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TCS Chiller Standard Operating Procedure

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1 Introduction

This document is an operator's manual for the TCS Chiller, and details the installation, operation, and troubleshooting of the chiller and its electronics.

2 Installation

The TCS Chiller should have been delivered with the tank lid and submerged components preassembled in accordance with the diagram in the TCS Chiller Design document. To finish the assembly:

- 1) Place the lid assembly into the tank and screw down the lid.
- 2) Set the tank in the wheeled base in the desired chiller location.
- 3) Screw down the eye bolts in the wheeled base until the base is resting on the rubber feet and level.

The chiller should be installed on the isolation slab at least 24' away from the optical level piers. The site chilled water should be plumbed into the exchanger with the final few feet consisting of flexible bellows, with the control valve on the supply side and a check valve on the return side to prevent backflow. Shutoff valves should be installed on both the supply and return lines.

The chiller should be plumbed to the TCS Laser Table through 1" copper tubing, with the final few feet consisting of flexible bellows, with no sharp bends or right angles in the tubing (only radius curves). Foam insulation should cover the supply and return lines to the TCS Laser Table. The total vertical head of this plumbing should be no more than 5'. A 0-2GPM rotameter should be installed at the TCS Laser Table supply. There should be shutoff valves in the supply and return lines to the TCS Laser Table at the Table and at the Chiller. There should be provision for draining or blowing the supply and return lines dry.

The submerged thermistor is delivered already installed into the lid assembly. The other four thermistors must be glued into place with Vac-Seal. The 'chiller input' thermistor should be glued to the inlet plumbing to the heat exchanger. The 'laser head' thermistor glues into a hole in the side cooler plate of the TCS Laser. The 'laser supply' and 'laser return' thermistors should be glued to the supply and return copper tubes on one of the TCS Laser cooler plates. The thermistors should be connected to the TCS Chiller control board through shielded twisted pair cable. The level

sensors and control valve can use unshielded and untwisted cable. The two pumps and the heater inside the tank plug into a power strip that is controlled by a relay on the TCS chiller board. The submerged heater may be left unplugged if it is desired that the TCS Laser Table provide the sole source of heat to allow the chiller to operate at lower temperature, but the TCS Chiller will not operate correctly if both the TCS Laser Table and submerged heater are off. **Never plug the heater directly into wall current! Never run the heater or pumps dry!**

3 Safety Interlocks

The TCS Chiller and TCS Laser Table have several safety interlocks to prevent overheating of the laser and large spills of chiller coolant and resulting damage to components. Any interlock causes the chiller to shut itself down within a few seconds of the interlock trigger. A TCS chiller shutdown turns off both chiller pumps, shuts off the submerged chiller heater, and closes the control valve on the exchanger.

Within the chiller reservoir are two water level sensors. The one submerged in the coolant ('droughtmon') detects loss of coolant in the event of a leak from the chiller. The nominal voltage from the sensor is 5V. If the coolant level falls below the sensor, it closes a switch, changing the voltage to 0V. The sensor above the coolant ('geysermon') detects overfilling of the chiller due to an heat exchanger leak. Its nominal voltage is 0V, and rises to 5V if the coolant level rises above the sensor.

Any of the five thermistors monitored by the TCS Chiller will trigger a shutdown if they leave the range of 10-30°C. This set of interlocks detects loss of flow through the heat exchanger, submerged heater failure, and laser supply pump failure. Failure of the circulation pump to operate is not detected by any interlock; however, the TCS Chiller does not necessarily need the additional circulation provided by the pump.

When the safety interlocks resume their nominal values, the TCS Chiller will automatically resume operation in accordance with the settings of the control channels. The TCS Chiller does not change the control channels as a result of an interlock-generated shutdown.

The TCS Chiller does not shut down the TCS Laser or TCS AOM when it shuts itself down. The TCS Laser and AOM have their own thermal sensors, and when the TCS Chiller shuts off the TCS Laser and AOM will sense their own temperature rise and will shut themselves off when this rise exceeds their operating ranges.

4 First Operation

The shutoff valves on the supply and return lines at the TCS Chiller and at the TCS Laser Table must be open before starting the TCS Chiller pumps.

Before switching on the TCS Chiller for the first time, after servicing, or after a long shutdown, first verify that it is filled with coolant to the fill level indicated on the tank side. The TCS Chiller coolant is a 15% propylene glycol, 85% water mixture. The level sensors will not permit operation unless the coolant level is close to the fill line. If the lines from the TCS Chiller to the TCS Table need to be filled, first fill the tank to the fill level, manually override the level sensors, and run the pumps, adding more coolant to the tank as needed until equilibrium is reached. **Do not run the**

pumps or heater unless they are submerged in coolant! The coolant can be added to the TCS Chiller through the fill port in the lid.

Verify that the flow to the TCS Laser Table as measured at the rotameter is at least 1.3GPM.

Be sure that the shutoff valves to the exchanger are open before starting the servo.

Once these precautions are met, simply enter a setpoint on the MEDM panel for the TCS Chiller and depress the ENABLE SERVO button.

The operating principle of the TCS Chiller relies on passive filtering of temperature fluctuations by the thermal inertia of the coolant reservoir. This makes the response of the TCS Chiller servo very slow. If the TCS Chiller has been idle for a long time, the acquisition of lock can be very long as the reservoir first heats to the setpoint value, then as the control valve remains open until cold site chilled water reaches the exchanger. Do not be dismayed if the process takes about an hour.

It will then be necessary to find a good operating temperature for the laser, where the laser power is large and stable. Once the TCS Chiller is locked, it acquires new setpoints relatively more rapidly. Simply adjust the setpoint, wait for the 'laser head' temperature to stabilize, and either accept this setpoint or choose a new one.

Before running the TCS Chiller unattended for long periods of time, verify that the safety interlocks are operating:

- 1) With the TCS Chiller running, lift the lid so that droughtmon is triggered. The TCS Chiller should stop running in a few seconds.
- 2) Manually lift droughtmon to restart the TCS Chiller, and then lift geyserson. The TCS Chiller should then again stop in a few seconds.
- 3) Rebolt the lid. The TCS Chiller should restart. Open probes to the thermistor interlock setpoints in the TCS Chiller database and set them above or below the current temperature. The TCS Chiller should stop in a few seconds.
- 4) Reset the thermistor interlock ranges to 10°C (low) and 30°C (high). The TCS Chiller should restart. You have now verified the safety interlocks.

5 Standard Operation

Unless the Thermal Compensation System is to be shut down for more than a day, the TCS Chiller should be allowed to run continuously, even if the TCS Laser is off, so that setpoint lock acquisition is rapid.

After the TCS Laser Table enclosure is opened or closed, or the AOM turned on or off, it is possible for the laser power to take about an hour to re-equilibrate.

To shut down the TCS Chiller servo, simply depress the SERVO DISABLE button on the MEDM panel. To shut down the TCS Chiller entirely, switch off the heater control on the MEDM panel. This will switch off not only the heater, but also the pumps. Unless the site chilled water plumbing is to be serviced, it is better to leave the control valve open at all time so that when the TCS Chiller servo is re-enabled it does not have to purge warm water from the site chiller lines.

The control valve will get hot during operation. This does not seem to be a problem for the valve.

6 Troubleshooting

Try these things if the TCS Chiller fails to operate to requirements:

TCS Chiller will not start.	<p>Check coolant level and coolant level sensors.</p> <p>Check that pumps are plugged in.</p> <p>Check that TCS Chiller board is powered and connected.</p> <p>Check the TCS Chiller database for appropriate thermistor override levels.</p> <p>Check the TCS Chiller database for appropriate coolant level sensor logic.</p>
No coolant flow to TCS Table.	<p>Check shutoff valves in supply and return lines.</p> <p>Check coolant level.</p> <p>Check that pumps are plugged in.</p> <p>Check that TCS Chiller board is powered and connected.</p>
Thermistor temperatures wildly wrong.	<p>Check that thermistor cables are connected.</p> <p>Check that TCS Chiller board is powered and connected.</p> <p>Check that submerged thermistor is not leaky.</p>
Thermistor temperatures slightly wrong.	<p>Check that thermistors are glued to chiller plumbing.</p> <p>Check that submerged thermistor is not leaky.</p>
Chiller temperature too high, even with control valve constantly open.	<p>Check that site chilled water shutoff valves are open.</p> <p>Setpoint may be too low; try a higher setpoint, or unplug the submerged heater.</p>
Chiller cannot heat, or heats very slowly.	<p>Check that TCS Laser or submerged heater or both are on.</p>
Laser power is highly sensitive to chiller temperature.	<p>Servo has not fully locked. Wait a bit.</p> <p>Laser is very close to a mode transition. Change the setpoint a few tenths of a degree.</p> <p>Some optic is retroreflecting power into the laser. Find and align that optic.</p>
Servo oscillates around setpoint erratically or with wider or longer oscillations than usual.	<p>Chiller may be very close to minimum operating temperature. Try a higher temperature.</p>

	Circulation pump has failed to start.
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