Engineering Bulletin

Freeze Avoidance Air-Cooled Chillers





Model Numbers: RTAC, CGAM, Ascend™ (ACR)
Sintesis™ (RTAF) and Ascend™ (ACS)

⚠SAFETY WARNING

Only qualified personnel should install and service the equipment. The installation, starting up, and servicing of heating, ventilating, and air-conditioning equipment can be hazardous and requires specific knowledge and training. Improperly installed, adjusted or altered equipment by an unqualified person could result in death or serious injury. When working on the equipment, observe all precautions in the literature and on the tags, stickers, and labels that are attached to the equipment.

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Introduction

Read this manual thoroughly before operating or servicing this unit.

Warnings, Cautions, and Notices

Safety advisories appear throughout this manual as required. Your personal safety and the proper operation of this machine depend upon the strict observance of these precautions.

The three types of advisories are defined as follows:

⚠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, could result in minor or moderate injury. It could also be used to alert against unsafe practices.
NOTICE	Indicates a situation that could result in equipment or property-damage only accidents.

Important Environmental Concerns

Scientific research has shown that certain man-made chemicals can affect the earth's naturally occurring stratospheric ozone layer when released to the atmosphere. In particular, several of the identified chemicals that may affect the ozone layer are refrigerants that contain Chlorine, Fluorine and Carbon (CFCs) and those containing Hydrogen, Chlorine, Fluorine and Carbon (HCFCs). Not all refrigerants containing these compounds have the same potential impact to the environment. Trane advocates the responsible handling of all refrigerants-including industry replacements for CFCs and HCFCs such as saturated or unsaturated HFCs and HCFCs.

Important Responsible Refrigerant Practices

Trane believes that responsible refrigerant practices are important to the environment, our customers, and the air conditioning industry. All technicians who handle refrigerants must be certified according to local rules. For the USA, the Federal Clean Air Act (Section 608) sets forth the requirements for handling, reclaiming, recovering and recycling of certain refrigerants and the equipment that is used in these service procedures. In addition, some states or municipalities may have additional requirements that must also be adhered to for responsible management of refrigerants. Know the applicable laws and follow them.

⚠WARNING

Proper Field Wiring and Grounding Required!

Failure to follow code could result in death or serious injury. All field wiring MUST be performed by qualified personnel. Improperly installed and grounded field wiring poses FIRE and ELECTROCUTION hazards. To avoid these hazards, you MUST follow requirements for field wiring installation and grounding as described in NEC and your local/state electrical codes.

⚠WARNING

Personal Protective Equipment (PPE) Required!

Failure to wear proper PPE for the job being undertaken could result in death or serious injury. Technicians, in order to protect themselves from potential electrical, mechanical, and chemical hazards, MUST follow precautions in this manual and on the tags, stickers, and labels, as well as the instructions below:

- **Before installing/servicing this unit, technicians MUST put on all PPE required for the work being undertaken (Examples; cut resistant gloves/sleeves, butyl gloves, safety glasses, hard hat/bump cap, fall protection, electrical PPE and arc flash clothing). ALWAYS refer to appropriate Safety Data Sheets (SDS) and OSHA guidelines for proper PPE.**
- **When working with or around hazardous chemicals, ALWAYS refer to the appropriate SDS and OSHA/GHS (Global Harmonized System of Classification and Labeling of Chemicals) guidelines for information on allowable personal exposure levels, proper respiratory protection and handling instructions.**
- **If there is a risk of energized electrical contact, arc, or flash, technicians MUST put on all PPE in accordance with OSHA, NFPA 70E, or other country-specific requirements for arc flash protection, PRIOR to servicing the unit. NEVER PERFORM ANY SWITCHING, DISCONNECTING, OR VOLTAGE TESTING WITHOUT PROPER ELECTRICAL PPE AND ARC FLASH CLOTHING. ENSURE ELECTRICAL METERS AND EQUIPMENT ARE PROPERLY RATED FOR INTENDED VOLTAGE.**

WARNING

Follow EHS Policies!

Failure to follow instructions below could result in death or serious injury.

- **All Trane personnel must follow the company's Environmental, Health and Safety (EHS) policies when performing work such as hot work, electrical, fall protection, lockout/tagout, refrigerant handling, etc. Where local regulations are more stringent than these policies, those regulations supersede these policies.**
- **Non-Trane personnel should always follow local regulations.**

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Revision History

- Removed Stealth™ Model RTAE.
- Added Ascend™ models ACR and ACS.
- Combined information for CGAM and ACS.
- Added low ambient refrigerant temperature cutout (LERTC) and low water temperature cutout (LWTC) table for Ascend™ Model ACS.
- Updated additional unit information sources table.

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General Information

Refrigerant Migration

When ambient temperatures are low, refrigerant will migrate from a relatively warm evaporator to a relatively cold condenser. This could cause portions of the evaporator to drop below fluid freezing temperature, and ice to form.

Note: *Migration most often occurs in low ambient temperatures. However, even in mild climates, refrigerant can migrate and cause evaporator freeze if unit experiences a rapid, drastic change in ambient temperature.*

RTAC

The RTAC has a flooded evaporator, which has a high ratio of refrigerant volume to water volume. This high ratio gives the potential to freeze water inside the evaporator tubes if the refrigerant is allowed to migrate and the ambient is below 32°F (colder if freeze inhibitor is applied). Migration can occur anytime that refrigerant is in the evaporator and the condenser is colder than the evaporator.

The most significant concern for freezing is upon shutdown or power failure in very cold conditions, when the condenser will rapidly change from high to low temperature.

Migration can also be an issue after long periods of off time when there is a rapid drop in ambient.

If the RTAC controls the chilled water flow, it will automatically start the flow in a condition where freeze is possible, and will keep the flow commanded 'on' until the refrigerant has migrated out of the evaporator, removing the potential for freezing from refrigerant migration. Chilled water flow control by the RTAC can help protect your customers from freeze damage as well as the associated frustration and cost of repair.

Additionally, the evaporator is susceptible to operational freezing if run with fluid flow rates below the specified minimum. If fluid flow rates are kept at or above the specified minimum, there is no risk of operational freezing. It is therefore critical to maintain minimum flow whenever the chiller is operating.

CGAM and ACS

CGAM and ACS evaporators are brazed plate heat exchangers (BPHE). The BPHE holds a very small volume of refrigerant and water, and unit controls minimize refrigerant left in evaporator upon unit shutdown. The unit, therefore, is not susceptible to refrigerant migration freeze. However, CGAM and ACS units are still at risk for static low ambient freeze.

ACR

The ACR evaporator has a high ratio of refrigerant volume to water volume. This high ratio gives the potential to freeze water inside the evaporator tubes if the refrigerant is allowed to migrate and the ambient is below 32°F (colder if freeze inhibitor is applied).

Migration can occur anytime that refrigerant is in the evaporator and the condenser is colder than the evaporator. The most significant concern for freezing is upon a diagnostic shutdown or power failure in very cold conditions, when the condenser will rapidly change from high to low temperature. Migration can also be an issue after long periods of off time when there is a rapid drop in ambient.

If the ACR controls the chilled water flow, it will automatically start the flow in a condition where freeze is possible, and will keep the flow commanded 'on' until the potential for freezing from refrigerant migration is gone. The required chilled water flow control by the ACR can help protect your customers from freeze damage as well as the associated frustration and cost of repair.

Additionally, the ACR evaporator is susceptible to operational freezing if run with fluid flow rates below the specified minimum. If fluid flow rates are kept at or above the specified minimum, there is no risk of operational freezing. It is therefore critical to maintain minimum flow whenever the chiller is operating.

RTAF

The RTAF evaporator has a high ratio of refrigerant volume to water volume. This high ratio gives the potential to freeze water inside the evaporator tubes if the refrigerant is allowed to migrate and the ambient is below 30°F (colder if freeze inhibitor is applied).

Migration can occur anytime that refrigerant is in the evaporator and the condenser is colder than the evaporator. The most significant concern for freezing is upon a diagnostic shutdown or power failure in very cold conditions. Migration can also be an issue after long periods of off time when there is a rapid drop in ambient.

If the RTAF controls the chilled water flow, it will automatically start the flow in a condition where freeze is possible and will keep the flow commanded 'on' until the potential for freezing from refrigerant migration is gone. The required chilled water flow control by the RTAF can help protect your customers from freeze damage as well as the associated frustration and cost of repair.

Additionally, the RTAF evaporator is susceptible to operational freezing if run with fluid flow rates below the specified minimum. This is especially true if the unit is low on refrigerant charge. It is therefore critical to maintain minimum flow whenever the chiller is operating and to address potential undercharge situations promptly.

Definition of Terms

Refrigerant Migration Freeze Avoidance

Methods designed to prevent evaporator freeze due to refrigerant migration. May include:

- Draining of evaporator
- Freeze inhibitor (glycol)
- Pump/flow control

Ambient Freeze Avoidance

Methods used to protect evaporator from freeze due to ambient temperatures. May include:

- Heaters

  Note: *Heaters alone do NOT provide sufficient freeze avoidance for situations with refrigerant migration.*

- Freeze inhibitor (glycol)

Methods

Maximum Freeze Avoidance

If sufficient freeze inhibitor (glycol) is used, or evaporator is fully drained, no further action is necessary.

Glycol

Glycols are used in HVAC systems to prevent damage from corrosion and freezing. Glycol suppliers provide concentration data for freeze protection and burst protection. Which one should I use?

As the temperature drops below the inhibited glycol solution's freeze point, ice crystals will begin to form. Because the water freezes first, the remaining glycol solution is further concentrated and remains fluid. The combination of ice crystals and fluid makes up a flowable slush. The fluid volume increases as this slush forms and flows into available expansion volume.

Freeze protection indicates the concentration of glycol required to prevent ice crystals from forming at the given temperature. Burst protection indicates the concentration required to prevent damage to equipment (e.g. coil tubes bursting). Burst protection requires a lower concentration of glycol, which results in less degradation of heat transfer capacity.

Burst protection is usually sufficient in systems where the system is inactive during winter and there is adequate space to accommodate the expansion of an ice/slush mixture. Given a sufficient concentration of glycol for burst protection, no damage to the system will occur. Burst protection is also appropriate for closed-loop systems which must be protected despite power or pump failure. An example is an air-cooled chilled-water system that does not need to run during subfreezing weather.

Freeze protection is mandatory in those cases where no ice crystals can be permitted to form or where there is inadequate expansion volume available. An example is a coil runaround loop. Also, HVAC systems that must start-up during cold weather following prolonged winter shutdowns may require freeze protection. However, specify freeze protection only when the fluid must remain 100% liquid at all times.

For either freeze or burst protection, the required concentration of glycol depends on the operating conditions of the system and the lowest expected ambient temperature. Often, the concentration is selected based on a temperature that is at least 5° F lower than the lowest anticipated design operating temperature.

Table 1 is an excerpt from product information bulletins published by The Dow Chemical Company

Table 1. Typical concentrations (by % volume) required to provide freeze and burst protection at various temperatures

Temperature (° F)	DOWTHERM SR-1 (ethylene glycol)		DOWFROST HD (propylene glycol)	
	Freeze	Burst	Freeze	Burst
20	16.80%	11.50%	18%	12%
10	26.2	17.8	29	20
0	34.6	23.1	36	24
-10	40.9	27.3	42	28
-20	46.1	31.4	46	30
-30	50.3	31.4	50	33
-40	54.5	31.4	54	35
-50	58.7	31.4	57	35
-60	62.9	31.4	60	35

Freeze Avoidance

Important: *If chiller is located in a climate which rarely sees freezing ambient temperatures, chiller can still experience freeze due to refrigerant migration.*

Pump Control and Heaters

Important: *Heaters alone are NOT sufficient to protect the evaporator from refrigerant migration freeze. Therefore,* ***it is required that water pump control be used*** *in conjunction with heaters for refrigerant migration freeze avoidance.*

Heaters

Heaters are factory-installed on the evaporator. Heaters will provide ambient freeze avoidance in temperatures down to -20°F (-29°C), but are not sufficient to provide refrigerant migration freeze avoidance.

Heat Tape

Install heat tape on all water piping, pumps, and other components that may be damaged if exposed to freezing temperatures. Heat tape must be designed for low ambient temperature applications. Heat tape selection should be based on the lowest expected ambient temperature.

Pump Control

For adequate refrigerant migration freeze avoidance, when chiller calls for flow, it must be provided without delay and meet minimum evaporator flow rate requirements shown in the unit IOM general data, or unit selection information. See Table 2 for IOM document numbers.

Note: *Call for chiller control CANNOT be routed through a Building Automation System (BAS), due to the resulting delays. The call for pump control MUST be sent directly to the controller.*

See “Flow Control,” p. 9 for more information.

Power Outages

NOTICE:

Equipment Damage!

All heaters have separate power from the unit. All heaters must be energized or the unit must control the pumps when the unit is off (unless the water circuit is drained or sufficient glycol is used). In the event of power loss, neither heaters nor unit control of the pumps will protect the evaporator from catastrophic damage. In order to provide freeze protection in the event of a power loss you MUST drain the evaporator, use sufficient freeze inhibitor in the evaporator or provide back-up power for pump.

If power is lost to the unit, neither heaters or unit control will protect the evaporator from freezing. Evaporator freeze due to power loss can only be prevented by draining the evaporator, using sufficient freeze inhibitor in the evaporator or providing a back-up power supply for the pumps/flow and controls (chiller and BAS).

Additional Unit Information

See chapters shown in the table below for more information regarding freeze avoidance for each product line.

Table 2. Additional unit information sources

Unit	Chapter	IOM
RTAC	“RTAC Freeze Avoidance,” p. 12	RTAC-SVX01*-EN
Sintesis™ RTAF	“Sintesis Model RTAF Freeze Avoidance,” p. 23	RTAF-SVX001*-EN
CGAM and ACS	“CGAM and ACS ambient freeze avoidance methods,” p. 15	CGAM-SVX17*-EN
Ascend™ (ACR)	“Ascend Model ACR Freeze Avoidance,” p. 21	AC-SVX001*-EN
Ascend™ (ACS)	“CGAM and ACS ambient freeze avoidance methods,” p. 15	AC-SVX002*-EN

For more detailed product information, see the chiller Installation, Operation, and Maintenance manuals listed in the above table.

If you have further questions, contact your local Trane office.

Flow Control

Refrigerant migration from the evaporator to the condenser may cause fluids to freeze, at such conditions evaporator flow may be required to avoid freezing. For this reason some manufacturers require antifreeze below specific outdoor air temperatures. As previously discussed use of anti-freeze is one method of ambient freeze avoidance.

This section describes refrigeration migration freeze avoidance when anti-freeze is not used. It also describes techniques to provide the required flow. Check with the chiller manufacturer to determine if this is allowed.

Fluid Flow Signal

When impending freeze conditions are experienced the chiller unit control signal will "call" for fluid flow.

Failure to provide adequate flow when called for by the chiller can quickly cause evaporator fluid to freeze.

Fluid Flow Rate

Once a fluid flow signal occurs, the minimum fluid flow rate defined by the chiller manufacturer must be met.

For Trane chillers this is defined in the unit IOM general data section. It may also be provided from a certified selection.

There can be system challenges if multiple chillers experiences impending freeze conditions and call for fluid flow.

System Fluid Flow Path

Once fluid flow is required, and the amount of chiller fluid flow is determined, there must be a system path through which that fluid can flow. Examples of possible fluid flow paths include:

- The bypass line in a primary-secondary (PS) system
- A normally open valve in the bypass line of a variable-primary-flow (VPF) system, or opening the bypass valve when flow control is required
- Three-way valves at air-handling coils
- A number of two-way valves that can be opened upon a call for flow. Normally open valves should be considered to ensure a flow path in the event of a system power loss.

Flow through the bypass line of either a PS or VPF system bypass line may still be a challenge if more than one chiller requires flow. At such conditions the flow rate may exceed that allowed for the bypass line size. In such cases two-way valves at select air handlers could be open to ensure the flow rate required by chillers is met.

Time to Achieve Fluid Flow

Fluid should start flowing as quickly as possible or freeze may occur. Limiting time factors include:

- Opening a chiller isolation valve and starting the pump

or

- Increasing pump speed enough to overcome the pressure drop of a triple-duty or check valve

To ensure rapid response the fluid flow signal should be sent directly to the chiller plant control system, which in turn should achieve flow as rapidly as possible.

Flow Control Example Configurations

Due to the myriad of chiller/pump configurations possible, this guide cannot address all of the possible configurations, but addresses four common configurations.

Important: *All of the scenarios assume there is a system flow path available that allows the chiller(s) required flow rate(s).*

Single Chiller, Single Pump.

In this configuration, the chiller unit control can directly control the pump.

1. Fluid flow signal initiated by chiller
2. Open the chiller isolation valve (if it is normally closed)
3. Start the pump
   a. If pump is constant speed it is enabled
   b. If pump is variable speed
      i. Start pump at minimum speed
      ii. Increase pump speed until the chiller minimum flow rate is reached

      Note: *Pump speed could be determined at the time of system balancing.)*
4. Allow flow for the time required by the manufacturer.
5. Once the flow requirement signal is satisfied
   a. Turn pump off
   b. Close the chiller isolation valve

Single Chiller, N+1 Pumps

In this configuration, some level of system control is required.

1. Fluid flow signal initiated by chiller
2. Open the chiller isolation valve (if it is normally closed)
3. Start the lead pump
   a. If pump is constant speed enable it

   b. If pump is variable speed
      i. Start pump at minimum speed
      ii. Increase pump speed until the chiller minimum flow rate is reached

      Note: *Pump speed could be determined at the time of system balancing.*

   c. Allow flow for the time required by the manufacturer
   d. Once the flow requirement signal is satisfied
      i. Turn pump off
      ii. Close the chiller isolation valve

Multiple Chillers, Dedicated Pumps

In this configuration, some level of system control is required.

1. Fluid flow signal initiated by chiller
2. Open the chiller isolation valve (if it is normally closed)
3. Start the pump for the chiller requiring flow
   a. If pump is variable speed
      i. Start pump at minimum speed
      ii. Increase pump speed until the chiller minimum flow rate is reached

      Note: *Pump speed could be determined at the time of system balancing.*
4. If an additional chiller calls for flow, follow steps 1-3 for that chiller also
5. Allow flow for the time required by the manufacturer
6. Once the flow requirement signal is satisfied
   a. Turn pump off
   b. Close the chiller isolation valve

Multiple Chillers, Manifolded Pumps (possibly including a redundant pump)

In this configuration, some level of system control is required.

1. Fluid flow signal initiated by chiller
2. Open the chiller isolation valve
3. Start the lead pump
   a. If pump is variable speed
      i. Start pump at minimum speed
      ii. Increase pump speed until the chiller minimum flow rate is reached

      Note: *Pump speed could be determined at the time of system balancing.*
4. If an additional chiller calls for flow, follow steps 1-3 for that chiller also
5. Allow flow for the time required by the manufacturer
6. Once the flow requirement signal is satisfied
   a. Turn pump off
   b. Close the chiller isolation valve

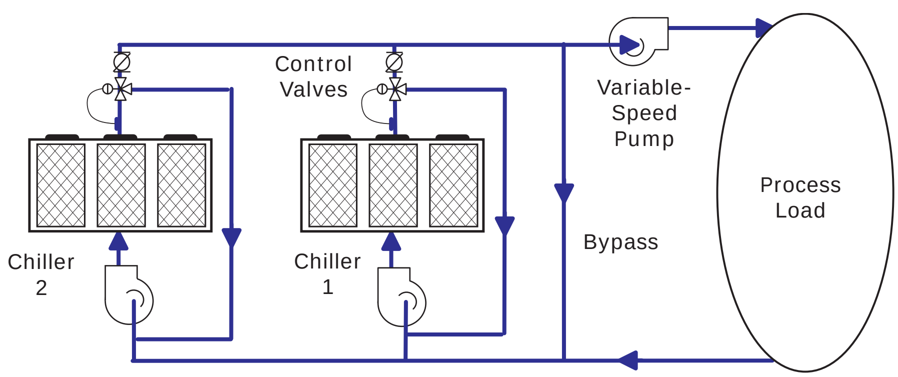
High Precision Process Cooling

In mission critical facilities such as data centers, or process operations requiring precise supply water temperature, if flow through a chiller is activated for freeze avoidance it could result in return water mixing with supply water through active chillers. This may cause the required system supply water temperature to rise.

Before considering any of the following options, confirm that the cooling in question cannot withstand the supply temperature change that results from mixing of temperatures for the time period required by the chiller manufacturer.

See the below figure for an example of a process application equipment layout.

Figure 1. Process application layout example



Option 1:
Pipe Around Chiller

Note: *Excerpted from "Chiller System Design and Control" Applications Manual (SYS-APM001-EN - 2009).*

If Chiller 1 is operating and there is a flow requirement for Chiller 2, it takes a certain amount of time to reach its supply-temperature setpoint. The dedicated control valve remains closed and water is bypassed until Chiller 2 reaches its setpoint, which keeps the water temperature supplied to the process within tolerance. When Chiller 2 reaches its setpoint, the control valve opens. Conversely, if the pump adds enough heat the flow control signal may be met with the bypass valve closed.

Advantage:

- Ensures precise temperature control at all times – including normal sequencing

Disadvantages:

- Additional cost
- Additional space
- Additional point of failure (control valve)

Option 2:
Start and Run the Additional Chiller (like normal operation)

Advantages:

- Simple
- No additional piping required
- Ensures the chiller can start if needed in emergency situation

Disadvantages:

- More chiller starts
- Splitting of load between chillers may not be optimal
- Possible electrical increase

RTAC Freeze Avoidance

One or more of the ambient freeze avoidance methods in the table below must be used to protect the RTAC chiller from ambient freeze damage.

Note: *A secondary set of pump interlock is **strongly recommended**, but not required.*

Table 3. RTAC freeze avoidance methods

Method	Protects to ambient temperature	Notes
Water Pump Control AND Heaters	Down to -20°F	• ***Heaters alone will provide low ambient protection down to -20°F (-29°C), but will NOT protect the evaporator from freezing as a result of charge migration. Therefore, it is required that water pump control be used in conjunction with heaters.*** • Heaters are factory-installed on the evaporator and water piping and will protect them from freezing • Install heat tape on all water piping, pumps, and other components that may be damaged if exposed to freezing temperatures. Heat tape must be designed for low ambient temperature applications. Heat tape selection should be based on the lowest expected ambient temperature. • Unit controller can start the pump when freezing conditions are detected. For this option the pump must to be controlled by the RTAC unit and this function must be validated. • Water circuit valves need to stay open at all times. • ***Water pump control and heater combination will protect the evaporator down to -20°F ambient temperature provided power is available to the pump and the unit controller. This option will NOT protect the evaporator in the event of a power failure to the chiller unless backup power is supplied to the necessary components.*** • While the Chiller is either off (no circuits or compressors running), in the Stop mode, or in any kind of run or start inhibit mode (when no chiller operation is possible), and the pump is already off, unit pump control for freeze protection will: Call out a diagnostic Low Evaporator Temp: Unit Off and energize, turn **ON** the Evaporator Water Pump Relay if the liquid level is > -0.83 "(inch) AND either of the Evaporator Saturated temperatures [as derived from the evaporator of suction pressure transducer(s)] fall below the LWTC for 30 ° F–sec (after RTAC Refresh...150 ° F–sec.) **OFF** when either the evaporator saturated temperature rises 2°F above the LWTC setting for 30 minutes or the liquid level < -0.83" (inch) for 30 minutes.
Freeze Inhibitor	Varies. See "Low Evaporator Refrigerant Cutout, Glycol Recommendations," p. 13	• Freeze protection can be accomplished by adding sufficient glycol to protect against freezing below the lowest ambient expected. • ***Use of glycol type antifreeze reduces the cooling capacity of the unit and must be considered in the design of the system specifications.***
Drain Water Circuit	Below -20°F	• Shut off the power supply to the unit and to all heaters. • Purge the water circuit. • Blow out the evaporator to ensure no liquid is left in the evaporator.

NOTICE:

Evaporator Damage!

If insufficient concentration or no glycol is used, the evaporator water flow must be controlled by the unit controller AND heaters must be used to avoid catastrophic damage to the evaporator due to freezing. It is the responsibility of the installing contractor and/ or the customer to ensure that a pump will start when called upon by the chiller controls.

Even with water pump control, a power loss of as little as 15 minutes under freezing conditions can damage the evaporator. Only the proper addition of freeze inhibitor or complete drainage of the water circuit can ensure no evaporator damage in the event of a power failure. See Table 4, p. 13 for correct concentration of glycol.

Low Evaporator Refrigerant Cutout, Glycol Recommendations

1. Solution freeze point is 4 deg F below operating point saturation temperature.
2. Low refrigerant temperature cutout (LRTC) is 4 deg F below freeze point.

Procedure

1. Is operating condition contained within Table 4, p. 13, If no, see "Specials," p. 13.
2. For leaving fluid temperatures greater than 40 deg F, use settings for 40 deg F.
3. Select operating conditions from Table 4.
4. Read off recommended % glycol.
5. Go to Table 5, p. 14 using the % glycol determined above.

Important: *Additional glycol beyond the recommendations will adversely effect unit performance. Unit efficiency and saturated evaporator temperature will be reduced. For some operating conditions this effect can be significant.*

6. If additional glycol is used, then use the actual % glycol to establish the low refrigerant cutout setpoint.
7. The minimum low refrigerant cutout setpoint allowed is -5 deg F. The minimum is established by the solubility limits of the oil in the refrigerant.

Specials

Any of the following conditions are considered special applications that must be calculated by engineering:

1. Freeze inhibitor other than ethylene glycol, propylene glycol, calcium chloride or methanol.
2. Fluid delta T outside the range 4 to 16 deg F.
3. Unit configuration other than Standard, Standard with extra pass, and Premium.
4. % Glycol greater than maximum in column in Table 5.

Special should all be calculated by engineering. The purpose of calculating is to make sure that design saturation temperature is greater than 3 deg F. Additionally, the calculation must verify that the fluid freeze point is a minimum of 4 deg. F lower that the design saturation temperature. The low evaporator temperature cutout will be 4 deg F below the freeze point or -5 deg F, whichever is greater.

Important: *When using glycol, Techview Setpoint View setting for "Freeze Inhibitor Present" must be set to "Yes" to prevent nuisance high approach diagnostic.*

Table 4. Glycol recommendations

		Ethylene Glycol						
	°F	**4**	**6**	**8**	**10**	**12**	**14**	**16**
DT	**°C**	**15**	**-14**	**-13**	**-12**	**-11**	**-10**	**-9**
Leaving Water Temperature °F (°C)	38 (3)	--	5	5	5	5	6	--
	34 (1)	--	11	11	11	12	--	--
	30 (-1)	--	15	16	17	18	--	--
	28 (-2)	--	18	18	19	--	--	--
	26 (-3)	--	20	21	22	--	--	--
	24 (-4)	--	22	23	26	--	--	--
	22 (-6)	--	24	26	--	--	--	--
	20 (-7)	--	26	30	--	--	--	--
	18 (-8)	--	29	--	--	--	--	--
	16 (-9)	--	31	--	--	--	--	--
	14 (-10)	30	--	--	--	--	--	--
	12 (-11)	32	--	--	--	--	--	--
	10.4 (-12)	34	--	--	--	--	--	--
		Propylene Glycol						
DT	**°F**	**4**	**6**	**8**	**10**	**12**	**14**	**16**
	°C	**-15**	**-14**	**-13**	**-12**	**-11**	**-10**	**-9**
Leaving Water Temperature °F (°C)	38 (3)	--	6	6	7	7	8	--
	34 (1)	--	13	13	15	17	--	--
	30 (-1)	--	19	21	--	--	--	--
	28 (-2)	--	22	--	--	--	--	--
	26 (-3)	--	25	--	--	--	--	--
	24 (-4)	--	--	--	--	--	--	--
	22 (-6)	--	--	--	--	--	--	--
	20 (-7)	--	--	--	--	--	--	--
	18 (-8)	--	--	--	--	--	--	--
	16 (-9)	--	--	--	--	--	--	--
	14 (-10)	--	--	--	--	--	--	--
	12 (-11)	--	--	--	--	--	--	--
	10.4 (-12)	--	--	--	--	--	--	--

Notes:

1. These tables represent the MINIMUM RECOMMENDED glycol percentages for each operating condition.
2. Operation is not recommended at certain operating conditions as some chillers may not satisfy maximum or minimum velocity requirements or minimum performance requirements. Contact Trane Sales Representative for more information regarding the operating limits of a particular chiller.

Table 5. Recommended low evaporator refrigerant cutout and percent glycol

% Glycol	Low Refrig. Temp Cutout (LRTC)		Solution Freeze Point	
	°F	°C	°F	°C
Ethylene				
0	28.0	-2.2	32	0
5	25.0	-3.9	29	-1.7
10	21.5	-5.8	25.5	-3.6
15	17.5	-8.1	21.5	-5.8
20	12.8	-10.7	16.8	-8.4
25	7.4	-13.7	11.4	-11.4
30	1.1	-17.2	5.1	-15.0
35	-5.0	-20.6	-2.3	-19.1
40	-5.0	-20.6	-10.8	-23.8
45	-5.0	-20.6	-20.7	-29.3
50	-5.0	-20.6	-32.1	-35.6
54	-5.0	-20.6	-42.3	-41.3
Propylene Glycol				
0	28.0	-2.2	32.0	0
5	25.3	-3.7	29.3	-1.5
10	22.4	-5.3	26.4	-3.1
15	19.1	-7.2	23.1	-4.9
20	15.3	-9.3	19.3	-7.1
25	10.8	-11.8	14.8	-9.6
30	5.3	-14.8	9.3	-12.6
35	-1.3	-19.5	2.7	-16.3
40	-5.0	-20.6	-5.2	-20.7
45	-5.0	-20.6	-14.6	-25.9
50	-5.0	-20.6	-25.8	-32.1
54	-5.0	-20.6	-36.1	-37.8
Chilled Water Temperature Cutout should be set to 5°F below the lowest allowable Chilled Water Set Point based on the %Glycol.				

CGAM and Ascend™ Model ACS Ambient Freeze Avoidance

Note: *CGAM and Ascend™ Model ACS chillers use brazed plate heat exchanges, which are NOT at risk for refrigerant migration freeze. Chiller must only be protected from freeze due to low ambient conditions.*

One or more of the ambient freeze avoidance methods in the table below must be used to protect the CGAM chiller from ambient freeze damage.

Table 6. CGAM and ACS ambient freeze avoidance methods

Method	Protects to ambient temperature	Notes
Water pump control	Down to 0°F	• Unit controller can start the pump when the ambient temperatures drops to prevent freezing. For this option the pump must to be controlled by the CGAM unit and this function must be validated. • Water circuit valves need to stay open at all times. • ***If dual high head pump package option is selected, the chiller MUST control the pumps.*** • ***By default the unit controller freeze protection control is enabled and will request the start of the chilled water pump with ambient temperatures less than the evaporator low leaving water temperature setpoint. The pump remains ON until the minimum evaporator water temperature is greater than low leaving water temperature setpoint plus 7°C. The minimum on time for the pump is 5 minutes. If you do NOT want the unit controller to start the pump when the ambient temperature drops to freezing, disable this freeze protection control.***
Heaters	Down to -20°F	• ***For CGAM, this option is not applicable for units ordered with "No Freeze Protection" (model number digit 18 = X). Factory mounted heaters are NOT installed on these units, and one of the other forms of freeze protection must be used.*** • ***For ACS, freeze protection heaters are provided on all chillers as standard.*** • For units with freeze protection selected (model number digit 18 is "1" for CGAM and all ACS units), heaters are factory-installed on the evaporator and water piping and will protect them from freezing in ambient temperatures down to -20°F (-29°C). **Note:** For ACS units with optional pump package, heaters will protect to -4°F (-20°C) for water, -20°F (-29°C) for ethylene glycol or propylene glycol. • Install heat tape on all water piping, pumps, and other components that may be damaged if exposed to freezing temperatures. Heat tape must be designed for low ambient temperature applications. Heat tape selection should be based on the lowest expected ambient temperature. • ***See NOTICE below for important information.***
Freeze Inhibitor	Varies. See "Low Evap Refrigerant Cutout/ Percent Glycol Recommendations, " p. 15	• Freeze protection can be accomplished by adding sufficient glycol to protect against freezing below the lowest ambient expected.
Drain Water Circuit	Below -20°F	• Shut off the power supply to the unit and to all heaters. • Purge the water circuit. • Blow out the evaporator to ensure no liquid is left in the evaporator.

NOTICE:

Equipment Damage!

All heaters have separate power from the unit. All heaters must be energized or the unit controller must control the pumps when the unit is off (unless the water circuit is drained or sufficient glycol is used). In the event of prolonged power loss, neither heaters nor unit control of the pumps will protect the evaporator from catastrophic damage. In order to provide freeze protection in the event of a power loss you MUST drain the evaporator, use sufficient freeze inhibitor in the evaporator or provide back-up power for pump.

Low Evap Refrigerant Cutout/Percent Glycol Recommendations

The table below shows the low evaporator temperature cutout for different glycol levels.

Additional glycol beyond the recommendations will adversely effect unit performance. The unit efficiency will be reduced and the saturated evaporator temperature will be reduced. For some operating conditions this effect can be significant.

If additional glycol is used, then use the actual percent glycol to establish the low refrigerant cutout setpoint.

Table 7. CGAM - low evap refrigerant temp cutout and low water temp cutout

ETHYLENE GLYCOL						
% Glycol	Solution Freeze Point (°F)	Low Refrig Temp Cutout (°F)	Low Water Temp Cutout (°F)	Min Chilled Water Set Point (°F) Compressor Quantity 2	4	6
0	32	26	36	42	42	42
1	31.6	25.6	35.6	42.0	40.1	39.2
2	31.0	25.0	35.0	42.0	39.5	38.6
3	30.3	24.3	34.3	41.3	38.8	38.0
4	29.7	23.7	33.7	40.7	38.2	37.3
5	29.0	23.0	33.0	40.0	37.5	36.7
6	28.3	22.3	32.3	39.3	36.8	36.0
7	27.6	21.6	31.6	38.6	36.1	35.3
8	26.9	20.9	30.9	37.9	35.4	34.6
9	26.2	20.2	30.2	37.2	34.7	33.9
10	25.5	19.5	29.5	36.5	34.0	33.1
11	24.7	18.7	28.7	35.7	33.2	32.4
12	23.9	17.9	27.9	34.9	32.4	31.6
13	23.1	17.1	27.1	34.1	31.6	30.8
14	22.3	16.3	26.3	33.3	30.8	30.0
15	21.5	15.5	25.5	32.5	30.0	29.1
16	20.6	14.6	24.6	31.6	29.1	28.2
17	19.7	13.7	23.7	30.7	28.2	27.3
18	18.7	12.7	22.7	29.7	27.2	26.4
19	17.8	11.8	21.8	28.8	26.3	25.5
20	16.8	10.8	20.8	27.8	25.3	24.5
21	15.8	9.8	19.8	26.8	24.3	23.5
22	14.7	8.7	18.7	25.7	23.2	22.4
23	13.7	7.7	17.7	24.7	22.2	21.3
24	12.5	6.5	16.5	23.5	21.0	20.2
25	11.4	5.4	15.4	22.4	19.9	19.1
26	10.2	4.2	14.2	21.2	18.7	17.9
27	9.0	3.0	13.0	20.0	17.5	16.7
28	7.7	1.7	11.7	18.7	16.2	15.4
29	6.4	0.4	10.4	17.4	14.9	14.1
30	5.1	-0.9	9.1	16.1	13.6	12.8
31	3.7	-2.3	7.7	14.7	12.2	11.4
32	2.3	-3.7	6.3	13.3	10.8	9.9
33	0.8	-5.2	4.8	11.8	9.3	8.5
34	-0.7	-6.7	3.3	10.3	7.8	7.0
35	-2.3	-8.3	1.7	8.7	6.2	5.4
36	-3.9	-9.9	0.1	7.1	4.6	3.8
37	-5.6	-11.6	-1.6	5.4	2.9	2.1
38	-7.3	-13.3	-3.3	3.7	1.2	0.4
39	-9.0	-15.0	-5.0	2.0	0.0	0.0
40	-10.8	-16.8	-6.8	0.2	0.0	0.0

PROPYLENE GLYCOL						
% Glycol	Solution Freeze Point (°F)	Low Refrig Temp Cutout (°F)	Low Water Temp Cutout (°F)	Min Chilled Water Set Point (°F) Compressor Quantity 2	4	6
0	32	26	36	42	42	42
1	31.6	25.6	35.6	42.0	40.1	39.2
2	31.0	25.0	35.0	42.0	39.5	38.7
3	30.4	24.4	34.4	41.4	38.9	38.1
4	29.9	23.9	33.9	40.9	38.4	37.5
5	29.3	23.3	33.3	40.3	37.8	37.0
6	28.7	22.7	32.7	39.7	37.2	36.4
7	28.1	22.1	32.1	39.1	36.6	35.8
8	27.6	21.6	31.6	38.6	36.1	35.2
9	27.0	21.0	31.0	38.0	35.5	34.6
10	26.4	20.4	30.4	37.4	34.9	34.0
11	25.7	19.7	29.7	36.7	34.2	33.4
12	25.1	19.1	29.1	36.1	33.6	32.8
13	24.4	18.4	28.4	35.4	32.9	32.1
14	23.8	17.8	27.8	34.8	32.3	31.4
15	23.1	17.1	27.1	34.1	31.6	30.7
16	22.4	16.4	26.4	33.4	30.9	30.0
17	21.6	15.6	25.6	32.6	30.1	29.3
18	20.9	14.9	24.9	31.9	29.4	28.5
19	20.1	14.1	24.1	31.1	28.6	27.8
20	19.3	13.3	23.3	30.3	27.8	26.9
21	18.4	12.4	22.4	29.4	26.9	26.1
22	17.6	11.6	21.6	28.6	26.1	25.2
23	16.7	10.7	20.7	27.7	25.2	24.3
24	15.7	9.7	19.7	26.7	24.2	23.4
25	14.8	8.8	18.8	25.8	23.3	22.4
26	13.8	7.8	17.8	24.8	22.3	21.4
27	12.7	6.7	16.7	23.7	21.2	20.4
28	11.6	5.6	15.6	22.6	20.1	19.3
29	10.5	4.5	14.5	21.5	19.0	18.2
30	9.3	3.3	13.3	20.3	17.8	17.0
31	8.1	2.1	12.1	19.1	16.6	15.8
32	6.8	0.8	10.8	17.8	15.3	14.5
33	5.5	-0.5	9.5	16.5	14.0	13.2
34	4.1	-1.9	8.1	15.1	12.6	11.8
35	2.7	-3.3	6.7	13.7	11.2	10.4
36	1.3	-4.7	5.3	12.3	9.8	8.9
37	-0.3	-6.3	3.7	10.7	8.2	7.4
38	-1.8	-7.8	2.2	9.2	6.7	5.8
39	-3.5	-9.5	0.5	7.5	5.0	4.2
40	-5.2	-11.2	-1.2	5.8	3.3	2.5

Table 7. CGAM - low evap refrigerant temp cutout and low water temp cutout (continued)

ETHYLENE GLYCOL						
% Glycol	Solution Freeze Point (°F)	Low Refrig Temp Cutout (°F)	Low Water Temp Cutout (°F)	Min Chilled Water Set Point (°F) Compressor Quantity		
				2	4	6
41	-12.7	-18.7	-7.0	0.0	0.0	0.0
42	-14.6	-20.6	-7.0	0.0	0.0	0.0
43	-16.6	-21.0	-7.0	0.0	0.0	0.0
44	-18.6	-21.0	-7.0	0.0	0.0	0.0
45	-20.7	-21.0	-7.0	0.0	0.0	0.0
46	-22.9	-21.0	-7.0	0.0	0.0	0.0
47	-25.1	-21.0	-7.0	0.0	0.0	0.0
48	-27.3	-21.0	-7.0	0.0	0.0	0.0
49	-29.7	-21.0	-7.0	0.0	0.0	0.0
50	-32.1	-21.0	-7.0	0.0	0.0	0.0
51	-34.5	-21.0	-7.0	0.0	0.0	0.0
52	-37.1	-21.0	-7.0	0.0	0.0	0.0
53	-39.7	-21.0	-7.0	0.0	0.0	0.0
54	-42.3	-21.0	-7.0	0.0	0.0	0.0
55	-45.0	-21.0	-7.0	0.0	0.0	0.0

PROPYLENE GLYCOL						
% Glycol	Solution Freeze Point (°F)	Low Refrig Temp Cutout (°F)	Low Water Temp Cutout (°F)	Min Chilled Water Set Point (°F) Compressor Quantity		
				2	4	6
41	-6.9	-12.9	-2.9	4.1	1.6	0.7
42	-8.8	-14.8	-4.8	2.2	0.0	0.0
43	-10.7	-16.7	-6.7	0.3	0.0	0.0
44	-12.6	-18.6	-7.0	0.0	0.0	0.0
45	-14.6	-20.6	-7.0	0.0	0.0	0.0
46	-16.7	-21.0	-7.0	0.0	0.0	0.0
47	-18.9	-21.0	-7.0	0.0	0.0	0.0
48	-21.1	-21.0	-7.0	0.0	0.0	0.0
49	-23.4	-21.0	-7.0	0.0	0.0	0.0
50	-25.8	-21.0	-7.0	0.0	0.0	0.0
51	-28.3	-21.0	-7.0	0.0	0.0	0.0
52	-30.8	-21.0	-7.0	0.0	0.0	0.0
53	-33.4	-21.0	-7.0	0.0	0.0	0.0
54	-36.1	-21.0	-7.0	0.0	0.0	0.0
55	-38.9	-21.0	-7.0	0.0	0.0	0.0

Table 8. Ascend™ Model ACS - low ambient refrigerant temperature cutout (LERTC) and low water temperature cutout (LWTC)

ETHYLENE GLYCOL				
Glycol Percentage (%)	Solution Freeze Point (°F)	Minimum Recommended LERTC (°F)	Minimum Recommended LWTC (°F)	Minimum Chilled Water Set Point (°F)
0	32.0	26.0	36.0	41.7
1	31.6	25.6	35.6	41.3
2	31.0	25.0	35.0	40.7
3	30.3	24.3	34.3	40.0
4	29.7	23.7	33.7	39.4
5	29.0	23.0	33.0	38.7
6	28.3	22.3	32.3	38.0
7	27.6	21.6	31.6	37.3
8	26.9	20.9	30.9	36.6
9	26.2	20.2	30.2	35.9
10	25.5	19.5	29.5	35.2
11	24.7	18.7	28.7	34.4
12	23.9	17.9	27.9	33.6
13	23.1	17.1	27.1	32.8
14	22.3	16.3	26.3	32.0
15	21.5	15.5	25.5	31.2
16	20.6	14.6	24.6	30.3
17	19.7	13.7	23.7	29.4
18	18.7	12.7	22.7	28.4
19	17.8	11.8	21.8	27.5
20	16.8	10.8	20.8	26.5
21	15.8	9.8	19.8	25.5
22	14.7	8.7	18.7	24.4
23	13.7	7.7	17.7	23.4
24	12.5	6.5	16.5	22.2
25	11.4	5.4	15.4	21.1
26	10.2	4.2	14.2	19.9
27	9.0	3.0	13.0	18.7
28	7.7	1.7	11.7	17.4
29	6.4	0.4	10.4	16.1
30	5.1	-0.9	9.1	14.8
31	3.7	-2.3	7.7	13.4
32	2.3	-3.7	6.3	12.0
33	0.8	-5.2	4.8	10.5
34	-0.7	-6.7	3.3	9.0
35	-2.3	-8.3	1.7	7.4
36	-3.9	-9.9	0.1	5.8
37	-5.6	-11.6	-1.6	4.1
38	-7.3	-13.3	-3.3	2.4
39	-9.0	-15.0	-5.0	0.7
40	-10.8	-16.8	-6.8	0.0

PROPYLENE GLYCOL				
Glycol Percentage (%)	Solution Freeze Point (°F)	Minimum Recommended LERTC (°F)	Minimum Recommended LWTC (°F)	Minimum Chilled Water Set Point (°F)
0	32.0	26.0	36.0	41.7
1	31.6	25.6	35.6	41.3
2	31.0	25.0	35.0	40.7
3	30.4	24.4	34.4	40.1
4	29.9	23.9	33.9	39.6
5	29.3	23.3	33.3	39.0
6	28.7	22.7	32.7	38.4
7	28.1	22.1	32.1	37.8
8	27.6	21.6	31.6	37.3
9	27.0	21.0	31.0	36.7
10	26.4	20.4	30.4	36.1
11	25.7	19.7	29.7	35.4
12	25.1	19.1	29.1	34.8
13	24.4	18.4	28.4	34.1
14	23.8	17.8	27.8	33.5
15	23.1	17.1	27.1	32.8
16	22.4	16.4	26.4	32.1
17	21.6	15.6	25.6	31.3
18	20.9	14.9	24.9	30.6
19	20.1	14.1	24.1	29.8
20	19.3	13.3	23.3	29.0
21	18.4	12.4	22.4	28.1
22	17.6	11.6	21.6	27.3
23	16.7	10.7	20.7	26.4
24	15.7	9.7	19.7	25.4
25	14.8	8.8	18.8	24.5
26	13.8	7.8	17.8	23.5
27	12.7	6.7	16.7	22.4
28	11.6	5.6	15.6	21.3
29	10.5	4.5	14.5	20.2
30	9.3	3.3	13.3	19.0
31	8.1	2.1	12.1	17.8
32	6.8	0.8	10.8	16.5
33	5.5	-0.5	9.5	15.2
34	4.1	-1.9	8.1	13.8
35	2.7	-3.3	6.7	12.4
36	1.3	-4.7	5.3	11.0
37	-0.3	-6.3	3.7	9.4
38	-1.8	-7.8	2.2	7.9
39	-3.5	-9.5	0.5	6.2
40	-5.2	-11.2	-1.2	4.5

Table 8. Ascend™ Model ACS - low ambient refrigerant temperature cutout (LERTC) and low water temperature cutout (LWTC) (continued)

ETHYLENE GLYCOL				
Glycol Percentage (%)	Solution Freeze Point (°F)	Minimum Recommended		Minimum Chilled Water Set Point (°F)
		LERTC (°F)	LWTC (°F)	
41	-12.7	-18.7	-7.0	0.0
42	-14.6	-20.6	-7.0	0.0
43	-16.6	-21.0	-7.0	0.0
44	-18.6	-21.0	-7.0	0.0
45	-20.7	-21.0	-7.0	0.0
46	-22.9	-21.0	-7.0	0.0
47	-25.1	-21.0	-7.0	0.0
48	-27.3	-21.0	-7.0	0.0
49	-29.7	-21.0	-7.0	0.0
50	-32.1	-21.0	-7.0	0.0
51	-34.5	-21.0	-7.0	0.0
52	-37.1	-21.0	-7.0	0.0
53	-39.7	-21.0	-7.0	0.0
54	-42.3	-21.0	-7.0	0.0
55	-45.0	-21.0	-7.0	0.0

PROPYLENE GLYCOL				
Glycol Percentage (%)	Solution Freeze Point (°F)	Minimum Recommended		Minimum Chilled Water Set Point (°F)
		LERTC (°F)	LWTC (°F)	
41	-6.9	-12.9	-2.9	2.8
42	-8.8	-14.8	-4.8	0.9
43	-10.7	-16.7	-6.7	0.0
44	-12.6	-18.6	-7.0	0.0
45	-14.6	-20.6	-7.0	0.0
46	-16.7	-21.0	-7.0	0.0
47	-18.9	-21.0	-7.0	0.0
48	-21.1	-21.0	-7.0	0.0
49	-23.4	-21.0	-7.0	0.0
50	-25.8	-21.0	-7.0	0.0
51	-28.3	-21.0	-7.0	0.0
52	-30.8	-21.0	-7.0	0.0
53	-33.4	-21.0	-7.0	0.0
54	-36.1	-21.0	-7.0	0.0
55	-38.9	-21.0	-7.0	0.0

Performance Adjustment Factors

Concentration and type of glycol used will affect unit performance. If operating conditions, including concentration of freeze inhibitor, have changed since the unit was ordered, contact sales representative to rerun selection. See the below figures for approximate adjustment factors.

Figure 2. Ethylene - compressor power adjustment

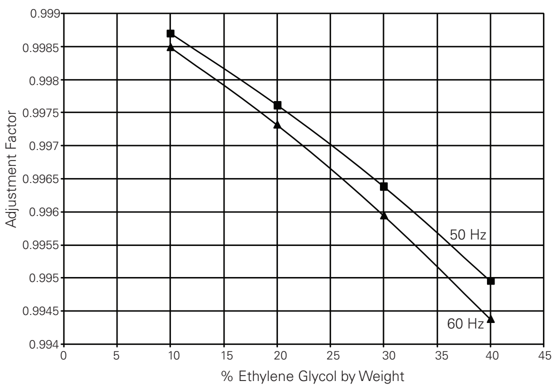


Figure 3. Propylene - compressor power adjustment

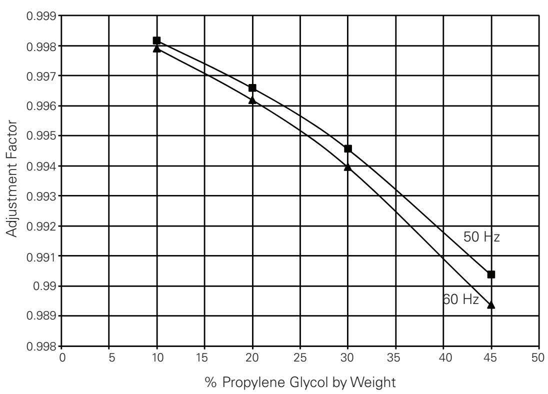


Figure 4. Ethylene - GPM adjustment

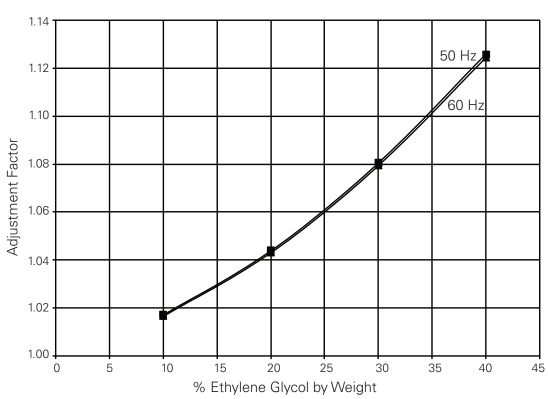


Figure 5. Propylene - GPM adjustment

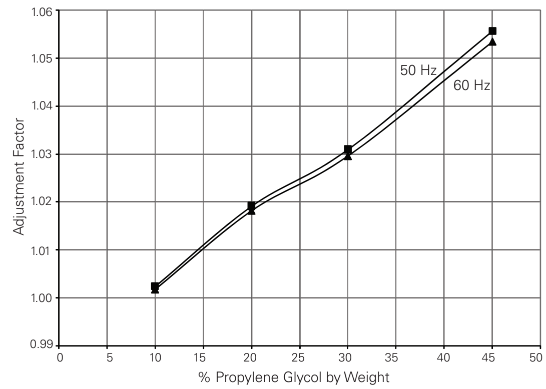


Figure 6. Ethylene - capacity adjustment

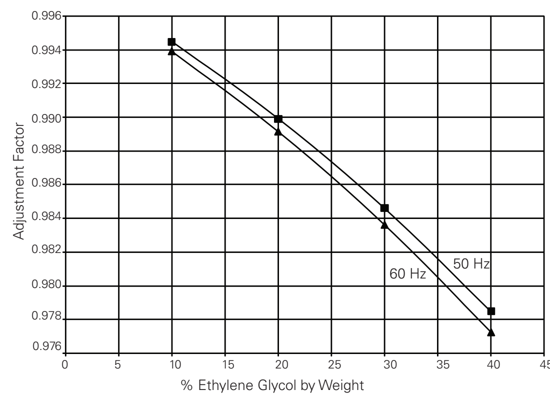
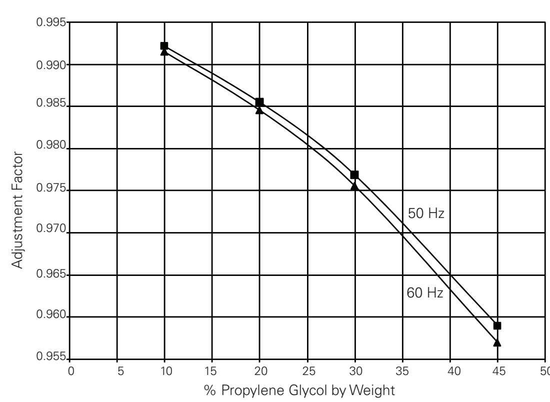


Figure 7. Propylene - capacity adjustment



Ascend Model ACR Freeze Avoidance

One or more of the ambient freeze avoidance methods in the table below must be used to protect the Ascend™ chiller from ambient freeze damage.

Table 9. Ascend™ model ACR freeze avoidance methods

Method	Protects to ambient temperature	Notes
Water Pump Control AND Heaters	Down to -20°F	• ***Heaters alone will provide low ambient protection down to -20°F (-29°C), but will NOT protect the evaporator from freezing as a result of charge migration. Therefore, it is required that water pump control be used in conjunction with heaters.*** • Heaters are factory-installed on the evaporator and water piping and will protect them from freezing • Install heat tape on all water piping, pumps, and other components that may be damaged if exposed to freezing temperatures. Heat tape must be designed for low ambient temperature applications. Heat tape selection should be based on the lowest expected ambient temperature. • Unit controller can start the pump when freezing conditions are detected. For this option the pump must to be controlled by the unit and this function must be validated. • Water circuit valves need to stay open at all times. • ***Water pump control and heater combination will protect the evaporator down to -20°F ambient temperature provided power is available to the pump and the controller. This option will NOT protect the evaporator in the event of a power failure to the chiller unless backup power is supplied to the necessary components.*** • When no chiller operation is possible and the pump is already off, unit controller pump control for freeze protection will command the pump to turn: **ON** if average of the evaporator entering water temperature, the evaporator leaving water temperature, and the evaporator refrigerant pool temperature is less than Low Evaporator Refrigerant Temperature Cutout (LERTC) + 4°F for a period of time. **OFF** again if the evaporator refrigerant pool temperature rises above the LERTC + 6F for a period of time. *Note: Time period referenced for ON and Off conditions above is dependent on past running conditions and present temperatures measured.* **ON** if entering OR leaving water temperature< LWTC for 30°F-sec (17°C-sec) **OFF** again if water temperature > LWTC for 30 min (where LWTC is low water temperature cutout)
Freeze Inhibitor	Varies. See "Low Evaporator Refrigerant Cutout, Glycol Requirements," p. 22	• Freeze protection can be accomplished by adding sufficient glycol to protect against freezing below the lowest ambient expected. • ***Use of glycol type antifreeze reduces the cooling capacity of the unit and must be considered in the design of the system specifications.***
Drain Water Circuit	Below -20°F	• Shut off the power supply to the unit and to all heaters. • Purge the water circuit. • Blow out the evaporator to ensure no liquid is left in the evaporator.

NOTICE:

Evaporator Damage!

If insufficient concentration or no glycol is used, the evaporator water flow must be controlled by the unit controller AND heaters must be used to avoid catastrophic damage to the evaporator due to freezing. It is the responsibility of the installing contractor and/ or the customer to ensure that a pump will start when called upon by the chiller controls.
Even with water pump control, a power loss of as little as 15 minutes under freezing conditions can damage the evaporator. Only the proper addition of freeze inhibitor or complete drainage of the water circuit can ensure no evaporator damage in the event of a power failure.

Low Evaporator Refrigerant Cutout, Glycol Requirements

The table below shows the low evaporator temperature cutout for different glycol levels. Additional glycol beyond the recommendations will adversely effect unit performance. The unit efficiency will be reduced and the saturated evaporator temperature will be reduced. For some operating conditions this effect can be significant.

If additional glycol is used, then use the actual percent glycol to establish the low refrigerant cutout setpoint.

Note: *Table below is not a substitute for full unit simulation for proper prediction of unit performance for specific operating conditions. For information on specific conditions, contact Trane product support.*

Table 10. Low evaporator refrigerant temperature cutout (LERTC) and low water temperature cutout (LWTC)

Ethylene Glycol			
Glycol Percentage (%)	Solution Freeze Point (°F)	Minimum Recommended LERTC (°F)	Minimum Recommended LWTC (°F)
0	32.0	28.6	35.0
2	31.0	27.6	34.0
4	29.7	26.3	32.7
5	29.0	25.6	32.0
6	28.3	24.9	31.3
8	26.9	23.5	29.9
10	25.5	22.1	28.5
12	23.9	20.5	26.9
14	22.3	18.9	25.3
15	21.5	18.1	24.5
16	20.6	17.2	23.6
18	18.7	15.3	21.7
20	16.8	13.4	19.8
22	14.7	11.3	17.7
24	12.5	9.1	15.5
25	11.4	8.0	14.4
26	10.2	6.8	13.2
28	7.7	4.3	10.7
30	5.1	1.7	8.1
32	2.3	-1.1	5.3
34	-0.7	-4.1	5.0
35	-2.3	-5.0	5.0
36	-3.9	-5.0	5.0
38	-7.3	-5.0	5.0
40	-10.8	-5.0	5.0
42	-14.6	-5.0	5.0
44	-18.6	-5.0	5.0
45	-20.7	-5.0	5.0
46	-22.9	-5.0	5.0
48	-27.3	-5.0	5.0
50	-32.1	-5.0	5.0

Propylene Glycol			
Glycol Percentage (%)	Solution Freeze Point (°F)	Minimum Recommended LERTC (°F)	Minimum Recommended LWTC (°F)
0	32.0	28.6	35.0
2	31.0	27.6	34.0
4	29.9	26.5	32.9
5	29.3	25.9	32.3
6	28.7	25.3	31.7
8	27.6	24.2	30.6
10	26.4	23.0	29.4
12	25.1	21.7	28.1
14	23.8	20.4	26.8
15	23.1	19.7	26.1
16	22.4	19.0	25.4
18	20.9	17.5	23.9
20	19.3	15.9	22.3
22	17.6	14.2	20.6
24	15.7	12.3	18.7
25	14.8	11.4	17.8
26	13.8	10.4	16.8
28	11.6	8.2	14.6
30	9.3	5.9	12.3
32	6.8	3.4	9.8
34	4.1	0.7	7.1
35	2.7	-0.7	5.7
36	1.3	-2.1	5.0
38	-1.8	-5.0	5.0
40	-5.2	-5.0	5.0
42	-8.8	-5.0	5.0
44	-12.6	-5.0	5.0
45	-14.6	-5.0	5.0
46	-16.7	-5.0	5.0
48	-21.1	-5.0	5.0
50	-25.8	-5.0	5.0

Sintesis Model RTAF Freeze Avoidance

One or more of the ambient freeze avoidance methods in the table below must be used to protect the Sintesis™ chiller from ambient freeze damage.

Table 11. RTAF freeze avoidance methods

Method	Protection Range	Notes
Water Pump Control AND Heaters	Down to -4°F	• ***Heaters alone will provide low ambient protection down to -4°F (-20°C), but will NOT protect the evaporator from freezing as a result of charge migration. Therefore, it is required that water pump control be used in conjunction with heaters.*** • Heaters are factory-installed on the evaporator and water piping and will protect them from freezing. • Install heat tape on all water piping, pumps, and other components that may be damaged if exposed to freezing temperatures. Heat tape must be designed for low ambient temperature applications. Heat tape selection should be based on the lowest expected ambient temperature. • Unit controller can start the pump when freezing conditions are detected. For this option the pump must to be controlled by the Sintesis unit and this function must be validated. • Water circuit valves need to stay open at all times. • ***Water pump control and heater combination will protect the evaporator provided power is available to the pump and the controller. This option will NOT protect the evaporator in the event of a power failure to the chiller unless backup power is supplied to the necessary components.*** • When no chiller operation is possible and the pump is already off, unit controller pump control for freeze protection will command the pump to turn: **ON** if the respective circuit's LERTC Integral was seen to be >0 for a period of time. The LERTC integral is increased if the Evap Refrigerant Pool Temp is below the value of the Low Evap Rfgt Temp cutout + 2°F. **OFF** if respective Evap Rfgt Pool Temp rises 4°F above LERTC setting for 1 minute and Chiller Off LERTC Integral = 0. *Note: Time period referenced for ON and Off conditions above is dependent on past running conditions and present temperatures measured.* **ON** if entering OR leaving water temperature< LWTC for 30°F-sec (1.11°C-sec) **OFF** if both entering and leaving water temps rise 2°F above the LWTC setting for 5 minutes.
Freeze Inhibitor	Varies.	• Freeze protection can be accomplished by adding sufficient glycol to protect against freezing below the lowest ambient expected. *Important: Be sure to apply appropriate LERTC and LWTC control setpoints based on the concentration of the freeze inhibitor or solution freeze point temperature. Note that these settings vary with unit size. See* *"Low Evaporator Refrigerant Cutout and Glycol Requirements," p. 24**.* • For units with free-cooling option, glycol solution is REQUIRED. See IOM RTAF-SVX001*-EN. • ***Use of glycol type antifreeze reduces the cooling capacity of the unit and must be considered in the design of the system specifications.***
Drain Water Circuit	Below -4°F	• Shut off the power supply to the unit and to all heaters. • Completely drain water from evaporator and exposed water piping not otherwise protected from freezing. See IOM RTAF-SVX001*-EN. • Blow out the evaporator to ensure no liquid is left in the evaporator and water lines.

NOTICE:

Evaporator Damage!

If insufficient concentration or no glycol is used, the evaporator water flow must be controlled by the unit controller AND heaters must be used to avoid catastrophic damage to the evaporator due to freezing. It is the responsibility of the installing contractor and/ or the customer to ensure that a pump will start when called upon by the chiller controls.
Even with water pump control, a power loss of as little as 15 minutes under freezing conditions can damage the evaporator. Only the proper addition of freeze inhibitor or complete drainage of the water circuit can ensure no evaporator damage in the event of a power failure.

y taking the steps outlined above, the RTAF Sintesis chiller should be protected from chilled fluid freezing down to the indicated ambient temperature. In addition, there are general recommendations and application details that may be considered to reduce the chilled fluid freeze potential. These include:

- Avoid the use of very low or near minimum chilled fluid flow rates through the chiller. Higher velocity chilled fluid flow reduces freeze risk in all situations. Flow rates below published limits have increased freeze potential and have not been considered by freeze protection algorithms.
- Avoid applications and situations that result in a requirement for rapid cycling or repeated starting and stopping of the chiller, especially with ambient temperatures below freezing. Keep in mind that chiller control algorithms may prevent a rapid compressor restart after shutting down when the evaporator has been operating near or below the LERTC limit.
- Maintain refrigerant charge at appropriate levels. If charge is in question, contact Trane service. A reduced or low level of charge can increase the likelihood of freezing conditions in the evaporator and/or LERTC diagnostic shutdowns.

Low Evaporator Refrigerant Cutout and Glycol Requirements

The tables below show the low evaporator temperature cutout for different glycol levels. Additional glycol beyond what is required for freeze protection will adversely effect unit performance. The unit efficiency will be reduced and the saturated evaporator temperature will be reduced. For some operating conditions this effect can be significant.

Always use the applied actual percent glycol to establish the low refrigerant cutout and low water temperature cutout setpoints.

Note: *Tables below should not be interpreted as suggesting operating ability or performance characteristics at all tabulated glycol percentages. Full unit simulation is required for proper prediction of unit performance for specific operating conditions. For information on specific conditions, contact Trane product support.*

Table 12. Ethylene glycol — low evaporator refrigerant temperature cutout (LERTC) and low water temperature cutout (LWTC)

Unit Sizes 115 to 250 tons				Unit Sizes 280 to 500 tons			
Glycol Percentage (%)	Solution Freeze Point (°F)	Minimum Recommended LERTC (°F)	Minimum Recommended LWTC (°F)	Glycol Percentage (%)	Solution Freeze Point (°F)	Minimum Recommended LERTC (°F)	Minimum Recommended LWTC (°F)
0	32.0	28.6	35.0	0	32.0	32.0	37.0
2	31.0	27.6	34.0	2	31.0	29.5	36.0
4	29.7	26.3	32.7	4	29.7	28.2	34.7
5	29.0	25.6	32.0	5	29.0	27.5	34.0
6	28.3	24.9	31.3	6	28.3	26.8	33.3
8	26.9	23.5	29.9	8	26.9	25.4	31.9
10	25.5	22.1	28.5	10	25.5	24.0	30.5
12	23.9	20.5	26.9	12	23.9	22.4	28.9
14	22.3	18.9	25.3	14	22.3	20.8	27.3
15	21.5	18.1	24.5	15	21.5	20.0	26.5
16	20.6	17.2	23.6	16	20.6	19.1	25.6
18	18.7	15.3	21.7	18	18.7	17.2	23.7
20	16.8	13.4	19.8	20	16.8	15.3	21.8
22	14.7	11.3	17.7	22	14.7	13.2	19.7
24	12.5	9.1	15.5	24	12.5	11.0	17.5
25	11.4	8.0	14.4	25	11.4	9.9	16.4
26	10.2	6.8	13.2	26	10.2	8.7	15.2
28	7.7	4.3	10.7	28	7.7	6.2	12.7
30	5.1	1.7	8.1	30	5.1	3.6	10.1
32	2.3	-1.1	5.3	32	2.3	0.8	7.3
34	-0.7	-4.1	5.0	34	-0.7	-2.2	5.0
35	-2.3	-5.0	5.0	35	-2.3	-3.8	5.0
36	-3.9	-5.0	5.0	36	-3.9	-5.0	5.0
38	-7.3	-5.0	5.0	38	-7.3	-5.0	5.0
40	-10.8	-5.0	5.0	40	-10.8	-5.0	5.0
42	-14.6	-5.0	5.0	42	-14.6	-5.0	5.0
44	-18.6	-5.0	5.0	44	-18.6	-5.0	5.0
45	-20.7	-5.0	5.0	45	-20.7	-5.0	5.0
46	-22.9	-5.0	5.0	46	-22.9	-5.0	5.0
48	-27.3	-5.0	5.0	48	-27.3	-5.0	5.0
50	-32.1	-5.0	5.0	50	-32.1	-5.0	5.0

Table 13. Propylene glycol — low evaporator refrigerant temperature cutout (LERTC) and low water temperature cutout (LWTC)

Unit Sizes 115 to 250 tons			
Glycol Percentage (%)	Solution Freeze Point (°F)	Minimum Recommended LERTC (°F)	Minimum Recommended LWTC (°F)
0	32.0	28.6	35.0
2	31.0	27.6	34.0
4	29.9	26.5	32.9
5	29.3	25.9	32.3
6	28.7	25.3	31.7
8	27.6	24.2	30.6
10	26.4	23.0	29.4
12	25.1	21.7	28.1
14	23.8	20.4	26.8
15	23.1	19.7	26.1
16	22.4	19.0	25.4
18	20.9	17.5	23.9
20	19.3	15.9	22.3
22	17.6	14.2	20.6
24	15.7	12.3	18.7
25	14.8	11.4	17.8
26	13.8	10.4	16.8
28	11.6	8.2	14.6
30	9.3	5.9	12.3
32	6.8	3.4	9.8
34	4.1	0.7	7.1
35	2.7	-0.7	5.7
36	1.3	-2.1	5.0
38	-1.8	-5.0	5.0
40	-5.2	-5.0	5.0
42	-8.8	-5.0	5.0
44	-12.6	-5.0	5.0
45	-14.6	-5.0	5.0
46	-16.7	-5.0	5.0
48	-21.1	-5.0	5.0
50	-25.8	-5.0	5.0

Unit Sizes 280 to 500 tons			
Glycol Percentage (%)	Solution Freeze Point (°F)	Minimum Recommended LERTC (°F)	Minimum Recommended LWTC (°F)
0	32.0	32.0	37.0
2	31.0	29.5	36.0
4	29.9	28.4	34.9
5	29.3	27.8	34.3
6	28.7	27.2	33.7
8	27.6	26.1	32.6
10	26.4	24.9	31.4
12	25.1	23.6	30.1
14	23.8	22.3	28.8
15	23.1	21.6	28.1
16	22.4	20.9	27.4
18	20.9	19.4	25.9
20	19.3	17.8	24.3
22	17.6	16.1	22.6
24	15.7	14.2	20.7
25	14.8	13.3	19.8
26	13.8	12.3	18.8
28	11.6	10.1	16.6
30	9.3	7.8	14.3
32	6.8	5.3	11.8
34	4.1	2.6	9.1
35	2.7	1.2	7.7
36	1.3	-0.2	6.3
38	-1.8	-3.3	5.0
40	-5.2	-5.0	5.0
42	-8.8	-5.0	5.0
44	-12.6	-5.0	5.0
45	-14.6	-5.0	5.0
46	-16.7	-5.0	5.0
48	-21.1	-5.0	5.0
50	-25.8	-5.0	5.0

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