General Service Bulletin

RTHD

Pueblo Built Units Only

CH530 Settings for Condenser Water Regulating Valve and Head Pressure Control Option

Introduction

This bulletin covers the items in the RTHD CH530 controller that may need to be adjusted if the optional condenser water regulating valve is installed.

Due to the variety of job site applications, the settings for the condenser water regulating valve or head pressure control may need to be adjusted to gain unit stability. A few examples of control setup for common job site conditions are also included in the bulletin.

RTHD 175-450 tons units (60 hz)
RTHD 125-450 ton units (50 Hz)

July 2007

RLC-SVB32A-EN

NOTICE: Warnings and Cautions appear at appropriate sections throughout this literature. Read these carefully.

⚠ WARNING: Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION: Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.

CAUTION: Indicates a situation that may result in equipment or property-damage only accidents.

⚠WARNING

Personal Protective Equipment (PPE) Required!
Always refer to appropriate MSDS and OSHA guidelines when handling fluorocarbon refrigerants. Use proper breathing, eye, and body protection during the handling of fluorocarbon refrigerants. Failure to follow proper handling guidelines could result in death or serious injury.

⚠WARNING

Hazardous Voltage!
Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/tagout procedures to ensure the power can not be inadvertently energized. Failure to disconnect power before servicing could result in death or serious injury.

⚠WARNING

Contains Refrigerant!
System contains oil and refrigerant under high pressure. Recover refrigerant to relieve pressure before opening the system. See unit nameplate for refrigerant type. Do not use non-approved refrigerants, refrigerant substitutes, or refrigerant additives. Failure to follow proper procedures or the use of non-approved refrigerants, refrigerant substitutes, or refrigerant additives could result in death or serious injury or equipment damage.

⚠WARNING

Hazardous Voltage w/Capacitors!
Disconnect all electric power, including remote disconnects and discharge all motor start/run capacitors before servicing. Follow proper lockout/tagout procedures to ensure the power cannot be inadvertently energized. Verify with an appropriate voltmeter that all capacitors have discharged. Failure to disconnect power and discharge capacitors before servicing could result in death or serious injury.

Note: For additional information regarding the safe discharge of capacitors, see PROD-SVB06A-EN or PROD-SVB06A-FR

Discussion

System Differential Pressure Logic

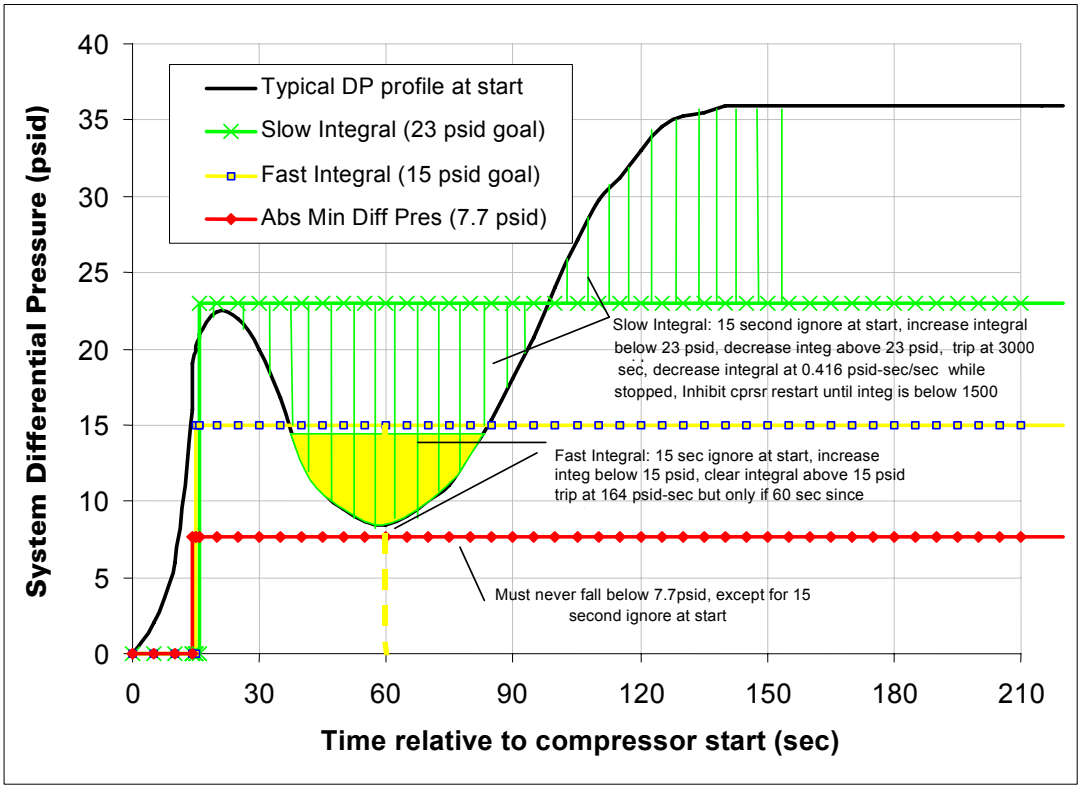
To satisfy system oil protection safeties and to maximize energy efficiency, adequate condenser water control on the RTHD units is necessary. The required system differential must be adhered to according to Figure 1, p. 3.

The following guidelines must be met in order to ensure adequate oil circulation throughout the system.

- The RTHD must maintain a 23 psid system pressure differential at all load conditions in order to ensure adequate oil circulation.
- The entering condenser water temperature must be above 55°F (12.8°C) or between 45°F (7.2°C) and 55°F (12.8°C) with a 1°F temperature rise per minute to 55°F (12.8°C).
- Condenser leaving water temperature must be 17°F degrees higher than evaporator leaving water temperature within 2 minutes of startup. A 25°F differential must be maintained thereafter.

If the above guidelines cannot be met, then some form of tower water control must be used.

Figure 1. CH530 System Differential Logic



To maintain proper oil flow to the compressor, strict condensing water control may be necessary. One method of achieving this control is through the installation of an optional

water regulating valve. Follow the vendors specific instructions for the mechanical installation of the regulating valve.

The CH530 provides for the embedded control of either an electronic modulating condenser water regulating valve, a condenser water pump Variable Frequency Drive (VFD), or any condenser water flow control device that can utilize a 0-10 Vdc input signal range. Control of these devices provide minimum refrigerant pressure differential (also known as “Head Pressure” control) for the chiller and allows for continuous operation of the chiller with entering condenser water temperatures less than 50 F. Adjustable control parameters provide flexibility in different applications yet it is relatively easy to set up and tune. Under conditions of varying evaporator conditions, this control will provide the most efficient operation of the chiller, since the control will work to allow the lowest condenser head pressure that will meet the chiller's fundamental oil flow requirements.

The following control sequence is meant to be adaptable to either a VFD or a modulating electronic control valve (with a 0 -10 Vdc input*) that can vary flow in the condenser water loop. Most of the complexity comes from having to deal with a finite, and possibly long stroke speed inherent in some modulating valves. The CH530's embedded head pressure control does not however actually sense or control condenser water flow directly. Instead the chiller's system differential pressure is measured and the flow device modulated to provide a minimum required differential pressure for the RTHD chiller. In the following specifications, the Condenser Head Pressure Control Output commanded voltage and the Flow Control Device's “position” are used interchangeably, but it is recognized that the device's position will lag behind the command due to its inherent stroke speed.

*Example:*Currently the CH530 platform does not have LLID hardware to provide a 4- 20 mA analog output.*

Sequence of Operation

In general, the following control states, chiller modes, delays, set points and functions only exist if the Refrigerant Pressure Output Configuration is set to “Condenser Head Pressure Control”. The notable exception is for Condenser Water Pump Pre-run, which is a standard function and is always available (including submode annunciation) regardless of the chiller configuration.

At CH530 power up or reset, the Condenser Head Pressure Control output is initialized to the voltage defined by the “Off State Output Command” setting. For use in determining sequence delay times that may be necessary due to both the fixed speed of the device, and its uncertainty of its starting position, the CH530 will keep track of the “worse case” scenario for the predicted position of the head pressure control device. This prediction assumes that the device's stroke time (as input) is correct and that the device does immediately begin movement towards its commanded position per the voltage output.

Upon call for condenser water pump, the Condenser Head Pressure Control output is commanded to the maximum flow position (Output Voltage @ Desired Maximum Flow). The condenser water pump start is delayed by the time it takes the condenser water flow

device to get into its normal control band, (i.e. anywhere between the minimum and maximum position) based on the inherent "stroke" time of the device (as user defined).

Example:If the controls have recently gone through a power up reset, there may still be some uncertainty about the flow control device's position, the timing associated with the worse case scenario must be accommodated before the pump can be commanded on.

During the time that the pump is delayed the DynaView shall display a submode:

Cond Pmp Strt Dly (Head Pres Ctrl) xx:xx

Once the condenser water regulating valve has stroked to the maximum open position, the condensing water pump is started. After the condenser water pump has been commanded on, but before the condenser water flow has been proven, the DynaView will display a submode:

Waiting for Condenser Flow xx:xx

Example:The flow control device may still be stroking to its maximum position during this time but this movement is in parallel with the flow proving and or condenser water pump pre-run time if applicable, and will not cause any delays in the sequence.

Once the pump flow has been proven, the DynaView will display a submode:

Condenser Water Pump PreRun Time xx:xx

Once the Pre-Run time (as set) has been completed, the condenser water flow device pre-positions for compressor start:

The pre-position is a function of entering condenser water temperature as follows:

- If condensing entering water temperature is **> 86F**, the condenser water regulating valve will go to the setting programmed in **"Output Voltage @ Desired Maximum Flow".**
- If condensing entering water temperature is between **86 and 50F**, linear interpolation is used to pre-position the condenser water regulating valve.
- If condensing entering water temperature is **< 50F**, the condenser water regulating valve will go to the setting programmed in **"Output Voltage @ Desired Minimum Flow".**

The compressor start must be delayed in order to allow the Condenser Water Flow Control device to stroke to its pre-position. During the time that the start sequence of the compressor is delayed, the DynaView will display a submode:

Cprsr Strt Delay (Head Pres Ctrl) xx:xx

Once the delay to position the condenser water flow control device has expired, the compressor is commanded on and once compressor operation is confirmed, the head pressure control will begin running closed loop control for pressure control per the internal hard coded setpoint (29 Psid for RTHD). The algorithm runs using the following parameters:

- Iteration Time (*fixed at 5 seconds*)
- Damping Coefficient (*defaulted to 0.5*)
- Entering Condenser Water Temperature (*measured variable*)
- Evaporator Pressure (*measured variable*)
- Delta Pressure Setpoint (*fixed at 29 Psid*)
- Condenser Pressure (*measured variable*)
- Condenser Saturated Temperature (*calculated from above pressure*)
- Min and Max Flow voltage limits.

Example:The logic for Head Pressure control has priority over Liquid Level control during start-up. The head pressure logic can command the EXV to close farther then the liquid level control commands. If the head pressure control is controlling the EXV, the display will show the following mode:

EXV Controlling Differential Pressure

The Head Pressure Control algorithm will continuously adjust the condenser water flow device to maintain the desired chiller differential pressure.

At the end of a compressor cycle, during the normal run unload period, the Condenser Head Pressure control will remain in its closed loop control. When the compressor is eventually stopped, and proven to be stopped, the Condenser pump is turned off, and the Water Flow Control device is positioned to the “Off State” position as set. The control will maintain internal “open loop” knowledge of the device's position at all times (except through a power down) to minimize positioning delays on a subsequent attempted startup.

Jobsite Conditions

Before the CH530 can be configured, a good understanding of the jobsite conditions is necessary.

1. Manually stroke the regulating valve or VFD. Record the actual time for the valve to stroke full open and the time to stroke full closed. The average stroke time is needed to program in the CH530.
2. Calculate the actual volume of water in the condensing loop (ie: condenser, cooling tower sump and pipe volumes)

   Example:Below is an example of a table for determining the volume of water in a steel pipe.

Table 1. Volume of Water in Steel Pipe

Nominal Pipe Size			Standard Steel Pipe			
			Inside Diameter		Volume	
in.	(mm)	Sched. No.	in.	(mm)	gal/ft	(L/m)
3/8	(10)	--	--	--	--	--
1/2	(15)	40	0.622	(1.58)	0.0157	(0.19)
5/8	(16)	--	--	--	--	--
3/4	(20)	40	0.824	(2.09)	0.0277	(0.34)
1	(25)	40	1.049	(2.66)	0.0449	(0.56)
1-1/4	(32)	40	1.380	(3.50)	0.0779	(0.97)
1-1/2	(40)	40	1.610	(4.09)	0.106	(1.32)
2	(50)	40	2.067	(5.25)	0.174	(2.16)
2-1/2	(65)	40	2.469	(6.27)	0.249	(3.09)
3	(80)	40	3.068	(7.79)	0.384	(4.77)
3-1/2	(90)	40	3.548	(9.01)	0.514	(6.38)
4	(100)	40	4.026	(10.23)	0.661	(8.21)
5	(125)	40	5.047	(12.82)	1.04	(12.92)
6	(150)	40	6.065	(15.41)	1.60	(18.63)
8	(200)	30	8.071	(20.50)	2.66	(33.03)
10	(250)	30	10.136	(25.75)	4.19	(52.04)
12	(300)	30	12.090	(30.71)	5.96	(74.02)

3. Measure the maximum water flow in the condensing water loop.
4. Calculate and record the actual condensing water loop time.

5. Determine and record the coldest water temperature that will be in the condenser water loop. Take into account the winter season, if necessary.
6. Determine if the job site uses free-cooling, by-pass valves or external controls to modulate flow through the condensing water loop.
7. Determine if water will be flowing through the condenser when the compressor is off.
8. Determine the minimum water flow requirements for the chiller.
9. Determine the lowest voltage signal required to obtain the design temperature differential across the condenser.

   Note: This can be done by placing the condenser water pump into manual control. Slowly step the voltage signal to the condensing water regulating valve or VFD. With each voltage change, record the pressure drop and temperature differential across the condenser. The voltage signal that produces the design pressure drop and temperature differential is the voltage that needs to be programmed in the CH530 under "Output Voltage at Desired Maximum Flow (0-10 VDC)."

Figure 2. Necessary Job Site Conditions.

Job Site Conditions for Condenser Regulating Valve Operation

Model Number:			
Serial Number:			
Type of Regulating Valve			
Stroke time:	Full Open		seconds
	Full Close		seconds
	Average		seconds
Volume of Condenser Water Loop			
	Condenser		gallons
	Piping		gallons
	Cooling Tower		gallons
	Additional		gallons
	Total volume		gallons
Maximum water flow in condensing loop			gallons/minute
Minimum water flow through condensing loop			gallons/minute
Actual condensing water loop time			minutes
Coldest condensing water temperature			F

Water flow through condenser during "off-state" ? Y/N

CH530 Configuration

Once the jobsite conditions are determined and recorded the CH530 can be configured.

Enable Condensing Head Pressure Control Option

The unit configuration needs to be updated if the"Condensing Head Pressure" tab is not listed on the Status View. To enable the condensing head pressure option follow the steps below:

1. In TechView click on **"View"**
2. On the pull down menu, click on **"Configuration"**
3. Click on the **"Options"** tab
4. Scroll down to "Rfgt Pressure Output Type"
5. Click on the pull down menu and click on **"Condenser Water Regulating Valve"**
6. Download the new configuration
7. The tab "Condensing Head Pressure" will now be listed in the "Setpoint" view

Set-up of Menu Items for Condenser Head Pressure

The items listed under "Condenser Head Pressure" affect how the RTHD unit controls the condenser water flow. The items that need to be adjusted are listed below:

Table 2. Menu Items

MENU ITEMS	RANGE	UNITS	DEFAULT
"Off State" Output Command	0-10	volts	2.0 vdc
Output Voltage at Desired Minimum Flow	0-10	volts	2.0 vdc
Desired Minimum Flow	0-100	percent	20%
Output Voltage at Desired Maximum Flow	0-10	volts	10 vdc
Actuator Stroke Time	0-300	seconds	30 s
Damping Coefficient	0.1-1.8	none	0.5
Condenser Pre-run time ("Setpoint" view)	0-30	minutes	0 minutes

"Off State" Output Command (0-10 VDC)

At CH530 power up or reset, the Condenser Head Pressure Control output shall be initialized to the voltage defined by the "Off State Output Command" setting. Also, once the compressor cycles off and the condenser pump is cycled off the "off state" command is sent to the condenser water regulating valve.

Output Voltage at Desired Minimum Flow (0-10 VDC)

When condensing water temperatures are colder than the evaporator, closing the EXV may not be enough to establish the required system differential. Reducing the water flow

through the condenser will help establish the necessary differential pressure in the system.

If condensing entering water temperature is < 50F, the condenser water regulating valve will go to the setting programmed in "Output Voltage @ Desired Minimum Flow" at the time of compressor start.

Desired Minimum Flow (%)

This sets the desired minimum flow of a particular application expressed as a percentage of the desired maximum flow.

This percentage must correspond with the "Output Voltage at Desired Minimum Flow". For example, if the valve at 100% flow point produces 800 gpm traveling through the condenser and a 2 VDC signal closes the valve to produce 160 gpm, then the% needs to be set at 20.

Example:Special consideration must be taken if a water regulating valve is oversized. An oversized valve will produce sluggish conditions and possible trips of the chiller, if the "Output Voltage at Desired Maximum Flow (VDC)" is not set correctly.

Desired Minimum flow (%) = {GPM produced with Output Voltage at Desired Minimum Flow/ GPM produced at 100% flow point}*100

Example: 160 gpm/ 800 gpm x 100 = 20%

Output Voltage at Desired Minimum Flow (0-10 VDC))

This value corresponds to 100% flow point of the device but does not necessarily have to be the wide open position of the device.

Example:For oversized regulating valves, program in the voltage that produces the selected water flow through the condenser. For example, an oversized valve may produce approximately 15 psid at any signal between 7-10 vdc. If 10 vdc, is programmed in the controller, the valve will appear sluggish and may not be able to respond fast enough for changes in the system conditions. For this case, 7 vdc needs to be programmed in to achieve optimum performance from the water regulating valve.

If condensing entering water temperature is > 86F, the condenser water regulating valve will go to the setting programmed in "Output Voltage @ Desired Maximum Flow".

Actuator Stroke Time (0-300 seconds)

This needs to be the time it takes the flow device to "stroke" from the "Output Voltage at Desired Maximum Flow (0-10 VDC)" to the "Output Voltage at Desired Minimum Flow (0-10 VDC)".

Note: The stroke time from full open to full closed measured while obtaining job site conditions is the worst case. For tighter control, time the stroke of the valve again after the output voltages for min. and max. position are programmed.

Follow the steps below to adjust the stroke time:

- Using TechView, click on "**View**"
- Click on "**Manual Override**"
- In the pull-down menu for "Head Pressure Control Override", click on "**Maximum**"
- Insure the regulating valve has stopped moving and be prepared to start timer.
- Start timer as soon as the "Head Pressure Control Override" is changed to **"Minimum**"
- Stop timing when the valve stops modulating
- Program this new time in the CH530 under "**Actuator Stroke Time"** for tighter control of the water regulating valve.
- Be certain to change "Head Pressure Control Override" back to "**Auto**"

Damping Coefficient (0.1 - 1.8)

This adjustment can be used to make the control output for the condenser water regulating valve either more or less aggressive for a given system delta pressure error.

An initial estimate of the coefficient is the ratio of the incremental flow to the total flow range over the first half of the actuator operating range. For example, assume the device produces 45% flow at 2.0 Vdc, (the set minimum), and 100% flow at 10 Vdc. At half stroke, the voltage would be 6.0 Volts. Further assume that the flow is determined to be approximately 80% flow at that stroke midpoint of 6.0 Vdc. Since the incremental flow is from 45% to 80%, that gives us a 35% change to the midstroke position. Dividing this by the total possible change over the full output voltage range (100% - 45% = 55%) we get, 35% / 55% or 0.64 for the Damping Coefficient, (A value 1 would in theory be the perfect setting for a linear actuator, but using half the theoretical value is safer; setting the coefficient too large can cause instability.)

Note: This setting is defaulted to 0.5.

Condenser Pre-run Time (0-30 minutes)

This setting allows the CH530 to cycle on the condenser water pump prior to cycling on the compressor. This is particularly important when the water through out the condensing water loop is at different temperatures. The condensing water pump should run as long as necessary to obtain a good mixture producing a stable water temperature.

Examples

Every jobsite has unique characteristics. All jobs have different condensing water loops, different chilled water loops, and different units performing these functions.

Understanding the buildings basic layout and control scheme is necessary to obtain proper condenser regulating valve operation.

Although every job site is unique, most application fall into common categories. For instance: cold condensing water in the winter or river water application.

These basic job site applications are listed below with a set of sample settings, to help the technician better utilize the capabilities of the condensing water regulating valve.

Cold Condenser Water

This is a typical application of an RTHD unit used year round. Through the winter months, the condensing water in the cooling tower may drop below 50 F. If a condensing regulating valve is not installed the chiller will most likely trip within a matter of minutes on a "Low System Differential Pressure" diagnostic. This occurs when closing the EXV on start-up is not enough to overcome the low pressure in the condenser caused from the cold tower water. Remember Figure 1, p. 3, this shows how fast the chiller must establish differential pressure between the condenser and evaporator for safe oil flow to the compressor.

To assure proper operation, work through the sample settings below and adjust accordingly for the specific jobsite conditions:

This scenario assumes the following conditions:

- RTHD 175 ton unit (configuration B1B1B1)
  - B1 condenser has water volume of 28 gallons
- Cooling tower with 100 gallon sump
- 184 ln. ft of 6" steel pipe used in the condensing loop
  - From standard piping tables = 184 x 1.6 gpm/ft = 294 gallons
- Condensing water pump operating at 400 gpm
- Total volume of condensing loop is sump + pipe + condenser
  - 28 + 100 + 294 = 422 gallons
- Assume that half of the water is at outdoor ambient temperature = 35 F
- Assume the remaining water is at building temperature = 65 F

Example:The water in the condensing loop needs to cycle 3 times through the entire loop to insure adequate mixing. The goal is to achieve a stable condensing water temperature in the condenser before the compressor starts.

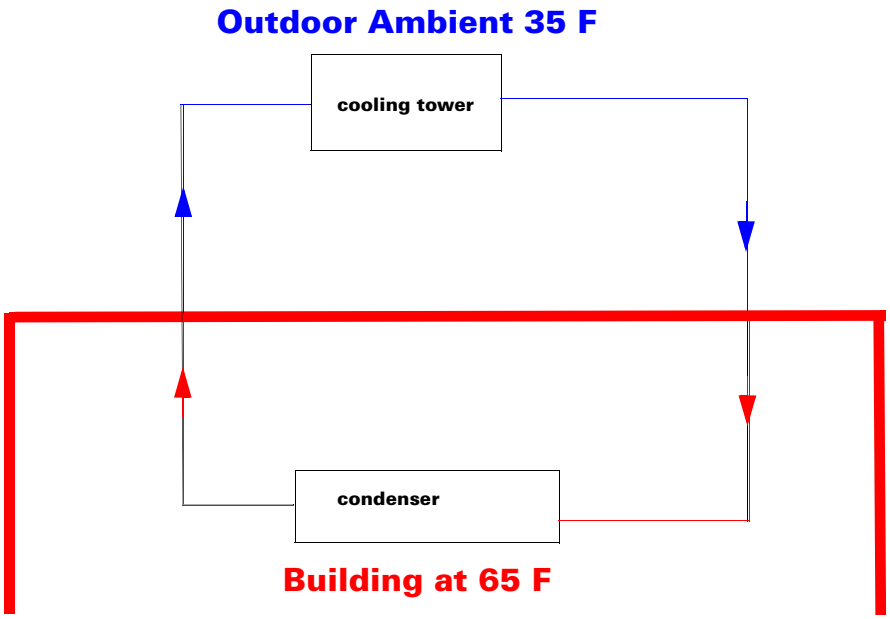


Table 3. Sample Settings for Cold Tower Water Conditions

MENU ITEMS	Sample Setting	Discussion
"Off State" Output Command	0 volts	customer preference
Output Voltage at Desired Minimum Flow	2 vdc	The voltage and the percentage must correspond with each other for the valve to be modulated correctly.
Desired Minimum Flow	20%	The voltage and the percentage must correspond with each other for the valve to be modulated correctly.
Output Voltage at Desired Maximum Flow	10 volts	opposite of "off state"
Actuator Stroke Time	15 sec	see procedures under "Actuator Stroke Time "
Damping Coefficient	.5	see definition under "Damping Coefficient"
Condenser Water Pump Pre-run time	3.2 min	see the example below for the formula.

Example:To calculate condenser per-run time for cold tower water, use the following formula.

Condenser Water Pump Pre-run Time= {Gallons of water in the condensing water loop / GPM of cond. water pump} x 3 + 1/2 stroke time (minutes)

Example:422 gallons / 400 gpm x 3 +.125 = 3.3 minutes of condenser pre-run

River Water Application

This is a typical application of an RTHD unit using a river for the condensing water loop. Because the condenser water regulating valve pre-positions itself at start-up, this application must account for the warm water in the building. To avoid a diagnostic on start-up, the condensing water regulating valve or VFD must be configured properly. Work through the sample settings below and adjust accordingly for the specific jobsite conditions:

This scenario assumes the following conditions:

- RTHD 175 ton unit (configuration B1B1B1)
  - B1 condenser has water volume of 28 gallons
- Condensing loop using river water at 40F
- 91 ln. ft of 6” steel pipe used to carry water from river to condenser
  - From standard piping tables: 91 ln. ft x 1.6 gal/ft = 146 gallons
- Condensing water pump operating at 400 gpm
- Assume that half of the water is at outdoor ambient temperature = 65 F
- Assume the remaining water is at building temperature = 70 F

Example:The important factor in this set-up is the actual stroke time of the condenser water regulating valve and the amount of time necessary to flush the warm building water from the loop.

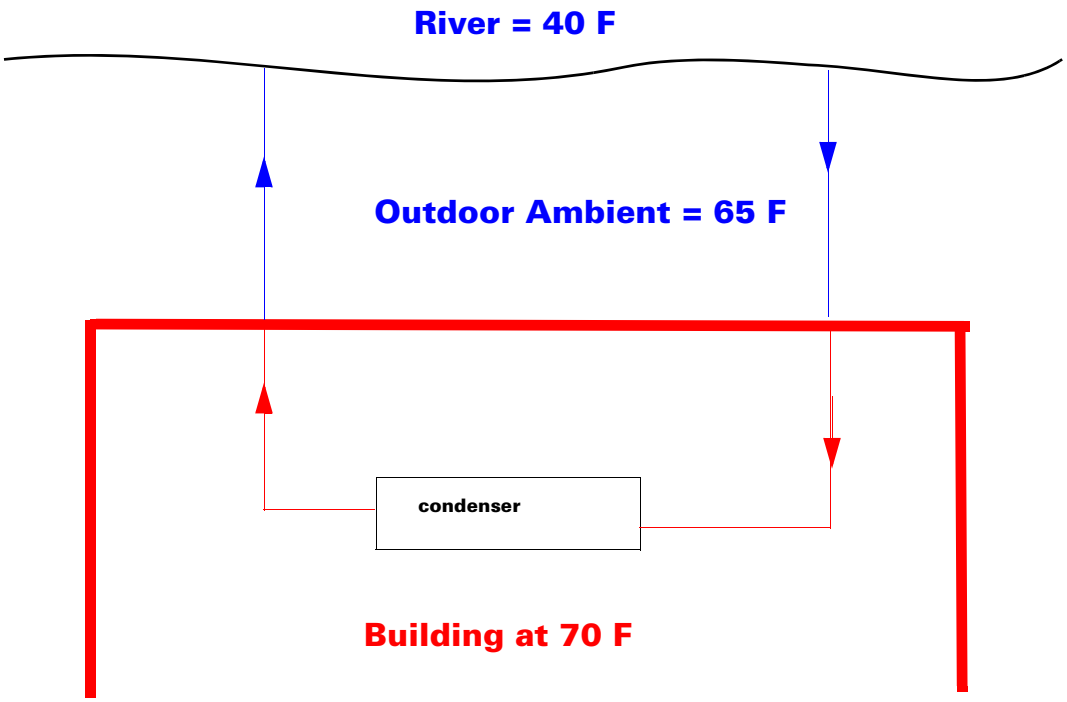


Table 4. Sample Settings for River Water Conditions

MENU ITEMS	Sample Setting	Discussion
"Off State" Output Command	0 volts	customer preference
Output Voltage at Desired Minimum Flow	2 vdc	The voltage and the percentage must correspond with each other for the valve to be modulated correctly.
Desired Minimum Flow	20%	The voltage and the percentage must correspond with each other for the valve to be modulated correctly.
Output Voltage at Desired Maximum Flow	10 volts	opposite of "off state"
Actuator Stroke Time	20 sec	see procedures under "Actuator Stroke Time "
Damping Coefficient	.5	see definition under "Damping Coefficient"
Condenser Water Pump Pre-run time	1.0 min	see the example below for the formula.

Example:To calculate condenser per-run time for river water applications, use the following formula:

Condenser Water Pump Pre-run Time= {vol. of water in pipe traveling from river to condenser (gallons)/condenser water pump vol. (gallons)} x {(1/2) stroke time (minutes)}

Example:{146gallons / 400 gpm} x (.166 minutes)= 0.531 minutes of condenser pre-run

Round-up calculation to the nearest minute

Questions

If the job site is still experiencing unit diagnostic after the basic set-up of the condenser water regulating valve, contact Technical Service at techservicepueblo@trane.com for additional assistance.

Trane
A business of American Standard Companies
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For more information, contact your local Trane office or e-mail us at comfort@trane.com

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