



Manufacturers of High Temperature & High Vacuum Equipment

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Specification Sheet

Equipment Model:
J-VAC-1600
High Vacuum Furnace

Type	Turbo Pumped High Vacuum and Partial Pressure
Chamber	Stainless Steel Coldwall, Electric Hoist Operated
Maximum Temperature	1600° C.
Maximum Ramp Rate	75° C per minute
Hot Zone	18" (45 cm) Dia. x 30" (76 cm) H. Nominal
Heating Element Type	0.125" Molybdenum Wire, Electric Resistive
Machine Dimensions (Closed)	75" (191 cm) W. x 34" (87 cm) D. x 88" (224 cm) H.
Power Requirements	480V 3 Ph. 120A 60 Hz - 240V 3 Ph. 240A 60 Hz. 380/400/415V 3 Ph. 150A 50 Hz.
Gas Requirements	VENT: 30 - 50 psig, regulated, clean dry Nitrogen PROCESS: 30 - 50 psig Argon or Helium, high purity
High-Vacuum Turbo Pump	ISO 250, 1000L/S, Agilent
Thermocouple	Type "C" Tungsten-Rhenium, Control and Overtemp
Compressed Air	80-100 PSI regulated Clean/Dry

Expected Vacuum, standard configuration:

- Process vacuum at temperature 10^{-6} torr [clean and empty chamber]
- Vacuum at ambient, 10^{-7} torr.

Cooling Requirements

- 10 Ton (120,000 BTU)
- 40 psig, at 8 gallons per minute.
- Note: Maximum backpressure is 15 psig.

Standard Features:

- 1000 L/S Agilent Turbomolecular Pump
- High Vacuum isolation valves
- Easy to use Touchscreen Controllers
- Mass Flow Controller for Process Gas
- Ethernet connectivity with webserver and FTP
- Survey Thermocouple with Cascade Control
- Equipment on casters to roll into place
- Sight glass for calibration melts
- **Fully automatic** - One button push starts the run. Automatically it will rough pump and cross over to high vac, ramp to temperature and soak, cooldown, and let up to ATM.

Options:

- Additional Survey Thermocouples
- Hydrogen / Inert Gas Operation
- Auxiliary High-Vacuum Ports
- 2000 L/S Turbo
- High-Temperature Furniture

CAMCo FURNACE

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Equipment Description

Model J-VAC-1600

TURBO-PUMPED, HIGH VACUUM FURNACE

For Automatic, Continuous Operation to 1600° C

Work Zone: 18" Dia. x 30" H



General machine overview:

Camco furnaces are controlled atmosphere, water-cooled "batch" style furnaces that are meant to process a single load at a time. Once parts are loaded, the user chooses the appropriate recipe for processing the load, and the entire profile is performed automatically. The controller determines when the furnace chamber can be opened safely at the end of the run based on physical and software safety interlocks, relay logic, pressure, and temperature checks. The outside of the water-cooled chamber is safe to touch at any process temperature, and also helps remove heat at the end of each run. Common uses for the machine are high-temperature brazing, sintering, heat treating, and clean firing.

Camco furnaces come standard with an advanced setpoint PID controller with many options, and this manual is a guide to the basic functions that users must understand before operating the machine. The controller was developed by Camco Furnace, for Camco furnaces, and is not recommended or supported for use with any other type of furnace or machine.

This machine is designed to heat to **1600°C**. It is intended to operate normally in a high-vacuum atmosphere. An included Argon connection with a Mass Flow Controller (MFC) can be used for creating a partial pressure environment, as well as a full positive pressure Argon atmosphere for processing or cooling parts. This furnace is also approved for use with forming gas (H5N) and helium in place of the argon. A nitrogen hookup is used with a throttled vent valve for venting the chamber to atmosphere.

Base Unit

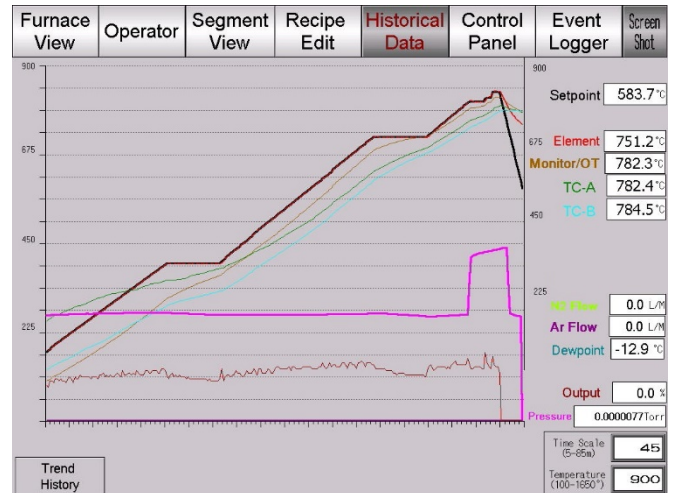
The base unit measures 75 inches wide by 34 inches deep and 88 inches tall with the chamber closed. Its' substantial frame is constructed of heavy wall square steel tubing. Service access is readily gained through a hinged steel door and the removable front, side, and rear panels. The plate steel floor within the base unit supports the heating transformers and closes the bottom. Also contained within the base unit are the SCR units, power components, and other electronics. At the lower right are the atmosphere control module, gas plumbing and cooling water plumbing. The high vacuum turbo pump, roughing pump and manifolds are also located within the right side of the cabinet. In addition, the base frame supports the instrument console and the water-cooled chamber bottom end at a convenient operator height for loading of product. A fan at the rear of the base unit draws cooling air through a replaceable filter element to cool the power control unit and transformer.

A handy feature is the inclusion of recessed heavy-duty casters. The unit is easily rolled into place, and the leveling feet are lowered to immobilize and level the equipment. This unit can roll through a standard door with the hoist and chamber disassembled, which can be shipped in this configuration if asked. The finish used on this, and all CAMCo equipment is baked powder coating, chosen for its' durability. The stainless steel top skin reduces the possibility of load contamination and makes for a convenient work surface.

Temperature Control

Multi-stage programmed Ramp & Soak Temperature control (closed-loop PID) and vacuum sequencing are achieved through the use of an IDEC PLC and HMI Touchscreen controller. The software was developed 100% in-house and is fully optimized for Camco Furnaces.

The controller receives its' input signal from a thermocouple located close to the heating element. A second thermocouple is used to monitor the load. A third flexible iniconel sheathed type "K" thermocouple can be attached directly to the workload for processes below 1250°C. All inputs are logged by the controller for real-time monitoring as well as observing historical data.



The furnace controller may also use any thermocouple input, or combination of installed thermocouples, to use for the heating loop or for guaranteed soak calculation. This is sometimes called "Cascade" controls and can be changed at any time based on recipes written by the user.

Operation

Once work is loaded into the furnace, the chamber is lowered over it and the clamps are latched. A user-programmed recipe is chosen, and the "start" key pressed. The high vacuum isolation valve opens and the chamber is rough pumped through the idle 250 mm, 1000 L/PS turbo molecular pump. At a pre-defined vacuum setpoint (approx. $5.0 \cdot 10^{-1}$ Torr) a process relay turns the turbo pump on and the system is further pumped down to the 10^{-6} Torr pressure range within approximately 15 minutes. The furnace then performs the pre-programmed ramp & soak temperature profile, cool down, and vent to nitrogen. Upon completion of the cooldown portion of the program, chamber access is allowed and parts can be unloaded.

Chamber/Furnace assembly

The stainless steel water-jacketed chamber and electric hoist is mounted on the base unit. It is sealed in operation to the chamber by a flange containing viton "O" rings. The location of the seals is such that it is well cooled and optically baffled assuring long life. The chamber bottom includes work and survey thermocouple feed-throughs, gas admission and exhausts plumbing. It supports the Molybdenum hearth and bottom end stack of six shields via the lower support structure.

The furnace "hot zone" is located within the jacketed stainless steel chamber. It incorporates Molybdenum heating elements consisting of twelve sections each supported by high alumina insulators. This surrounds the eighteen-inch diameter by thirty-inch high work area. A series of six Molybdenum cylindrical heat shields and the top and bottom shield stacks of nine shields surround the elements. This assembly is supported from the inner wall of the chamber.

In addition, the chamber includes the insulated water-cooled power feedthroughs, control thermocouple, sightport, and required cylindrical heat shield support structure. All exposed surfaces of the chamber are safe to touch during the full normal operation of the furnace.

Power Control

Power is proportionally controlled through use of a digitally controlled SCR three phase power module. This unit is phase angle fired control, and includes three phase current limiting made necessary by the strongly positive resistivity coefficient of the heating element. In the event of a power outage at higher temperature, the load temperature would drop to a level where a hard application of heat might thermally shock damage the parts. In this event, an abort relay will trip, and the program will resume and time out under the process atmosphere without the application of heat. Impedance match of the heating elements to the incoming power is accomplished through a conservatively rated 40 KVA transformer driven by this power module. This furnace incorporates two independent heating zones each with its own transformer, SCR and PID heating instruction.

Vacuum Pumps and Gauges

This machine achieves a high-vacuum with two-stage pumping of a mechanical backing “foreline pump” and a turbo-molecular pump. Starting and stopping the turbo pump is handled automatically and must pass several pressure, leak, and interlock checks before operating. All high vacuum pumping is isolated from the chamber with a large-bore gate valve.

A “Roughing” bypass valve exists for pumping around the gate valve and turbo pump. This allows a large amount of pumping to be performed without disturbing the high vacuum components, allowing additional cleanliness and less wear and tear.

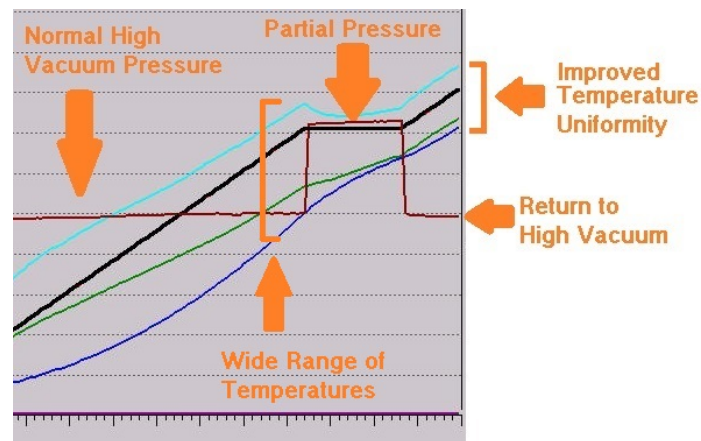
System pressures are read with four different types of gauges: A dual scale pressure transducer (Capacitance manometer and Pirani, $1.0e-3$ to 1000 Torr), standard convection gauges (for general chamber and foreline low-pressure, $1.0e-3$ to 1.0 torr), and a hot-filament ionization gauge which can accurately measure high vacuum to $1.0e-9$ torr. The convection gauges are used for verifying safe conditions to start the turbo pump. The pressure transducer is a gas-agnostic gauge used for accurately measuring higher pressures closer to atmosphere, as well as partial-pressure environments using argon or helium that would otherwise disrupt convection gauges from reading properly.

Partial Pressure Operation: $1e^{-4}$ to $1e^{-1}$ Torr

For certain brazing processes, it is advantageous (or even necessary) to suppress the high-vacuum levels during the actual braze melt. This is due to the vapor point of some alloys becoming very close to the melting point at pressures achievable in the furnace, and the braze alloy risks evaporating if there is even a slight overshoot on the temperature of the furnace reaches. **Please understand the vapor curve of all metals introduced into the furnace** to not accidentally volatilize any parts or braze alloy.

To mitigate this, the furnace allows the recipe to sweep a small amount of high purity noble gas, typically argon, while the turbo pump is still operating to maintain approximately $1e^{-2}$ torr pressure level. This gas is carefully metered with a mass flow controller (MFC) and is highly repeatable. This effectively raises the vapor point of the braze alloy. This state causes some slight stress on the turbo and is only recommended to use during the actual braze melt portion of the recipe and to use a high vacuum for all other times to minimize wear and tear.

Partial pressure can also be performed at higher pressures (between 1 and 5 torr) with a “roughing” valve that will bypass the turbo entirely.



Vacuum Ramp Delay

Logic based on the ion gauge and a set-point declared in the recipe can be used to toggle the recipe timer between RUN and HOLD to keep vacuum level below a programmed vacuum cap setpoint during periods of high gas load (vacuum/heat ramp delay). This feature can be programmed to be active, or non active, anytime throughout the run. The controller will keep track of how often this is triggered while used, and reports it to the event logger and in the run summary at the end of every cycle.

Atmosphere Control Option

All Camco high-vacuum furnaces can be ordered with combination hydrogen atmosphere control. Customer-supplied Hydrogen and Nitrogen gasses are admitted to the chamber through programmed valves and preset flow-meters. An interlock is included which provides for automatic Nitrogen purge in the event of loss of Hydrogen/Nitrogen or chamber pressure. Recipe-set Mass Flow Controllers operate the flow of gasses to achieve the appropriate operating atmosphere.

This option included many additional components and safety features but otherwise does not change the overall size of the machine or work zone. Please inquire for more information.

Standard Features

All Camco machines adhere to relevant standards outlined in the NFPA 86 Standard for Industrial Ovens and Furnaces, among others. Individual certification marks available upon request (CE, CSA, etc.)

These numerous interlocking safety features include but are not limited to:

- Panel Interlocks remove high voltage when open
- Over-temperature Limit Abort
- Adjustable chamber "Safe Access Temperature" to protect operators
- High cabinet temperature
- Chamber exterior temperature
- Low coolant flow
- Low Process Gas pressure switches
- Vacuum cap delay, and various over-pressure abort setpoints
- All turbo pump operation and venting is completely automatic to prevent costly failures
- Many other hard-coded sequences minimize operator and programming errors.

Other quality-of-life features include:

- Digital Mass Flow Controllers (MFCs) for all process gasses, for precise control and totalizing.
- Event and Operator logs for tracking all alarms, major events, and button presses
- User levels to prevent normal operators from modifying recipes or settings
- Screenshot any page at any time to capture and review anomalies
- Ethernet connectivity-
 - Webserver for real-time monitoring
 - FTP for easy retrieval of all data logs
- Front-panel USB for retrieving data logs, screenshots, and backing up recipes
- Free firmware updates when available - no subscription or extra costs

Documentation

Facilities information is supplied to assist in site preparation for installation. An operating manual is supplied with the equipment. Worksheets included in the manual provide a convenient form to depict the desired process for entry into the touchscreen controller. The worksheets also serve as a hard copy of the program. The unit is shipped with an example program stored in memory, depicted by the example worksheet. Wiring and plumbing schematics along with a published spare parts list are also included in the manual. Vendor-supplied manuals for the program controller, overtemp, SCR, vacuum pumps, and other small items are supplied in our documentation.

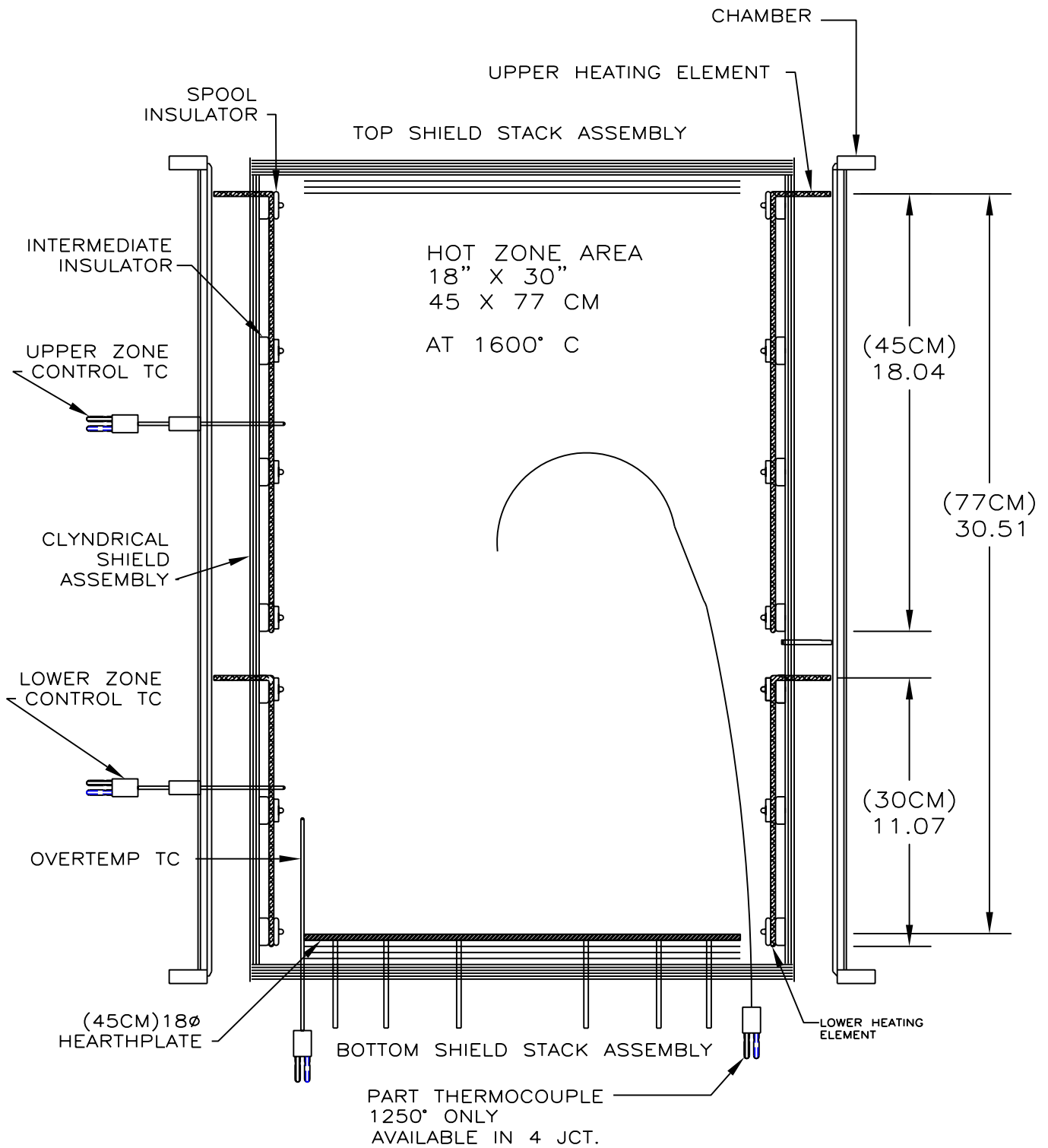
A recommended startup sequence and relatively simple operation of the furnace are well described and documented in the manual. Most customers can start up the machine without additional on-site support from Camco. However, commissioning and on-site training are always available, and costs can be included in furnace quotations if desired.

While the furnace is a complete, stand-alone unit as described, many applications suggest the inclusion of one or more of the options described in the enclosed data. Other, less commonly ordered options can also be provided. Please inquire for more information.

Note: The required process chiller is NOT included in any quotation prices. If your facility requires additional process cooling, Camco can recommend vendors and appropriate units if needed.



REV.	DATE	DESCRIPTION



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		TOL'S EXCPT AS NOTED	DRN.BY: T BARULICH	
		fract. ±1/32	APP.BY:	
		.XX ±.010	DATE: 4-20-05	
		.XXX ±.005	MAT: NOTED	
J-16 FURNACE		.XXXX ±.0005	FINISH:	TITLE: J-16 HOTZONE DIM
USED ON TASK	FWO	ANGLES ±1/2'		DWG.NO: 88912
				SHEET OF
				REV:

UTILITIES: PREPARED AS SHOWN BY CUSTOMER.

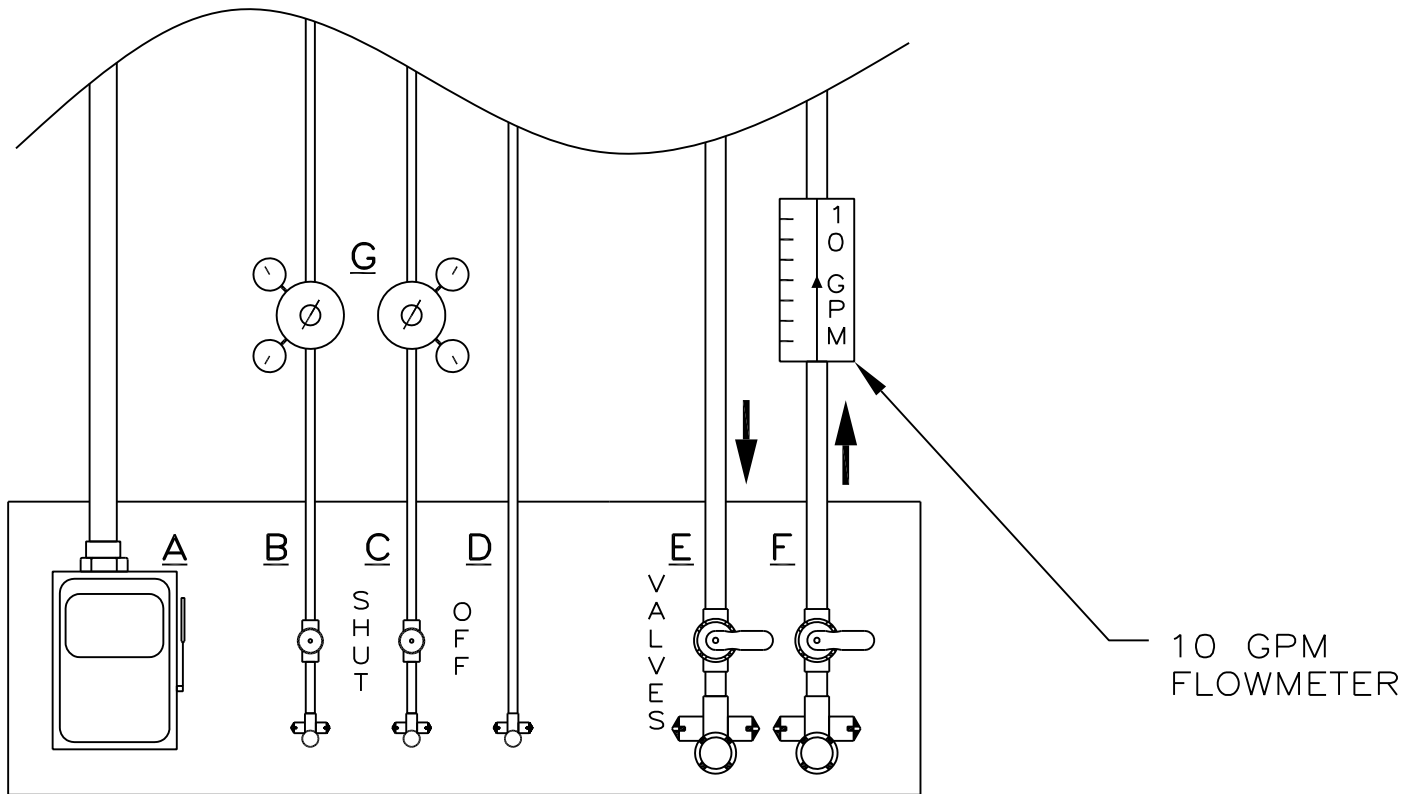
REV.	DATE	DESCRIPTION

- A: 250A./LEG @ 240V, 120A/LEG @480V, 60Hz 3 PH DISCONNECT.
- B: NITROGEN, 25 TO 50 PSIG AT A MAXIMUM FLOW OF 100 SCFH
- C: CLEAN DRY AIR, 90-110-PSI
- D: PROCESS ATMOSPHERE EXHAUST
- E: COOLING WATER SUPPLY; 30 PSIG MIN. AT 10 GPM.
- F: COOLING WATER RETURN OR PRESS. DRAIN IF USED.
- G: LINE PRESSURE REGULATORS SET AT 40 PSI.

- 1/4" SWAGELOK
- 1/4" SWAGELOK
- 1/2" FPT
- 3/4" FPT
- 1" FPT

NOTE: (MAX. BACK PRESSURE 20 PSIG AT 8 G.P.M.)

WATER COOLING REQUIREMENT
120K BTU, 10 TON CHILLER AT MAX TEMPERATURE (1600° C)



SUGGESTED UTILITY PANEL LAYOUT

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		TOL'S EXCPT AS NOTED	DRN.BY: T BARULICH	
K-VAC 16		fract. ±1/32	APP.BY:	
J-VAC 16	389	.XX ±.010	DATE: 8-4-08	
USED ON TASK	FWO	.XXX ±.005 .XXXX ±.0005	MAT:	
		ANGLES ±1/2"	FINISH:	TITLE: JVAC 16 FURN FACILITIES PREP.
				DWG.NO: 89235
				SHEET 1 OF
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