HORUS Technologies Inc.
www.horus.ca
HORUS Technologies Inc.
11 - 17075 Leslie Street, Newmarket, Ontario L3Y 8E1
Phone (905) 895-7069 * Fax (905) 895-7069

RECOMMENDED CONTROL METHODS FOR HYDRONIC HEAT/COOL SYSTEMS WITH INDIRECT FREE COOLING (HEAT REJECT) LOOPS

Many current building designs, especially large buildings, require ‘core cooling’ during the colder seasons and even at times in the winter months. Buildings must use air conditioning systems year-round to reject heat collected from occupant utility loads and radiant solar energy. This is due to better building designs and the use of better insulating materials in the construction of buildings to meet ‘Green’ building construction initiatives.

The ability of cooling towers to produce water temperatures typical of chilled-water temperatures in colder months has led to an increase in utilization of ‘free cooling’ as the best means to reduce overall system energy demand. Of course with outdoor temperatures below 0.6°C designs must ensure that freezing does not occur in the process loops. Ethylene glycol (EG) is generally used as water anti-freeze in hydronic loops for comfort air-conditioning chilled water services that may be required to operate at process temperatures below 0.6°C.

Although water/glycol solutions are commonly used to provide freeze protection for chilled-water systems, consideration for containment, cost and handling of toxic EG solutions should be made when designing the building hydronic systems. Using an Indirect Free Cooling configuration to reject building heat load (Building and Cooling Tower Loops isolated by a Heat Exchanger) reduces the volume of the freeze protected process required for the chilled-water loop, providing advantages of reduced operating cost and EG contamination liability, and smaller/safer process containment for system operation and maintenance. Reduced volume chilled-water loops also permit further consideration for the use of non-toxic Propylene Glycol (typically more expensive than EG) for a more environmentally friendly water/glycol antifreeze solution.

An Indirect Free Cooling configuration requires the addition of heat exchanger/s, pumps, and controls for the heat reject loop. Generally, the cost of implementing an Indirect Free Cooling heat reject loop is difficult to justify based only on reducing the cost of system antifreeze used in the hydronic loop (except possibly in buildings with very large volume loops). However, when the cost of containment/replacement of water/glycol solution during maintenance operations and projected liability cost of clean-up and re-mediation for toxic process leaks are considered; Indirect Free Cooling configurations become a preferred method of providing building hydronic systems with year-round heat reject control capability.

The Heat Exchanger/s and Pumps used in an indirect free cooling heat reject loops must be properly sized to accommodate the heat load and flow requirements of the system (flow & power requirements for water/glycol loops may be 150 - 200% higher than water loops). Heat Reject Loop Controls should include pump multiplexing and temperature monitoring/control of the cooling loop.

The following is a recommended method for controlling Indirect Free Cooling Loops used to reject heat from a Heat Pump Loop using HORUS Series HLC-2K Dual Mode Hydronic Loop Controllers and HORUS Redundant Load Controllers. The HLC-2K Series controller provides control for the HP Loop Pumps, Closed Loop Temperature (Heating/Cooling Relay Stages and PID Heat/Cool Analog Control) and Closed Loop Diff. Pressure (Pump Speed vs. Riser Supply/Return D.P.) to ensure proper control of Water Source Heat Pump Loops. The Redundant Load Controller provides duplex control of the Heat Reject Loop Pumps.

1. **Heat Pump Loop Controller - HORUS HLC-2K Series**
   The Heat Pump Loop Controller shall provide the following functions:

   i. Automatic pump start/stop control for 1 - 4 Loop Pumps
   ii. Flow proving feedback monitoring and fault alarm indication for all Loop Pumps
   iii. Pump multiplex control (Lead/Lag) for load sharing, economizing and flow fault recovery
   iv. Automatic changeover of Lead Pump based on run time (ie. 14 Day Pump changeover)
   v. Analog input for Loop Pressure feedback, monitoring and control

vi. Analog pump speed/loop pressure control output with PID control algorithm for variable volume demand Loops
vii. Analog inputs for Temperature feedback, monitoring and control (Supply,Return,OAT)
viii. 4/8 Stage CFH/CFC stage control relays with independent target/differential set-points for Heat Accept/Reject control devices
ix. Analog Heat Accept/Reject control outputs with independent PID control algorithms
x. Local Heat Pump Loop status indication & fault alarm annunciation

2. **Heat Reject Loop Pump Controller - HORUS Model 1000E947 Load Controller**
The Heat Reject Loop Pump Controller shall provide the following functions:

i. Automatic pump start/stop control on Call-for-Cooling (CFC) command input
ii. Flow proving feedback monitoring and fault alarm indication
iii. Pump duplex/multiplex control (Lead/Lag) for load sharing and flow fault recovery
iv. Automatic changeover of Lead Pump based on run time (ie. 7 Day Pump changeover)

3. **Description of Operation**

The operation sequence of Heat Pump Loop Controller set-up to reject heat load through a Cooling Tower configured with an Indirect Free Cooling loop may vary from system to system, and is generally described as follows:

HP Loop Cooling Mode

3.1 When the Heat Pump Loop Return Temperature is equal to or greater than C1 Stage Set-point (84°F typ), the C1 Relay is energized to provide a Call-for-Cooling (CFC) signal to the Heat Reject Loop Pump Controller. When the Return Temp is less than the C1 Differential Set-point (S.P. - DIFF, Δ2°F typ) the C1 Relay is de-energized.

HR Loop Pump Control

3.1.1 The CFC contact closure input causes the Heat Reject (HR) Loop Pump Controller to ENABLE the LEAD Pump Motor Starter or VFD by closing the appropriate Pump Relay based on the pump run time setting of the pump controller (7 Day LEAD/LAG Run Time Changeover typ.)

3.1.2 The HR Loop LEAD pump starts and runs at full speed (FVNR Motor Starter) or at preset speed selected to suit the capacity of the HR Loop (VFD Motor Speed Control).

3.1.3 HR Loop Pump Controller monitors HR Loop flow status (contact closure from a Diff. Pressure type Flow Sensor/Switch). If sufficient flow is not detected after 10-15 Seconds of RUN time, the controller will DISABLE the LEAD Pump, activate a Flow Fault Alarm, and ENABLE the LAG Pump Motor Starter or VFD by closing the appropriate Pump Relay. This Pump Change-over will cause the LAG Pump to become the HR Loop LEAD Pump. The controller will attempt to establish process flow in the HR Loop by cycling through all available pumps.

3.1.4 If the HR Loop Pump Controller cannot establish sufficient process flow in the HR Loop after 3 Pump ENABLE attempts for each available HR Loop Pump, the Pump Relays will remain de-energized until the Flow Alarm is Manually Reset.

3.2 When the Heat Pump Loop Return Temperature is equal to or greater than C2 Stage Set-point (85°F typ), the C2 Relay is energized to provide a ‘Damper Open’ signal to the Cooling Tower Motor Control Panel. When the Return Temp is less than the C2 Differential Set-point (S.P. - DIFF, Δ2°F typ) the C2 Relay is de-energized to Close the CT Dampers.

Note: The Cooling Tower Motor Controls require that the Dampers must be fully OPEN and the Damper Open End-of-Travel Limit Switch must be actuated to permit operation of Cooling Tower Spray Pumps or Fans.

3.3 When the Heat Pump Loop Return Temperature is equal to or greater than C3 Stage Set-point (86°F typ), the C3 Relay is energized to provide a 'Spray Pump Run' signal to the Cooling Tower Motor Control Panel. When the Return Temp is less than the C3 Differential Set-point (S.P. - DIFF, Δ2°F typ) the C3 Relay is de-energized to Stop the CT Spray Pumps.

3.4 When the Heat Pump Loop Return Temperature is equal to or greater than C4 Stage Set-point (87°F typ), the C4 Relay is energized to provide a 'CT Fan Run' signal to the Cooling Tower Motor Control Panel. When the Return Temp is less than the C4 Differential Set-point (S.P. - DIFF, Δ2°F typ) the C4 Relay is de-energized to Stop the CT Fans.

Note: The Cooling Tower Fan Motors driven by VFDs are controlled by 'RUN ENABLE' interposing relays located in the CT Motor Control panel that are interlocked with the CT Damper EOT Switch.

3.5 Cooling Tower Fan Speed is controlled by the Heat Pump Loop Controller. The CFC Analog Output (Ach2) provides a 4-20mA / 0 - 100% Cooling Demand speed reference signal to the CT Fan VFD based on the Closed Loop Cooling PID control algorithm. The Cooling Set-point (Control Variable) for the Cooling PID (85°F typ) can be adjusted to suit system Heat Reject requirements.

3.6 The HP Loop Supply Temp Sensor Signal is used for the Cooling Temperature Feedback (Process Variable) for the Cooling PID to keep HP Loop Supply Water Temperatures from causing condensation on Heat Pump Loop piping.

3.7 The range of CT Fan speed control must be set in the VFD to be within a reasonable range of control for CT Fan operation (ie. 30 - 100% Fan Speed = 0 - 100% Cooling Demand).

IMPORTANT NOTICE

HORUS Technologies and its subsidiaries (HORUS) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgment, including those pertaining to warranty, patent infringement, and limitation of liability.

HORUS warrants performance of its products to the specifications applicable at the time of sale in accordance with HORUS' standard warranty. Testing and other quality control techniques are utilized to the extent HORUS deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

CERTAIN APPLICATIONS USING INSTRUMENTATION OR CONTROL PRODUCTS MAY INVOLVE POTENTIAL RISKS OF DEATH, PERSONAL INJURY, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE (“CRITICAL APPLICATIONS”). HORUS INSTRUMENTATION AND CONTROL PRODUCTS ARE NOT DESIGNED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS. INCLUSION OF HORUS PRODUCTS IN SUCH APPLICATIONS IS UNDERSTOOD TO BE FULLY AT THE CUSTOMER'S RISK.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

HORUS assumes no liability for applications assistance or customer product design. HORUS does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of HORUS covering or relating to any combination, machine, or process in which such products or services might be or are used. HORUS' publication of information regarding any third party's products or services does not constitute HORUS' approval, warranty or endorsement thereof.