NuMI Dehumidification Controls

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The controls to collect and dispose of tritiated water generated by the target hall dehumidifiers are split between two PLCs: NuMI-Tritium in target hall support room (THSR) rack 109 and NuMI-Evap in the southwest corner of the MI-65 service building. All condensate-handling I/O has been removed from NuMI-THSR PLC, although software stubs and idle hardware remain should it be necessary to restore those functions to THSR.

NuMI-Tritium Operation

NuMI-Tritium is an eight slot Automation Direct DL450 PLC with an additional 8 slot local expansion base. Fifty six channels of RTD input are used to monitor various dehumidifier temperatures, decay pipe temperatures, and decay pipe supply and return water manifold temperatures. Two eight-bit relay output modules operate the seven Munters dehumidifiers and provide miscellaneous outputs. Two sixteen-bit input modules monitor status of the Munters units and read miscellaneous other inputs. A sixteen-channel 0-10V output module repeats Munters vent temperatures to the MADC87, controls the glycol flow to the two large target hall dehumidifiers, and drives the barrel fill station level display. A sixteen-channel 4-20mA analog input module collects measurements from the condensate handling components in the target hall. Tritium is directly connected to the Controls ethernet.

Condensate Tank Instrumentation

- A float-type level meter transmits a 0-10V signal to an FC33 signal converter. The FC33 produces a 4-20mA input to the PLC.
- An independent float switch drives a relay at the PLC rack. One contact pair of that relay goes directly to FIRUS and a second pair is the HH input to the PLC.
- A probe at the north end of the secondary containment connects to a leak detect module at the PLC rack. The leak detector looks for the resistance between the probe and the metal wall of the containment to drop below 10Kohms for a leak. One output goes directly to FIRUS and a second to the PLC.
- A second float operates a mechanical alternator device. The alternator selects between one motor and another on each pumpdown.
- A pressure gauge on the pump discharge sends a 4-20mA signal to the PLC.

Interlocks

- A Klixon glued to the Glycol supply line in the elevator shaft opens if the glycol from the mezzanine chiller goes over 55°F and a flow switch up at the chiller opens on loss of glycol flow. Either occurrence causes Munters A and B to turn off.
- Tritium will turn off the mezzanine chiller if either the condensate tank goes HH or there is water in the secondary containment.
- Beam permit to Pernicious Panel input #8 in rack 104 is removed on HH, Leak, Glycol Temp Hi, or No Glycol Flow.
- A signal to the evaporator PLC is generated on HH, Leak, or analog tank level over 18 inches. (Leak doesn't really result in any useful action since the pumps can't be forced on.)

MCP1 & 2 and Barrel Fill Station Controls

- MCP1 and MCP2 are the normal pumps that drain the condensate tank. They are turned on by the mechanical float and alternator. A permit from the evaporator PLC to the motor control box allows the pumps to run. Neither Tritium nor Evap can force the pumps on.
- A separate motor and motor control box will pump water to the barrel fill station in the elevator shaft. The barrel fill motor is not tied into any PLC or interlocks, although Tritium does monitor the motor current. Tritium drives a display of the condensate tank level at the station. One inch in the tank is approximately 8.3 gallons of water.

Munters A & B Three-Way Control Valves – The two large dehumidifiers are equipped with motorized three-way valves on the glycol lines. The 24VAC transformer that powers them is located in THSR rack 109 and they receive a 0-10V control input from Tritium. Two PID loops on Tritium regulate the reactivation inlet temperature of A and B. The valves are currently fixed at 80% flow by software.

An output called "TH Pumpdown Req" latches ON when the condensate level reaches 14.5 inches. The output resets when the level drops below 10.0 inches.

Spare cables – There is a spare 9 pair cable between Tritium and the Munters A-B RTD junction box.

Evaporator System

Neutralization Tank – The tank is a cube 48 inches on a side. One inch of water height translates to a volume of 10 gallons.

- An Echopod ultrasonic level meter generates a 4-20mA output representative of the water level and four relay indications: LL, L, H, and HH. The relay closure thresholds are programmed into the device through a USB connection. A panel switch selects between program and run modes and an adapter cable and USB fob complete the connection to a PC. The 4-20mA signal passes through an FC33

signal conditioner to become 0-10V at MADC89 Channel 33. The relay outputs become inputs to Evap.

- A tuning fork level sensor acts a last defense against overflow. It is set into the side of the tank at about 44 inches. Its output drives the coil of a relay. One contact pair from the relay goes directly to FIRUS and another pair is the HH input to Evap.
- An optical water sensor is mounted on the floor of the concrete secondary containment tub. Its output drives the coil of a second relay. One contact pair from the relay goes directly to FIRUS and another pair is the LEAK input to Evap.
- A recirculation pump on the side of the tank is fitted with a flowmeter. The flowmeter contacts are made up when the pump is running.
- A spring return valve in the tank outlet plumbing is actuated by Evap to let water down into the evaporator.

pH Controller – A Hanna Instruments 504 is mounted in the PLC rack. It maintains its own feedback loop to control the acidity of the water discharged to the evaporator. A probe mounted in a vertical position on the recirculation plumbing connects to the pH input of the controller. A second probe mounted into the back side of the tank is used for its RTD and reference outputs (The second probe cannot be used for pH because it was mistakenly mounted horizontal. Removal would require completely draining the tank. Its RTD and reference are used solely for convenience: its wires reach the controller terminals without patching. The primary probe doesn't.). The controller switches the hot leg of a power outlet through its RELAY1 to a dosing pump. The dosing pump meters sodium hydroxide solution into the top of the tank to effect neutralization. RELAY2 is used as "pHOK" by the PLC and the ALARM relay is also sent to the PLC. The 4-20mA analog pH output is converted to 0-10V by a second FC33 and cabled to MADC89 Channel 32.

Evaporator – The evaporator is a self-contained unit that includes its own Automation Direct D0-05AR PLC, 480V heaters, and instrumentation. The evaporator shuts down when the air pressure across the internal mist pad is less than .01in WC (for example, if the roof fan fails) or greater than .50inWC. The evaporator operates a motorized feed valve that is in series with the let-down valve. If power were to fail with the feed valve open, the let-down valve would close to keep water from overflowing the evaporator tank. There are no status outputs from the evaporator. A single alarm to Evap is derived by tapping off the evaporator alarm light. An airflow switch on the vent stack is made up as long as the roof fan is running and is an input to the PLC.

PLC - NuMI-Evap is a nine-slot Automation Direct DL240 PLC. It works with the pH controller to bring water up from the target hall, neutralize its acidity, and feed processed water to an evaporator. The evaporator is a self-contained unit that disposes of the water by boiling it and discharging the vapor to the outside. NuMI-Evap returns status to ACNET through a CAMAC C216 card in Slot 10 of Crate 55 in the MI-65 electronics room. Analog signals bypass the Evap PLC and go directly to MADC89.

The PLC receives two digital tank level inputs from Tritium (TH-HH,open for TH condensate tank greater than 18 inches, and TH Pumpdown Req) and sends a target hall pump permit signal to the pump motors control box at the north end of the target hall. The pump motors are actually turned on and off by a float and a mechanical alternating device attached to the condensate tank but need the permit to send voltage to the motors.

The PLC has two user switches connected: HAND/AUTO and DRAIN/OFF/FILL. In HAND-DRAIN, both the pump permit and the let-down valve are held on. Water moves freely to the evaporator feed valve. In HAND/OFF, no water moves between units. In HAND/FILL, only the pump permit is on. Water from the target hall can be stored in the neutralization tank but cannot be dumped to the evaporator. In AUTO, the PLC controls the permit and the let-down valve.

An output module in slot 9 is used to display latched status. Latched status can be reset from ACNET E:EVPSTS. A convenient placard hanging from the PLC rack can be used to identify and read all Evap I/O.

Mezzanine Analog Signals – Four signals are mentioned here even though they have nothing to do with the evaporator. Current transformers on the two chiller motor 480V feeds go to MADC89 Channels 36 and 37. Chiller Glycol Supply and Return temperatures are on MADC89 Channels 34 and 35. The temperatures originate at RTDs in thermowells near the pumps. Process transmitters are in a wall box above the pumps.

Spare Cables – There are 7 spare wire pairs in the cable between Evap and Tritium. There is a single spare twin-ax run between the evap rack and MADC89.

Evaporator Batching Logic

The PLC works to maximize the transfer of water to the evaporator. As long the neutralization tank pH is greater than 7.5, the let-down valve ahead of the evaporator feed valve is held open.

Independently, the PLC monitors “TH Pumpdown Request” from NuMI-Tritium. When the signal goes active, Evap turns on the TH pump permit and waits for TH Pump Request to de-assert. The PLC continues to hold the pump permit for an additional five minutes to ensure that the target hall tank is fully drained (to between 9 and 9.5 inches).

If the target hall tank should reache 18 inches (TH beam permit trips at about 19 inches), Tritium sends Target hall High (THH) to Evap. In response Evap turns on the pump permit and now waits for THH to clear before removing the permit and entering the mixing phase. Note that the TH tank may not be completely pumped down.

At all times, HH, Leak, and Echopod HH keep the pump permit off. “pH-NOT-OK”, loss of recirculation and loss of roof fan airflow will keep the let-down valve from opening.

Echopod LL, L, H, and HH are set to 6 inches, 9 inches, 14 inches, and 22 inches respectively.