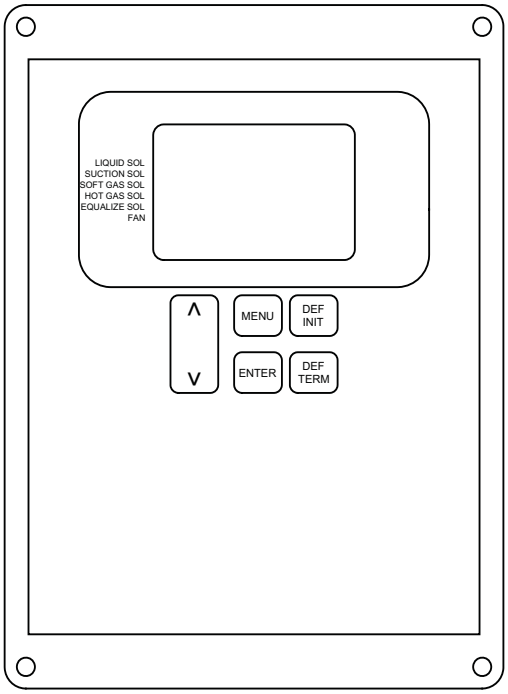
Defrost Controller

Product Bulletin 90-00

Customer Value Proposition:

The Refrigerating Specialties Defrost Controller is a powerful yet user friendly device for controlling the sequence of events that occur during system defrost cycles. The Controller may be applied to both industrial and commercial refrigeration systems, and is suitable for use on hot gas, electric, or water defrost applications.



Contact Information:

Parker Hannifin Corporation
Refrigerating Specialties Division
2445 South 25th. Avenue
Broadview, IL 60155-3891

phone (708) 681-6300
fax (708) 681-6306

www.parker.com/refspec

Product Features:

- Digital display
- Wide range of programmable features
- Easily upgradable to new versions of software
- Selectable defrost initiation modes: 24 hr/constant interval, constant interval, time of day, remote contact
- Selectable defrost termination modes: time, temperature with time override, remote contact with time override
- 30 day time/date/day retention after power failure
- Weekend/holiday energy-savings schedules
- Settings stored indefinitely in non-volatile memory
- RS485 communication port
- Operating temperature range 5°F to 120°F (-20°C to 50°C)
- UL/CSA/CE Approval

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Table of Contents

FEATURES AND SPECIFICATIONS

The focus of this manual is on hot gas defrost, however the information here can easily be adapted to one of the other defrost methods.

The Controller is programmed using on-screen prompts and four clearly marked push buttons (arrow up, arrow down, ENTER and MENU) on the front panel of the unit (Figure 1). There are two additional buttons on the front panel for immediately initiating or terminating a defrost cycle (DEF INIT, DEF TERM).

The DEF INIT and DEF TERM buttons are only active when the Status Screen appears in the LCD display. Before a defrost cycle is manually begun or ended, the user is prompted to confirm that this action is really desired.

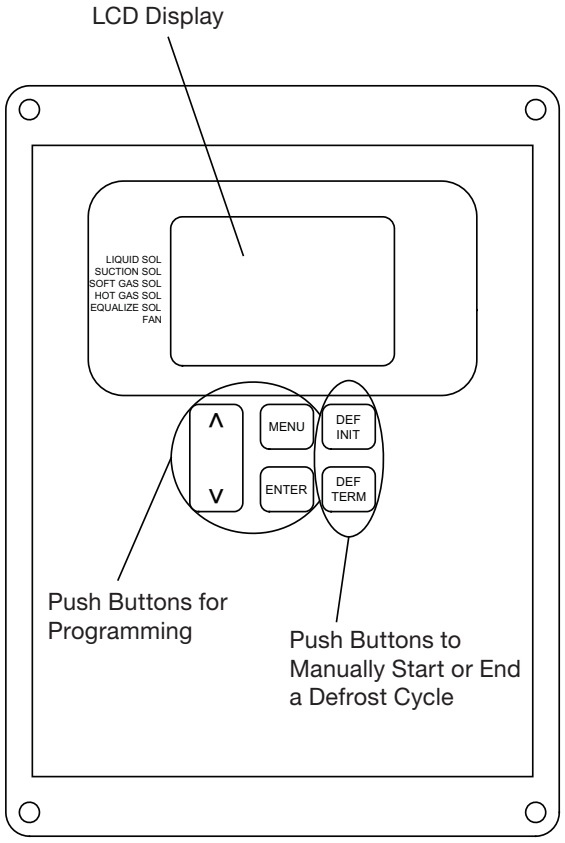


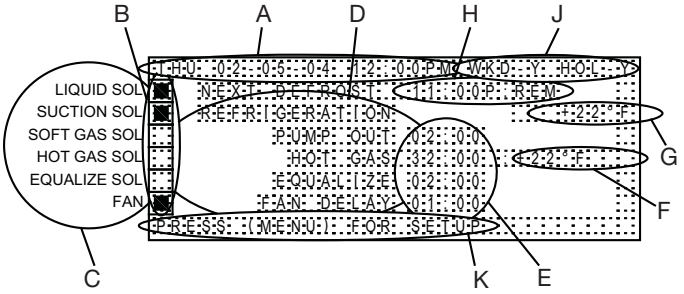
Figure 1: Controller Front Panel

Detailed programming information is given later in this manual. The program for controlling defrost cycles is stored in the non-volatile memory of the electronic processor (EPROM). This memory is virtually unaffected by power outages. The included NiMH batteries for powering the internal clock are continuously charged while power is applied to the Controller. In the event of a power failure, the batteries have a life of up to thirty (30) days. The nuisance of resetting the unit after either short or long term power loss is therefore eliminated.

Defrost cycles are initiated or terminated based on criteria that can be easily tailored to a specific system.

The flexibility of the Controller gives the user a means to customize the defrost cycle for maximum energy efficiency.

In regular operation, status of the refrigeration system is continuously displayed on an LCD screen that is rated for operation at 32°F (0°C). The Status Screen contains enough information to quickly show the system status as well as the defrost settings.



Item	Description
A	Displays current day, date, and time.
B	A group of indicators that correspond with markings on the controller front panel (Item C). These indicators show which of the controller relays is currently energized.
C	Markings on the controller front panel that correspond with the indicators (Item B).
D	Lists the steps in the defrost cycle. At any given time, one of these items will be highlighted.
E	Shows the time duration programmed for each defrost step. When one of the steps is active, the time counts-down to zero and resets. (The time shown for HOT GAS is actually the sum of the soft and hot gas times. During the soft gas phase, the words HOT GAS are replaced by SOFT GAS along with the set time for soft gas.)
F	Shows either a temperature set point at which the hot gas step ends (e.g., “+22 °F”), or identifies that a remote contact is being used to terminate the hot gas (e.g., “REM2”).
G	Shows the temperature actually measured by an analog sensor, this measurement is compared to the set point (Item F) to determine when defrost is complete, or is simply an indication of room temperature.
H	Shows the time of the next scheduled defrost cycle. If the defrost cycle occurs based on time and a remote contact closure, the message “REM” will also be displayed. If defrost is initiated by a remote contact only, then only the message “REM: will be displayed.
J	shows whether or not a weekend and holiday schedule will be applied to the normal defrost times.
K	All screens give the user a one or two line prompt for optional actions.

Figure 2: LCD Status Screen

Basic Operating Modes

The RS Defrost Controller operates in any of the three basic modes listed in Table 1. Within each of these modes, the controller will initiate or terminate defrost cycles based on a variety of criteria, described below.

Mode	Description
Normal Operation	Defrost cycles occur according to any of the Initiation and Termination Modes shown in Tables 2 & 3.
Weekend Operation	Allows the user to specify a special schedule to occur once each week for 1-3 days. At the end of the weekend, the normal schedule resumes. Weekend Operation only works in conjunction with 24 Hour / Constant Interval Initiation.
Holiday Operation	Allows the user to specify a Weekend Schedule that occurs one-time only for a period of one to six days. At the end of the Holiday Schedule, either the Normal or Weekend Schedule will resume, depending on the day of the week. Holiday Operation observes the defrost frequency programmed for Weekend Operation.

Table 1: Operating Modes

Defrost Initiation Criteria

The Controller can be programmed to consider several factors to determine when (and if) a defrost cycle should occur. These criteria are described briefly in Table 2.

The details of the events that must occur during a defrost cycle will vary somewhat, depending on the type of refrigeration system. The user is encouraged to read Appendix A: Hot Gas Defrost Cycle later in this manual for insight on how to best program the controller for his particular application. The basic steps of a hot gas defrost cycle should be modified appropriately for water or electric defrost.

Defrost Termination Criteria

The Controller signals the end of a defrost cycle by one of the three criteria listed in Table 3. The Cycle Steps, Table 4, are described in detail in Appendix A. Detailed programming steps are given later in this manual.

Criteria	Description
24 Hour / Constant Interval	Causes defrost cycles to begin every 2, 3, 4, 6, 8, or 12 hours This is the default mode used in Quick Setup. Defrost cycles occur at the same time each day, unless a separate Weekend or Holiday Schedule is programmed.
Constant Interval	Allows the user to specify the time interval between the start of defrost cycles (from 15 minutes to 23 hours, 45 minutes in 15-minute increments). The interval is maintained indefinitely regardless of time of day or day of week.
Exact Time	Allows the user to specify the exact times of day (in 15 minute increments) when defrost cycles can occur. Up to 12 defrost start-times can be programmed. The schedule repeats every day, regardless of day of week.
Liquid Feed Time	Allows the user to specify the length of time that liquid can be fed to the evaporator before a defrost is warranted. In this mode, the Defrost Controller is able to open and close the liquid feed solenoid based on a signal from either a temperature sensor or a temperature switch.
Remote	Allows defrost cycle to be triggered by remote contact closure.
24 Hour / Constant / Remote:	Causes defrost cycles to occur according to the 24 Hour Constant Interval Schedule only if a remote contact is closed. If the contact is not closed at the scheduled defrost time, the controller will check for contact closure again at the next scheduled defrost time.
Constant / Remote:	Causes defrost cycles to occur according to the Constant Interval Schedule only if a remote contact is closed. If the contact is not closed at the scheduled defrost time, the controller will check for contact closure again at the next scheduled defrost time.
Exact / Remote:	Causes defrost cycles to occur according to the Exact Time Schedule only if a remote contact is closed. If the contact is not closed at the scheduled defrost time, the controller will check for contact closure again at the next scheduled defrost time.

Table 2: Initiation Criteria

Criteria	Description
Time	Causes a defrost cycle to terminate at the conclusion of the Defrost Cycle Steps (Table 4).
Time / Temperature	Causes Defrost Cycle to terminate when an analog temperature measurement reaches a pre-set limit, unless the Hot Gas Time (Table 4) expires first.
Time / Remote	Causes Defrost Cycle to terminate when a remote contact closes, unless the Hot Gas Time (Table 4) expires first.

Table 3: Termination Criteria

Cycle Steps	Available Range	Quick-Setup Default Value
Pump Out	1 to 30 minutes	1 minutes
Soft Gas	0 to 15 minutes	0 minutes
Hot Gas	1 to 45 minutes	20 minutes
Equalize	1 to 60 minutes	1 minutes
Fan Delay	1 to 5 minutes	1 minutes
First Defrost	12:00 AM - 11:45 PM (15 minute increments)	See Note [1]

Table 4: Cycle Steps

Manual Defrost Modes

DEF INIT: When the system is in normal refrigeration mode, pressing the DEF INIT button on the Controller panel will cause the Pump Out step of a defrost cycle to begin immediately after verifying that this is the desired action. The defrost cycle will proceed through the steps in Table 4, and terminate according to the criteria from Table 3 already programmed into the controller.

Note that if the Time/Temperature or Time/Remote termination criteria, Table 3, have been programmed, pushing DEF INIT may cause the unit to immediately step to the Equalize phase. This will occur either if the temperature measured by the sensor exceeds the pre-set limit, or if the remote contact is closed.

The DEF INIT button is only active when the System Status screen is displayed. If the system is already in a defrost cycle, the DEF INIT button has no effect.

DEF TERM: When the system is in either the Pump Out, Soft Gas, or Hot Gas steps of a defrost cycle, pushing the DEF TERM button will cause the Equalize step of the defrost cycle to begin immediately after verifying that this is the desired action.

The DEF TERM button is only active when the System Status screen is displayed. If the system is already in the Equalize or Fan Delay steps, the DEF TERM button has no effect.

Specifications and Installation

Installation of the Controller should be guided by the specifications summarized in Table 5. The Controller should be mounted in an indoor location having an ambient temperature between 32°F (0°C) and 120°F (50°C). Proper mounting position is shown in Figure 3 of this manual. The Controller should not be subject to severe vibration, as this could cause sporadic electrical contacts and fatigue in the connections of any device. As shown on the wiring diagram (Figure 4), the Controller should be protected with a 5A external fuse. The Controller is not to be connected to rigid metallic conduit.

Item	Description
Power	85 – 265 VAC, 50/60 Hz
Ambient Temperature Range	32°F to 120°F (0°C to 50°C)
Enclosure	IP65/NEMA 4 (Watertight) CAUTION: Non-metallic enclosures do not provide grounding between conduit connections. Use grounding bushings and jumper wires when connecting to metal conduit or equivalent.
Relays [2]	Sealed Enclosure Contact: SPDT Rating: 10A/125VAC, 7A/250VAC, 7A/30VDC Contact Resistance: 100mW Max init. Operate/Release Time: 10 ms / 5 ms Temperature Range: -20°F to +160°F (-30°C to +70°C)
Terminal Strip	Accepts 14-22 AWG Maximum allowable torque on field wiring terminals is 3.5 in.-lb.
Approvals	UL, CSA, FCC , CE

Table 5: Specifications

Power Interruption

In the event that power to the controller is interrupted, either during normal refrigeration operations or during defrost; the Controller will perform in a manner for maximum safety and reliability.

- When power is interrupted, all relays will move to their de-energized positions (indicated on the wiring diagram, Figure 4).
- If the system was in defrost mode when power was interrupted, then when power is restored the Controller will immediately enter the “Equalization Phase” of the defrost cycle.

---

[1] The unit is shipped without a First Defrost Time programmed. No defrost cycle can occur until a specific time is entered.

[2] Solenoid and Fan control relay common terminals are to be connected to the line voltage of the device.

[3] This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

- If the system was in refrigeration mode when power was interrupted, then when power is restored the Controller will return to the refrigeration mode.

Blank Screen

If the front panel cable is disconnected while the controller is energized and reconnected, the screen will be blank. This situation can be corrected by de-energizing the controller and re-energizing with the front panel connected.

Screen Contrast Adjustment

The screen contrast can be adjusted by depressing the "enter" and "def term" keys simultaneously.

Spare Parts

Contact Refrigerating Specialties if replacements are needed for any of the following components.

PN	Description
208022	RTD Temperature Sensor
208942	RTD Converter Board
310780	Relay, SPDT, Defrost Controller

Internal Fuse: 250V, 3.5A

Internal Batteries: Non-repaceable

Table 6: Spare Parts

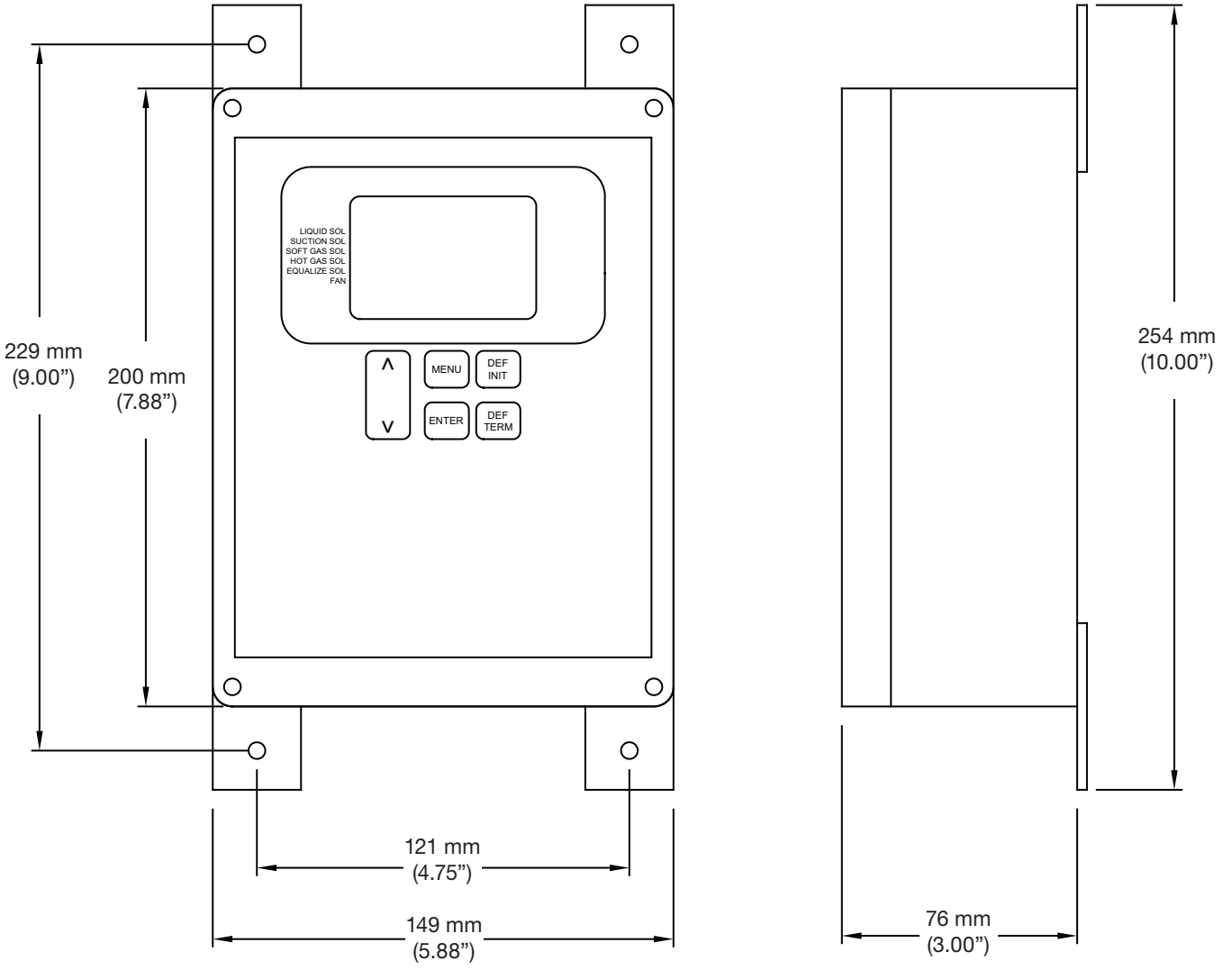
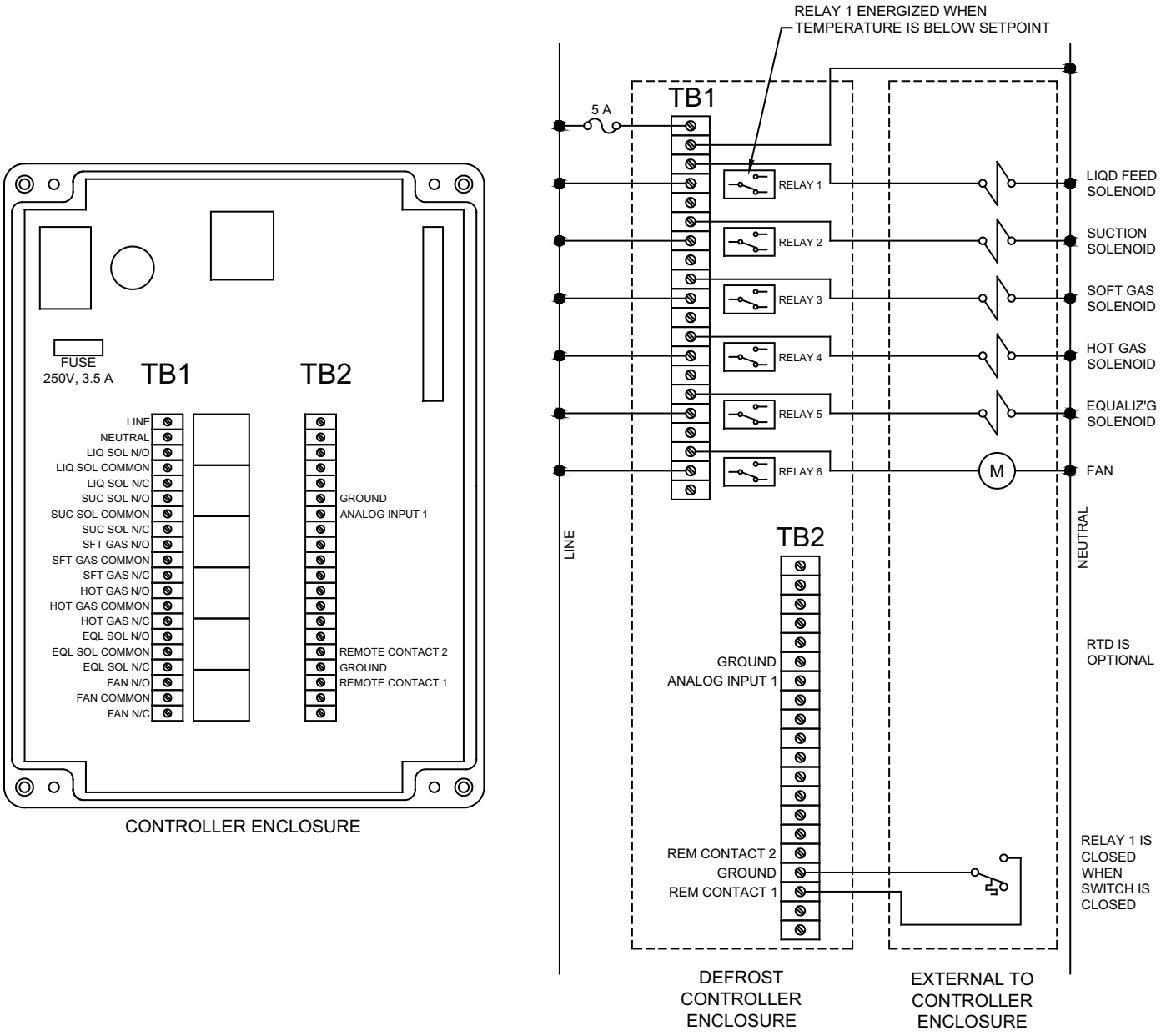


Figure 3: Controller Enclosure



Note: Low voltage sensor wiring shall be through a wire routing device in a manner which maintains 1/4" separation from line voltage field wiring.

Figure 4: Basic Controller Wiring Diagram

QUICK SETUP

In its most basic operating mode, the Controller will cause defrost cycles to occur at regular intervals each day, according to the 24-Hour Constant Interval Mode, described in Table 1. The default duration of each step in the defrost cycle are given in Table 4.

The first time power is applied to the Controller, this System Status screen will appear:

```
SUN 01-01-01      12:00 AM          WKD-N  HOL-N

■
■  REFRIGERATION                    +20°F
□      PUMP OUT:                    4:00
□      HOT GAS:                    20:00
□      EQUALIZE:                    1:00
■      FAN DELAY:                   2:00
PRESS (MENU) FOR SETUP / OPTIONS
```

Press the MENU button on the front panel, and the Main Menu will appear. Use the ▲▼ keys to highlight SET TIME / DAY then, press ENTER.

```
MAIN MENU:
        SET TIME / DAY
        SET TIMERS
        SET DEFROST OPTIONS
        SET ROOM TEMPERATURE
        INITIATE / DISABLE HOLIDAY

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```

Use the ▲▼ keys, to set month, and press ENTER.
Use the ▲▼ keys, to set day, and press ENTER.
Use the ▲▼ keys, to set year, and press ENTER.

```
WHAT IS THE DATE?  00/00/00




PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```

Use the ▲▼ keys, to set day, and press ENTER.

```
WHAT IS THE DAY?  SUN




PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```

Use the ▲▼ keys, to set hour, and press ENTER.
Use the ▲▼ keys, to set mintues, and press ENTER.
Use the ▲▼ keys, to set AM/PM, and press ENTER.

```
WHAT IS THE TIME?  11:54 AM




PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```

After entering the time, the Main Menu reappears. Select SET TIMERS with the ▲▼ keys, and press ENTER.

```
MAIN MENU:
        SET TIME / DAY
        SET TIMERS
        SET DEFROST OPTIONS
        VIEW SCHEDULE
        INITIATE / DISABLE HOLIDAY

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```

Use the ▲▼ keys, to set Pump Out duration, and press ENTER.

```
SET PUMP OUT DURATION:

          04 MINUTES
            30 MAX

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```

If there is no soft gas valve, enter zero for Soft Gas Duration; otherwise use the ▲▼ keys, to set Soft Gas Time, and press ENTER. If you are using an S4AD as your hot gas valve, answer "Yes" to the prompt. You can then use the std wiring diagram on page 8 to wire the S4AD.

```
SET SOFT GAS DURATION:

          00 MINUTES
            50 MAX

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```

Use the ▲▼ keys, to set Hot Gas Duration, and press ENTER.

```
SET HOT GAS DURATION:

          20 MINUTES
            45 MAX


PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```

Use the ▲▼ keys, to set Equalization Time, and press ENTER.

```
SET HOT GAS EQUALIZATION:

          01 MINUTES
            60 MAX


PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```

Use the ▲▼ keys, to set Fan Delay, and press ENTER.

```
SET FAN DELAY DURATION:

          02 MINUTES
            05 MAX


PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```

To choose the times when defrost should occur, select SET DEFROST OPTIONS with the ▲▼ keys, and press ENTER.

```
MAIN MENU:
        SET TIME / DAY
        SET TIMERS
        SET DEFROST OPTIONS
        VIEW SCHEDULE
        INITIATE / DISABLE HOLIDAY

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```

Select DEFROST INITIATION OPTIONS with the ▲▼ keys, and press ENTER.

```
SET DEFROST OPTIONS:

        DEFROST INITIATION OPTIONS
        DEFROST TERMINATION OPTIONS
         WEEKEND/HOLIDAY
         VIEW SCHEDULE

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```

Each of the defrost initiation options was described in Table 2. For each of the first three modes listed, you will be given the option of selecting whether a remote contact needs to be closed at the scheduled time for a defrost to occur.

```
DEFROST INITIATION MODES:

        24 HOUR CONST INTERVAL
        CONSTANT INTERVAL
        EXACT TIME
        TOTALIZED LIQUID
        REMOTE CONTACT ONLY

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```

The most straightforward method for initiating defrost is the 24 HOUR CONSTANT INTERVAL mode. In this mode, defrost will occur at the same time each day as long as the remote contact (if selected) is closed. The 24 Hour Constant Interval Mode is also the only mode that can be used with a separate weekend or holiday schedule.

After selecting 24HOUR CONST INTERVAL, the following screen appears.

```
DEFROST FREQUENCY:          0 HOURS
                            2 HOURS
                            3 HOURS
                            4 HOURS
                            6 HOURS
                            8 HOURS
                           12 HOURS

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```

By selecting 0 HOURS for defrost frequency, the Controller is prevented from initiating a defrost sequence.

Selecting 2 HOURS will result in 12 defrost sequences every day at 2-hour intervals. Selecting 3 HOURS will result in 8 defrost sequences every day at 3-hour intervals, and so on.

If REMOTE CONTACT 1 is selected, no defrost will occur at the scheduled time if this contact is open. (More detailed instructions are given later in this manual.)

REMOTE CONTACT FOR DEFROST INIT:

NO CONTACT
REMOTE CONTACT 1

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)

Time can be entered in 15 minute increments. After entering the time for the first defrost to occur, the Defrost Initiation screen will reappear.

SET TIME FOR FIRST
DEFROST

6:00 AM

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)

Press MENU to return to the Main Menu. Then select SET DEFROST OPTIONS. When the following menu appears, select DEFROST TERMINATION OPTIONS.

SET DEFROST OPTIONS:

DEFROST INITIATION OPTIONS
DEFROST TERMINATION OPTIONS
WEEKEND/HOLIDAY
VIEW SCHEDULE

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)

The most straightforward way to terminate a defrost cycle is the Time Only mode. Selecting this option will cause defrost cycle to end after time duration for each phase (Pump Out through Fan Delay) has expired.

DEFROST TERMINATION MODES:

TIME ONLY
TIME OR TEMPERATURE
TIME OR REMOTE CONTACT 2

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)

More detailed instructions are given later in this manual for the Time/Temperature and Time/Remote Contact Modes.

ADVANCED PROGRAMMING

Set the time between defrosts to be as long as possible. Remember, although defrost cycles save energy by allowing the evaporators to operate at maximum efficiency, the defrost cycle itself costs energy. The 24-Hour Constant Interval Mode allows defrost cycles to occur every 2, 3, 4, 6, 8, or 12 hours. These frequencies allow defrost cycles to occur at the same time every day. If your system needs to be defrosted at a different frequency, this can be accomplished by employing the Constant Interval Mode. In this mode, defrosts occur at evenly spaced intervals, but the time of defrost will differ from one day to the next. Another option is to use the Exact Time Mode, and set the exact times of day (up to 12) when defrost cycles should begin. The Exact Time mode permits different time intervals between defrost cycles.

Defrost Schedule Worksheet

The Refrigerating Specialties Defrost Controller permits flexibility in setting defrost schedules for energy efficiency while accommodating the realities of the the business day. In more complex situations, this flexibility can lead to unnecessarily long or short periods between defrost cycles. This can especially occur when using the Weekend or Holiday Modes, or Exact Time Initiation. The Worksheet on the following page may be useful in avoiding inappropriate periods between defrost cycles.

If you are using multiple Defrost Controllers on numerous cooling units, it may be helpful to make copies of the worksheet for each controller. Remember, in general only a maximum of one-third of the units should be defrosted at the same time.

To use the worksheet, first determine the defrost frequency that best suits your system. Then determine the best time of day for the first defrost to occur, taking into consideration such factors as shift-changes and times when the load on the system is heaviest, such as during daily delivery of new product into the refrigerated space.

With this preliminary information, put marks on the worksheet to indicate the start time of each defrost cycle throughout the day.

As an example, consider a refrigerated warehouse that receives deliveries throughout the day but is relatively inactive during the evenings. It may be advantageous to defrost the cooling unit once before deliveries start, say at 4:00AM. By noon, however, the coil is usually covered with a significant amount of frost. A second defrost could be scheduled to begin after the lunch break has begun, say 12:15. Shift-change might be the best time to schedule the next defrost, say 5:00PM. In the evening, when activity is low, only one defrost cycle may be necessary before the first daily 4:00AM defrost. A 10:30PM defrost cycle could be scheduled.

If a defrost cycle typically lasts 30 minutes (1 minute pump-out, 1 minute soft gas, 25 minute hot gas, 2 minute equalize, and 1 minute fan delay), the worksheet would look something like this. This schedule could easily be programmed using the Exact Time Initiation Mode.

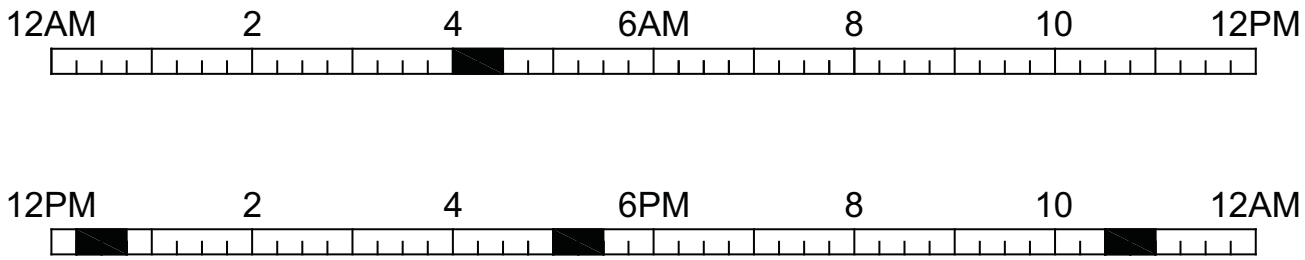


Figure 5: Example Worksheet

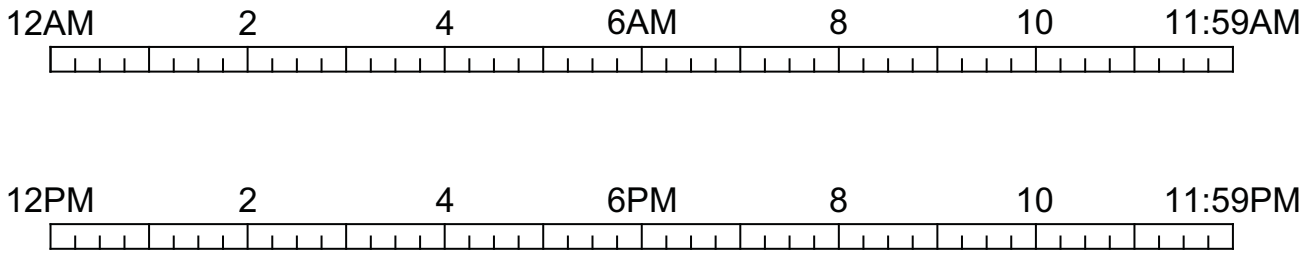


Figure 6: Regular Workday Defrost Schedule

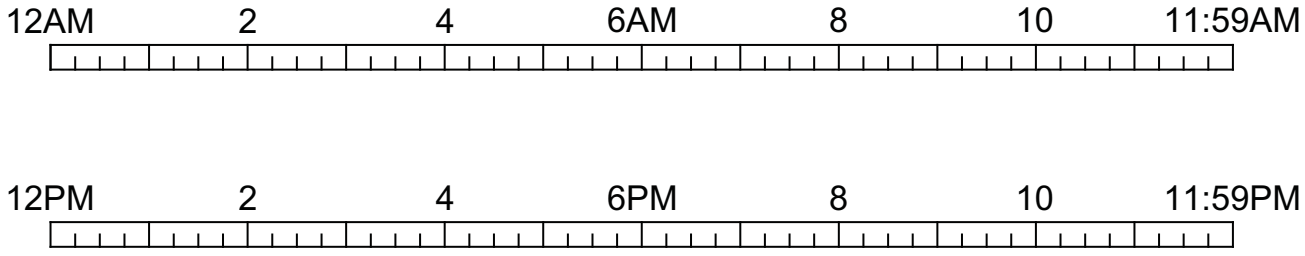


Figure 7: Weekend / Holiday Defrost Schedule

Changing Temperature Units

The temperature units displayed on the Status Screen (Figure 1), can be changed between °F and °C. The units are changed by simultaneously pressing the ▲▼ keys on the front panel, and then releasing them. The Unit Setup Screen will appear.

If at any time it becomes necessary to calibrate the temperature sensor, depress the "▼" and "enter" keys simultaneously. Following the directions displayed allows the entering of an offset. This offset will be applied to the reading throughout the entire range of the RTD. This option is only available on units with a serial no. having a date code later than 1106.

```
UNIT SETUP
              SOFTWARE VERSION 1.3

          BRUD RATE:  19200
              PARITY:  EVEN
TEMPERATURE SCALE:  CELSIUS
            SLAVE ID:  01

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```

"BAUD RATE", "PARITY", and "SLAVE ID" are not used at this time.

With the Unit Setup Screen displayed, press ENTER twice and the temperature units will appear (either CELCIUS or FAHRENHEIT). Use the ▲▼ keys to switch to the desired temperature units. Press ENTER two more times to return to the Status Screen. The desired temperature units should be displayed.

Liquid Solenoid Control

Liquid Solenoid Control (LSC) can be accessed through the main menu, shown below:

```
MAIN MENU:
        SET TIME / DAY
        SET TIMERS
        SET DEFROST OPTIONS
        LIQUID SOLENOID CONTROL
        INITIATE / DISABLE HOLIDAY

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```

Following the selection of Liquid Solenoid Control, the following menu should appear

```
LIQUID SOLENOID CONTROL:  N

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```

```
LSC SETPOINTS:

ON TEMPERATURE SETPOINT:    +25°F
OFF TEMPERATURE SETPOINT:   +20°F

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```

To use LSC with an RTD, the Figure 8 wiring diagram applies. If the RTD is supplied with the Defrost Controller the RTD consists of 3-wires (one white and two red). The signal line, white wire, must be inserted into terminal 1 of the converter board. The two common leads, red wires, must me inserted into terminals 2 and 3. It doesn't matter which terminal the two common leads are inserted, just as long they are both connected. After connecting all three leads on to the amplifier, tighten down the leads using a small screw driver.

Install the RTD converter board inside the Defrost Controller by mounting directly to the terminal blocks as shown in Figure 8. Match the analog input 1, 12VDC power supply, and ground pins from the amplifier with the terminal blocks in the controller. Tighten down the pins using a small screw driver.

The liquid solenoid status LED will show the current status of the liquid solenoid valve. Liquid solenoid control will be indicated on the Status screen immediately after "Refrigeration" as LSC.

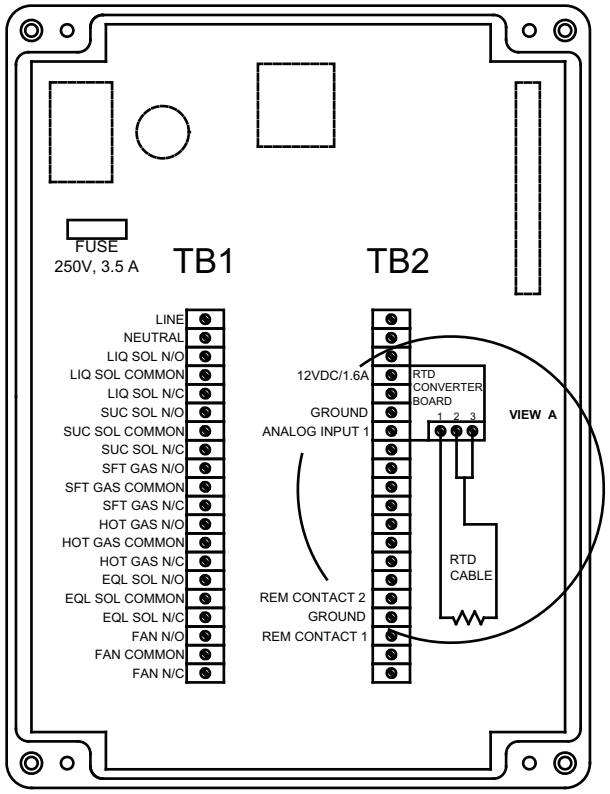
```
SUN 01-01-01      12:06 AM            WKD-N  HOL-N
☐  NEXT DEFROST 03:00 AM
■  REFRIGERATION      LSC                      +20°F
☐       PUMP OUT:                      4:00
☐       HOT GAS:                      20:00
☐       EQUALIZE:                      1:00
■       FAN DELAY:                     2:00
PRESS (MENU) FOR SETUP / OPTIONS
```

Defrost Initiation Based on Totalized Liquid Time (TLT) can only be used if LSC is active. This mode is accessed through the following menu and can only be used when using Liquid Solenoid Control (LSC).

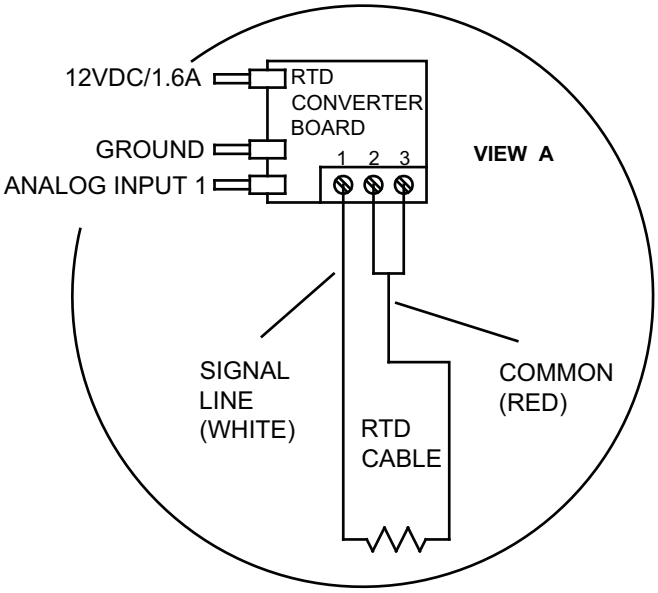
```
DEFROST INITIATION MODES:

        24 HOUR CONST INTERVAL
        CONSTANT INTERVAL
        EXACT TIME
        TOTALIZED LIQUID
        REMOTE CONTACT ONLY

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```

If TOTALIZED LIQUID TIME (TLT) is selected, the following menu should appear:

```
SET TOTAL LIQUID TIME:

          03 : 45
          12 HR MAX

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```



Controller Enclosure



Note: The RTD temperature probe common and signal leads may not have the same colors as shown in View A. The common leads may not be red, but the two leads will always be the same color and should be wired to terminals 2 and 3. The single lead will always be a different color from the common leads and should always be wired to terminal 1. (Example: signal-white with common-red or signal-red with common-white)

RTD BOARD INSTALLATION AND REPLACEMENT

CAUTION: Turn off electrical power supply

1. Loosen the screw for the 12VDC power supply, ground, and analog input 1 on the TB2 side of the circuit board inside the defrost controller enclosure
2. If replacing an existing RTD converter board, remove the board from the defrost controller, unscrew terminals 1 - 3, and remove the RTD leads as shown in View A
3. Re-assemble in reverse order (See note above)
4. Hand tighten screws on the RTD converter board and inside the defrost controller enclosure

Figure 8: RTD Converter Board Wiring Diagram

Once TLT is set, the following indicator should appear on the Status Screen:

```
SUN 01-01-01      12:06 AM          WKD-N  HOL-N
☐  NEXT DEFROST 03:00 AM : TLT
■  REFRIGERATION      LSC                +20°F
☐       PUMP OUT:                  4:00
☐       HOT GAS:                  20:00
☐       EQUALIZE:                  1:00
■       FAN DELAY:                 2:00
PRESS (MENU) FOR SETUP / OPTIONS
```

The NEXT DEFROST TIME is "dynamic", changing based on whether the liquid solenoid is open or closed.

Using Time and Remote Contact to Start Defrost

A remote contact may be used either alone or in conjunction with time to start a defrost cycle. The remote contact used to start a defrost cycle should be a normally open device connected to the REMOTE CONTACT 1 terminal. (See wiring diagram, Figure 4.)

The device should have an electrical contact that closes under conditions normally associated with a frosted evaporator coil. For example, a temperature switch installed in the evaporator air stream may sense a high temperature indicating frost has blocked the airflow.

This device can be used in any of the modes shown on the Defrost Initiation Mode screen, except TOTALIZED LIQUID. In TOTALIZED LIQUID MODE, REMOTE CONTACT 1 is used as a signal to open and close the liquid feed solenoid.

```
DEFROST INITIATION MODES:

        24 HOUR CONST INTERVAL
        CONSTANT INTERVAL
        EXACT TIME
        TOTALIZED LIQUID
        REMOTE CONTACT ONLY

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```

If either 24 HOUR CONST INTERVAL, CONSTANT INTERVAL, or EXACT TIME mode is selected, the following screen will appear later to permit REMOTE CONTACT 1 to be selected.

```
REMOTE CONTACT FOR DEFROST INIT:

        NO CONTACT
        REMOTE CONTACT 1

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```

After selecting REMOTE CONTACT 1, the "REM" indicator will appear on the Status Screen.

```
TUE 01-01-01      12:00 AM          WKD-Y  HOL-Y
■  NEXT DEFROST 06:00 AM : REM
■  REFRIGERATION                     +20°F
☐       PUMP OUT:                  4:00
☐       HOT GAS:                  20:00
☐       EQUALIZE:                  1:00
■       FAN DELAY:                 2:00
PRESS (MENU) FOR SETUP / OPTIONS
```

Note: In the Time/Contact modes, the Controller uses an "AND" criteria to determine if a defrost cycle should begin. Consider the events that will occur if defrosts are scheduled for 1AM and 7AM in conjunction with REMOTE CONTACT 1. If the contact is open at 1:00 AM, no defrost will occur. If the contact closes at 1:01 AM, the next defrost will occur 7:00 AM (provided the contact remains closed). It may be advisable, therefore, to schedule defrost cycles at shorter intervals. The user is responsible for ensuring the reliability of the device connected to REMOTE CONTACT 1.

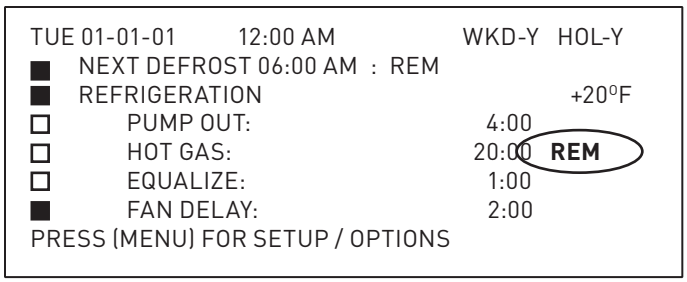
Using Time and Remote Contact to Stop Defrost

A remote contact may be used in conjunction with time to stop a defrost cycle. The remote contact used to stop a defrost cycle should be a normally open device connected to the REMOTE CONTACT 2 terminal. (See wiring diagram, Figure 4.)

The device should have an electrical contact that closes under conditions normally associated with a defrosted evaporator coil. For example, a temperature switch installed in the refrigerated space or on the coil may sense a high temperature indicating frost has been cleared from the coil.

```
DEFROST TERMINATION MODES:

        TIME ONLY
        TIME OR TEMPERATURE
        TIME OR REMOTE CONTACT 2

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```

After selecting TIME OR REMOTE CONTACT 2, the Status Screen will reappear with the "REM" indicator showing.

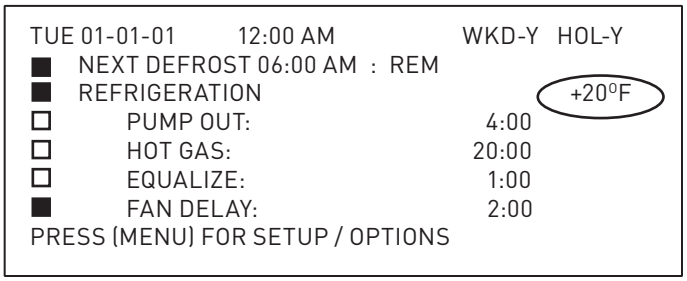


Note: In the Time/Contact mode, the Controller uses an "OR" criteria to determine if a defrost cycle should be terminated. If the contact device closes at any phase during the defrost cycle (Pump Out through Hot Gas), the controller will immediately switch to the Equalization phase regardless of how much time remains. The user is responsible for ensuring the reliability of the device connected to REMOTE CONTACT 2

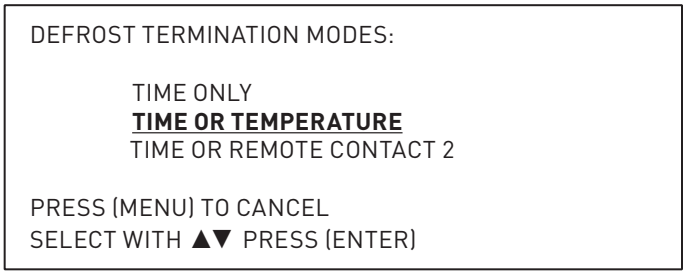
Using a Temperature to Stop Defrost

A PT100 type RTD (100Ω at 0°C) may be used in conjunction with time to stop a defrost cycle. The RTD should be connected to the ANALOG INPUT 1 terminal. (See wiring diagram, Figure 4.)

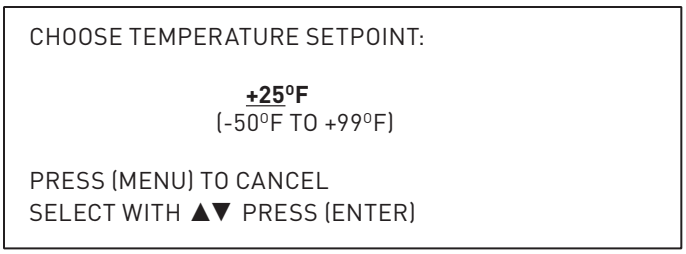
The RTD may be installed in the refrigerated space or on the coil to sense a high temperature, indicating frost has been cleared from the coil. The measured temperature is shown on the Status Screen.



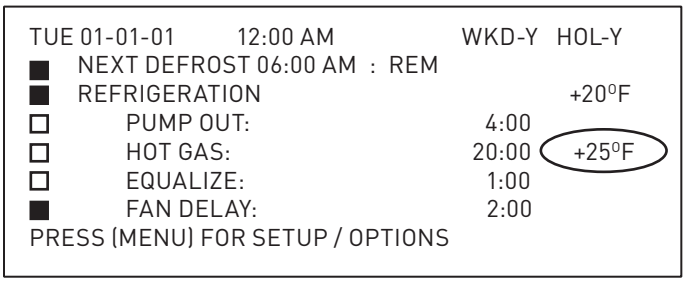
To create a setpoint, go to the Defrost Termination options screen and select TIME OR TEMPERATURE.



The Setpoint Screen will appear. Use the ▲▼ keys to change to the desired temperature setpoint.



After entering the setpoint, the Status Screen will reappear with the setpoint, as shown below.

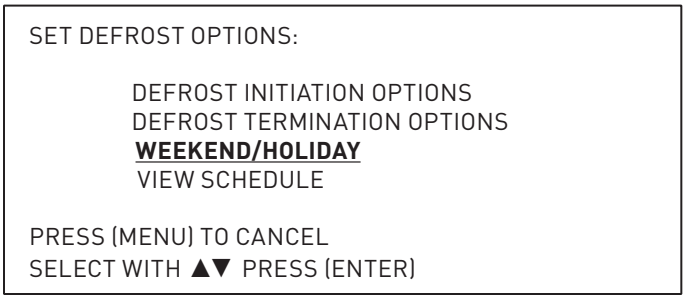


Note: In the Time/Temperature mode, the Controller uses an "OR" criteria to determine if a defrost cycle should be terminated. If the temperature sensed by the RTD rises above the set-point at any phase during the defrost cycle (Pump Out through Hot Gas), the controller will immediately switch to the Equalization phase regardless of how much time remains. The user is responsible for ensuring the reliability of the RTD.

Weekend and Holiday Schedules

The Controller can be programmed for reduced defrost frequency on weekends and holidays. This mode is very similar to the 24 Hour Constant Interval mode discussed under Quick Setup. Holiday defrost frequency is the same as programmed for the weekend schedule. The only difference between holiday and weekend schedules is that weekend schedules repeat every week for the days specified (one to three consecutive days), the holiday schedule occurs only once (one to six consecutive days). A weekend schedule must be entered into the Controller before a holiday can be scheduled.

To program a weekend schedule, go to the Main Menu and select Set Defrost Options. From the Defrost Options Screen, select Weekend/Holiday.



The following screen will appear. Selecting zero hours will disable both weekend and holiday schedules. The contrroller will follow the normal schedule.

```
DEFROST FREQUENCY:        0 HOURS
                          2 HOURS
                          3 HOURS
                          4 HOURS
                          6 HOURS
                          8 HOURS
                          12 HOURS

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```

```
WEEKEND STARTS ON:

                SAT
            DAYS ARE FROM
        12:00 AM 10 11:59 PM

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```

Next, select the day that the weekend ends on (for example Sunday).

```
WEEKEND STARTS ON:

                SUN
            DAYS ARE FROM
        12:00 AM 10 11:59 PM

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```

Next set the time for first weekend defrost to occur (for example 6:00 PM)

```
SET TIME FOR FIRST
DEFROST

          6:00 AM

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```

When the following menu appears, push MENU twice to return to the Status Screen. The weekend indicator should have changed to "Y".

```
TUE 01-01-01    12:00 AM        WKD-Y HOL-Y
■ NEXT DEFROST 06:00 AM
■ REFRIGERATION
□     PUMP OUT:                  1:00
□     HOT GAS:                  20:00
□     EQUALIZE:                  1:00
■     FAN DELAY:                 2:00
PRESS (MENU) FOR SETUP / OPTIONS
```

To initiate a holiday schedule, return to the Main Menu and select Initiate/Disable Holiday.

```
MAIN MENU:
        SET TIME / DAY
        SET TIMERS
        SET DEFROST OPTIONS
        SET ROOM TEMPERATURE
        INITIATE / DISABLE HOLIDAY

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```

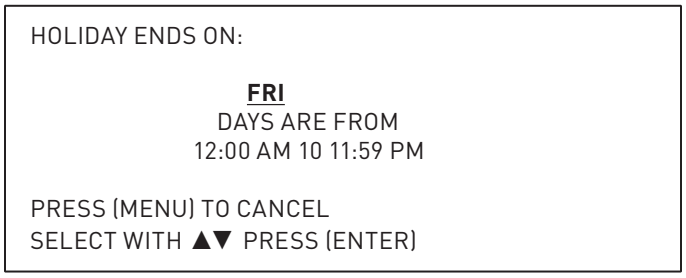
Select Enable Holiday from the menu shown below.

```
        ENABLE HOLIDAY
        DISABLE HOLIDAY

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```

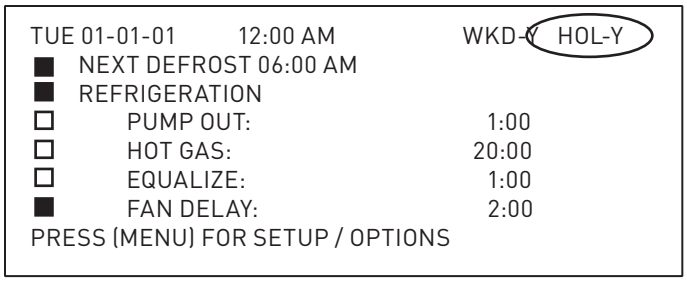
Select the day that the holiday is to begin (for example THU).

```
HOLIDAY STARTS ON:

                THU
            DAYS ARE FROM
        12:00 AM 10 11:59 PM

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)
```

Select the day that the holiday is to end (for example FRI).



When the Main Menu reappears, push MENU to return to the Status Screen. The holiday indicator should have changed to "Y".



In the example given, defrost will occur the following Thursday at 6:00AM, 2:00PM, 10:00PM, and Friday at 6:00AM, 2:00PM, and 10:00PM (using the weekend frequency of eight-hours). The next defrost will occur at 6:00AM on Saturday, and follow the weekend schedule. The following Thursday, the Controller will follow the normal weekday schedule.

APPENDIX A: THE HOT GAS DEFROST CYCLE

The means for melting the ice accumulated on evaporator coil surfaces will vary greatly from one system to another. Most typically, hot gas is employed. However, other methods such as the use of electric heaters or a warm water spray can also be used. The hot gas method will be discussed because it is the most common on large systems, and because of its complexity. The sequence of events described below can easily be adapted to either electric or warm water defrost.

In a Hot Gas Defrost Cycle, the heat for melting the ice is provided by hot gas taken from the compressor discharge[4]. As described below, the hot gas enters the evaporator and melts the ice as it cools and condenses to a liquid. The condensate then flows to some other part of the system, such as a suction accumulator.

While the exact details of the defrost cycle will vary according to the details of the system, there are a few general considerations which should always be observed:

- **Be sure the refrigerated space does not get too warm during defrost.** When some coils are in defrost, the remaining evaporators must handle their refrigeration load, as well as the additional load from the defrost heat. For this reason (as well as for the reason given later) never more than 1/3 of the evaporators in a system should be in defrost mode at any given time. Typically, the defrost cycle is terminated based on a pre-set time limit. However, there may also be a temperature sensor (located either in the refrigerated space or on the evaporator coil itself) which terminates the defrost cycle if the temperature rises too high before the pre-set time has expired.

- **Be sure there is an adequate supply of hot gas.** Remember, the hot gas is generated by compression of low temperature gas from operating evaporators. When one or more evaporators are being defrosted, they are no longer supplying cold vapor to the compressor so the supply of hot gas is reduced. (This is the other reason why the number of units in defrost should limited to a maximum of 1/3 the total.)

- **Be sure the hot gas upstream of the hot gas solenoid is supplied at sufficient pressure.** While it is possible to defrost a system with hot gas at a pressure of 90 psig[5], such a low pressure will result in longer defrost time. Best results are obtained if the gas supplied throughout the defrost cycle is kept between 100 and 125 psig.

- **Keep the pressure inside the evaporator from rising too high.** This function is generally served by a defrost pressure regulator that is set to open when the coil temperature is between about 40°F and 55°F (60-80 psig for ammonia, 70-90 psig for R22). Besides raising the temperature of the refrigerated space, higher defrost temperatures cause more of the melt water to evaporate back into the air instead of draining out.

- **Arrange to warm drain pans and drain pipes in rooms below 32°F with either hot gas or electric heaters.** Melt water should be prevented from falling onto the floor or the products/processes in the refrigerated space. So to ensure that the water is removed, drain pans and associated piping should be pre-warmed so the water does not freeze and block them.

The types and arrangement of components will vary greatly from one refrigeration system to another. It is important that the valves and pipes for these systems be sized properly for safe, energy-efficient defrost. There are many resources available from both from Refrigerating Specialties and from industry groups such as IIAR, which will assist in properly sizing system components.

Figure 7 shows the valves typically found on a hot gas defrost arrangement. The sequence of events that occurs during hot gas defrost are similar for liquid recirculation, gravity flooded, and direct expansion systems.

1. **REFRIGERATION PHASE:** During normal refrigeration, liquid refrigerant flows through a Liquid Feed Solenoid Valve and into the evaporator. Here, heat is absorbed from the air that the Fan moves over the coil. This causes some (or all) of the refrigerant to vaporize. The liquid/vapor mixture (or vapor only) exits through the Normally Open Suction Stop Solenoid Valve and flows to an accumulator (or the compressor). When the evaporator coil temperature is below 32°F (0°C), water vapor in the air will freeze onto the coil surface and block the free flow of air.

2. **PUMP OUT PHASE:** (1 to 30 minutes): During the pump out phase, the Liquid Feed Solenoid is de-energized, shutting off the supply of liquid refrigerant to the evaporator. The fan(s) continue to run, and the liquid inside the coil vaporizes and exits through the Suction Stop Solenoid. (When the suction main is located below the evaporator, liquid will exit the coil by gravity.) By either draining or evaporating the liquid out of the coil, heat from the hot gas will be applied directly to the frost instead of being wasted on vaporizing liquid refrigerant.

3. **SOFT GAS PHASE:** (0 to 10 Minutes): On many systems,

---

[4] In the case of Warm or Cool Gas Defrost, the gas is taken from the high-pressure receiver at a temperature lower than the compressor discharge.

[5] Ammonia Refrigeration Piping Handbook, © IIAR 2000

a small Soft Gas Solenoid Valve is installed in parallel with the Hot Gas Solenoid Valve. At the beginning of the soft gas phase, the fan is shut down, the Suction Stop Valve is closed, and the Soft Gas Solenoid is energized, allowing hot gas from the compressor discharge to slowly enter the coil. The purpose of the Soft Gas Solenoid is to more gradually raise the pressure inside the coil when some residual liquid remains. Too rapid an introduction of hot gas can cause residual liquid to flash suddenly into vapor, resulting in potentially damaging pressure shocks. In addition, if there is any condensate in the hot gas line, the lower flow associated with the Soft Gas Valve greatly reduces the potential for harmful liquid slugging. Notice that the hot gas enters the tops of the coils after warming the drain pan. Doing so allows liquid inside the coil to drain downward, giving a more efficient defrost process.

Notice the two check valves in the system. One prevents liquid from flowing down into the drain pan during normal refrigeration. The second is mounted directly to the outlet of the Liquid Feed Valve. Liquid Feed Valve can only block flow moving into the evaporator. Without the second check valve, high pressure gas inside the coil during defrost would force the solenoid valve open and flow into the liquid line.

4. **HOT GAS PHASE:** (1 to 45 minutes): If there was a Soft Gas Phase, then during the Hot Gas Phase the Hot Gas Solenoid is energized and the Soft Gas Solenoid is de-energized. If there is no Soft Gas Phase, the fan is shut down and the Hot Gas Solenoid is energized. Hot gas now flows more quickly into the coil and begins condensing as it gives up heat to melt the frost. Pressure inside the coil gradually rises high enough for Defrost Regulator to open. (The pressure setting of the Defrost Regulator should be between 60 and 80 psig in order to maintain the temperature in the coil between 40° and 55°F (5° - 15°C).) The liquid, or vapor/liquid mixture, flows through the Defrost Regulator and is typically routed to a suction accumulator. Hot gas continues to flow into the evaporator until either the pre-set time limit is reached or until a temperature sensor terminates the hot gas phase.

5. **EQUALIZATION PHASE:** (1 to 60 minutes): After the time limit of the hot gas phase has been reached, the equalization phase begins. In this phase, the pressure inside the coil is permitted to decrease, either by allowing the warm liquid inside the coil to cool naturally or by energizing a small Equalizing Solenoid Valve that is installed in parallel with the Suction Stop Valve. The equalization phase reduces or eliminates the system shock, which would occur if (for example) warm 90 psig liquid was released into the 10 psig (or lower) suction piping. In addition to the pressure-related forces, the high-pressure liquid would generate a great deal of vapor inside the suction accumulator, resulting in sudden compressor loading.

6. **FAN DELAY PHASE:** (1 to 5 minutes): At the conclusion of the equalization phase, the Equalizing Valve is closed, the Suction Stop Valve is opened and the Liquid Feed Solenoid is opened. However, the Fan is not yet energized. Instead, the coil temperature is allowed to drop, thereby freezing any water droplets that remain on the coil surface from the hot gas phase. After the fan delay has elapsed, the fan motor can be energized without water droplets being blown into the refrigerated space. The refrigeration phase has resumed, and will continue until the next scheduled defrost cycle.

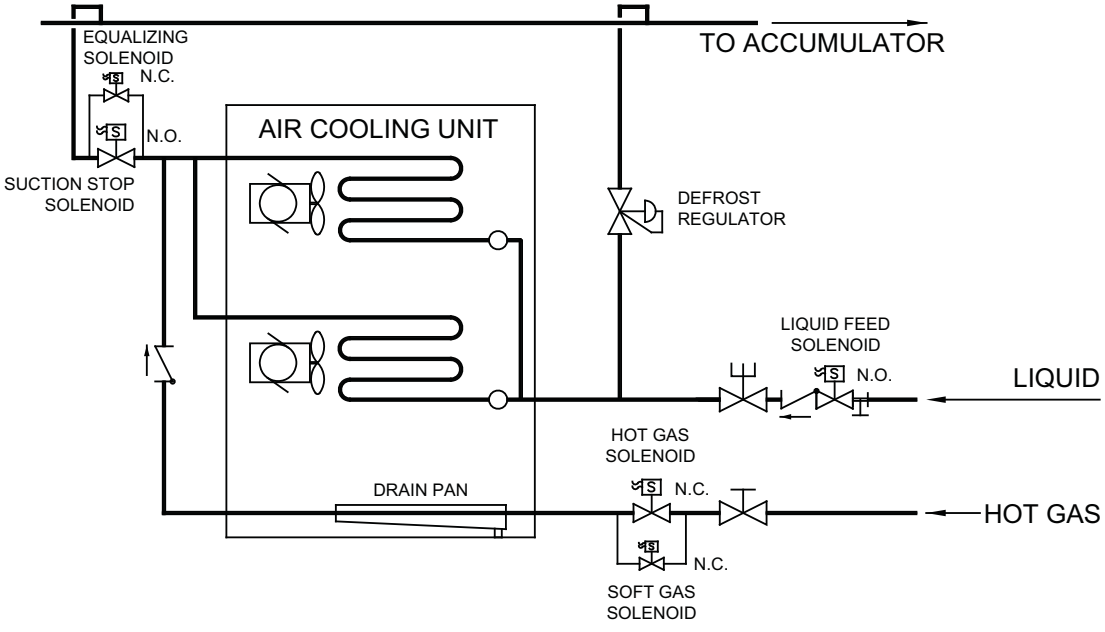


Figure 9: Typical Evaporator Configuration

Safe Operation (See Bulletin RSB)
People doing any work on a refrigeration system must be qualified and completely familiar with the system and the Refrigerating Specialties Division valves involved, or all other precautions will be meaningless. This includes reading and understanding pertinent Refrigerating Specialties Division Product Bulletins and Safety Bulletin RSB prior to installation or servicing work.

Where cold refrigerant liquid lines are used, it is necessary that certain precautions be taken to avoid damage which could result from liquid expansion. Temperature increase in a piping section full of solid liquid will cause high pressure due to the expanding liquid which can possibly rupture a gasket, pipe or valve. All hand valves isolating such sections should be marked, warning against accidental closing, and must not be closed until the liquid is removed. Check valves must never be installed upstream of solenoid valves, or regulators with electric shut-off, nor should hand valves upstream of solenoid valves or downstream of check valves be closed until the liquid has been removed.

It is advisable to properly install relief devices in any section where liquid expansion could take place. Avoid all piping or control arrangements which might produce thermal or pressure shock.

For the protection of people and products, all refrigerant must be removed from the section to be worked on before a valve, strainer, or other device is opened or removed. Flanges with ODS connections are not suitable for ammonia service.

Warranty
All Refrigerating Specialties products are under warranty against defects in workmanship and materials for a period of one year from date of shipment from factory. This warranty is in force only when products are properly installed, field assembled, maintained, and operated in use and service as specifically stated in Refrigerating Specialties Catalogs or Bulletins for normal refrigeration applications, unless otherwise approved in writing by the Refrigerating Specialties Division. Defective products, or parts thereof returned to the factory with transportation charges prepaid and found to be defective by factory inspection, will be replaced or repaired at Refrigerating Specialties option, free of charge, F.O.B. factory. Warranty does not cover products which have been altered, or repaired in the field, damaged in transit, or have suffered accidents, misuse, or abuse. Products disabled by dirt or other foreign substances will not be considered defective.

The express warranty set forth above constitutes the only warranty applicable to Refrigerating Specialties products, and is in lieu of all other warranties, expressed or implied, written including any warranty of merchantability, or fitness for a particular purpose. In no event is Refrigerating Specialties responsible for any consequential damages of any nature whatsoever. No employee, agent, dealer or other person is authorized to give any warranties on behalf of Refrigerating Specialties, nor to assume, for Refrigerating Specialties, any other liability in connection with any of its products.

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