



Manufacturers of High Temperature & High Vacuum Equipment

1017 Bransten Road
San Carlos, CA 94070

Phone (650) 593-1064
Fax (650) 593-4458

Specification Sheet

Equipment Model:
K-COM-1200-20x48
Controlled Atmosphere Furnace



Type	Hydrogen, High Vacuum and Partial Pressure
Chamber	Stainless Steel Coldwall, Top loading
Maximum Temperature	1200° C Continuous in all atmosphere types Up to 1400° C for 30 minutes in High-Vacuum
Maximum Ramp Rate	50° C per minute
Hot Zone	20" (50 cm) Dia. x 48" (122 cm) H. Nominal
Heating Element Type	Molybdenum Wire Elements, Molybdenum Shields
Frame Dimensions	74" (188 cm) W. x 34" (86 cm) D. x 167" (425 cm) H.
Power Requirements	480V 3 Ph. 120A 60 Hz / 400V 3 Ph. 150A 50 Hz.
Gas Requirements	REDUCING: 30-50 psig regulated Hydrogen INERT: 30 - 50 psig, regulated, clean dry Nitrogen PROCESS: 30 - 50 psig Argon or Helium, high purity
High-Vacuum Turbo Pump	ISO 250, 2000 L/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:

- 2000 L/s Agilent Turbomolecular Pump
- 500 L/min Agilent Dry Foreline 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
- Industrial Tower Light
- Oxygen Sensor and Burnoff Column
- **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 ambient pressure to open.

Options:

Additional Survey Thermocouples
Auxiliary High-Vacuum Ports
High-Temperature Furniture



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Equipment Description

Model K-COM-1200-20x48

Hydrogen and High-Vacuum Furnace

For Automatic, Continuous Operation to 1200° C

Work Zone: 20" Dia. x 48" H



General machine overview:

Camco furnaces are fully 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 automation features, 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 **1200°C**. It is capable of operating in a high-vacuum or positive-pressure reducing atmosphere. In high vacuum, these furnaces are capable of operating to higher temperatures (up to 1400°C) for up to 30 minutes. All process gasses are run through Mass Flow Controllers (MFC) and can also be used for creating a partial pressure environment. Standard gas loadout is Nitrogen (purge), Hydrogen (reducing/flux), and high-purity argon. This furnace is also approved for use with forming gas (H5N) or helium **in place of the argon**.

Base Unit

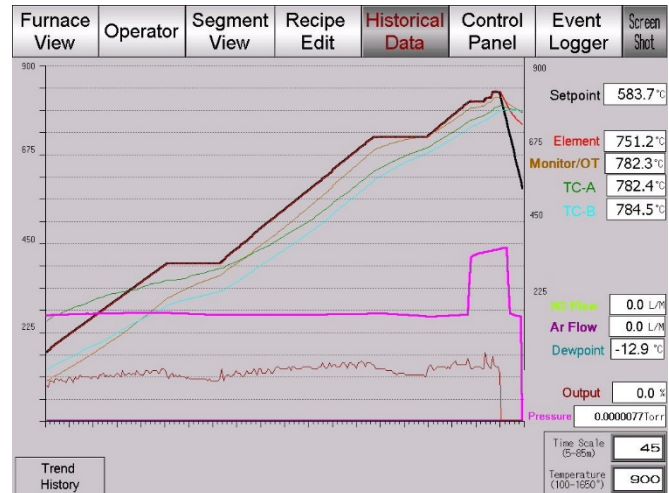
The base unit measures 74 inches wide by 34 inches deep and 112 inches tall with the hoist down. With the hoist fully raised, it measures 167 inches. Its' substantial frame is constructed of heavy wall square steel tubing. Service access is readily gained through a hinged steel door and the removable 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 is the SCR unit, 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 useful 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 fit through a standard door with the chamber and hoist removed. 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.

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 inonel 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

A robust electric hoist raises the chamber to expose the "hot zone." Work is loaded into the furnace stacked onto a solid molybdenum plate. The hoist then lowers the chamber back down and seals to the bottom flange with pneumatic clamps. One hundred selectable user-programmed thermal profiles may be chosen, and the "start" key pressed. The chamber is then automatically evacuated to below 1 torr where a mandatory leak-back test is performed. Once successful, the furnace continues to turn on the turbo pump for high-vacuum recipes, or backfills with nitrogen to ambient pressure before introducing hydrogen for positive pressure operation.

Chamber/Furnace assembly

The stainless steel water-jacketed chamber bottom end is mounted on the base unit. It is sealed in operation to the chamber by a flange containing a viton "O" ring. The location of the seal 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 a Molybdenum heating element consisting of twelve sections each supported by high alumina insulators. This surrounds the twenty-inch diameter by forty-eight-inch high work area. A series of Molybdenum cylindrical heat shields in the top and bottom zones 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 digitally controlled SCR three phase power modules. 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 stop and display relevant error messages. Impedance match of the heating elements to the incoming power is accomplished through a pair of conservatively rated 40 KVA transformer driven by SCR power modules.

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.

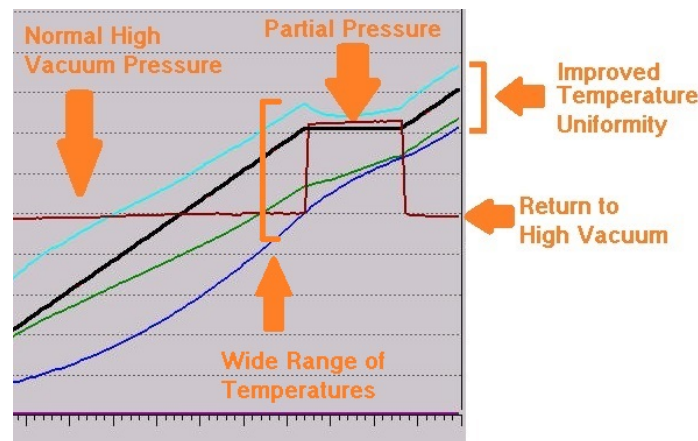
System pressures are read with four different types of gauges: A dual scale pressure transducer (Capacitance manometer and Pirani, $1.0\text{e-}3$ to 1000 Torr), standard convection gauges (for general chamber and foreline low-pressure, $1.0\text{e-}3$ to 1.0 torr), and a hot-filament ionization gauge which can accurately measure high vacuum to $1.0\text{e-}9$ 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: $1\text{e-}4$ to $1\text{e-}1$ 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 $1\text{e-}2$ 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

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.

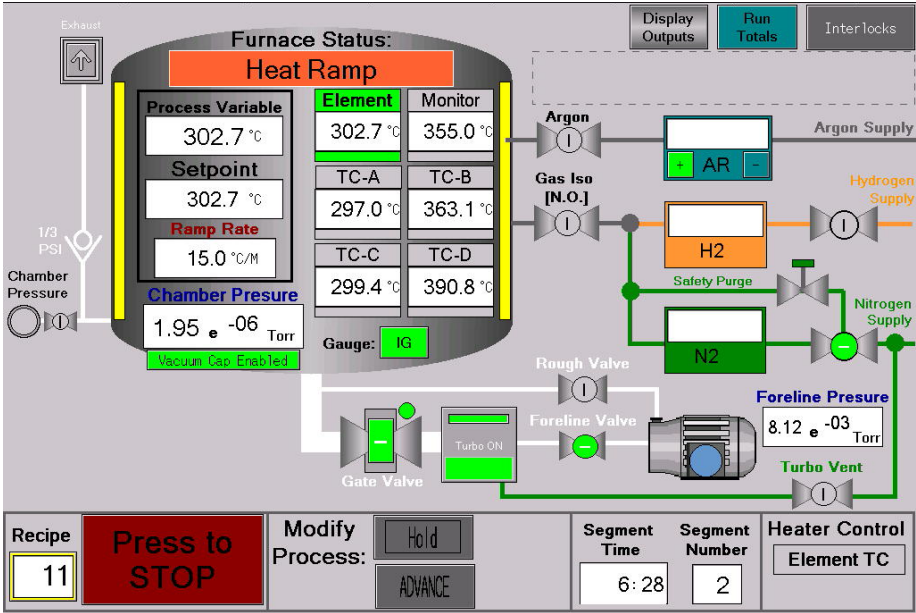
Note: The required process chiller is NOT included in any quotation prices. If your facility requires additional process cooling, Camco can recommend vendors and appropriate units if needed.



Graphical User Interface

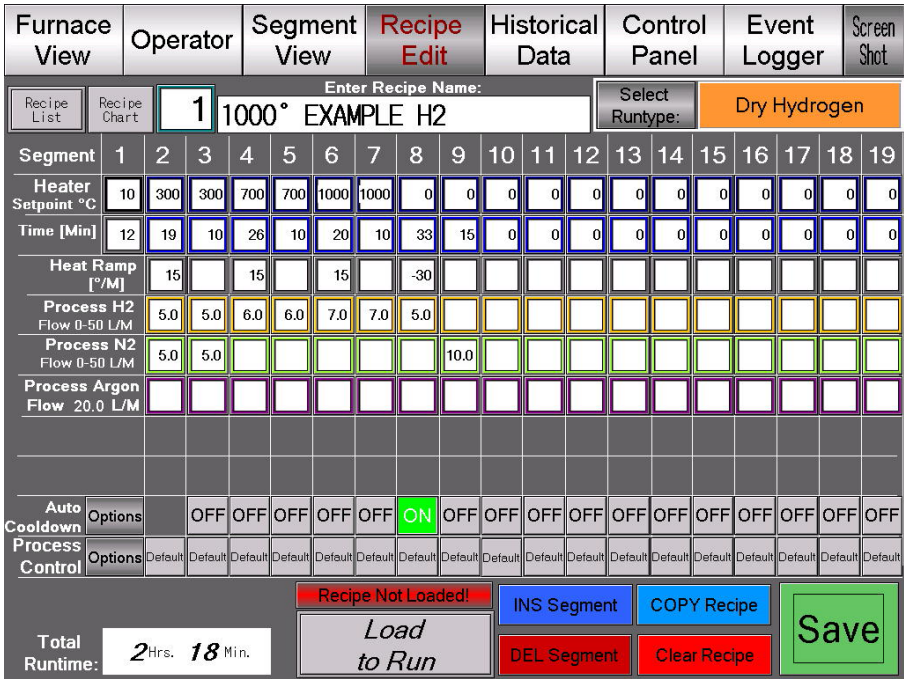
Camco furnace is proud to announce that it has fully launched a standard line of touchscreen HMI/PLC controllers for all of its furnaces. These new components boast many advancements and quality-of-life upgrades compared to their previous controller schema. Most major features are now available standard and always without subscriptions or hidden costs. The intuitive user interface shows current furnace performance and the state of all components to take any guesswork out of the furnace operation.

(The following screens depict a standard combination high vacuum and hydrogen furnace - All furnaces are similar, but this may not be the exact interface for the information pack this is attached to)



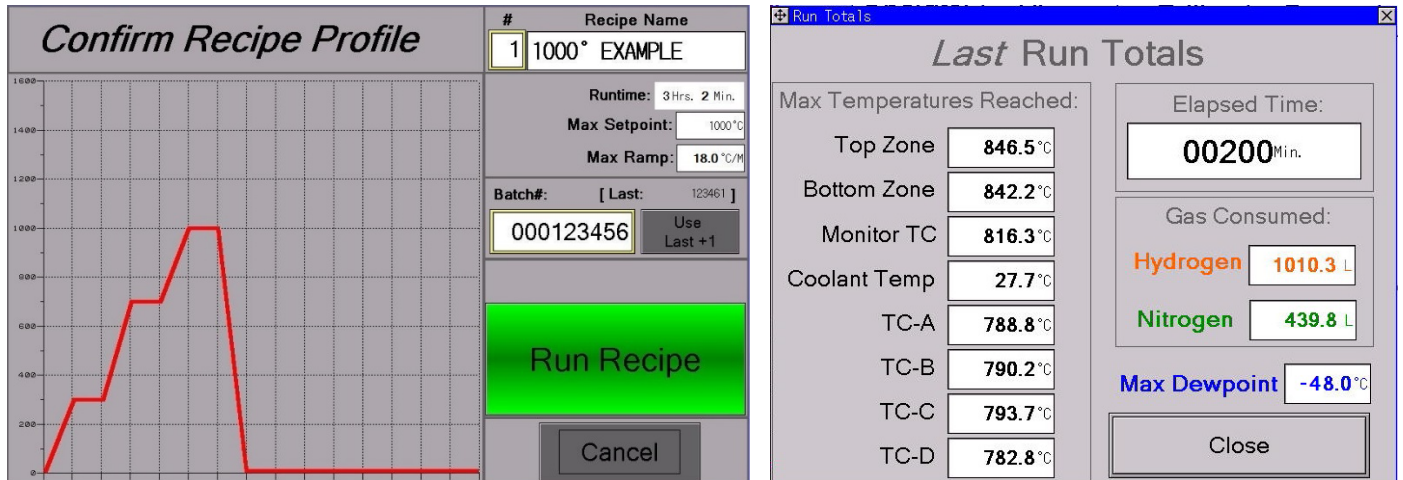
Easy Recipe Creating

Create segment-based recipes using a temperature setpoint and then input either time or ramp rate. All relevant events and inputs are displayed on one page to easily see at a glance what the entire profile will do. Events that are not relevant to the recipe runtime are hidden to remove screen clutter and prevent invalid recipes from being created.



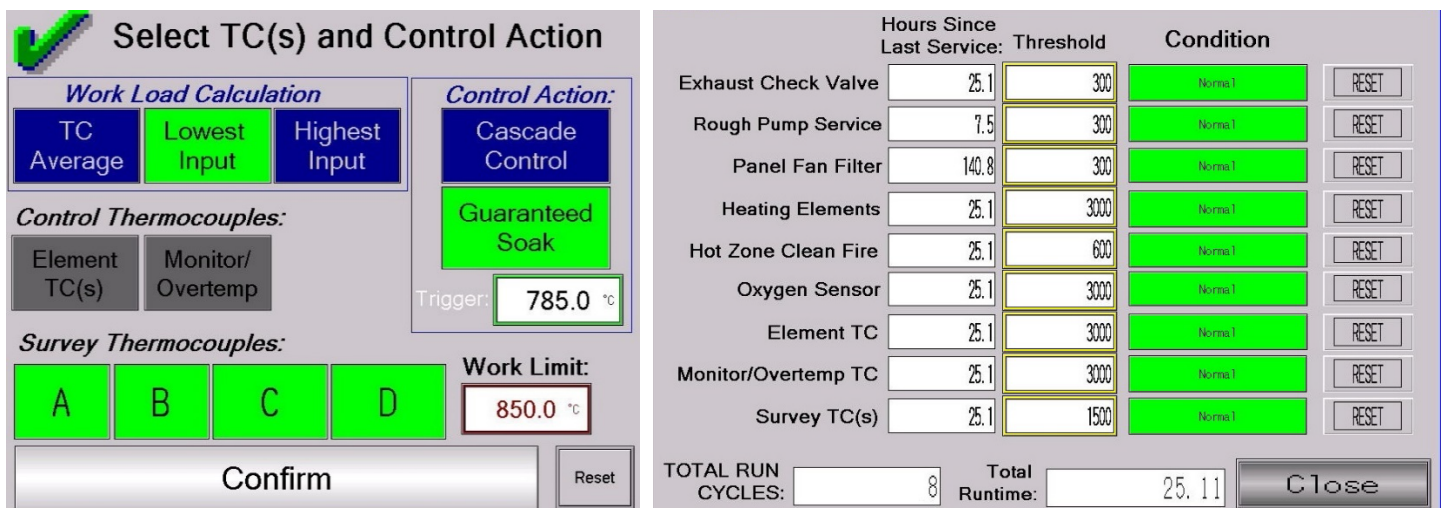
Helpful tools for Operators and Process Engineers

Users are presented with a Recipe Confirmation page before the furnace can be run to help prevent incorrect profiles from being used. Batch numbers are required for data logging but can be easily integrated into any existing downstream processing. Current and last run totals are kept track of for quick summaries including some of the most relevant data points.



Multiple options for setting special control action to the heating loop - Cascade controls and guaranteed soak using different methods of workload calculation for highly customizable recipes. An easy-to-use software-enabled work limit prevents parts from melting or reaching otherwise problematic temperatures.

Built-in preventative maintenance tracker simplifies monitoring commonly serviced items, their intervals, and current conditions.



Many other helpful graphical popups and operator pages have been created specifically for Camco equipment. Please inquire if you are interested in a remote tech demo or more information on the software.

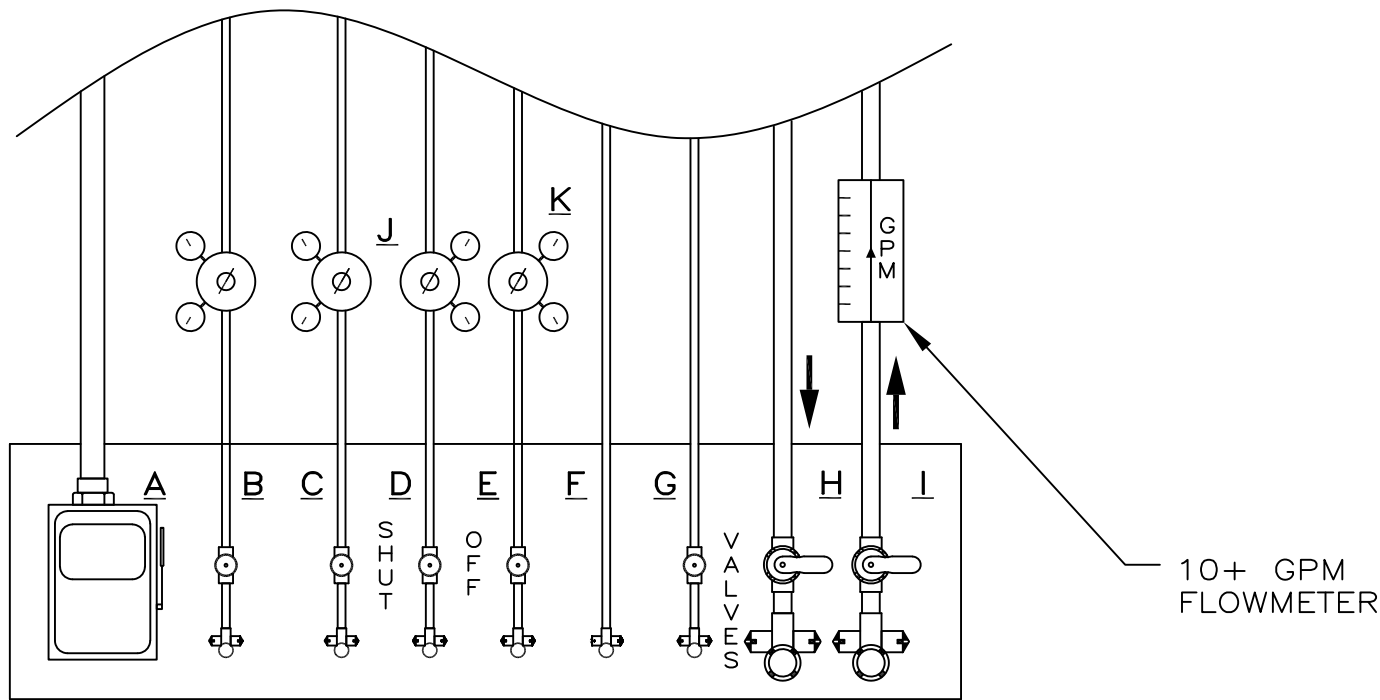
REV.	DATE	DESCRIPTION

UTILITIES: PREPARED AS SHOWN
BY CUSTOMER.

- A: 120A./LEG @ 480V. 60Hz 3 PH WITH GROUND, DISCONNECT.
- B: NITROGEN, 35–60 PSI AT A MAXIMUM FLOW OF 50 LPM
- C: HYDROGEN 35–60 PSI AT A MAXIMUM FLOW OF 50 LPM
- D: ARGON 20–50 PSI AT A MAXIMUM FLOW OF 20 LPM
- E: CDA (100 MICRON OR BETTER) SHOP AIR 80–100 PSI WITH AIR DRYER
- F: PROCESS ATMOSPHERE EXHAUST (NOT NEEDED WITH BURNOFF OPTION)
- G: D.I. WATER FOR BUBBLER MAKEUP
- H: COOLING WATER SUPPLY; 30 PSI MIN. AT 8–10 GPM.
- I: COOLING WATER RETURN OR PRESS. DRAIN IF USED.
- J: LINE PRESSURE REGULATORS SET AT 45 PSI X3
- K: LINE PRESSURE REGULATOR SET AT 100 PSI.

- 1/4" SWAGELOK
- 3/8" SWAGELOK, SS TUBE
- 1/4" SWAGELOK
- 1/4" SWAGELOK
- 1/2 FPT 1/2 COPPER PIPE
- 1/4" POLYFLOW
- 3/4" FPT, 3/4 COPPER PIPE
- 3/4" FPT 3/4" COPPER PIPE

NOTE: (MAX. BACK PRESSURE 15 PSI AT 5 GPM)
MAX HEAT LOAD 125,000 btu (10 TON) FOR CHILLER CALCULATION



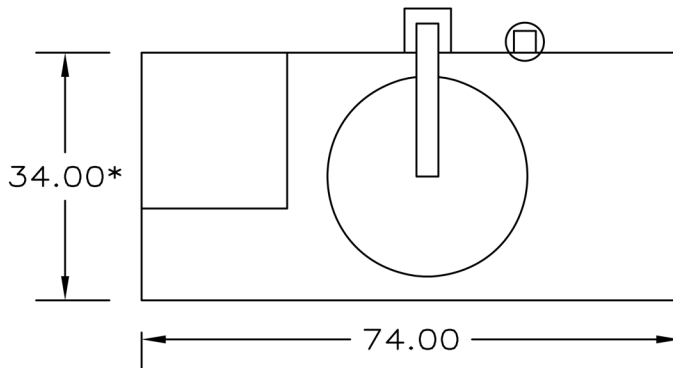
SUGGESTED UTILITY PANEL LAYOUT

NOTE; WATER SUPPLY SHOULD BE CONNECTED TO
EMERGENCY CITY WATER BACK UP IN CASE OF
POWER FAILURE AT HIGH TEMPERATURE

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K-COM-14	812	TOL'S EXCPT AS NOTED	DRN.BY: PAB	 Concepts & Methods Company, Inc. TITLE: 2-ZONE COMBO FAC PREP. 60HZ 480V DWG.NO: 88958 SHEET 7 OF 7 REV:		
		fract. ±1/32	APP.BY:			
		.XX ±.010	DATE: 11/3/22			
		.XXX ±.005	MAT: NOTED			
USED ON TASK	FWO	.XXXX ±.0005	FINISH:			
		ANGLES ±1/2'				

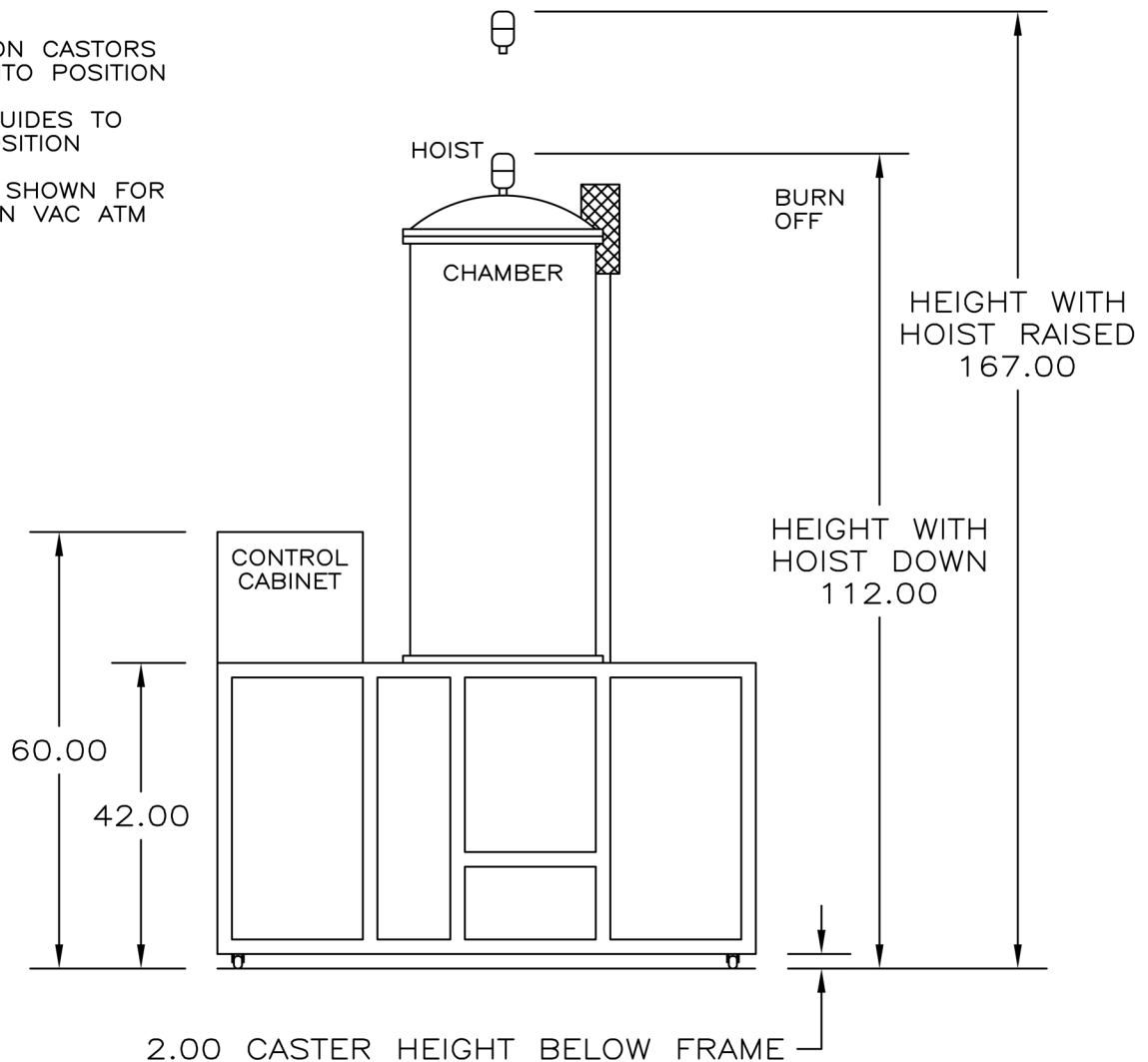
REV.	DATE	DESCRIPTION



NOTES;
FRAME IS ON CASTORS
TO ROLL INTO POSITION

LEVELING GUIDES TO
SECURE POSITION

BURN-OFF SHOWN FOR
COMBINATION VAC ATM
MODELS



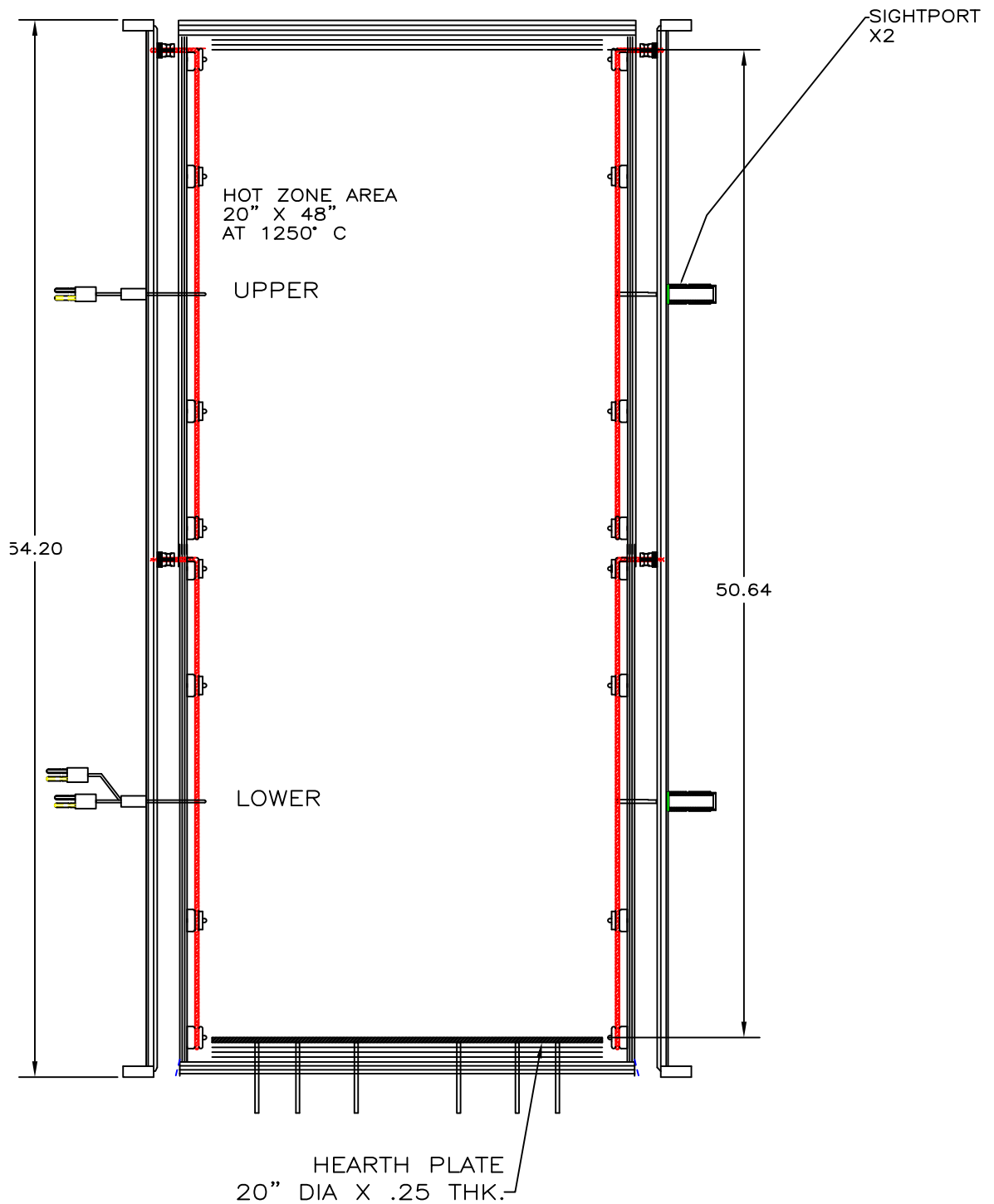
*WITH HOIST REMOVED.

NOTE: WITH THE TOP END OF THE CHAMBER AND THE HOIST REMOVED, THE FURNACE WILL
FIT THRU A 3-O DOOR.

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		TOL'S EXCPT AS NOTED fract. ±1/32 .XX ±.010 .XXX ±.005 .XXXX ±.0005 ANGLES ±1/2"	DRN.BY: T BARULICH		 Concepts & Methods Company, Inc.		
			APP.BY:				
			DATE: 12-8-09				
J-VAC 18X48	427		MAT:				
USED ON TASK	FWO		FINISH:				
			TITLE: J-VAC 12 18X48 FRAME DIM				
			DWG.NO: 89320		SHEET OF	REV:	

REV.	DATE	DESCRIPTION



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		TOL'S EXCPT AS NOTED fract. ±1/32 .XX ±.010 .XXX ±.005 .XXXX ±.0005 ANGLES ±1/2'	DRN.BY: P BARULICH		 Concepts & Methods Company, Inc.		
			APP.BY: TB				
			DATE: 6-1-20		TITLE: K-20X48 HOT ZONE LAYOUT		
K-20X48			MAT:				
USED ON TASK	FWO		FINISH:		DWG.NO: 89986	SHEET 1 OF 2	REV:

Considerations for Successful Installation and Startup

Installations should be completed following the provided specification sheets for Camco furnaces, and are usually straightforward. However, we ask you to please complete these additional best practices when connecting your machine. Following these steps and procedures for self-checking proper installation will save lots of time, money, and headaches in the future. Exact installations will vary between furnace models, options ordered, building environment, and state or local regulations, but the following points will be the same for most Camco machines.

General Machine Guidelines

- ➔ Carefully have your completed installation verified by a qualified electrician, plumber, and/or other facilities expert who is familiar with industrial machines. It is of paramount importance that your gas lines are leak-free and your high voltage electrical connections are properly terminated.
- ➔ Consult local codes or ordinances to determine if this machine should be bolted to the floor. Areas prone to earthquakes, for example, typically require the machine to be secured in this way. If it is not required, please use the leveling feet in each corner of the frame to lift the equipment off the casters to prevent it from rolling once in place.
- ➔ Make sure there is at least 18" of open space around the machine before bolting the machine to the floor. This is for proper airflow, but it ensures access to all sides of the machine which is necessary for several basic maintenance items.
- ➔ The equipment is intended to be installed in a facility with maintained environmental conditions.

Facilities Hookups

- Please make sure that all ball valves for shutting off the gas and water supply to your furnace are well-labeled and un-obstructed for easy access.



- Train all operators of the machine to be familiar with these shutoff valves, their locations, and when they should be shut off.
- Shut-off valves are not effective if you cannot understand what they control at a quick glance, or if you simply cannot reach them.
- It is good practice to be able to lock out any pressurized gas supply with a ball-valve lockout device. Alternately, you may be able to simply remove the handle once the valve is shut off to achieve nearly the same level of lock-out.
- Pressure gauges are not required at each hookup **but are extremely useful**. They allow all furnace users to quickly check for abnormal conditions and notify facilities personnel for correction before problems get out of hand.

- ➔ Camco does not recommend wiring our machines directly into a circuit breaker.

Instead, please install a knife switch or appropriately rated power plug close to the machine. Make sure that the power shutoff switch or power plug is also clearly marked and in a location that can be easily and quickly reached, typically marked with yellow tape on the ground in front of it. It is extremely important that the machine can be de-energized quickly in the event of an emergency. Train any operators of the machine on where this main shutoff or plug is located and how to use it.

Process Cooling

- ➔ If you intend to run the furnace directly from a closed-loop chiller with nothing else in the system, you typically do not need additional coolant filtering. However, make sure your process cooling water is clean and remains clean. Detritus and mineral deposits are detrimental to the chamber over time and can result in very expensive repairs after only a couple of years. It is recommended to install high flow in-line filters if you suspect your water is "dirty" in any way.
- ➔ Test your coolant system by turning on your process water cooling to the furnace once you have completed the initial machine installation. This should be done before the furnace is powered on for the first time. There are no valves in the system other than a simple swing-arm check valve that will not allow water to run through the machine backward if the supply and return are switched. Verify there are no leaks and that you achieve water flow. See your furnace's spec sheet to verify you meet the recommended water flow rate.