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STANDARD OPERATING PROCEDURE
STAN MAYFIELD BIOREFINERY PILOT PLANT

TITLE: Refrigeration system

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APPROVALS: Process Change Committee **DATE:**

A. Scope

This SOP describes the procedure to operate the refrigeration system in order to supply chilled and cooling water for the requirements of the plant.

B. Safety and Training Requirements

Refer to UF lab safety policies regarding equipment listed in section D below before starting any process work.

Review the location of fire extinguishers, fire blankets, safety showers, spill cleanup equipment and protective gear before beginning any process work.

During operations in the plant, the following safety gear will be utilized at all times:

- Safety Goggles or Face Shield
- Protective Gloves
- Hard Hat

C. Related Documents and SOPs

1. Refrigeration Package manual XXXX
2. Biomass Pretreatment SOP-2110
3. Biomass Liquefaction SOP-2325
4. Trace Elements Storage SOP-3250
5. Ethanol Distillation SOP-4905
6. Hydrolysate pH Adjustment SOP-2320
7. Process Water System Operation SOP-9505
8. Fermentation Tank A SOP-3230
9. Fermentation Tank B SOP-3235
10. Fermentation Tank C SOP-3240
11. Primary Propagator 2A SOP-3210
12. Primary Propagator 2B SOP-3215
13. Secondary Propagator 3A SOP-3220
14. Secondary Propagator 3B SOP-3225

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D. Preparation/Materials/Equipment

1. Refrigeration Plant Package (PK-9201)
2. Cooling Water Heat Exchanger (HP-9202)
3. Cooling Water Tank (TS-9202)
4. Cooling Water Pump (PC-9202)

E. Detailed Procedure

E.1 Startup Procedure

1. Initial valve positions settings are given in the table below.

Refrigeration System				
Line	Line Number	Valve	Position	Check
Process Water supply to Refrigeration Package	RCW-9501-08-SS98	9501-V-27	~~Close~~	
		9201-V-01	Close	
Chilled Water return to Refrigeration Package	CHWR-9202-01-CS51	9201-V-03	~~Close~~	
		9202-V-08	~~Close~~	
	Pressure Indicator	9201-V-02	Open	
	Drain	9202-V-07	Close	
	CHWR-2302-06-CS51	9202-V-10	Close	
	CHWR-2102-05-CS51	9202-V-09	Close	
Chilled Water to Cooling Water Heat Exchanger	CHWS-9201-01-CS51	9201-V-04	~~Close~~	
		9202-V-04	~~Close~~	
	Pressure Indicator	9202-V-03	Open	
Chilled Water to Liquefaction Cooler	CHWS-9202-34-CS51	9202-V-02	~~Close~~	
Chilled Water to Flash Steam Condenser	CHWS-9202-03-CS52	9202-V-01	~~Close~~	

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Refrigeration System				
Line	Line Number	Valve	Position	Check
Cooling Water to Cooling Water Heat Exchanger	CWR-9203-01-CS51	9203-V-26	~~Close~~	
	Drain	9203-V-27	Close	
	CWR-9203-02-CS51	9202-V-05	Close	
		9203-V-30	~~Close~~	
	Drain	9202-V-06	Close	
		9203-V-31	Close	
	Pressure Indicator	9203-V-29	Open	
Cooling Water to Downstream Processes to Hydrolysate pH Adjustment Tank	CWS-9202-02-CS51	9202-V-11	~~Close~~	
	CWS-9202-32-SS98	9202-V-12	~~Close~~	
to Liquefaction Tank	CWS-9202-05-SS98	9202-V-14	~~Close~~	
to Regen Condenser	CWS-9202-06-SS98	9202-V-15	~~Close~~	
to Reflux Condenser	CWS-9202-07-SS98	9202-V-16	~~Close~~	
to Ethanol Condenser	CWS-9202-08-SS98	9202-V-17	~~Close~~	
to Fermentor C	CWS-9202-25-SS98	9202-V-19	~~Close~~	
to Fermentor B	CWS-9202-24-SS98	9202-V-20	~~Close~~	
to Fermentor A	CWS-9202-12-SS98	9202-V-21	~~Close~~	
to Propagator 3B	CWS-9202-26-SS98	9202-V-24	~~Close~~	
to Propagator 3A	CWS-9202-17-SS98	9202-V-25	~~Close~~	
to Propagator 2A	CWS-9202-18-SS98	9202-V-26	~~Close~~	
to Propagator 1A	CWS-9202-19-SS98	9202-V-27	~~Close~~	
to Propagator 2B	CWS-9202-28-SS98	9202-V-29	~~Close~~	
to Propagator 1B	CWS-9202-27-SS98	9202-V-30	~~Close~~	
to Process Water Cooler	CWS-9202-29-SS98	9202-V-31	~~Close~~	
to SIP Vacuum Pump	CWS-9202-31-SS98	9202-V-32	~~Close~~	
to Prep Tank Cooler	CWS-9202-33-SS98	9202-V-33	~~Close~~	
	Spare Valves	9202-V-18	Close	
		9202-V-22	Close	
		9202-V-23	Close	
		9202-V-28	Close	

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Refrigeration System				
Line	Line Number	Valve	Position	Check
Cooling Water to Cooling Water Tank	CWR-9203-03-CS51			
		9203-V-06	Close	
		9203-V-08	Close	
		9203-V-12	Close	
		9203-V-16	Close	
	CWR-2104-12-CS51	9203-V-01	~~Close~~	
	CWR-9501-30-CS51	9203-V-03	~~Close~~	
	CWR-3209-13-SS98	9203-V-04	~~Close~~	
	CWR-3210-13-SS98	9203-V-05	~~Close~~	
	CWR-3201-13-SS98	9203-V-07	~~Close~~	
	CWR-3202-13-SS98	9203-V-09	~~Close~~	
	CWR-3203-14-SS98	9203-V-10	~~Close~~	
	CWR-3204-14-SS98	9203-V-11	~~Close~~	
	CWR-3205-15-SS98	9203-V-13	~~Close~~	
	CWR-3206-15-SS98	9203-V-14	~~Close~~	
	CWR-3207-15-SS98	9203-V-15	~~Close~~	
	CWR-4605-01-SS98	9203-V-17	~~Close~~	
	CWR-4603-01-SS98	9203-V-18	~~Close~~	
	CWR-4604-01-SS98	9203-V-19	~~Close~~	
	CWR-2301-02-SS98	9203-V-20	~~Close~~	
	CWR-2303-01-SS98	9203-V-22	~~Close~~	
	CWR-9203-06-CS51	9203-V-32	~~Close~~	
Drain		9203-V-23	Close	
Process Water to Cooling Water Tank	RCW-9501-13-SS10	9203-V-24	Close	
Level Indicator		9203-V-25	Open	

2. Assure all valves are in the positions as specified in the initial valve configuration table.
3. Assure the process water is ready according to the Process Water System Operation SOP-9505.
4. Open valves 9201-V-01, ~~V-03, V-04, 9202-V-04, V-08, and 9501-V-27~~
5. On the refrigeration package, set the temperature to 45 °F.
6. On the refrigeration package, turn on the unit.
7. Locally monitor the returning chilled water pressure in PI-9201-01 to be within xxx and yyy psi.

8. When chilled water needs to be supplied for pretreatment (the Liquefaction Cooler HP-2301 and the Flash Steam Condenser HS-2201), refer to the Biomass Pretreatment SOP-2110 for valve operation.
9. Locally monitor the chilled water pressure in PI-9202-02 to be within xxx and yyy psi.
10. At the HMI, monitor the temperature in TIC-9202-01 to be at the value set in step E.1.5. above.
11. Open valves ~~9501-V-34~~, 9203-V-24 to start filling the Cooling Water Tank (TS-9202) with process water.
12. At HMI, set the Cooling Water Tank level to 80% in LIC-9202-06.
    a. LT-9202-06 measures the level in the Cooling Water Tank (TS-9202) and transmits a signal to LIC-9202-06 in the PLC, which modulates LV-9202-06, thereby controlling the flow rate of recycle water into the tank.
13. ~~Open valves 9203-V-26, -30, to open the discharge line from the Cooling Water Tank (TS-9202) to the Cooling Water Heater Exchanger (HP-9202).~~
14. ~~Open valve 9203-V-32 to the cooling water loop.~~
    a. Make sure that PRV-9202-10 is set to xxx PSI.
15. At the HMI, set the temperature at 85 °F in TIC-9202-04.
    a. The temperature transmitter TT-9202-04 measures the temperature in the cooling water outlet to the Cooling Water Heat Exchanger and sends a signal to TIC-9202-04.
    b. TIC-9202-04 controls the temperature valve TV-9202-04 which regulates the flow rate of the chilled water exchanging heat with the cooling water, thereby maintain the cooling water at the set temperature.
16. At the HMI, turn on the Cooling Water Pump (PC-9202) to start transferring the water from the Cooling Water Tank (TS-9202) to the Cooling Water Heat Exchanger (HP-9202).
17. Locally monitor the downstream line pressure in PI-9202-09.
    a. The line pressure should not be higher than the pressure set in PRV-9202-10.
18. At the HMI, monitor the flow rate in FI-9202-08 to be within xxx and yyy gpm.
19. Open valves 9202-V-05 ~~V-11~~ to open the cooling water supply line ~~(main line).~~
20. The cooling water supplies various systems. These systems also return cooling water to the Cooling Water Tank after use. Refer to the respective SOP's for valve operation.
21. At the HMI, monitor the temperature in TI-9202-03.
    a. The temperature transmitter TT-9202-03 measures the temperature in the cooling water inlet to the Cooling Water Heat Exchanger (HP-9202).
    b. TT-9202-03 transmits the temperature signal to the temperature indicator TI-9202-03.

E.2 Shut Down Procedure

E.2.a. Short Term (less than a week)

1. At the HMI, turn off the Cooling Water Pump (PC-9202).
2. Turn off the Refrigeration Plant Package (PK-9201).
3. Close valves 9201-V-01 and ~~valve 9501-V-27~~ to close the process water supply to the Refrigeration Plant Package.
4. Refer to the Process Water System Operation SOP-9505 if the process water system needs to be shut down.

E.2.b. Long Term (more than a week)

1. At the HMI, turn off the Cooling Water Pump (PC-9202).
2. Turn off the Refrigeration Plant Package (PK-9201).
3. Restore all valves to the initial positions according to the initial valve configuration table.
4. Refer to the Process the Process Water System Operation SOP-9505 if the process water system needs to be shut down.