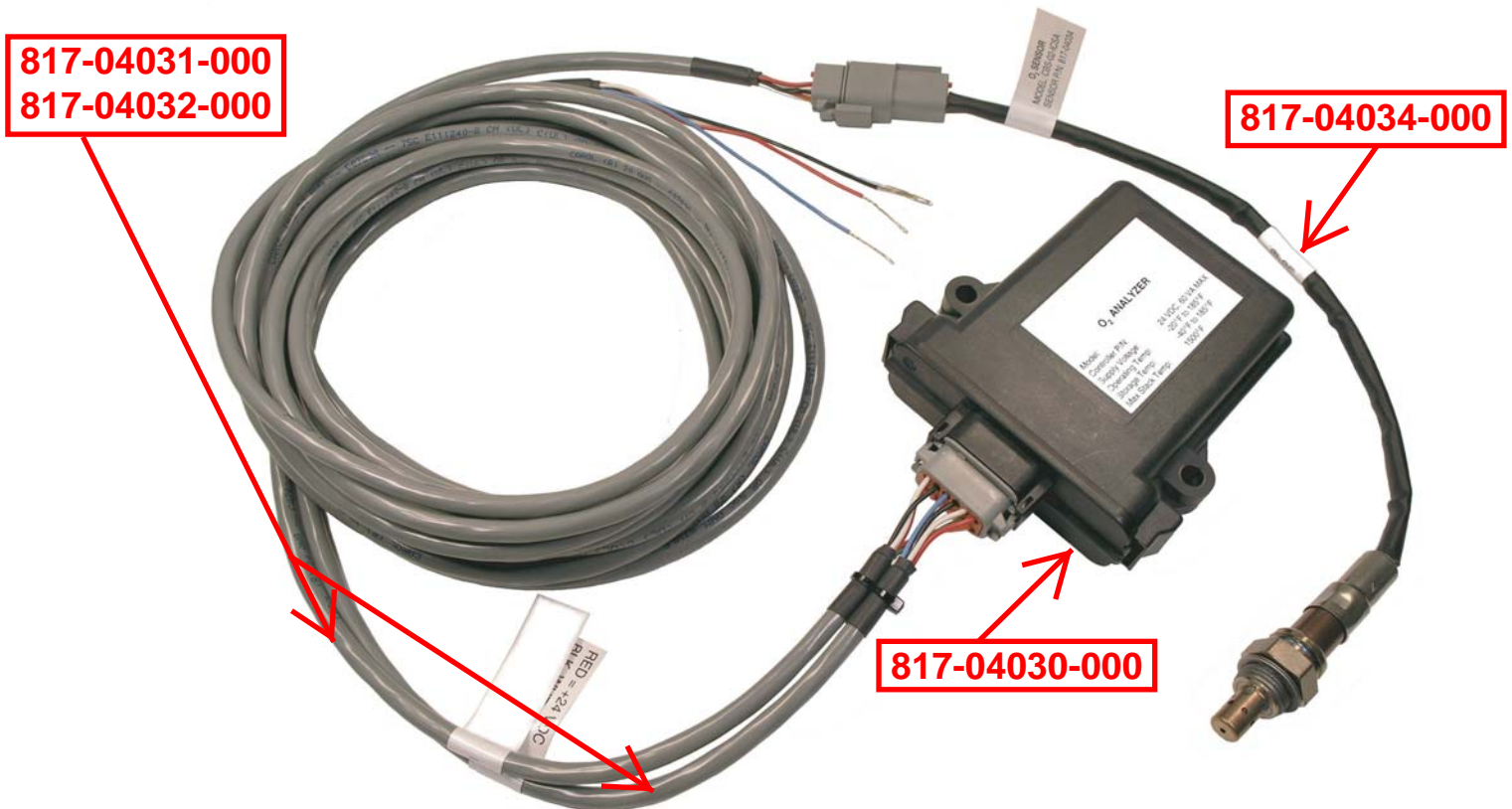
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E  
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B

**CB #'s 817-04030-000, 817-04031-000,  
817-04032-000, & 817-04034-000**

# **ECM XCU113 O<sub>2</sub> (Oxygen) Measurement System**



ECM's XCU113 is a ceramic sensor-based O<sub>2</sub> measurement system designed for combustion monitoring and control. Applications include combustion engines and industrial combustion processes such as furnaces. For example, the XCU113 can be used to monitor the O<sub>2</sub> in the exhaust of a natural gas furnace and be part of a closed-loop control system. Maintaining a target exhaust O<sub>2</sub> will help maximize thermal efficiency and minimize emissions over the furnace's life. The XCU113 consists of a sensor, cabling, and a control module. The sensor is mounted in the exhaust of the combustion device and via an electrochemical O<sub>2</sub> pumping process, determines the %O<sub>2</sub> in the exhaust. The response time of the sensor is less than 200 ms. The module controls the temperature of the O<sub>2</sub> sensor so as to eliminate any measurement dependency on exhaust gas temperature. In addition, the control module outputs a 0 to 8V signal that is linear with %O<sub>2</sub>. This signal can be fed to a data acquisition or control system. The XCU113 will operate over a wide voltage range with a modest current draw and the system is easily calibrated in ambient air.

## **Specifications**

Measurement Range: 0 to 25% O<sub>2</sub>  
Accuracy: 0.1% O<sub>2</sub>  
Fuels Allowed: Any hydrocarbon fuel  
Calibration: Expose sensor to air  
O<sub>2</sub> Sensor Mounting: 18mm x 1.5mm thread  
Maximum Exhaust Temperature: 850 °C

Module Voltage Output: 0 to 8V  
Module Output: Linear with %O<sub>2</sub>  
Module Size: 145mm x 120mm x 40mm  
Module Environment: -40 to 85 °C, IP67  
Cable to Sensor: 34'  
Cable to Power: 4'  
Power: 11 to 28V, 5A max

## ECM XCM113 Kit %O<sub>2</sub> Oxygen Measurement Kit

### 1. Safety Warnings:

- a. The sensor is heated and you can burn yourself by touching it.
- b. The sensor should not be used in an environment where an oxidizer and fuel exist because the sensor may ignite the mixture.

### 2. General:

The XCM113 is a ruggedized, environmentally sealed, general-purpose UEGO sensor controller providing %O<sub>2</sub> information. The measurement range is -5 to 25 %O<sub>2</sub>. The XCM113 is to be used with a XCM113-63 sensor and a XCM113-2 harness.

### 3. Output Voltage:

$$\%O_2 = ((V_{out} - 1)/(V_{cal} - 1)) \times \%O_{2cal} \quad [\text{Equation 1}]$$

where:

%O<sub>2</sub> = the measured oxygen concentration

V<sub>out</sub> = the measured output voltage (range: 0 to 8 V)

(measure between the blue and black wire on the power/signal harness)

V<sub>cal</sub> = the output voltage measured when the sensor is in calibration gas

%O<sub>2cal</sub> = the calibration gas oxygen concentration

Note:

Output voltage (V<sub>out</sub>) ground (i.e. signal ground) is internally tied to power ground. Connect harness directly to power ground or a voltage differential between output ground and power ground will result. Output voltage is to be referenced to power ground.

### 4. Calibration Procedure:

- a. With the controller powered and connected to the harness and the sensor, expose the sensor to a calibration gas. Ambient air often is a suitable calibration gas. Ambient air is 20.946% oxygen minus the oxygen displaced by humidity. Often an “average” value of 20.7 %O<sub>2</sub> is used for %O<sub>2cal</sub>.
- b. Two minutes after power-on, record the output voltage (V<sub>cal</sub>). It will be close to 5 volts. If it is below 4 volts or above 6 volts, the sensor is broken and needs to be replaced.
- c. %O<sub>2cal</sub> and V<sub>cal</sub> are used in Equation 1.

### 5. Using the XCM113:

Measure the output voltage  $V_{out}$  and calculate the  $\%O_2$  using Equation 1. If  $V_{out}$  is greater than 6 volts, the sensor is broken and needs to be replaced. In the case of a detected failure, the analog output of the XCM113 will be encoded with a “pulsed” trouble code that will describe the failure. See Diagnostics section, below.

### 6. Diagnostics:

<b>Failure Mode</b>	<b>Judgment Condition</b>	<b>Action After Failure Condition</b>		
		<b>Heater</b>	<b>Stop</b>	<b>Code</b>
Heater Open	-	Off	1	x1
Heater Shorted	-	Off	1	x2
Under or over Vbat	$V_{bat} < 11V$ or $V_{bat} > 28V$	Off	1	x3
Sensor Warmup or Vs too high	$V_{VS} > 3.7V$ ( $V_s > 1.7V$ )	On	1	x4

Codes: The codes represent the number of times the output voltage ( $V_{out}$ ) is pulled low.

For example:

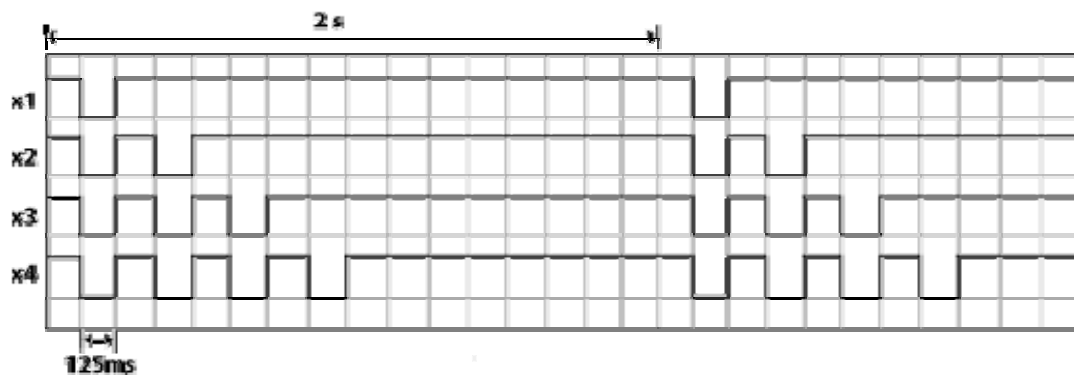
x1 – One 125ms pulse every 2 seconds

x2 – Two 125ms pulses every 2 seconds

x3 – Three 125ms pulses every 2 seconds

x4 – Four 125ms pulses every 2 seconds

See figure below for the code waveform diagram.



### 7. Operating Conditions:

Source Voltage: 11 to 28V, 5A maximum for 1 minute after start-up. 1.2 A steady-state.

Operating Temperature: -20°C to +85°C

Storage Temperature: -40°C to +85°C

Sensor thread: 18mm x 1.5mm.

Maximum gas temperature: 850 deg. C

Output Impedance: 1Kohm (0-8Vdc)

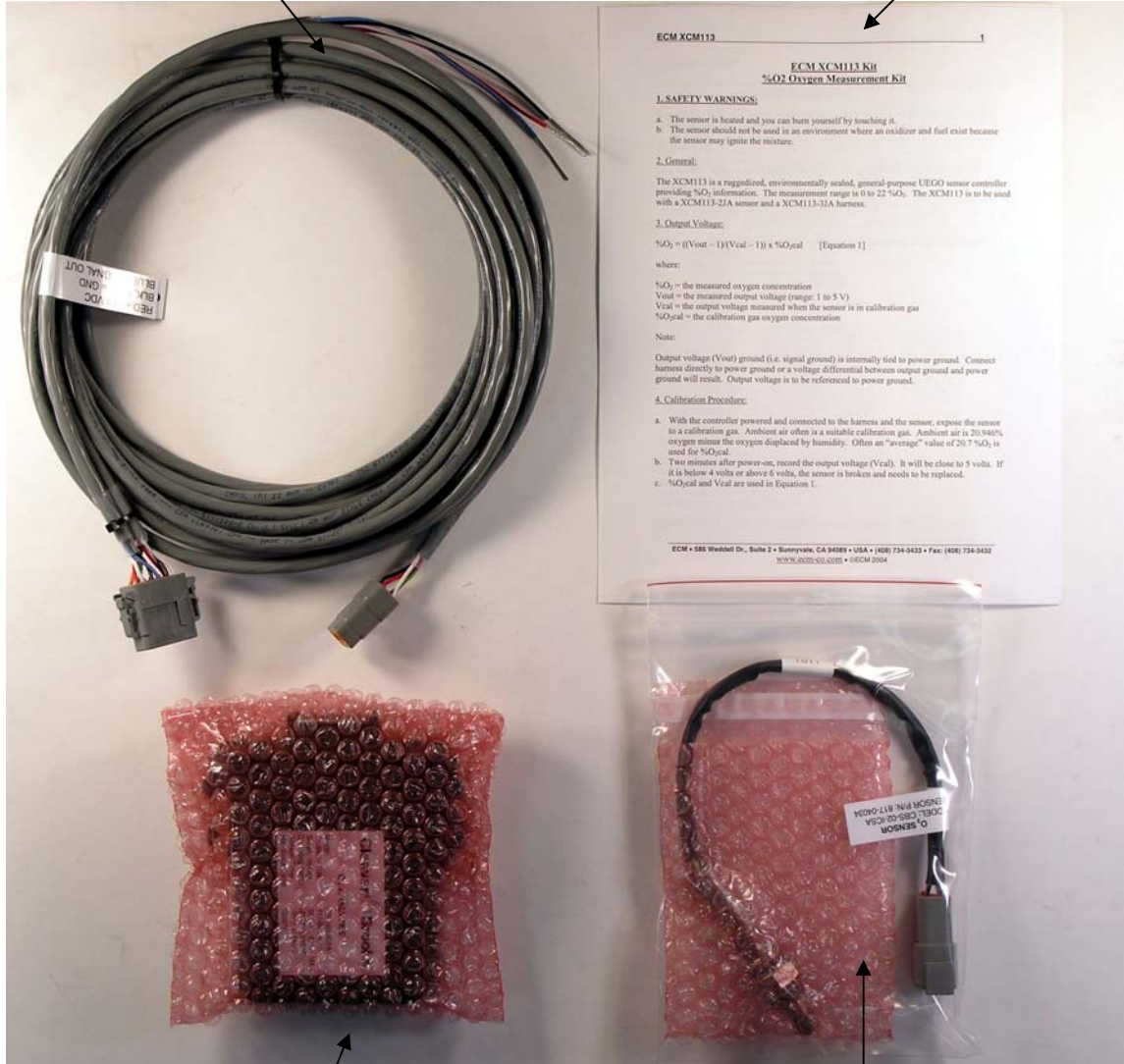
Document: ECM\_XCM113\_Manual.doc, Last revised: March 3, 2010



XCM113 Kit

Power (34')/signal (4') harness (p/n XCM113-2)

Dual sided XCM113 info sheet



XCM113 module  
(set switches 4 & 6)

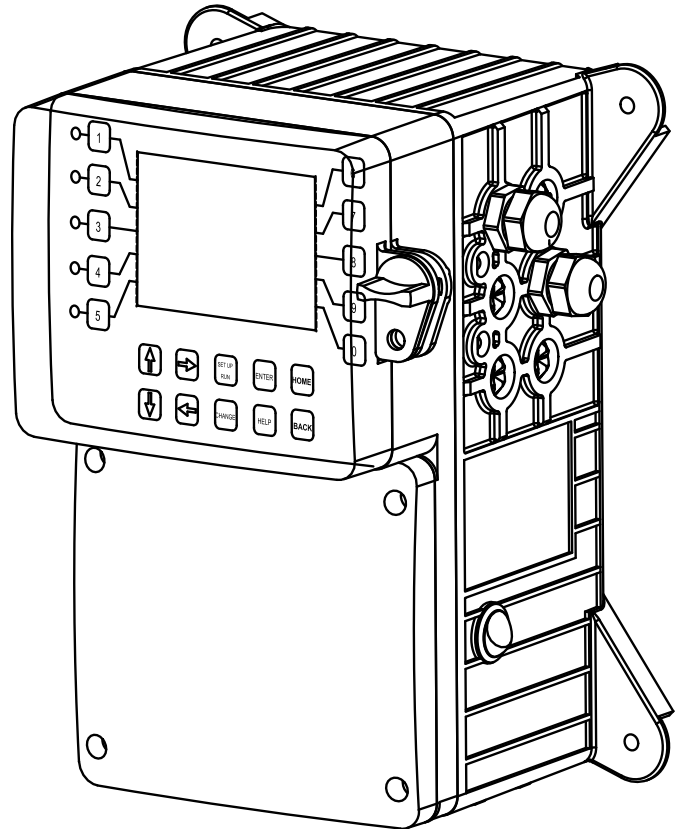
NTK UEGO (p/n XCM113-63)  
w/ 6pin deutsch connector



# MegaTron SS Controller

## Microprocessor Control of:

- Conductivity
- pH
- ORP
- Chemical Feed
- Biocide Feed
- Service Reports
- 4-20mA In & Outs



## Key Features

- Customizable LCD Display
- On Board History Graphs
- Simple ATM Style Menu
- One Point Calibration
- Internet Communications Option
- 5 Assignable Relays
- Relay Test Keys
- Customizable Notepad
- Multi-Level Security Code
- LSI or RSI Index Options
- 2 Year Replacement Warranty
- Email Alarm Capable
- MODbus and BACnet Options

## Application

The MegaTron SS controllers offer all of the user friendly features of the original MegaTron at a more economical price for single water treatment systems.

Units can be configured to control a wide range of digital and analog inputs. Relay activation and names plus many other features are field selectable. The "Notepad" allows the input and history gathering of service report parameters.

MegaTron SS units can control a single cooling tower or boiler system with the most customization flexibility available.

## Build a Model

The model number starts with SS followed by the code for each function needed for the first system. (SSCPF3E)

Once the main control functions have been selected, insert another - and list the desired common options. (SSCPF3-H1).

### Conductivity Control (1 per system max)

**B2** = BE-32 Standard Boiler probe  
**C** = TE-4A Standard Tower probe

### PH Control (1 per system max)

**P** = TPE-21 Standard Tower probe

### ORP Control (1 per system max)

**R** = TOE-21 Standard ORP probe

### Feed Timers (max of 5 per system)

**F1 to F5** (F4 = Four feed timers)

### Flow Switch

**E** = Flow Switch

### OPTIONS

**A** - Conduit connection  
**A3** - Conduit with CE approval  
**H1** - Internet Connect Communications  
**H4** - Internet card with phone modem  
**H5** - Internet card with cellular router  
**H11** - Internet card w/ CAT5 & Modbus TCP/IP  
**H21** - Internet card w/ CAT5 & BACNet TCP/IP  
**N3** - (3) 4-20mA Inputs (no option U3 if selected)  
**O3** - (3) 4-20mA Outputs  
**S** - pH saturation indexes (with pH control)  
**U3** - (3) 0-5 volt inputs (no option N3 if selected)  
**V** - 5 volt D.C. output with water meter wires  
**W3** - (3) Auxiliary flow meter inputs  
**Y** - Agency Approval (ETL, US&C)

### NOTES:

1. Timers selectable (pulse, %, post bleed, limit or 28-day). Each system has 2 water meter inputs.
2. All expansion slots provided.
3. MegaTron SS controllers can have 3 probes max.
4. MegaTron SS controllers have 5 relays max.
5. Contact the factory for a complete option list.

## Specifications

### Electrical

- **Input:** 95-240 VAC, 50/60 Hz
- **Control:** Equal to input voltage (95-240VAC) fused at 2.5A per relay

Prewired units are supplied with an 8' (248.84 cm) power cord and 8" (20.32 cm) output receptacles.

### Operational

- **Display:** 240 x 128 Graphic LCD
- **Conductivity Control:** 0-10,000  $\mu$ S/cm scale  
Boiler sample method is selectable from continuous, timed sampling or sample and hold.
- **pH:** 0-14 scale
- **ORP:** +/- 1000 millivolts scale  
The ORP setpoint can be tied to an optional 28-day feed timer as an override.
- **Accuracy:** +/- 1%
- **Feed Timers are all selectable from:**  
**Pulse** - water meter activated w/accumulator  
**Percent** - 1 - 100% of a cycle time.  
**Limit** - Limits feed with bleed  
**Post** - 1-100% of post bleed or other time with an over all limit.  
**28 Day** - biocide timer.

### Enclosure

Heavy duty NEMA 4X style high impact thermoplastic with padlockable gasketed Lexan viewing door.

### Environment

Ambient temperature: 0° to 125°F (-17 to 52°C)  
Relative humidity: 0 to 100%

### Electrodes

Tower Standard electrodes are supplied in 3/4" (1.91 cm) SCH 80 PVC female slip tees with quick release nut.

- **Conductivity:** TE-4A 150 psi (10.3 bar) / 140°F(58°C) Max
- **pH:** TPE-2 100 psi (6.8 bar) / 140°F(58°C) Max
- **ORP:** TOE-2 100 psi (6.8 bar) / 140°F(58°C) Max
- **Temperature:** TC-1 150 psi (10.3 bar) / 140°F (58°C) Max

Boiler Conductivity electrodes are supplied with 1" (2.54 cm) MNPT SS threads.

- **Conductivity:** BE-32 350 psi (24 bar) / 436°F(224°C) Max

**Shipping Weight:** Approximately 8 lbs. (3.62 kg)

### Dimensions:

W 10" (28.4 cm) x H 12" (30.5 cm) x D 7.25" (18.4 cm)

**Get the Advantage**



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Muskogee, OK 74403  
800-743-7431 phone  
888-686-6212 fax  
[www.advantagecontrols.com](http://www.advantagecontrols.com)



# PowerFlex 400 AC Drive

Providing users with easy installation and ideal for mechanical fan and pump systems, the PowerFlex 400 AC drive offers a wide range of built-in features allowing for seamless HVAC building system integration. The PowerFlex 400 is designed to meet global OEM, contractor and end-user demands for flexibility, space savings and ease-of-use.

Ratings	200...240V: 2.2...37 kW / 3...50 Hp / 12...145 A
	380...480V: 2.2...250 kW / 3...350 Hp / 6...460 A
Motor Control	V/Hz control
Communications	Integral RS 485, Common Industrial Protocol
User Interface	Integral programming keypad and local LED
Enclosures	IP20, IP30
Additional Features	PID/ PIP for fan and pump applications
Certifications	<ul style="list-style-type: none"> <li>• UL</li> <li>• IEC (Designed to Meet)</li> <li>• cUL</li> <li>• CE</li> <li>• C-Tick</li> <li>• UL508C Plenum Rating</li> </ul>
Options	See pages 24... 31
Additional Information	<a href="#">PowerFlex 400 Technical Data, publication 22C-TD001</a> <a href="#">PowerFlex 400 User Manual, publication 22C-UM001</a>

## 200...240V AC, Three-Phase Drives

Drive Ratings				Rating	Panel Mount	Flange Mount
kW	Hp	Output Current *	Frame Size		Cat. No.	Cat. No.
2.2	3	12	C	IP20, NEMA/UL Open Type †	22C-B012N103	22C-B012F103
3.7	5	17.5	C	IP20, NEMA/UL Open Type †	22C-B017N103	22C-B017F103
5.5	7.5	24	C	IP20, NEMA/UL Open Type †	22C-B024N103	22C-B024F103
7.5	10	33	C	IP20, NEMA/UL Open Type †	22C-B033N103	22C-B033F103
11	15	49	D	IP30, NEMA/UL Type 1	22C-B049A103	–
15	20	65	D	IP30, NEMA/UL Type 1	22C-B065A103	–
18.5	25	75	D	IP30, NEMA/UL Type 1	22C-B075A103	–
22	30	90	D	IP30, NEMA/UL Type 1	22C-B090A103	–
30	40	120	E	IP30, NEMA/UL Type 1	22C-B120A103	–
37	50	145	E	IP30, NEMA/UL Type 1	22C-B145A103	–

\* Drive terminals are sized according to UL. Depending on operating ambient and wire used, some local or national codes may require a larger wire size than what the power terminals can accept. Multiple conductors, 90°C wire, and/or lugs may be required. Refer to the PowerFlex 400 *User Manual* for details on terminal block wire ranges.

† IP30, NEMA/UL Type 1 can be achieved for panel mount drives with top cover and optional conduit box kit installed. Field installed conversion kit specified under User Installed Options.

### 380...480V AC, Three-Phase Drives

Drive Ratings				Rating	Panel Mount	Flange Mount
kW	Hp	Output Current *	Frame Size		Cat. No.	Cat. No.
		A				
2.2	3	6	C	IP20, NEMA/UL Open Type ‡	22C-D6P0N103	22C-D6P0F103
4	5	10.5	C	IP20, NEMA/UL Open Type ‡	22C-D010N103	22C-D010F103
5.5	7.5	12	C	IP20, NEMA/UL Open Type ‡	22C-D012N103	22C-D012F103
7.5	10	17	C	IP20, NEMA/UL Open Type ‡	22C-D017N103	22C-D017F103
11	15	22	C	IP20, NEMA/UL Open Type ‡	22C-D022N103	22C-D022F103 ‡
15	20	30	C	IP20, NEMA/UL Open Type ‡	22C-D030N103	22C-D030F103 ‡
18.5	25	38	D	IP30, NEMA/UL Type 1	22C-D038A103	–
22	30	45.5	D	IP30, NEMA/UL Type 1	22C-D045A103	–
30	40	60	D	IP30, NEMA/UL Type 1	22C-D060A103	–
37	50	72	E	IP30, NEMA/UL Type 1	22C-D072A103	–
45	60	88	E	IP30, NEMA/UL Type 1	22C-D088A103	–
55	75	105	E	IP30, NEMA/UL Type 1	22C-D105A103	–
75	100	142	E	IP30, NEMA/UL Type 1	22C-D142A103	–
90	125	170	F	IP30, NEMA/UL Type 1	22C-D170A103	–
110	150	208	F	IP30, NEMA/UL Type 1	22C-D208A103	–
132	200	260	G	IP30, NEMA/UL Type 1	22C-D260A103 §	–
160	250	310	G	IP30, NEMA/UL Type 1	22C-D310A103 §	–
200	300	370	H	IP30, NEMA/UL Type 1	22C-D370A103 §	–
250	350	460	H	IP30, NEMA/UL Type 1	22C-D460A103 §	–

\* Drive terminals are sized according to UL. Depending on operating ambient and wire used, some local or national codes may require a larger wire size than what the power terminals can accept. Multiple conductors, 90°C wire, and/or lugs may be required. Refer to the PowerFlex 400 *User Manual* for details on terminal block wire ranges.

‡ IP30, NEMA/UL Type 1 can be achieved for panel mount drives with top cover and optional conduit box kit installed. Field installed conversion kit specified under User Installed Options.

‡ 11 and 15 kW (15 and 20 Hp) Frame C flange mount drives require external DC series bus inductor.

§ 132...250 kW (200...350 Hp) have an integral AC bus choke.

# PowerFlex 4-Class Options

## Human Interface Modules and Accessories

Description	Cat. No.	Used with PowerFlex Drive				
		4M	4	40	40P	400
Remote (Panel Mount) LCD Display, Digital Speed Control, CopyCat Capable. IP66 (NEMA/UL Type 4X/12) Indoor Use Only. Includes 2.0 meter cable.	22-HIM-C2S §	✓	✓	✓	✓	✓
Remote Handheld, LCD Display, Full Numeric Keypad, Digital Speed Control, CopyCat Capable. IP30 (NEMA/UL Type 1). Includes 1.0 meter cable. Panel mount with optional Bezel Kit.	22-HIM-A3	✓	✓	✓	✓	✓
Remote Handheld, Wireless Interface Module with Bluetooth* Technology. IP30 (NEMA/UL Type 1). Panel Mount with optional Bezel Kit.	22-WIM-N1	✓	✓	✓	✓	✓
Remote (Panel Mount), Wireless Interface Module with Bluetooth Technology. IP66 (NEMA/UL Type 4X/12) Indoor Use Only.	22-WIM-N4S	✓	✓	✓	✓	✓
Bezel Kit. Panel Mount for LCD Display, Remote Handheld Unit. IP30 (NEMA/UL Type 1). Includes a 22-RJ45CBL-C20 cable.	22-HIM-B1	✓	✓	✓	✓	✓
DSI HIM Cable (DSI HIM to RJ45 cable)						
1.0 Meter (3.3 Feet) DSI HIM Cable (DSI HIM to RJ45 cable)	22-HIM-H10	✓	✓	✓	✓	✓
2.9 Meter (9.51 Feet) DSI HIM Cable (DSI HIM to RJ45 cable)	22-HIM-H30	✓	✓	✓	✓	✓

§ The 22-HIM-C2S is smaller than the 22-HIM-C2 and cannot be used as a direct replacement.

## Safety Options

Description	Cat. No.	Used with PowerFlex Drive				
		4M	4	40	40P	400
DriveGuard Safe Torque-Off	20A-DG01				✓	

## Other Options

Description	Cat. No.	Used with PowerFlex Drive				
		4M	4	40	40P	400
Auxiliary Relay Board - Expands drive output capabilities - Frames D-H only.	AK-U9-RLB1					✓

## Terminators

Description *	Cat. No.	Used with PowerFlex Drive				
		4M	4	40	40P	400
for use with 3.7 kW (5 Hp) & below drives	1204-TFA1	✓	✓	✓	✓	✓
for use with 1.5 kW (2 Hp) & up drives	1204-TFB2	✓	✓	✓	✓	✓

\* Refer to Appendix A of publication *DRIVES-IN001* for selection information.

## Reflected Wave Reduction Modules w/Common Mode Choke

Description *	Cat. No.	Used with PowerFlex Drive				
		4M	4	40	40P	400
17A with Common Mode Choke	1204-RWC-17-A	✓	✓	✓	✓	✓

\* Refer to Appendix A of publication *DRIVES-IN001* for selection information.

## Reflected Wave Reduction Modules

Voltage	ND kW	ND Hp	Cat. No.	Used with PowerFlex Drive				
				4M	4	40	40P	400
380... 480V AC	2.2...4	3...5	1321-RWR8-DP	✓	✓	✓	✓	✓
	4	5	1321-RWR12-DP	✓		✓	✓	✓
	5.5	7.5	1321-RWR18-DP	✓		✓	✓	✓
	7.5	10	1321-RWR25-DP	✓		✓	✓	✓
	11	15	1321-RWR25-DP	✓		✓	✓	✓
	15	20	1321-RWR35-DP					✓
	18.5	25	1321-RWR45-DP					✓
	22	30	1321-RWR55-DP					✓
	30	40	1321-RWR80-DP					✓
	37	50	1321-RWR80-DP					✓
	45	60	1321-RWR100-DP					✓
	55	75	1321-RWR130-DP					✓
	75	100	1321-RWR160-DP					✓
	90	125	1321-RWR200-DP					✓
	110	150	1321-RWR250-DP					✓
500... 600V AC	149	200	1321-RWR320-DP					✓
	187	250	1321-RWR320-DP					✓
	4	5	1321-RWR8-EP			✓	✓	
	5.5	7.5	1321-RWR12-EP			✓	✓	
	7.5	10	1321-RWR18-EP			✓	✓	
	11	15	1321-RWR25-EP			✓	✓	

## Communication Option Kits

Description	Cat. No.	Used with PowerFlex Drive				
		4M	4	40	40P	400
BACnet™ MS/TP RS485 Communication Adapter	22-COMM-B		✓ ‡	✓ ♣		✓
ControlNet™ Communication Adapter	22-COMM-C	✓ ‡	✓ ‡	✓ ♣	✓ ♣	✓
DeviceNet™ Communication Adapter	22-COMM-D	✓ ‡	✓ ‡	✓ ♣	✓ ♣	✓
EtherNet/IP™ Communication Adapter	22-COMM-E	✓ ‡	✓ ‡	✓ ♣	✓ ♣	✓
LonWorks® Communication Adapter	22-COMM-L		✓ ‡	✓ ♣	✓ ♣	✓
PROFIBUS™ DP Communication Adapter	22-COMM-P	✓ ‡	✓ ‡	✓ ♣	✓ ♣	✓
Serial Converter Module (RS485 to RS232). Provides serial communication via DF1 protocol for use with DriveExplorer and DriveExecutive™ software. Includes DSI to RS232 serial converter, 1203-SFC serial cable, 22-RJ45CBL-C20 cable, and DriveExplorer Lite CD.	22-SCM-232	✓	✓	✓	✓	✓
Serial Cable. 2.0 meter with a locking low profile connector. Connects the serial converter to a 9-pin sub-miniature D female computer connector.	1203-SFC	✓	✓	✓	✓	✓
Serial Null Modem Adapter. Use when connecting the serial converter to DriveExplorer on a handheld PC.	1203-SNM	✓	✓	✓	✓	✓
Universal Serial Bus™ (USB) Converter includes 2m USB, 20-HIM-H10 & 22-HIM-H10 Cables	1203-USB	✓	✓	✓	✓	✓
DSI Cable. 2.0 meter RJ45 to RJ45 cable, male to male connectors.	22-RJ45CBL-C20	✓	✓	✓	✓	✓
Splitter Cable. RJ45 one to two port splitter cable.	AK-U0-RJ45-SC1	✓	✓	✓	✓	✓
Terminal Block. RJ45 two position terminal block (6 pieces) with two 120 Ohm terminating resistors (loose).	AK-U0-RJ45-TB2P	✓	✓	✓	✓	✓
Terminating Resistors. 120 Ohm resistor embedded in an RJ45 connector (2 pieces).	AK-U0-RJ45-TR1	✓	✓	✓	✓	✓
DSI External Communications Kit. External mounting kit for 22-COMM Communication Adapters.	22-XCOMM-DC-BASE	✓	✓	✓	✓	✓
External Communications Kit Power Supply Optional 100...240V AC Power Supply for External DSI Communications Kit.	20-XCOMM-AC-PS1	✓	✓	✓	✓	✓
Compact I/O Module (3 Channel)	1769-SM2	✓	✓	✓	✓	✓
Serial Flash Firmware Kit Updates drive firmware via computer.	AK-U9-FLSH1					✓
Communication Adapter Cover Houses the Communication Adapter for B & C Frame drives. Note: Cover adds 25 mm (0.98 in.) to the overall depth of the drive.						
Frame B Drive	22B-CCB			✓ >		
Frame C Drive	22B-CCC			✓ >		
Frame C Drive	22C-CCC					✓ >
Frame B Drive	22D-CCB				✓ >	
Frame C Drive	22D-CCC				✓ >	

‡ PowerFlex 4 & 4M drives require External DSI Communication Kits. Communication Adapters cannot be drive mounted.

♣ Requires a Communication Adapter Cover when used with Frame B & C PowerFlex 40/40P drives or Frame C PowerFlex 400 drives.

> If IP30, NEMA/UL Type 1 is required, a 22-JBCB (Frame B drives) or 22-JBCC (Frame C drives) must also be ordered.

## IP30, NEMA/UL Type 1 Conversion Kit

Description	Frame	Cat. No.	Used with PowerFlex Drive				
			4M	4	40	40P	400
Converts IP20 drive to IP30, NEMA/UL Type 1 enclosure. Includes conduit box, mounting screws and plastic top panel.	A	22-JBAA		✓			
	B	22-JBAB		✓	✓	✓	
	C	22-JBAC			✓	✓	✓
Converts IP20 drive to IP30, NEMA/UL Type 1 enclosure. Includes communication option conduit box, mounting screws and plastic top panel.	B	22-JBCB			✓	✓	
	C	22-JBCC			✓	✓	✓

**Dynamic Brakes Resistors**

Voltage	Drive Rating		Minimum Resistance	Resistance ⌘	Cat. No. †	Used with PowerFlex Drive				
	kW	Hp	Ohms ±10%	Ohms ±5%		4M	4	40	40P	400
100...120V, 50/60 Hz, Single-Phase	0.2	0.25	48	91	AK-R2-091P500		✓			
	0.4	0.5	48	91	AK-R2-091P500		✓	✓		
	0.75	1	48	91	AK-R2-091P500		✓	✓		
	1.1	1.5	48	91	AK-R2-091P500			✓		
200...240V, 50/60 Hz, Single-Phase	0.2	0.25	48	91	AK-R2-091P500		✓			
	0.4	0.5	48	91	AK-R2-091P500		✓	✓		
	0.75	1	48	91	AK-R2-091P500		✓	✓		
	1.5	2	48	91	AK-R2-091P500		✓	✓		
200...240V, 50/60 Hz, Three-Phase	2.2	3	32	47	AK-R2-047P500			✓		
	0.2	0.25	48	91	AK-R2-091P500		✓			
	0.4	0.5	48	91	AK-R2-091P500		✓	✓	✓	
	0.75	1	48	91	AK-R2-091P500		✓	✓	✓	
	1.5	2	48	91	AK-R2-091P500		✓	✓	✓	
	2.2	3	32	47	AK-R2-047P500		✓	✓	✓	
	3.7	5	19	47	AK-R2-047P500		✓	✓	✓	
380...480V, 50/60 Hz, Three-Phase	5.5	7.5	13	30	AK-R2-030P1K2	✓		✓	✓	
	7.5	10	10	30	AK-R2-030P1K2	✓		✓	✓	
	0.4	0.5	97	360	AK-R2-360P500		✓	✓	✓	
	0.75	1	97	360	AK-R2-360P500		✓	✓	✓	
	1.5	2	97	360	AK-R2-360P500		✓	✓	✓	
	2.2	3	97	120	AK-R2-120P1K2		✓	✓	✓	
	4.0	5	77	120	AK-R2-120P1K2		✓	✓	✓	
500...600V, 50/60 Hz, Three-Phase	5.5	7.5	55	120	AK-R2-120P1K2	✓		✓	✓	
	7.5	10	39	120	AK-R2-120P1K2	✓		✓	✓	
	11	15	24	120	AK-R2-120P1K2 ❖	✓		✓	✓	
	0.75	1	120	360	AK-R2-360P500			✓	✓	
	1.5	2	120	360	AK-R2-360P500			✓	✓	
	2.2	3	82	120	AK-R2-120P1K2			✓	✓	
	4.0	5	82	120	AK-R2-120P1K2			✓	✓	
500...600V, 50/60 Hz, Three-Phase	5.5	7.5	51	120	AK-R2-120P1K2			✓	✓	
	7.5	10	51	120	AK-R2-120P1K2			✓	✓	
	11	15	51	120	AK-R2-120P1K2 ❖			✓	✓	

⌘ Verify resistor Ohms against minimum resistance for drive being used.

† Resistors listed are rated 5% duty cycle.

❖ Requires two resistors wired in parallel.

## Spare Parts

Description		Cat. No.	Used with PowerFlex Drive				
			4M	4	40	40P	400
Fan Replacement Kits	Fan Replacement Kit - Frame A	SK-U1-FAN1-A1		✓			
	Fan Replacement Kit - Frame B, 1 Fan	SK-U1-FAN1-B1		✓	✓	✓	
	Fan Replacement Kit - Frame B, 2 Fans	SK-U1-FAN2-B1		✓	✓	✓	
	Fan Replacement Kit - Frame A	SK-U1-FFAN1-A1	✓				
	Fan Replacement Kit - Frame B	SK-U1-FFAN1-B1	✓				
	Fan Replacement Kit - Frame C	SK-U1-FFAN1-C1	✓				
	Fan Replacement Kit - Frame C, 1 Fan	SK-U1-FAN1-C1			✓	✓	✓*
	Fan Replacement Kit - Frame C, 1 Fan, 15 Hp	SK-U1-FAN1-C2			✓	✓	✓⊛
	Fan Replacement Kit, NEMA 4X	SK-U1-FAN1-B4			✓		
	Fan Replacement Kit - Frame D, 2 Fans, B049...B090 & D038...D060 Ratings	SK-U1-FAN2-D1					✓
	Fan Replacement Kit - Frame E, 2 Fans, B120...B145 & D072...D142 Ratings	SK-U1-FAN2-E2					✓
	Fan Replacement Kit - Frame F, 2 Fans, IGBT, D170 & D208 Ratings	SK-U1-FAN2-F1					✓
	Fan Replacement Kit - Frame F, 1 Fan, Rectifier, D170 & D208 Ratings	SK-U1-FAN1-F2					✓
	Fan Replacement Kit - Frame F, 1 Fan, Choke, D170 & D208 Ratings	SK-U1-FAN1-F3					✓
	Fan Replacement Kit - Frame G, 1 Fan (Side), D260 & D310 Ratings	SK-U1-FAN1-G1					✓
	Fan Replacement Kit - Frame G, 2 Fans (Top), D260 & D310 Ratings	SK-U1-FAN1-G2					✓
	Fan Replacement Kit - Frame G, 4 Fans (Bottom), D260 & D310 Ratings	SK-U1-FAN4-G3					✓
	Fan Replacement Kit - Frame H, 1 Fan (Upper Side), D370 & D460 Ratings	SK-U1-FAN1-H1					✓
	Fan Replacement Kit - Frame H, 1 Fan (Middle Side), D370 & D460 Ratings	SK-U1-FAN1-H2					✓
	Fan Replacement Kit - Frame H, 4 Fans (Bottom), D370 & D460 Ratings	SK-U1-FAN4-H3					✓
Covers	Encoder Terminal Cover (All Frames)	SK-U1-DCVR4-EN				✓	
	Frame A Cover with Power Terminal Guard	SK-U1-ACVR1-A1		✓			
	Frame B Cover with Power Terminal Guard	SK-U1-ACVR1-B1		✓			
	Frame A Cover	SK-U1-FCVR1-A1	✓				
	Frame B Cover	SK-U1-FCVR1-B1	✓				
	Frame C Cover	SK-U1-FCVR1-C1	✓				
	Frame B Cover with Power Terminal Guard	SK-U1-BCVR1-B1			✓		
	Frame C Cover with Power Terminal Guard	SK-U1-BCVR1-C1			✓		
	Frame B Cover, NEMA 4X	SK-U1-BCVR1-B4			✓		
	Frame B Cover with Power Terminal Guard	SK-U1-DCVR3-B1					✓
	Frame C Cover with Power Terminal Guard	SK-U1-DCVR3-C1					✓
	Frame C Cover with Power Terminal Guard	SK-U1-CCVR1-C1					✓
	Frame D Cover	SK-U1-CCVR1-D1					✓
	Frame E Cover	SK-U1-CCVR1-E1					✓
	Frame F Cover	SK-U1-CCVR1-F1					✓
	Frame G Cover	SK-U1-CCVR1-G1					✓
	Frame H Cover	SK-U1-CCVR1-H1					✓
	NEMA 4X Replacement Conduit Plugs	SK-U1-PLUGS-B4			✓		

\* 3...10 HP @ 200...240V AC and 3...10 HP @ 380...480V AC

⊛ 15...20 HP @ 380...480V AC



**EMC Filters (Required to Meet CE Certification)**

Drive Ratings			PowerFlex 4M		PowerFlex 4		PowerFlex 40/40P		PowerFlex 400
Input Voltage	kW	Hp	S Type Filter	L Type Filter	S Type Filter	L Type Filter	S Type Filter	L Type Filter	IP00 (NEMA/UL Type Open)
			Cat. No. *	Cat. No. ‡	Cat. No. *	Cat. No. ‡	Cat. No. *	Cat. No. ‡	Cat. No. *
100...120V, 50/60 Hz, Single-Phase	0.2	0.25	-	22F-RF010-AL	-	22-RF010-AL	-	-	-
	0.4	0.5	-	22F-RF010-AL	-	22-RF010-AL	-	22-RF018-BL ♣	-
	0.75	1	-	22F-RF025-BL	-	22-RF018-BL	-	22-RF018-BL ♣	-
	1.1	1.5	-	22F-RF025-BL	-	22-RF025-CL §	-	22-RF018-BL ♣	-
200...240V, 50/60 Hz, Single-Phase	0.2	0.25	⊗	22F-RF010-AL	⊗	22-RF010-AL	-	-	-
	0.4	0.5	⊗	22F-RF010-AL	⊗	22-RF010-AL	⊗	22-RF018-BL ♣	-
	0.75	1	⊗	22F-RF010-AL	⊗	22-RF010-AL	⊗	22-RF018-BL ♣	-
	1.5	2	⊗	22F-RF025-BL	⊗	22-RF018-BL	⊗	22-RF018-BL ♣	-
200...240V, 50/60 Hz, Single-Phase, NO BRAKE	0.2	0.25	-	-	⊗	22-RF010-AL	-	-	-
	0.4	0.5	-	-	⊗	22-RF010-AL	-	-	-
	0.75	1	-	-	⊗	22-RF010-AL	-	-	-
	1.5	2	-	-	⊗	22-RF018-BL	-	-	-
200...240V, 50/60 Hz, Three-Phase	2.2	3	-	-	⊗	22-RF025-CL §	-	-	-
	0.2	0.25	22F-RF9P5-AS	22F-RF9P5-AL	22-RF9P5-AS	22-RF9P5-AL	-	-	-
	0.4	0.5	22F-RF9P5-AS	22F-RF9P5-AL	22-RF9P5-AS	22-RF9P5-AL	22-RF021-BS >	22-RF021-BL	-
	0.75	1	22F-RF9P5-AS	22F-RF9P5-AL	22-RF9P5-AS	22-RF9P5-AL	22-RF021-BS >	22-RF021-BL	-
	1.5	2	22F-RF9P5-AS	22F-RF9P5-AL	22-RF9P5-AS	22-RF9P5-AL	22-RF021-BS >	22-RF021-BL	-
	2.2	3	22F-RF021-BS	22F-RF021-BL	22-RF021-BS	22-RF021-BL	22-RF021-BS >	22-RF021-BL	22-RF034-CS
	3.7	5	22F-RF021-BS	22F-RF021-BL	22-RF021-BS	22-RF021-BL	22-RF021-BS >	22-RF021-BL	22-RF034-CS
	5.5	7.5	22F-RF039-CS	22F-RF039-CL	-	-	22-RF034-CS	22-RF034-CL	22-RF034-CS
	7.5	10	22F-RF039-CS	22F-RF039-CL	-	-	22-RF034-CS	22-RF034-CL	22-RF034-CS
	11	15	-	-	-	-	-	-	22-RFD070
	15	20	-	-	-	-	-	-	22-RFD100
	18.5	25	-	-	-	-	-	-	22-RFD100
	22	30	-	-	-	-	-	-	22-RFD150
	30	40	-	-	-	-	-	-	22-RFD150
37	50	-	-	-	-	-	-	22-RFD180	
380...480V, 50/60 Hz, Three-Phase	0.4	0.5	22F-RF6P0-AS	22F-RF6P0-AL	22-RF5P7-AS	22-RF5P7-AL	22-RF012-BS	22-RF012-BL	-
	0.75	1	22F-RF6P0-AS	22F-RF6P0-AL	22-RF5P7-AS	22-RF5P7-AL	22-RF012-BS	22-RF012-BL	-
	1.5	2	22F-RF6P0-AS	22F-RF6P0-AL	22-RF5P7-AS	22-RF5P7-AL	22-RF012-BS	22-RF012-BL	-
	2.2	3	22F-RF012-BS	22F-RF012-BL	22-RF012-BS	22-RF012-BL	22-RF012-BS	22-RF012-BL	22-RF018-CS
	3.7	5	22F-RF012-BS	22F-RF012-BL	22-RF012-BS	22-RF012-BL	22-RF012-BS	22-RF012-BL	22-RF018-CS
	5.5	7.5	22F-RF026-CS	22F-RF026-CL	-	-	22-RF018-CS	22-RF018-CL	22-RF018-CS
	7.5	10	22F-RF026-CS	22F-RF026-CL	-	-	22-RF018-CS	22-RF018-CL	22-RF018-CS
	11	15	22F-RF026-CS	22F-RF026-CL	-	-	22-RF026-CS	22-RF026-CL	22-RF026-CS
	15	20	-	-	-	-	-	-	22-RFD036
	18.5	25	-	-	-	-	-	-	22-RFD050
	22	30	-	-	-	-	-	-	22-RFD050
	30	40	-	-	-	-	-	-	22-RFD070
	37	50	-	-	-	-	-	-	22-RFD100
	45	60	-	-	-	-	-	-	22-RFD100
	55	75	-	-	-	-	-	-	22-RFD150
	75	100	-	-	-	-	-	-	22-RFD180
	90	125	-	-	-	-	-	-	22-RFD208
	110	150	-	-	-	-	-	-	22-RFD208
	132	200	-	-	-	-	-	-	22-RFD323
160	250	-	-	-	-	-	-	22-RFD480	
200	300	-	-	-	-	-	-	22-RFD480	
250	350	-	-	-	-	-	-	22-RFD480	

Continued on next page

## EMC Filters (continued)

Drive Ratings			PowerFlex 4M		PowerFlex 4		PowerFlex 40/40P		PowerFlex 400
Input Voltage	kW	Hp	S Type Filter	L Type Filter	S Type Filter	L Type Filter	S Type Filter	L Type Filter	IP00 (NEMA/UL Type Open)
			Cat. No. *	Cat. No. ‡	Cat. No. *	Cat. No. ‡	Cat. No. *	Cat. No. ‡	Cat. No. *
500...600V, 50/60 Hz, Three-Phase	0.75	1	-	-	-	-	-	22-RF8P0-BL	-
	1.5	2	-	-	-	-	-	22-RF8P0-BL	-
	2.2	3	-	-	-	-	-	22-RF8P0-BL	-
	4.0	5	-	-	-	-	-	22-RF8P0-BL	-
	5.5	7.5	-	-	-	-	-	22-RF015-CL	-
	7.5	10	-	-	-	-	-	22-RF015-CL	-
	11	15	-	-	-	-	-	22-RF024-CL	-

\* This filter is suitable for use with a cable length of up to 10 meters for Class A and 1 meter for Class B environments.

⊗ Drives are available in these ratings with internal "S Type" filters.

‡ This filter is suitable for use with a cable length of up to 100 meters for Class A and 5 meters for Class B environments.

§ The piggyback mounting option cannot be used with Frame B PowerFlex 4 drives and Frame C EMC Line Filters.

♣ PowerFlex 40 Only.

➤ Filter must be Series B or later.

## DC Series Bus Inductors

Voltage	Drive Rating			Inductance	Cat. No.	Used with PowerFlex Drive				
	kW	Hp	Amps	mH		4M	4	40	40P	400
200...240V, 50/60 Hz, Three-Phase	2.2	3	12	1.00	1321-DC12-1					✓
	3.7	5	17.5	0.65	1321-DC18-1					✓
	5.5	7.5	32	0.85	1321-DC32-1			✓		✓
	7.5	10	40	0.75	1321-DC40-2			✓		✓
400...480V, 50/60 Hz, Three-Phase	2.2	3	6	2	1321-DC9-2					✓
	4.0	5	10.5	2.1	1321-DC12-2					✓
	5.5	7.5	18	3.75	1321-DC18-4			✓		✓
	7.5	10	25	1.28	1321-DC25-4			✓		✓
	11	15	32	2.68	1321-DC32-3			✓		✓
500...600V, 50/60 Hz, Three-Phase	15	20	30	2.5	1321-DC40-4					✓
	5.5	7.5	12	2.1	1321-DC12-2_600			✓		
	7.5	10	18	3.75	1321-DC18-4			✓		
	11	15	25	1.28	1321-DC25-4			✓		

**Isolation Transformers for PowerFlex 400 - IP32, NEMA/UL Type 3R Standalone, 4...6% Nominal Impedance**

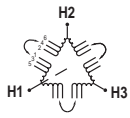


Diagram 1

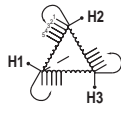


Diagram 2

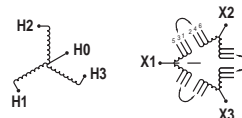


Diagram 3  
230V Primary, 460V Secondary Only

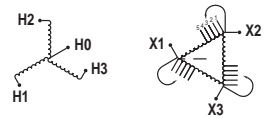


Diagram 4  
230V Primary, 460V Secondary Only

Rating		Wiring Diagram	208V, 60 Hz, Three-Phase Secondary	230V, 60 Hz, Three-Phase Secondary				460V, 60 Hz, Three-Phase Secondary		
			208V Primary	230V Primary	460V Primary	575V Primary	230V Primary	460V Primary	575V Primary	
kW	Hp		Cat. No.	Cat. No.	Cat. No.	Cat. No.	Cat. No.	Cat. No.	Cat. No.	
2.2	3.0	1/3	1321-3TW005-XX	1321-3TW005-AA	1321-3TW005-BA	1321-3TW005-CA	1321-3TW005-AB	1321-3TW005-BB	1321-3TW005-CB	
4.0	5.0	1/3	1321-3TW007-XX	1321-3TW007-AA	1321-3TW007-BA	1321-3TW007-CA	1321-3TW007-AB	1321-3TW007-BB	1321-3TW007-CB	
5.5	7.5	1/3	1321-3TW011-XX	1321-3TW011-AA	1321-3TW011-BA	1321-3TW011-CA	1321-3TW011-AB	1321-3TW011-BB	1321-3TW011-CB	
7.5	10	1/3	1321-3TW014-XX	1321-3TW014-AA	1321-3TW014-BA	1321-3TW014-CA	1321-3TW014-AB	1321-3TW014-BB	1321-3TW014-CB	
11	15	2/4	1321-3TW020-XX	1321-3TW020-AA	1321-3TW020-BA	1321-3TW020-CA	1321-3TW020-AB	1321-3TW020-BB	1321-3TW020-CB	
15	20	2/4	1321-3TW027-XX	1321-3TW027-AA	1321-3TW027-BA	1321-3TW027-CA	1321-3TW027-AB	1321-3TW027-BB	1321-3TW027-CB	
18.5	25	2/4	1321-3TW034-XX	1321-3TW034-AA	1321-3TW034-BA	1321-3TW034-CA	1321-3TW034-AB	1321-3TW034-BB	1321-3TW034-CB	
22	30	2/4	-	1321-3TW040-AA	1321-3TW040-BA	1321-3TW040-CA	1321-3TW040-AB	1321-3TW040-BB	1321-3TW040-CB	
30	40	2/4	-	1321-3TW051-AA	1321-3TW051-BA	1321-3TW051-CA	1321-3TW051-AB	1321-3TW051-BB	1321-3TW051-CB	
37	50	2/4	-	1321-3TH063-AA	1321-3TH063-BA	-	1321-3TH063-AB	1321-3TH063-BB	-	
45	60	2/4	-	-	-	-	1321-3TH075-AB	1321-3TH075-BB	-	
55	75	2/4	-	-	-	-	1321-3TH093-AB	1321-3TH093-BB	-	
75	100	2/4	-	-	-	-	1321-3TH118-AB	1321-3TH118-BB	-	
90	125	2/4	-	-	-	-	1321-3TH145-AB	1321-3TH145-BB	-	
110	150	2/4	-	-	-	-	1321-3TH175-AB	1321-3TH175-BB	-	
132	200	2/4	-	-	-	-	1321-3TH220-AB	1321-3TH220-BB	-	
160	250	2/4	-	-	-	-	1321-3TH275-AB	1321-3TH275-BB	-	
200	300	2/4	-	-	-	-	1321-3TH330-AB	1321-3TH330-BB	-	
250	350	2/4	-	-	-	-	1321-3TH440-AB	1321-3TH440-BB	-	

## Input & Output Line Reactors - 3% Impedance

Voltage	Drive Ratings			IP00 * (NEMA/UL Open Type)	IP11 * (NEMA/UL Type 1)	Used with PowerFlex Drive				
	kW	Hp	Amps	Cat. No.	Cat. No.	4M	4	40	40P	400
200...240V, 60 Hz, Three-Phase	0.2	0.25	2.0	1321-3R2-A	-	✓	✓			
	0.4	0.5	4.0	1321-3R4-B	-	✓	✓	✓	✓	
	0.75	1	8.0	1321-3R8-B	-	✓	✓	✓	✓	
	1.5	2	8.0	1321-3R8-A	-	✓	✓	✓	✓	
	2.2	3	12	1321-3R12-A	1321-3RA12-A	✓	✓	✓	✓	✓
	3.7	5	17.5	1321-3R18-A	1321-3RA18-A	✓	✓	✓	✓	✓
	5.5	7.5	24	1321-3R25-A	1321-3RA25-A	✓		✓	✓	✓
	7.5	10	33	1321-3R35-A	1321-3RA35-A	✓		✓	✓	✓
	11	15	49	1321-3R45-A	1321-3RA45-A					✓
	15	20	65	1321-3R55-A	1321-3RA55-A					✓
	18.5	25	75	1321-3R80-A	1321-3RA80-A					✓
	22	30	90	1321-3R80-A	1321-3RA80-A					✓
	30	40	120	1321-3R100-A	1321-3RA100-A					✓
37	50	145	1321-3R130-A	1321-3RA130-A					✓	
380...480V, 60 Hz, Three-Phase	0.4	0.5	2.0	1321-3R2-B	-	✓	✓	✓	✓	
	0.75	1	4.0	1321-3R4-C	-	✓	✓	✓	✓	
	1.5	2	4.0	1321-3R4-B	-	✓	✓	✓	✓	
	2.2	3	6.0	1321-3R8-C	1321-3RA8-C	✓	✓	✓	✓	✓
	4.0	5	10.5	1321-3R8-B	1321-3RA8-B	✓	✓	✓	✓	✓
	5.5	7.5	12	1321-3R12-B	1321-3RA12-B	✓		✓	✓	✓
	7.5	10	17	1321-3R18-B	1321-3RA18-B	✓		✓	✓	✓
	11	15	22	1321-3R25-B	1321-3RA25-B	✓		✓	✓	✓
	15	20	30	1321-3R35-B	1321-3RA35-B					✓
	18.5	25	38	1321-3R35-B	1321-3RA35-B					✓
	22	30	45.5	1321-3R45-B	1321-3RA45-B					✓
	30	40	60	1321-3R55-B	1321-3RA55-B					✓
	37	50	72	1321-3R80-B	1321-3RA80-B					✓
	45	60	88	1321-3R80-B	1321-3RA80-B					✓
	55	75	105	1321-3R100-B	1321-3RA100-B					✓
	75	100	142	1321-3R130-B	1321-3RA130-B					✓
90	125	170	1321-3R160-B	1321-3RA160-B					✓	
110	150	208	1321-3R200-B	1321-3RA200-B					✓	
500...600V, 60 Hz, Three-Phase	0.75	1	2.0	1321-3R2-B	-			✓	✓	
	1.5	2	4.0	1321-3R4-C	-			✓	✓	
	2.2	3	4.0	1321-3R4-B	-			✓	✓	
	4.0	5	8.0	1321-3R8-C	-			✓	✓	
	5.5	7.5	12	1321-3R12-B	-			✓	✓	
	7.5	10	12	1321-3R12-B	-			✓	✓	
	11	15	18	1321-3R18-B	-			✓	✓	

\* Catalog numbers listed are for 3% impedance. 5% impedance reactor types are also available. Refer to publication 1321-TD001....

# Model CBJT

## Package Firetube Boiler

## Standard Warranty

### **Pressure Vessel:**

Cleaver-Brooks, Inc. (the Company) warrants that at the time of shipment the pressure vessel, limited to tube sheets, furnace, and rear turnaround of the Model identified below will be free from defects in materials, design and workmanship for a period of one (1) year from the date of shipment.

**The foregoing is in lieu of all other warranties, oral or express or implied, including any warranties that extend beyond the description of the equipment or the parts or the services. There are no express warranties other than those stated herein, and to the extent permitted by law, there are no implied warranties of marketability or fitness for a particular purpose.** The provisions of the warranty as to duration, warranty adjustment and limitation of liability shall be the same for both implied warranties (if any) and express warranties.

This pressure vessel warranty is solely as stated above and does not apply (a) when alterations or repairs are provided by persons not expressly approved by the Company; or (b) the materials used are not of the Company's specification or manufacture; or (c) abuse or misuse of the equipment is evident, including boilers subjected to thermal shock conditions; or (d) insulative or corrosive substances such as scale and improper chemical balance are involved and/or witnessed; or (e) if the unit identified below is not inspected annually by an authorized Company representative (which such annual inspection shall be at prevailing rates); or (f) it does not apply to the welded attachment at the entrance of the second pass tubes.

### **Efficiency:**

CBJT boilers are guaranteed to meet efficiencies subject to specified operating conditions as published by the Company.

The Company shall guarantee that, at the time of startup, the boiler will achieve stated fuel-to-steam efficiency at 100% firing rate (and additionally at 25%, 50%, and 75% of rating, if required). If the boiler(s) fail to achieve the corresponding guaranteed efficiency as published, the boiler manufacturer will rebate, to the ultimate boiler owner, ten thousand dollars (\$10,000) for every full efficiency point (1.0%) that the actual efficiency is below the guaranteed level.

The specified boiler efficiency is based on fuel specifications, ambient conditions, excess air, and radiation/convection losses. See job specific efficiency guarantee document for more details.

### **Burner:**

The CBJT jet burner carries a 1-year reliability warranty for all major components.



**Warranty Adjustments:**

Owner must make claim of any breach of this Warranty by written notice to the Company's home office within thirty (30) days of discovering any defect. The Company agrees, as its sole option, to repair or replace, but not install, such parts or pressure vessel components as it deems necessary ("Warranty Adjustment"). Any Warranty Adjustment(s) made by the Company shall not extend the warranty period(s) set forth above.

The above Warranty Adjustment sets forth buyer's exclusive remedy and the extent of the Company's liability for breach of implied (if any) and express warranties, representations, instructions or defects from any cause in connection with the sale or use of equipment. **The company shall not be liable for any special, indirect or consequential damages or for loss, damage or expense, directly or indirectly arising from the use of the equipment or from any other cause whether based on warranty (expressed or implied) or tort or contract, and regardless of any advice or recommendations that may have been rendered concerning the purchase, installation or use of the equipment.**

Model No. \_\_\_\_\_

Unit No. \_\_\_\_\_

Representative Organization \_\_\_\_\_

Sales Engineer \_\_\_\_\_

Date of Shipment \_\_\_\_\_

