ATAMI Standard Operating Procedure

Camco Brazing Furnace

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Revision	Date	Description/Change	Curator
0	4/12/2019	New document	Randy Greb
1	9/28/2019	Added procedures – how to stop a run before it's done, how to re-set the overtemp TC controller after re-start. Moved descriptions of DCP302 controller to attachments section. See contents for links to changes.	Randy Greb

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Scope:

This document describes basic operating procedures for the CAMCO brazing furnace.

System Specifications:

See the System description on the ATAMI WEB site.

Maximum sample size is 18 inches in diameter and 24 inches in height.

Safety

General

The Camco Brazing furnace uses high temperature, H2 gas and has a large chamber body. All safety protocols must be followed to prevent injury

PPE Required

Safety glasses must be worn at all times when operating the furnace.

Nitrile gloves

Hazardous Energies

Electrical

NA

Mechanical

The large chamber can crush body parts if it is lowered incorrectly. Always ensure all body parts are out of the path of the chamber when lowering it.

Stored/Potential

NA

Thermal

Conditioned parts may be at high temperature after treatment, even if the control TC has reached a temperature below which opening the chamber is allowed.

If you suspect that the part is still hot and can cause a burn or melt gloves, contact ATAMI staff for help.

Materials/Consumables Hazards

Because this is a mutli-user system, there may be contaminants present in the chamber.

Always use gloves when handling parts and remove and dispose of them properly when finished.

Do not blow off or try to clean the inner surfaces of the chamber in any way. Only ATAMI staff are allowed to conduct maintenance or cleaning procedures.

H2 gas is plumbed to the system

Interlocks

The chamber is interlocked so that it will not open until the control TC indicates a temperature less than 80 deg C.

Training Requirements

1. Pass all ATAMI required safety courses
2. Finish lab tour with qualified ATAMI trainer.
3. Complete all hands on training for this system and signed off by trainer.
4. Verify access to this document for reference.

Procedures

MUST DO if running hydrogen reducing environment:

- When programming Segment 1, **ALWAYS** program at 0° for 1 Hour for pre-purging.
- Segment 2 should be programmed at 0° for 15 minutes for Process Gas Fill.
- The last segment of the program should **ALWAYS** be programmed at 0° for 45 minutes for post purge.
- Time Event 1 (Process Gas Fill) should **ALWAYS** be programmed ON at the beginning of Segment 2 and programmed OFF at the beginning of the last segment (The purge segment). See example of Event Relay Function write up in this manual.
- Vacuum Purge **MUST** be programmed ON for the first five minutes of Segment 1.

See Prog#1 Practice Hyd in the brazing recipes spreadsheet for an example.

How to Create a New Program:

Step	Action	Notes
1	Get a programming spreadsheet and diagram your program before starting.	The spreadsheets are located on the ATAMI share drive at: \\mohr.engr.oregonstate.edu\atami\Capabilities and SOPs\Camco Brazing Furnace\SOPS_and_standard_recipes\recipes

2	Press PROG until you get to the program number that you are going to edit.	If you ever get lost during the programming process you can press DISP to exit programming mode and go back to the main display.
3	Press FUNC + PROG to enter programming mode.	You'll see the PRG LED light.
4	Press ENT to edit the upper display and enter the desired temperature.	**"0" is room temp.** Otherwise, temps are in deg C. Use the left/right arrow keys to change position, use the up/down keys to change value.
5	After entering the temperature value ENT again to go to the lower display to enter the time.	Time is hh.mm (mm goes up to 59). Use the left/right arrow keys to change position, use the up/down keys to change value.
6	Press ENT to save the time for the lower display.	
7	Use the up/down keys to move to each program item and set using the same method (ENT).	To clear an item in the lower display, use FUNC+CLR
8	After saving all of the EVn and Tn events, cycle back to the initial temp/time setting. Then press the right/left keys to go to the next segment.	

How to Load a Sample and Program:

Step	Action	Notes
1	Raise the chamber using the raise/lower switch on the front panel	If the chamber does not raise it may still have some vacuum. You can press the vent until you see CG2 to get to $3.4x10^2$ torr. If it still doesn't raise after that, it may be above temperature. The control thermocouple will indicate a temp > 80 deg C. In that case, you will need to wait until it cools. 
2	After you put the sample in the chamber, use the switch to close it.	You can use some of the graphite and metal blocks on the table to the left of the furnace if you want to support your sample. If you suspect any possibility of melting, be sure to place the sample on a substrate so that you don't melt it to the base of the chamber.

		Be sure that the O-ring is clean to ensure that there are now leaks into the chamber when it is pumping down. If it appears dirty, you can carefully wipe it down with a wipe that is partially soaked with IPA.
3	You can tell that the chamber is closed when you see the clamp close. It will not stay closed.	
4	Press PROG to get the program you want.	If you have not recently used the program, you may want to check the program using the "How to Create a New Program" steps to verify that each segment matches the program you want to use.
5	Press RUN/HOLD to start the program.	If you are running vacuum, you will hear the vacuum system and see CG1 start to drop. After a few minutes, you will see CG2 start to drop and it will match the high vacuum value, which will eventually reach the 10^{-5} to 10^{-6} Torr range. 
6	If you need to end the program before it is complete, you can press the RUN/HOLD button while holding down the PROG key.	This will re-set the DCP. If the chamber is pumped down, you will have to manually vent or run a vent program to bring it back to atmosphere.

How to stop a run before completion, if needed:

Step	Action	Notes
1	If you need to end the program before it is complete, you can press the RUN/HOLD button while holding down the PROG key.	This will re-set the DCP. If the chamber is pumped down, you will have to manually vent or run a vent program to bring it back to atmosphere.

How to collect and analyze data:

Step	Action	Notes
1	When you start your program, carefully open the cover door on the Yokogawa controller and press Start. This will collect vacuum and T data during your program run.	
2	When you are done, press Stop on the controller.	It will also stop automatically after 48 hours.
3	You can use the memory card and USB reader to get data to your computer for analysis. BE CAREFUL, THE DOOR IS DELICATE.	 
4	You will need the custom software from Yokagawa to read the data and convert it to csv file format for use in other tools such as excel.	The software (DxViewer.exe) is on the share drive here: \\mohr.engr.oregonstate.edu\atami\Capabilities and SOPs\Camco Brazing Furnace\data_analysis\DAQSTANDARD

How to re-set the overtemp TC after re-starting the system:

If the Camco is powered down, the overtemp TC alarm must be manually reset. Here are notes from the manual:

> To reset the LIMIT alarm press the **MA/Reset** key once. Reset this alarm only when the program is complete.
>
> If the Limit Alarm is tripped a flashing "**LIMIT**" will appear on the screen and the power to the elements will be disengaged. When the program is operating the "Overtemp Alarm" will be lit
>
> When this happens **THE ALARM MUST BE MANUALLY RESET** in order to continue or perform another run.

Overnight or Extended Shutdown (from Camco manual):

The furnace can be left on overnight. Many users leave the furnace powered on all the time. It can be left on indefinitely.

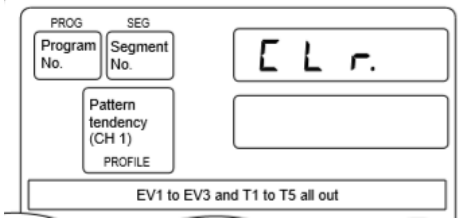
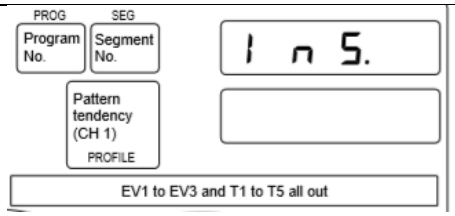
One reason to shut the furnace off overnight or during the weekend would be in case of an extended power failure to your facilities. When the furnace is turned off or has no power applied to it, it will automatically purge with Nitrogen. This could waste unnecessary gas.

If you are going to turn the furnace off overnight or for an extended period of time do so via the key.

BE SURE TO TURN THE NITROGEN SUPPLY VALVE OFF AT THE WALL or it will purge with Nitrogen indefinitely.

NEVER turn the purge flowmeter off!

How to insert a segment:

Step	Action	Notes
1	In the setting display state, move to the segment of interest with the right/left arrow keys.	
2	Press FUNC+ENT, and the display shows InS.	

3	Press the up arrow key to see InS blinking and then ENT while Ins is blinking to insert a segment.	When you insert a segment, a new segment is automatically created at the currently displayed segment No., and all segment Nos. onward are incremented by one.
4	Press the down arrow key to see dEL blinking and then ENT to delete that segment.	

How to delete all segments greater than the current segment number:

Step	Action	Notes
1	Press FUNC+PROG to enter programming mode.	
2	Use the right/left arrows to choose the segment of interest.	
3	Press FUNC+CLR.	The display will flash and show the letters, “CLr”.
4	If you press ENT, it will clear all the segments that are greater in number than the current segment.	
5		

Standard or Example Recipes

Recipe spreadsheet:

See the spreadsheets on the ATAMI share drive for typical recipes.

\\mohr.engr.oregonstate.edu\atami\Capabilities and SOPs\Camco Brazing Furnace\SOPS_and_standard_recipes\recipes

When using H2:

Be sure to follow instructions from this SOP, above.

Basic Troubleshooting

Difficulty achieving vacuum:

Step	**If**	**Then**	**Notes**
1	You have issues with getting appropriate Vacuum.	You may have a particle or issue at the o-ring on the bottom of the chamber. You can stop your run, vent (per procedure above) and then when	

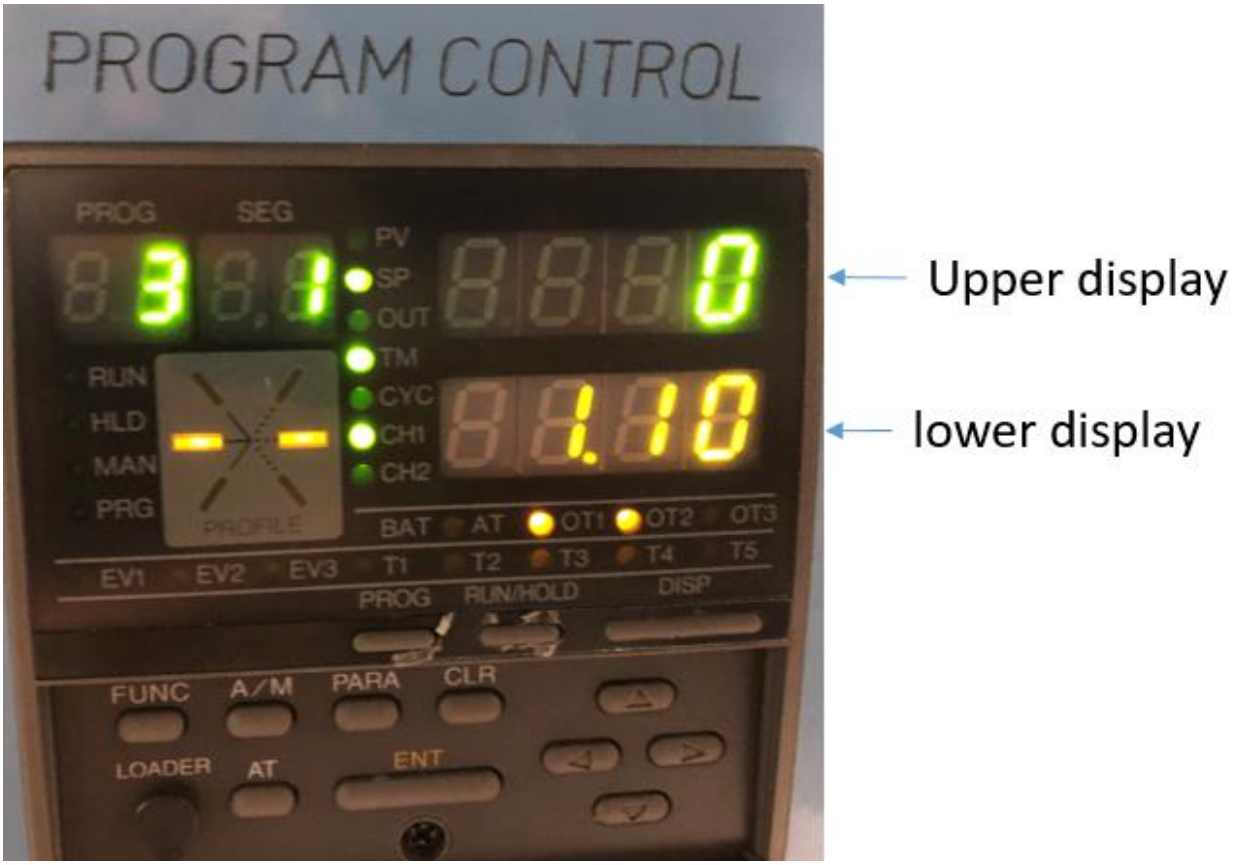
		the chamber is at temperature, it can be raised up again. Carefully use a lint free wipe and clean the o-ring. Then try again.	
2	If wiping the o-ring doesn't work.	Contact ATAMI staff.	

Attachments

Diagram of DCP302 Controller and examples of what it is displaying:

Overall display showing buttons that are referenced in the procedures below. This is the baseline display to start actions described in this SOP:

SP, TM and CH1 LED's lit. OT1 and OT2 lit. If it doesn't look like this, press DISP until it does.



For running a program:

What the temperature ramp display means: The left bar is the current temperature ramp, the right is the next program sequence. The direction of the bar indicates cooling, steady, or ramping temperatures.

What programming spreadsheet map positions mean:

Funtion	segment item	Display	Units	Values to set	What is this
Starting Display	**SP**	Upper Display	SP (deg C)	Temperature set point in deg C	The temperature that is set for this segment.
	Time	Lower Display	Time (hh.mm)	Time in hrs and minutes for the segment.	The time value for this segment.
Not Programable	**EV1**	Upper Display	na	Not programmable, just leave blank	Not programmable.
		Lower Display	na	Not programmable, just leave blank	Not programmable.
Vacuum enable	**EV2**	Upper Display	na	000 to turn it on. Blank when off.	Needs to be on for segments that have heat in vaccuum, or during purge events.
		Lower Display	na	Just leave as ----	
Partial Pressure	**EV3**	Upper Display		000 to turn it on. Blank when off.	Flows N2 gas for partial pressure treatment.
		Lower Display	set pt	Just leave as ---- to leave on for the whole segment time, or put a value to end before the end of the segment.	
Process Gas	**T1**	Upper Display	ON hh.mm	time after start of segment to turn it on.	Flows process gas (N2, Ar or H2). Setpoint is shown on front panel of camco furnace.
		Lower Display	OFF hh.mm	time after start of segment to turn it off. Leave as ---- if you want it to stay on for the whole segment.	
Bubbler	**T2**	Upper Display	ON hh.mm	time after start of segment to turn it on.	Flows the process gas through the bubbler. Be sure that the bubbler has water in it.
		Lower Display	OFF hh.mm	time after start of segment to turn it off. Leave as ---- if you want it to stay on for the whole segment.	
Vacuum pump/purge	**T3**	Upper Display	ON hh.mm	time after start of segment to turn it on.	Turns the vacuum pump on/off. Purges vacuum with N2 when temp is set to 0. Runs vacuum when temp is not 0.
		Lower Display	OFF hh.mm	time after start of segment to turn it off. Leave as ---- if you want it to stay on for the whole segment.	
Vent (vacuum)	**T4**	Upper Display	ON hh.mm	time after start of segment to turn it on.	Vents the chamber. EV2 and T3 should be off when this is enabled.
		Lower Display	OFF hh.mm	time after start of segment to turn it off. Leave as ---- if	

Funtion	segment item	Display	Units	Values to set	What is this
				you want it to stay on for the whole segment.	
Vacuum Delay	**T5**	Upper Display	ON hh.mm	000 to turn it on. Blank when off.	During ramp segments (current T is > previous T), this will stop the T increase until the vacuum goes below the normal range again. This is typically used when outgassing from samples occurs.
		Lower Display	OFF hh.mm	Just leave as ---- to leave on for the whole segment time, or put a value to end before the end of the segment.	
PID	**PID group**	Upper Display	PID		
	selection	Lower Display	Group No.		
Guaranteed Soak	**G. Soak**	Upper Display	G.S.	"25" if used, "000" if not	Guaranteed soak can be added to the last segment before the Vent segment. This will ensure that the chamber does not vent until it gets down to within 25 deg of 125 deg C.
	setting	Lower Display	no or yes	"YES" if used, "----" if not	

Function keys for programming DCP302

Category	Function	Key operation
Program setup	To start program setup (programming) (in basic display state)	FUNC + PROG
	To move between program items and segment Nos.	↑ ↓ ← →
	To start changing of item setting values (while setting value is blinking)	ENT
	To end changing of item setting values (while setting value is blinking)	
	To change item setting values (while setting value is blinking)	↑ ↓ ← →
	To clear item setting (while setting value is blinking)	FUNC + CLR
	To cancel changing item setting values (while setting value is blinking)	DISP
	To insert/delete segments	FUNC + ENT
	To change the program No. in ascending order	FUNC + PROG
	To change the program No. in descending order	FUNC + ↓
	To end program setup (programming)	DISP
Program copy	To start program copy (in basic display state)	↑ + PROG
	To change the copy destination program No.	↑ ↓
	To execute program copy (while setting value is blinking)	ENT
	To end program copy	DISP

Descriptions of EV1-EV3 and T1-T5 functions:

Event No.1 (EV1): Calls for purge and enables process gas. **Not programmable**. Turns on and off with the start and end of the run.

Event No.2 (EV2): This output defeats the chamber pressure interlock and allows for heat in vacuum. It is only to be programmed ON to heat in High Vacuum and for Vacuum purge. Also allows for vacuum venting of the chamber and turbo (**TM4**)

This event will not allow **Time Event 1** to operate. You cannot pump and have process gas at the same time.

Event No.3 (EV3): Activates the partial pressure vent solenoid. This fills the chamber with a third gas and will turn off with an alarm in the recorder. (The recorder monitors the pressure of the capacitance manometer and shuts off the partial pressure solenoid with alarm #3)

Time Event No.1 (TM1): Calls for process gas and turns purge gas off.. Must be programmed **ON** at the beginning of seg 02 and programmed **OFF** in the last segment of the run. SEE EXAMPLE!

This event used only for Hydrogen atmosphere runs.

Time Event 1 must be programmed **ON** for every segment **Except the first and last segment.**

Example:

		Pre-Purge						Post Purge
	Seg. No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
	On	-----	000	000	000	000	000	------
Time Event 1	**Off**	-----	------	------	------	------	------	------

Process gas flows when Time Event is ON.

Time Event No.2 (TM2): Calls for the Bubbler to be active. It is usually programmed ON in segment 3 (the heat ramp segment). It will divert a portion of the **process gas** through the Bubbler to humidify the process gas. The Bubbler flowmeter must be open for gas to flow and is manually adjusted.

Time Event No.3 (TM3): Calls for the vacuum pumps to operate. It will open the gate valve and foreline valve. Used for **Vacuum purge** and also **High Vacuum** for the heat cycle. The turbo pump will automatically turn on when the chamber reaches 9.5E-1 torr on gauge "A" . Turn this OFF when performing partial pressure runs.

Time Event No.4 (TM4): Calls for venting the **Chamber and Turbo** after a High Vacuum pump.

EV2 must also be programmed ON for this to operate. The flowmeter labeled "VENT" is active with this output. You may choose to stop pumping and vent at an elevated temperature. This will not operate while the furnace is pumping (If TM3 is on). You cannot pump and vent at the same time!

Time Event No.5 (TM5): This output is the Vacuum Delay Enable circuit. It works with setpoint #1 in the Vacuum Gauge Controller to give hold and run signals in the event of out gassing during a ramp heat up (see SP1 in the GP discussion). This feature is usually only applied to the ramp segments of a **Vacuum program**. It has the effect of extending the ramp. It should always be programmed on at the fist ramp of a **Vacuum program**.

Setting Gas Flows:

As is convention, the flowmeters used in CAMCo furnaces are calibrated to be direct reading for air. As the density of Nitrogen is very nearly the same, they can also be directly read for Nitrogen. Hydrogen, being much less dense, requires a correction to be applied.

For the Hydrogen flowmeter, the observed reading must be multiplied by 3.3 to determine the mass flow of this gas. Applying this factor allows blending the process gas to virtually any volumetric ratio desired.

The below listed process gas flowmeter settings for example, provide a recommended total process gas flow of 20-25 SCFH of some commonly used mixtures of Hydrogen and Nitrogen.

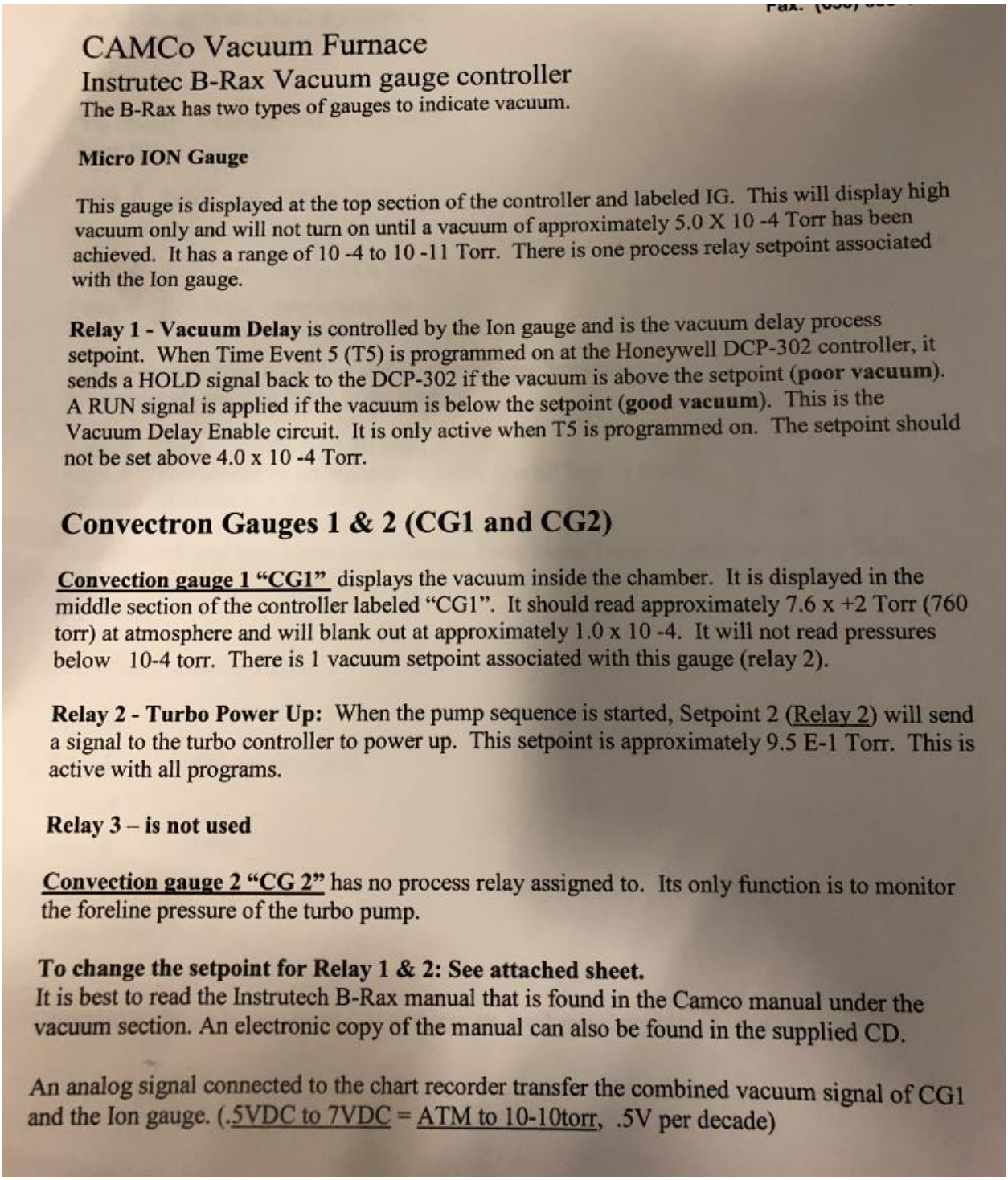
100% Hydrogen: Set Hydrogen flow to 7 and Nitrogen to 0.

75%	Hydrogen-25% Nitrogen:	Set Hydrogen flow to 5 and Nitrogen to 5.
50%	Hydrogen-50% Nitrogen:	Set Hydrogen flow to 3 and Nitrogen to 10.
25%	Hydrogen-75% Nitrogen:	Set Hydrogen flow to 2 and Nitrogen to 17.

CAUTION! THE NITROGEN PURGE FLOWMETER IS ALWAYS LEFT SET TO AT LEAST 30 SCFH. PROPER PURGING IS AN IMPORTANT SAFETY FUNCTION!

Note: Over-tightening of flowmeter valves when shutting them off can damage their seats and/or cause a downward creep of flow when first turning them on. Be sure to check flow frequently if a flowmeter valve has been turned off.

Camco Vacuum Gauge Descriptions:



CAMCo Vacuum Furnace

Instrutec B-Rax Vacuum gauge controller

The B-Rax has two types of gauges to indicate vacuum.

Micro ION Gauge

This gauge is displayed at the top section of the controller and labeled IG. This will display high vacuum only and will not turn on until a vacuum of approximately 5.0 X 10 -4 Torr has been achieved. It has a range of 10 -4 to 10 -11 Torr. There is one process relay setpoint associated with the Ion gauge.

Relay 1 - Vacuum Delay is controlled by the Ion gauge and is the vacuum delay process setpoint. When Time Event 5 (T5) is programmed on at the Honeywell DCP-302 controller, it sends a HOLD signal back to the DCP-302 if the vacuum is above the setpoint (**poor vacuum**). A RUN signal is applied if the vacuum is below the setpoint (**good vacuum**). This is the Vacuum Delay Enable circuit. It is only active when T5 is programmed on. The setpoint should not be set above 4.0 x 10 -4 Torr.

Convectron Gauges 1 & 2 (CG1 and CG2)

Convection gauge 1 "CG1" displays the vacuum inside the chamber. It is displayed in the middle section of the controller labeled "CG1". It should read approximately 7.6 x +2 Torr (760 torr) at atmosphere and will blank out at approximately 1.0 x 10 -4. It will not read pressures below 10-4 torr. There is 1 vacuum setpoint associated with this gauge (relay 2).

Relay 2 - Turbo Power Up: When the pump sequence is started, Setpoint 2 (Relay 2) will send a signal to the turbo controller to power up. This setpoint is approximately 9.5 E-1 Torr. This is active with all programs.

Relay 3 – is not used

Convection gauge 2 "CG 2" has no process relay assigned to. Its only function is to monitor the foreline pressure of the turbo pump.

To change the setpoint for Relay 1 & 2: See attached sheet.
It is best to read the Instrutech B-Rax manual that is found in the Camco manual under the vacuum section. An electronic copy of the manual can also be found in the supplied CD.

An analog signal connected to the chart recorder transfer the combined vacuum signal of CG1 and the Ion gauge. (.5VDC to 7VDC = ATM to 10-10torr, .5V per decade)