CAMCO FURNACE
Manufacturers of High Temperature & High Vacuum Equipment
1017 Bransten Road
San Carlos, CA 94070
Phone (650) 593-1064
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Specification Sheet

Equipment Model: G-VAC-16
High Vacuum Furnace

Type	Vertical / Top Loading, High Vacuum
Chamber	Electropolished Stainless Steel, Coldwall
Maximum Temperature	1600° C.
Hot Zone (Nominal)	6” (150mm) Dia. X 10” (250mm) Deep Nominal
Frame Dimensions	51” (130 cm) W. x 26” (66 cm) D. x 20” (51 cm) H.
Power Requirements	240V 1 Ph. 60A 60 Hz. – 230V 1Ph. 60A 50 Hz..
Gas Requirements	25 – 50 psig, Nitrogen (¼” Swagelok)
Compressed Air	80 – 100 psi (¼” Swagelok)
Element Style	.125 Molybdenum Wire

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

Cooling Requirements - 25 psig at 3 gallons per minute.
Note: Maximum back pressure is 15 psig. (34,000 BTU)

Weight: 420 LBS (190 KG) designed to operate on a standard table modified to 20” high.

Heat up ramp rate 100° C per minute - empty chamber.

Heating elements and heat shields are constructed of Molybdenum. Insulators are made of High Alumina.

Standard Features:

- 250 L/s Turbomolecular Pump
- 200 L/min Mechanical “Roughing” Pump
- High Vacuum Isolation Valve
- Easy to Operate Microprossesor Controllers
- 19 Programs - 20 Segments per Program
- Digital Chart Recorder
- Ethernet Connectivity; Webserver and FTP
- Sight glass for calibration melts
- Active Braze Control with Survey Thermocouple
- **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.

Options:

Dry Scroll Pump
Survey Thermocouples (up to 4)
Tower Indicator Lights - 3 Color
Computer Control
Partial Pressure Operation
Helium Quick Cool
Combination Hydrogen/Inert Operation
Custom Support Table

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Equipment Description

CAMCo 6"DIA by 10" Deep, 1600° C

TABLETOP HIGH VACUUM TURBO-PUMPED FURNACE
For Automatic Programmed Operation to 1600° C.

Model GVAC-1600

Overview

The Concepts & Methods Co., Inc. "GVAC-1600" tabletop high vacuum furnace is designed to reproducibly vacuum braze, degas and otherwise process loads of up to 6" wide by 10" deep. The letter selected ramp and soak program is accurately controlled to 1600° C at pressures to the 10^{-6} Torr range. The furnace and vacuum controls, pump system and interlocks, are integrated in a fully automated unit to assure simple reliable operation.

Operation

The work is lowered from the top of the furnace onto a 6" dia hearth plate, the top heat shield stack inserted, and the door closed and latched. One of nineteen selectable, user programmed pump down and thermal profiles is chosen, and the "Start" key pressed. The high vacuum gate valve opens and the turbo-pump is enabled. A direct drive mechanical pump is coupled to the turbo-pump thru a foreline valve and trap rough pumps the system. This is accomplished thru the idle 100 mm turbo-molecular high vacuum pump in approximately three minutes. At its limiting fore-pressure, the turbo-pump is automatically started. It reaches full speed within 4 minutes. As the pressure falls below $1 \cdot 10^{-3}$ Torr, the high vacuum ionization gauge is powered. In the clean system, low five-scale mid six-scale pressure is reached in a total time from cold start-up of approximately fifteen minutes. The selected time vs. temperature profile then runs. Upon completion of the cooldown portion of the program, the gate valve closes if the program does not provide to leave the load under vacuum, the turbo-pump is powered down and the foreline valve closed. The chamber is let up to Nitrogen or other inert gas to facilitate un-loading. If desired to facilitate more rapid cooling, the furnace may be programmed to close the gate valve immediately on removal of power, and as the turbo-pump is powered down, inert gas is admitted to a programmed level. The furnace is programmed to remain in this state until the safe access temperature has been reached, at which time the program ends, leaving the load in the inert atmosphere until the operator wishes to continue backfilling to remove the work.

Construction

The cabinet measures approximately 51" wide by 26" deep by 20" high. Its substantial frame is constructed of heavy steel structural shapes. Square tubular support feet provide a convenient location in which to insert bars for lifting. Panels are readily removed to gain access for efficient, on the spot service. A cooling fan draws air thru a disposable filter to cool the power components. The cabinet's sturdy steel floor supports the furnace power transformer and the mechanical pump. Mounted within this structure also, are the S.C.R. power control, turbo-pump converter, control transformer, logic electronics, interlocks and plumbing. The controls are conveniently located at the left front. The finish used on this, and all CAMCo equipment is baked powder coat paint, chosen for its' durability and solvent resistance.

Vacuum Chamber Assembly

The double wall, water-cooled stainless steel vacuum chamber, a water-cooled copper pumping port baffle within the chamber, the gate valve, and the turbo-pump are assembled as a module. This is bolted at the chamber flange to a front right panel that supports the chamber assembly within the cabinet. The chamber cylindrical wall is penetrated by the element power feedthrough ports, furnace thermocouple fittings, and the vacuum system neck. This neck includes fittings for the ion and convectron gauges, and gas letdown port.

Chamber Door Assembly

The double walled, water-cooled stainless steel door is flanged to mate with the chamber. The door handle includes a cam locking arrangement to easily compress the "O" ring door seal. Needle-bearing hinges provide accurate registration of the door to the chamber. A centrally located sight port permits viewing the work through the viewing holes in the front shield stack. A positive locking solenoid prevents the door assembly from opening until the temperature of the furnace has cooled to the predetermined safe access temperature setpoint.

Heat Shield and Element Assembly

The furnace proper is located within the double wall water-cooled chamber. It is very conservatively rated for continuous 1600^{o} C operation. The low voltage, serpentine Molybdenum rod heating element is of two semi-cylindrical sections supported by high alumina insulators. It surrounds the top, sides and bottom of the work area. Work is placed on a refractory metal hearth that in turn is supported, as is the heat shields with optically staggered pumping ports, the rear end stack of six shields, and the front shield stack surround the element and work area.

Heating Power Supply

Power is delivered by a conservative, continuously rated 10 KVA transformer. This is driven by a digital line and load regulated, phase fired SCR control. A current limiting feature is included, which provides long element life.

Instrumentation and Controls

Closed loop control of the furnace SCR power unit as a function of temperature is accomplished by a Honeywell multi-program, ramp and soak process controller. The "vacuum system enable signal" and other control functions are also supplied at the appropriate time by this unit. A Granville-Phillips type 358 digital gauge control unit, supporting two convectron (Pirani) gauges and one Bayard-Alpert gauge is included to monitor system pressure. The Bayard-Alpert gauge tube and one convectron measure chamber pressure. The second convectron is located to measure pressure at the foreline. When the pumping system is isolated from the chamber, this sensor also provides information regarding the condition of the mechanical pump oil. A process control module is included in the vacuum gauge controller. This allows the pre-configured pressure set-points to control the system automatic valving and turbo power-up functions. Vacuum system operation is integrated with furnace operation through the process controller. A linearized analog output provided by the gauge control, and output from the furnace temperature thermocouple can drive two channels of a chart recorder, providing a record of the process. When the recorder option is ordered, it is installed and tested prior to shipment. Included is a vacuum setpoint temperature delay feature that is programmable ON or OFF during the heating cycle of the program. A preprogrammed vacuum cap will put the controller on "Hold", preventing the temperature from increasing until the vacuum has recovered from outgassing and then resumes the ramping of the heating cycle.

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 burn-off column to ignite excess process gas is also standard. 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:

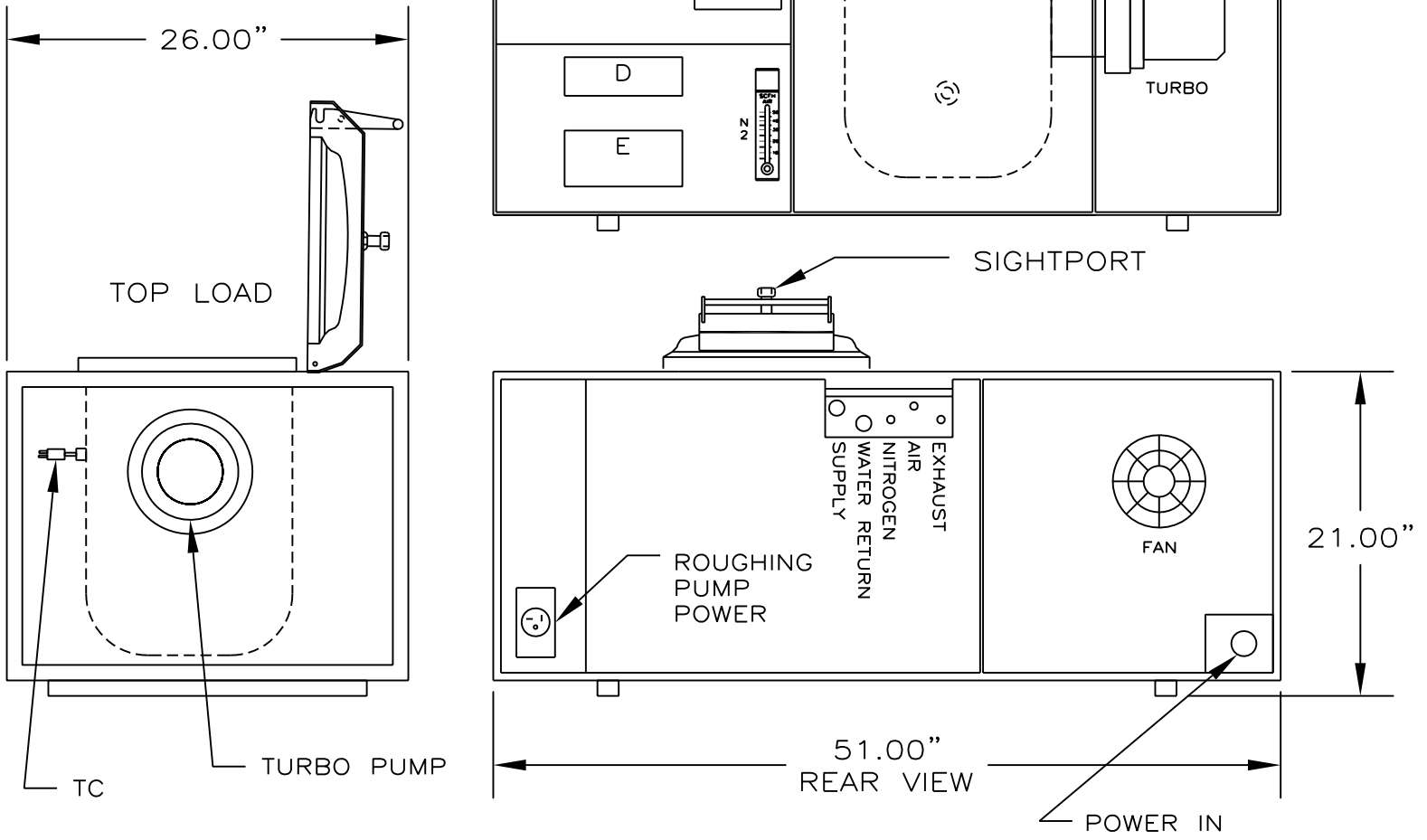
- Panel Interlock
- High Cabinet Temperature
- Low Coolant Flow
- Low Gas Pressure Switches
- Vacuum Ramp Delay
- Heaters are interlocked with the vacuum gauge control so that heating will not occur if there is insufficient vacuum.
- Thermal overload protection for the Turbo Molecular Pump
- High Vacuum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

Documentation

An operating manual is supplied with the equipment. Blank worksheets included in the manual provide a convenient form for depicting the desired process for entry into the microprocessor controller, and also serve as a hard copy of the program. The unit is shipped with an example program stored in memory, which is depicted by the enclosed example worksheet. Included are a trouble-shooting guide, spare parts list, major component product sheets, manuals and a full equipment description with facilities drawings. Facilities information is supplied prior to shipment to assist in preparation for receipt of the equipment.

REV.	DATE	DESCRIPTION

A: PROGRAM CONTROL
B: WORK MONITOR
C: RECORDER
D: VACUUM GAUGE CONTROLLER
E: TURBO CONTROLLER



G-VAC FURNACE TOP LOAD	
USED ON TASK	FWO

TOL'S EXCPT AS NOTED
fract. ±1/32
.XX ±.010
.XXX ±.005
.XXXX ±.0005
ANGLES ±1/2°

DRN.BY: T BARULICH
APP.BY:
DATE: 11/21/07
MAT:
FINISH:

Concepts & Methods Company, Inc.

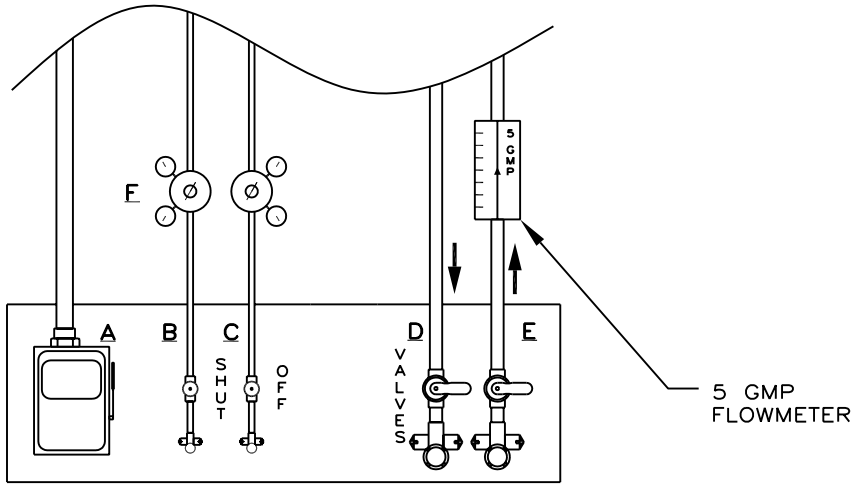
TITLE: G-VAC FURNACE FACILITIES PREP.

DWG.NO: 88509 | SHEET 3 OF 5 | REV:

REV.	DATE	DESCRIPTION

UTILITIES: PREPARED AS SHOWN BY CUSTOMER.

A: 60A. @ 208 OR 240V. 60 Hz SINGLE PHASE DISCONNECT.
B: NITROGEN, 30 TO 50 PSIG AT A MAXIMUM FLOW OF 30 SCFH — 1/4" TUBE
C: DRY FILTERED AIR, 80–100 PSI — 1/4" TUBE
D: COOLING WATER SUPPLY; 25 PSIG MIN. AT 2.5 GPM – SEE NOTE — 1/2" FPT*
E: COOLING WATER RETURN OR PRESS. DRAIN IF USED––SEE NOTE — 1/2" FPT*
F: LINE PRESSURE REGULATOR SET AT 40 PSI.



SUGGESTED UTILITY PANEL LAYOUT

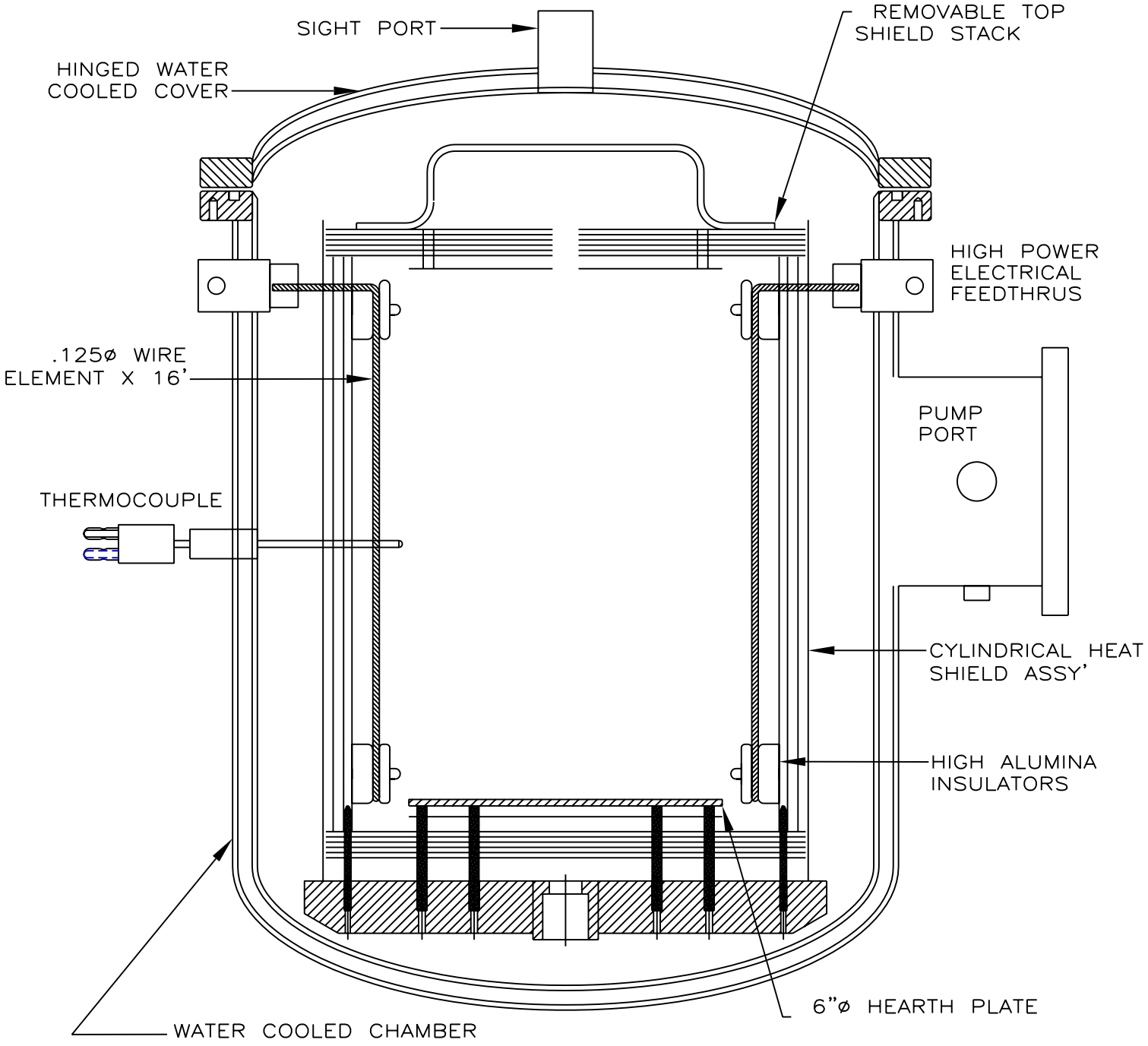
LOCATE ON WALL BEHIND TABLE

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

		TOL'S EXCPT AS NOTED	DRN.BY: T BARULICH	Concepts & Methods Company, Inc.
		fract. ±1/32	APP.BY:	
		.XX ±.010	DATE: 6–12–06	
G–VAC TOP LOAD	345	.XXX ±.005	MAT:	TITLE: G–VAC TOP LOAD FACILITIES PREP.
USED ON TASK	FWO	.XXXX ±.0005	FINISH:	DWG.NO: 89078 SHEET 1 OF REV:
		ANGLES ±1/2°		

REV.	DATE	DESCRIPTION
A	1-21-06	MOVE .128 HOLE
B	8-25-6	ADD DETAILS, CHAMBER AND ELEMENTS

G-16

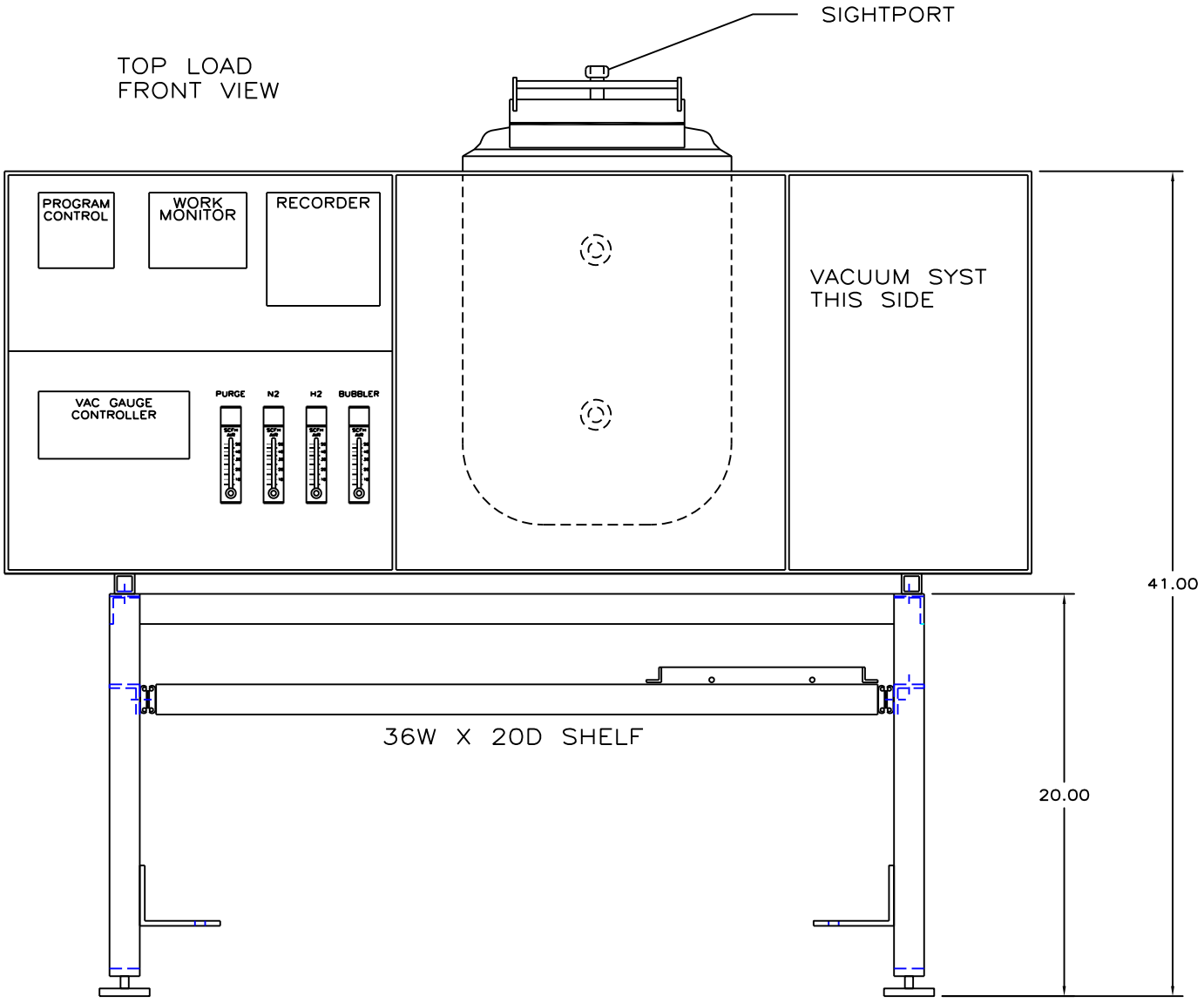


		TOL'S EXCPT AS NOTED fract. ±1/32 .XX ±.010 .XXX ±.005 .XXXX ±.0005 ANGLES ±1/2°	DRN.BY: ZEVADA 02/20/04 APP.BY: T BARULICH 1-21-06 DATE: 02/23/96 MAT: 304 SS FINISH:	Concepts & Methods Company, Inc.	
				TITLE: SPIDER ASSEMBLY	
G-16 TOP LOAD	328			DWG.NO: 87819	SHEET 2 OF 2 REV: A
USED ON TASK	FWO				


250 PSI
READY
ACCESS

REV.	DATE	DESCRIPTION

TOP LOAD
FRONT VIEW



		TOL'S EXCPT AS NOTED fract. ±1/32 .XX ±.010 .XXX ±.005 .XXXX ±.0005 ANGLES ±1/2°	DRN.BY: ZEVADA 11/07/06	Concepts & Methods Company, Inc.	
			APP.BY: T BARULICH 1-25-07		
			DATE: 4-1-08		
TOP LOAD FURNACE			MAT: NOTED	TITLE: G FURN TABLE WITH TOP LOAD	
USED ON TASK	FWO		FINISH: DARK BLUE TEXTURED	DWG.NO: 89154	SHEET 5 OF 4 REV: