## Marshall Two-Zone Tube Furnace (20 – 1100° C)

You may use this furnace only after training from Facility staff. Reserve the furnace in CCMR Coral and be sure to enable and disable when you start and finish. The furnace is listed under Thin Film Deposition and Material Processing – Heat Treating – Controlled Atmosphere Furnaces.

Maximum temperature can be 1100° C. High ramp rates may overshoot your setpoint temperature so lower ramp rates may be desired. The ramp should not exceed 5 °C/min. Control is achieved using the furnace temperature; the thermocouple inside the tube may deviate slightly from this.

**General Rules of Courtesy**

Use Coral to reserve time and to enable the furnace once you start using it. Reserving and enabling are separate actions on Coral. Furnaces are charged on a per run basis so coral must be enabled and disabled for each run.

Make sure you remove your samples as soon as your reservation on Coral is over.

Do not take other users’ samples out of the furnace without their explicit permission.

**Sample loading, gas flow, and zones:**

* Samples are loaded from the left and should be held in an appropriate boat or crucible.
* Zone 1 is on the left and Zone 2 is on the right. Both can be programmed independently if a non-uniform heating profile is desired.
* If gas flow is desired, attach the cap to the left of the tube and secure the threading.
* Gases come from the cylinder rack behind the control rack (which is not used). There are four output channels on the rack; verify that the gas you need is connected to one of these on the back, and connect the hose to the front using the push-to-connect fitting. From there, the gas flows through a valve, the tube, and an exhaust bubbler. Regulator should be set to an outlet pressure below 10psi

**To program the zones and run:**

1. **Read instructions below in advance** and read the example programs; taking too long between button presses may restart process
2. To program the controller (follow these instructions carefully so that the desired temperatures and hold times are obtained)
	1. **Push and hold the circle-P button**, Pnr1 will appear for program 1.
		1. **Use the arrow keys to select program 1, 2, 3, or 4**
		2. **Push the circle-P button to cycle through the 8 program steps and step parameters. Press the arrow keys to see and adjust the setting for each of the following (# indicates step number):**
			1. Pr# Ramp setting in °C/min. Setting below 0 gives ‘STEP’, ‘NONE’ or ‘END’. STEP means no controlled ramp (jump directly to the next setpoint). The ramp should not exceed 5 °C/min.
			2. PL# Setpoint temperature (level) in °C
			3. Pd# Hold (dwell) time in hours. Setting of 0 is no hold, below 0 will show ‘END’
	2. The current program should run until it encounters an ‘END’ hold command, but to be sure, you should **set all unused steps to ramp/setpoint/hold settings of STEP/0/END**
3. Press ‘Run/Hold’ to run the program you are on.
	1. You can always press the white up/down arrow keys together to abort a running program. This will disable power output and the furnace will simply return to room temperature.
	2. The display will show the current step at the bottom right corner.
	3. You can press the circle-P button to see the current setpoint or time remaining
	4. Pressing the HOLD button will pause the setpoint at the current temperature and a HOLD light will appear
	5. If the ‘manual’ light is on, you can manually adjust OP setting as 0-100% of output power.
	6. An ‘E’ will appear when the program has ended
4. Wait until tube temperature is below 50° C before removing samples.

**Notes on programming:**

* An excerpt from the temperature controller manual featuring hints and programming examples is kept next to the controller.
* Take note of the 'Cnt' setting which will link programs 1,2,3,4. For example if ‘Cnt’ is set to yes, when you run program 1, and there's something in program 4, program 4 will run also.
* PLC setting should be 1 for one cycle. You can repeat the program up to 999 times.
* STEP just means no ramp, so setpoint will be changed immediately and 0% or 100% power may be applied.
* END ramp setting on step X holds the temperature at the setpoint of step X-1 indefinitely, regardless of the hold time for step X-1. Manually aborting the program (press both arrows) is the only way to end the program from this state.
* STEP/0/END will send the setpoint to 0 and cooling will be as fast as possible. If you want a controlled cool, you can do: 10/20/END and that should end the program. You can also add in STEP/0/END just to be sure.

**Programming example:**

The program outlined here would heat to 1000°C at a rate of 5°C/min (300°C/hr) and hold for 4 hours.

* Push and hold the circle-P button, Pnr1 will appear for program 1.
* Push the circle-P button to bring up Pr1. Use the arrow up or down to key to set to 300.
* Push the circle-P button to bring up PL1. Use the arrow up or down to key to set to 1000.
* Push the circle-P button to bring up Pd1. Use the arrow up or down to key to set to 4.
* Push the circle-P button to bring up Pr2. Use the arrow down to key to set to go past 0 to STEP.
* Push the circle-P button to bring up PL2. Use the arrow up or down to key to set to 0.
* Push the circle-P button to bring up Pd2. Use the arrow down to key to set to go past 0 to END.
* If necessary, set steps 3 and up to STEP/0/END as described above.