



Manufacturers of High Temperature & High Vacuum Equipment

370-G Industrial Road | San Carlos, CA 94070  
Phone (650) 593-1064 | Fax (650) 593-4458

## Model BVAC-2300

8" DIA. X 12" Work Area  
TURBO-PUMPED HIGH VACUUM FURNACE

For programmed continuous operation  
to 2300° C.



Size: 65" (165 cm) W. x 28" (72 cm) D. x 50" (127 cm)H.

*A High Vacuum and Atmosphere version of the CAMCo Model B Furnace.  
B-VAC Furnaces are available with ratings to 2300° C .*

### Standard Features

- 550 L/S Turbo Pump
- High Vacuum isolation valve
- 19 Programs – 20 Segments per program
- Fully Automatic
- Vacuum Delay Setpoint
- All Stainless Steel construction

### Options

- Cable Hoist
- Video Chart Recorder
- Tower Indicating Lights – 3 color
- Survey Thermocouples
- Computer Controls
- Hydrogen atmosphere combination



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Model B-2300 shown with standard controls and cable hoist

## Specification Sheet

Equipment Model: B-Vac 2300  
 High Vacuum / Inert, Reducing Atmosphere Furnace,

<b>Type</b>	Coldwall, Vertical, Top Loading / High Vacuum
<b>Maximum Temperature</b>	2300 Degrees C.
<b>Element Size</b>	6" (150mm) Dia. x 9" (230mm) H. Nominal
<b>Frame Dimensions</b>	65" (165 cm) W. x 28" (72 cm) D. x 50" (127 cm) H.
<b>Power Requirements (Specify at order)</b>	480V 3 Ph. 60A 60 Hz. – 208.240V 3 Ph. 120A 60 Hz. 415V 3 Ph. 60A 50 Hz.
<b>Gas Requirements</b>	25 – 50 psig, Nitrogen (1/4" swagelok)
<b>Compressed Air</b>	80 – 100 psi (1/4" swagelok)

Process Vacuum at temperature  $10^{-6}$  Torr range  
 Vacuum in  $10^{-7}$  Torr range at ambient

**Cooling Requirements** - 25 psig at 4 gallons per min. Note maximum drain back pressure is 15 psig.

Heat up ramp rate 0 to 100 degrees C per minute.

Heating elements and heat shields are constructed of Tungsten & Molybdenum.  
 W-5 Thermocouple and Optical pyrometer temperature control.

### Standard Features:

- 550 L/S Turbo molecular high vacuum pump
- High Vacuum isolation valve
- Equipment on casters to roll into place
- Honeywell Controls - Ramp & Soak
- DCP302 Program Controller
- UDC2500 Overtemp Control
- Fully automatic - One button push starts the run. Automatically it will rough pump/cross over to high vac - ramp to temperature and soak - cooldown - let up to ATM - and show amber indicator light when run is finished.
- Safety interlocks include: Separate over-temp thermocouple and controller, Panel interlock, High cabinet and transformer temperature, Low coolant flow, Low gas pressure, Low chamber pressure.

### Options:

- Cable Hoist
- Paperless Recorder, Yokagowa DX1006
- Tower Indicating Lights - 3 color
- Survey Thermocouple
- Computer controls, Think & Do software



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## **Equipment Description**

### **CAMCo 6" Dia. X 9" H. , 2300 deg. C**

#### **TURBO-PUMPED, HIGH VACUUM FURNACE**

*For Automatic, Programmed Operation to 2300 deg. C*

### **Model B-VAC 2300**



## **Overview**

The furnace is of the top loading style and is the result of twenty years of evolution of our coldwall furnaces. From their inception, CAMCo furnaces were developed using materials and design that allowed us to expand our product line to include high vacuum furnaces, the earliest ones being diffusion pumped. Now, they feature ceramic bearing turbo pumps of demonstrated long life. This allows us to confidently offer clean systems that pump large gas loads typical of furnace operations to low ultimate pressure very rapidly. Inclusion of stainless steel gas plumbing makes this furnace an ideal choice for processes requiring high vacuum as the process cycle.

The furnace chamber, centered in the base unit is of the top loading "coldwall" variety, capable of continuous operation at 2300 degrees C. It incorporates a low voltage, three phase wye Tungsten heating element supported by its' 2000 ampere power terminations. These include Teflon and Alumina insulation with Viton seals. The element surrounds the five-inch diameter by seven-inch high work area. Work is placed on a Tungsten hearth plate, 6" diameter, which in turn is held by the support structure within the chamber. A stack of seven Molybdenum and three Tungsten cylindrical heat shields surround the element. A bottom end stack of seven Molybdenum and five Tungsten shields and similar removable top shield stack finish the insulation of the work zone.

A double wall, water-jacketed stainless steel chamber contains these items as well as the water cooled, insulated power feedthroughs and control and work thermocouples. A Nickel-plated Copper water-cooled baffle within the chamber isolates the pumping neck from heat radiated by the furnace. A hinged, water-jacketed cover assembly is easily Viton "O" ring sealed to the chamber through use of a camming latch.

A 5/8" inside diameter vertical sightport is located at the center of the cover. In registration with this are holes of approximately 7/16" diameter, which penetrate the top heat shield stack. A twelve-inch, water cooled extension is attached at this point which in turn is attached to the optical pyrometer for controlling at elevated temperatures.

## **Base Unit**

The base unit measures approximately 63" wide by 29" deep (to fit through a standard door) by 50" high. Its' substantial frame is constructed of heavy wall square steel tubing. Service access is readily gained through a hinged steel front door and removable front, side and rear panels.

The plate steel floor within the left third of the base unit supports the heavy transformer and closes the bottom. This left section, containing the power components and electronics is, for safety, isolated from the right two thirds by an internal airflow-directing baffle. 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.

The floor within the right third of the base unit supports the mechanical pump. In addition, the base frame supports and houses the instrument console, chamber, high vacuum plumbing and cover hinge and latch assemblies.

A convenient feature is the inclusion of recessed heavy-duty casters. The unit is easily rolled into place, and the leveling feet lowered to immobilize and level the equipment. The stainless steel top provides an area for convenient load preparation, and completes closure of the base unit. The finish used on this, and all CAMCo equipment is baked, environmentally friendly powder coating, chosen for its' durability.

## System and Temperature Control

Temperature control is achieved using open loop power control to approximately 600 deg C, and optical pyrometer control for elevated temperatures. Multi-stage programmed control is achieved through use of a Honeywell DCP302 microprocessor controller which receives its' input signal from the optical pyrometer which looks at a target that is within close proximity to the heating element. Automatic time/temperature ramp and soak programmed control of up to nineteen programs with up to 19 segments programs may be stored in the microprocessor. The operator is required only to insert the load, specify a program by letter and press the start button to operate the furnace. The process controller, in conjunction with the vacuum gauge control, also provides necessary vacuum system control functions.

Over-temperature monitoring is provided by a thermocouple located within close proximity to the third most inner heat shield. It drives a Honeywell UDC2500 process monitor, which provides digital readout and a relay that will shutdown the power to the elements. The process monitor also provides a safe chamber access interlock and access signal for the operator. This second set-point locks the operator out of the furnace chamber until it has reached a safe temperature.

## Operation

Work is lowered into the hot zone and placed onto the 6" diameter hearth plate, the top heat shield stack inserted, and the cover closed and latched. One of nineteen selectable, user programmed thermal profiles is chosen, and the "start" key pressed. The high vacuum isolation valve opens and the chamber is rough pumped through the idle 160 mm, 600 L/PS turbo molecular pump. At a pre-defined vacuum setpoint (approx.  $5.0^{-1}$  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, the chamber is opened and unloaded.

## Vacuum System

This automatically controlled, turbo pumped version of the type B furnace is designed for clean, oil-free elevated temperature in a high vacuum atmosphere. From a cold start, the clean furnace will evacuate to the  $10^{-6}$  Torr range in approximately 15 minutes, and is capable of maintaining six-scale vacuum at temperature. When pumped for a longer period, lower pressures are easily attained. The vacuum plumbing is designed to provide convenient component access, and to provide maximum practical conductance to the chamber. Mass spectrometer leak checks are performed on all high vacuum assemblies.

The high vacuum system is specifically designed to handle the large gas loads presented by vacuum furnaces. An ISO160 flanged, 600 L/Sec. ceramic bearing turbo molecular pump, capable of  $10^{-9}$  scale ultimate vacuum, is used for the application. The turbo-pump is capable of very rapid 3 thru 7 scale pumping of air and water vapor typically evolved during the earlier outgassing part of the firing cycle. For maximum pumping speed, it is close-coupled to the chamber pumping neck through the high conductance high vacuum gate valve, as are the chamber vacuum gauges and inert gas let-up valve.

Chamber roughing is accomplished through the turbo pump by a quiet, direct drive mechanical pump. The foreline includes a backstreaming trap and electro-pneumatic foreline valve. At acceptable foreline pressure, the turbo-pump is automatically powered up. For ultra clean operations, a dry scroll or diaphragm pump can be substituted for the mechanical pump.

## Vacuum Instrumentation and Control

A Granville-Phillips digital gauge control unit with process control module, supporting two Convector (Pirani) gauges and one Bayard-Alpert Ion gauge is included to monitor system pressure. The Bayard-Alpert gauge tube, and the Convector that measures chamber pressure are located on the ISO160 flanged chamber neck. The second Convector is located to measure pressure at the roughing/backing line.

A circuit receiving a signal from an ion gauge related setpoint can be used to toggle the program between run and hold to keep below a programmed vacuum cap during periods of high gas load (vacuum/heat ramp delay).

Linearized, analog output provided by the gauge control may be coupled to a recorder when a recorder is ordered. A circuit receiving a signal from the turbo-pump power-up setpoint shuts down power to the elements if this setpoint is exceeded, to preclude application of voltage with inadequate vacuum.

## **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. 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 process atmosphere without the application of heat.

Impedance match of the heating elements to the incoming power is accomplished through the conservatively rated 50 KVA transformer driven by this power module.

Note: Facility voltage should be specified at time of order. 240 or 480 volt 3phase

## **Atmosphere Control**

Our vacuum furnaces can be ordered with Combination Vacuum and Inert Reducing Atmosphere control. Through programming, either vacuum or atmosphere can be chosen to make this an ideal R & D or laboratory furnace. When this option is ordered, the furnace can run either Nitrogen or Argon as the purge gas. The process gas can be Hydrogen, Hydrogen Argon or Hydrogen Nitrogen.

A Bubbler to humidify the process gas comes standard with this option. A burnoff column to ignite excess process gas is also supplied.

As with our standard atmosphere furnaces, this combination furnace comes with all the safety interlocks required with Hydrogen operation.

## **Safety Features**

- Thermocouple break protection (Thermocouple burn-up) assures that heating power is removed from the furnace in the event of sensor failure.
- Overtemperature indication is read on a separate control module from the monitor thermocouple. This overtemp alarm causes the heating elements to shut down as a further backup.

Other numerous interlock functions protecting the operator and equipment include:

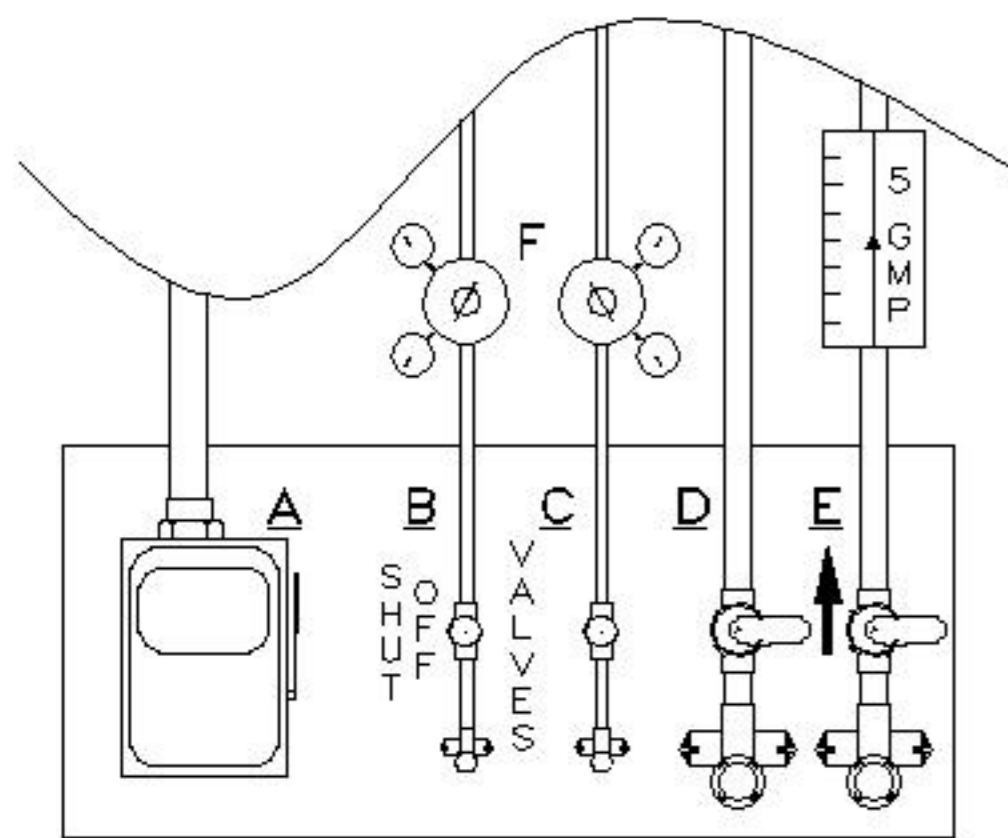
- Panel Interlock
- High Cabinet Temperature
- Low Coolant Flow
- Low Gas Pressure Switches
- Vacuum Ramp Delay
- Heaters are interlocked with the vacuum gauge control so that heating will not occur if there is insufficient vacuum.
- Thermal overload protection for the Turbo Molecular Pump
- High Vacuum isolation valve to protect the Turbo Pump during vent and quick cooling of the hot zone.

## **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 microprocessor 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, recorder, dewpointer, and other small items are supplied in our documentation.

A program and operation section has a complete button-by-button push instruction for installation of a generic program. The relatively simple operation of the furnace is well described and documented in the manual.

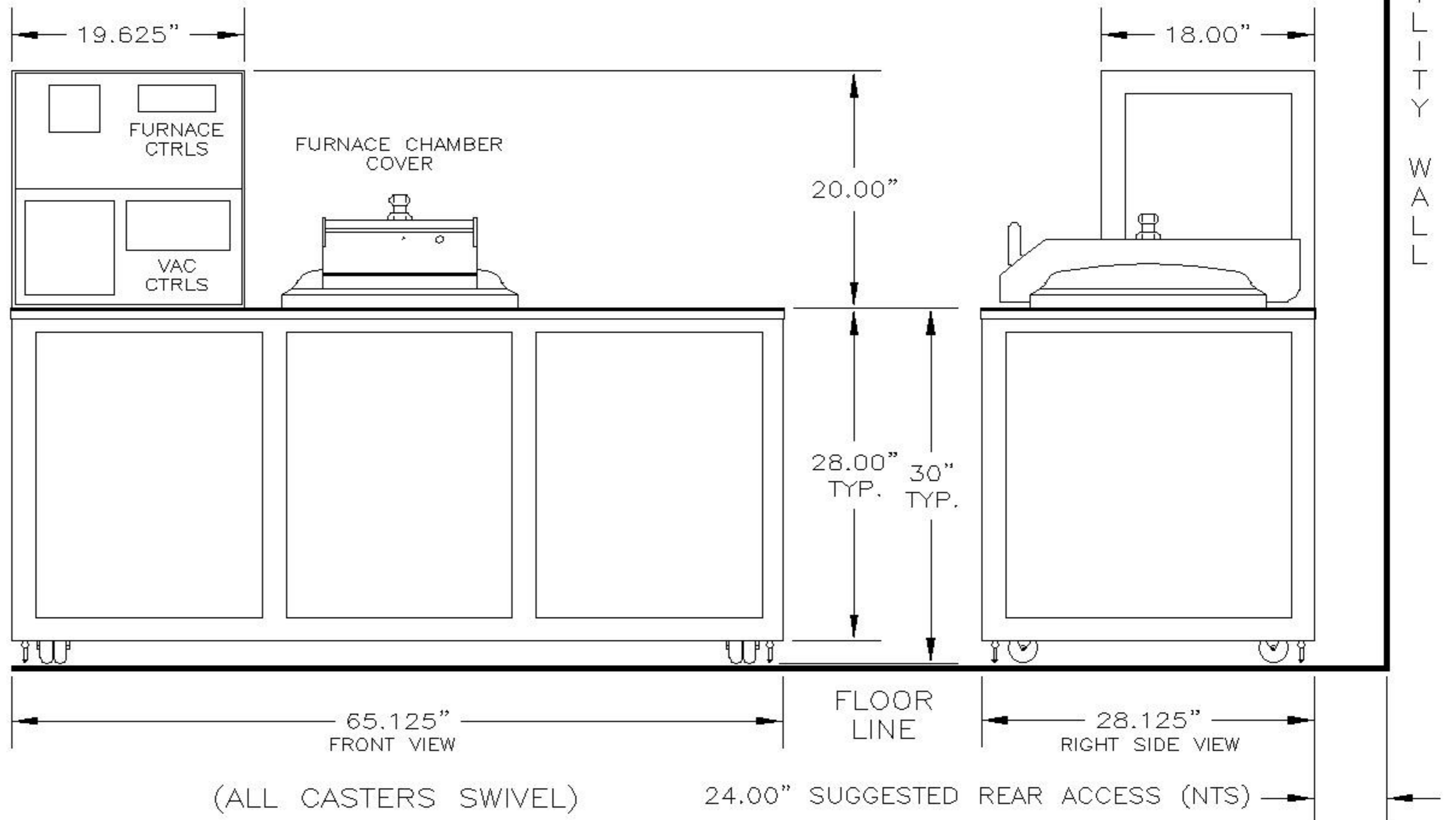


SUGGESTED UTILITY PANEL LAYOUT

- A: 150 A/LEG 208V. 120@240V. OR 60@480V. 60Hz 3 PH DISCONNECT.
- B: NITROGEN, 25 TO 30 PSIG AT A MAXIMUM FLOW OF 30 SCFH.
- C: COMP. AIR FOR VAC VALVES: 80-100 PSI 2 CFM MAX.
- D: COOLING WATER SUPPLY; 25 PSIG MIN AT A 4GPM MAX.
- E: COOLING WATER RETURN OR PRESS. DRAIN IF USED.
- F: LINE PRESSURE REGULATORS SET AT 40 PSI.

- 1/4" FPT
- 1/4" FPT
- 1/2" FPT
- 1/2" FPT

NOTE: (MAX. BACK PRESSURE 15 PSIG AT 4 G.P.M.)



		TITLE: B-VAC INSTALLATION DRAWING			
		DRN.BY: ZEVADA 08/01/00	APP.BY: TONY BARULICH		
USED ON TASK	FWO	DATE: 01/29/96	DWG.NO: 87698	SHEET 1 OF 2	