## LabTemp Tube Furnace (20 – 1700° 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 as “Tube-Furnace-1700-C”.

Maximum temperature can be 1700° C. Do not use a quartz tube above ~1000° C. High ramp rates may overshoot your setpoint temperature so lower ramp rates may be desired. The ramp should not exceed 300 °C/hr. Control is achieved using the furnace temperature; the thermocouple inside the tube may deviate slightly from this. The type B thermocouple is not designed to measure at room temperature, and thus (erroneously) reads around 70 at room temperature. This is normal and not an indication of any problem.

**General Rules of Courtesy**

Use Coral to reserve time and to enable the furnace once you start using it.

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 and gas flow:**

* Samples are loaded from the front and should be held in an appropriate boat or crucible.
* If gas flow is desired, attach the cap to the front of the tube and secure the threading.
* Gases come from the cylinder rack to the right of the furnace. 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 flow gauge (adjust flow level using the cylinder regulator if necessary), a valve, the tube, and an exhaust bubbler. Outlet pressure should be set below 10psi

**To program the furnace 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/hr. Setting below 0 gives ‘STEP’, ‘NONE’ or ‘END’. STEP means no controlled ramp (jump directly to the next setpoint). The ramp should not exceed 500 °C/hr.
			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:**

* It is possible to run a simple setpoint operation rather than using a program. A setpoint may be entered without using the program menu; pressing Run will apply 100% power until that temperature is reached (with no controlled ramp up). In this case, the power must be manually stopped by the user.
* 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.
* Sometimes, the thermocouple does not give proper feedback to the controller, causing an alarm to completely shut off the furnace. If this happens, press the black ON button at the left-center of the panel and wait for the controller self-check. If it shuts off when you let go of the button, you can hold the button down while programming. Alternatively, you can hold it down and press the TEST button on the thyristor, which bypasses the controller and applies power directly to the furnace, causing the temperature to rise. Hold it until the temperature rises over 100°C, at which point the thermocouple should start communicating with the controller.
* If an E is displayed on the controller, this indicates an error which can be cleared by pressing both arrow keys.

**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.