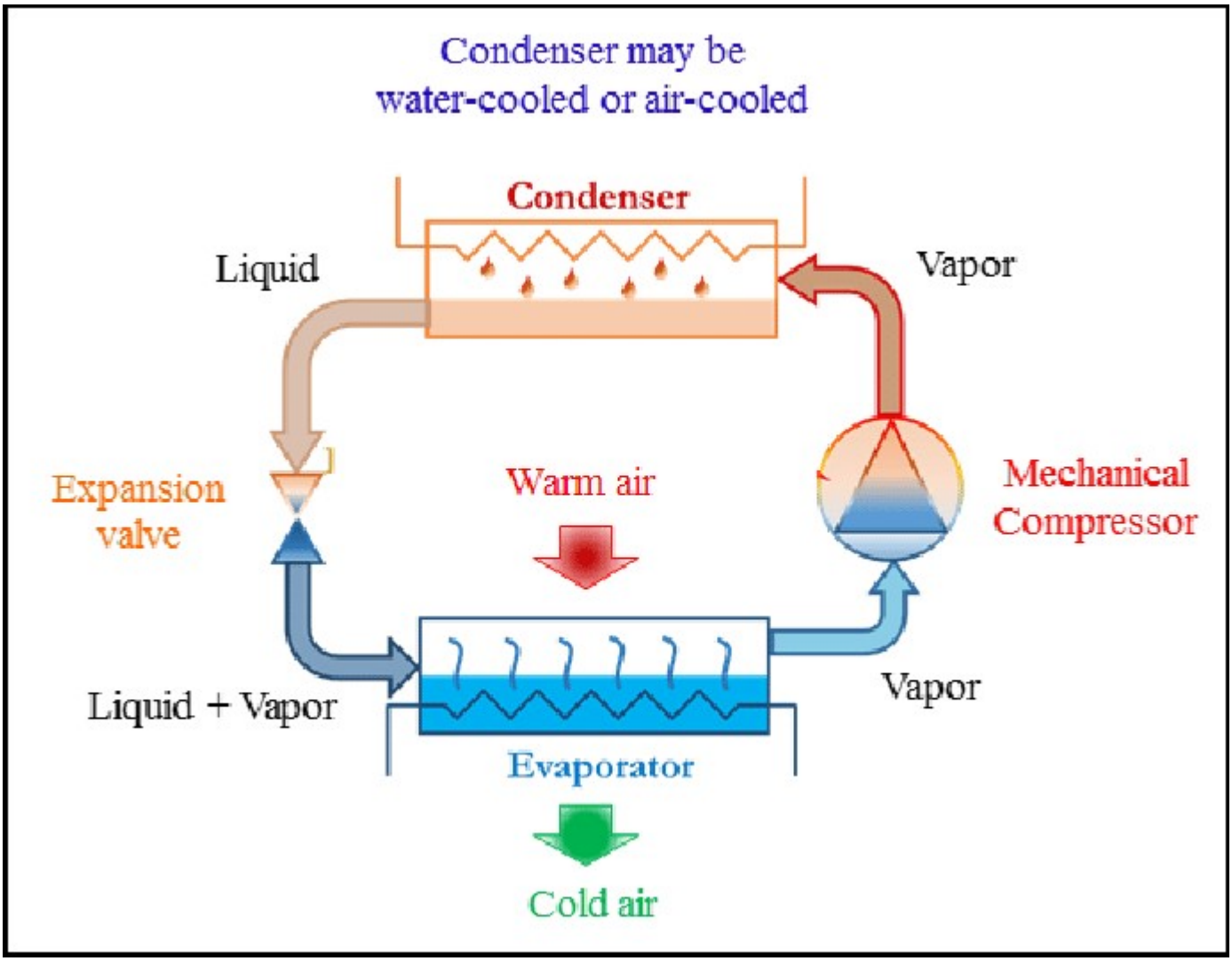
Sequence Of Operations

VAPOR COMPRESSION CYCLE

The compressor sends hot discharge gas to the condenser. The condenser removes superheat, condenses from a gas to liquid, and provides a degree or two of subcooling. The high pressure liquid refrigerant accumulates in the liquid receiver and is sent toward an evaporator to cool the load. The expansion valve, just before the evaporator, reduces pressure of the liquid refrigerant which causes the start of phase change, as heat is absorbed in the evaporator, the liquid refrigerant continues to boil; the expansion valve regulates the flow rate of refrigerant such that all liquid is evaporated and superheat is generated before the outlet of the heat exchanger. Superheated, low pressure, low temperature vapor is returned to the compressor, where it cools the motor, is re-compressed and sent back to the condenser for another cycle.



METHODS OF CONTROL

JTS condensing units come standard with three types of methods of control. The method of choice needs to be programmed on the supplied JTS controller during commissioning.

ON/OFF is the most simplistic method of control. When the dry contact between wiring terminals “A” and “B” is closed, the machine will run at 100% (full capacity). When the contact between terminals “A” to “B” is removed, the machine will shut down (0% capacity). ON/OFF control is suitable for applications where either full capacity or zero capacity is required.

PID is a more advanced method, allowing for variable capacity control. When the dry contact between wiring terminals “A” and “B” is closed, the machine will run at a percentage between 0% and 100%. When the contact between

terminals “A” to “B” is removed, the machine will shut down. With “A” to “B” closed, the controller references either a temperature sensor or pressure transducer as its basis of control. PID control is most suitable for refrigerant circuits with multiple stages of compressors, unloading, hot gas bypass or the use of variable frequency drives.

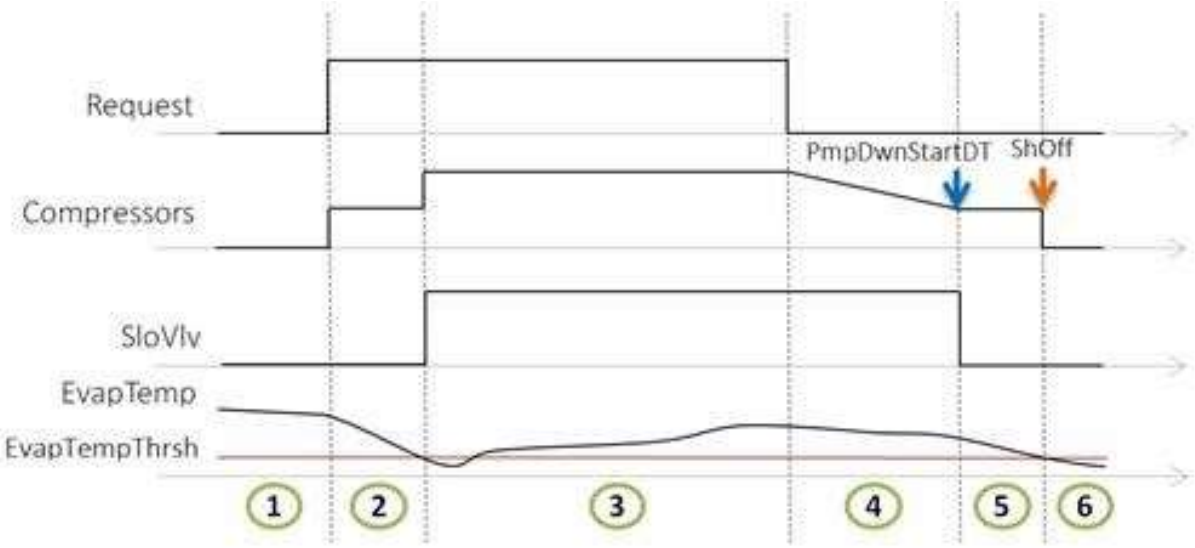
Temperature sensor: JTS controller is supplied with a temperature sensor for field install. The temperature sensor could be installed in either the return or supply air stream of the evaporator. A temperature setpoint and differential can be set such that the JTS controller knows it target temperature. With a target temperature and actual measured temperature, JTS control calls for a percentage of demand between 0% and 100%, and stages capacity accordingly. Within the controller menu, the proportional gain, integral time and derivative (PID) could be adjusted or fine-tuned to match the application needs.

Suction pressure transducer: JTS controller is supplied with a suction pressure transducer already installed. A pressure setpoint and differential can be set such that the JTS controller knows it target pressure. With a target pressure and actual measured pressure, JTS control calls for a percentage of demand between 0% and 100%, and stages capacity accordingly. Within the controller menu, the proportional gain, integral time and derivative (PID) could be adjusted or fine-tuned to match the application needs.

Analog input: the last method of control is the use of an analog input for variable capacity control. In this control method, a field supplied 0-10vdc or 4-20ma control signal sets the demand of the condensing unit when contacts “A” to “B” are closed.

PUMPDOWN / NON-PUMPDOWN

Pumpdown: Pumpdown is often used in refrigeration applications where it is desirable to pump out the evaporator before or after each refrigeration cycle. JTS pumpdown feature allows for pumpdown at the start of cooling, pumpdown at the stop of cooling, or pumpdown at both the start and stop. See image below for sequence detail:



Non pumpdown: In certain cases, it is desirable to run the refrigeration system without pumping out the suction line and evaporator. Pumpdown can be turned off within the JTS controller, which causes the compressor and liquid line solenoid to start and stop at the same time without any pumpdown capability.

CAPACITY CONTROL:

Seasonal changes create differences in refrigeration loads though out the year. In the colder months often there is much less demand for cooling – capacity control allows the refrigeration system to match the load which is ideal for maintaining a space temperature. In addition, capacity control saves energy and reduces wear and tear on the refrigeration system by preventing short cycling. Capacity control comes in many forms, JTS utilizes unloading, VFD, multiple compressors and hot gas bypass.

Unloaders: Unloaders are energized when demand falls. The unloader blocks a port on the compressor which reduces its capacity by as much as 50%. Unloaders are often applied in multiple steps for better capacity control.

VFD: A VFD could be used to vary the speed of the compressor. Compressors can typically modulate between 30Hz – 70Hz, which allows for very fine capacity control between 50% and 110% of nominal rating. When used with multiple compressors, the VFD compressor is always the first on and last off.

Parallel compressors: Parallel or tandem compressors could be staged on or off. This is very similar to unloading where multiple steps is desirable for finer capacity control. Parallel compressors can lead / lag and rotate to balance run hours.

Hot gas bypass: hot gas bypass is used to bypass a percentage of the hot gas to the compressor suction. Hot gas is typically injected at the evaporator distributor, but sometimes on the suction line with the use of a desuperting TXV. This method of capacity control allows for very tight capacity control at the low end, allowing the evaporator load to go as low as 0% while keeping the compressor running. Because of its low-end advantage, JTS utilizes hot gas bypass as the last step of capacity control and is utilized only after all other forms have reached their minimum.

HEAD PRESSURE CONTROL:

Variable speed fans are used for head pressure control and is a 0-10v analog output from JTS controller. Likewise, water regulating valves are used to vary the flow rate of condenser water in water cooled applications. Condenser Pressure should be set somewhere around 220PSI, but user adjustable based upon the application.

LIQUID RECEIVER:

Heated & insulated receiver: Optional heated & insulated receiver energizes a heat pad on the liquid receiver every time the receiver pressure drops below 150PSI. The heater de-energizes when the pressure goes over 200PSI. The purpose of the heated & insulated receiver is to maintain receiver pressure during the off cycle in low ambient conditions.

Receiver level gauge / probe: Optional 0-10v or 4-20ma analog input measures the liquid level in the receiver. When the level goes low, it indicates loss of system charge (a system leak), or evaporator flooding (refrigerant is elsewhere, no longer in the receiver).

OIL SEPARATOR:

Reciprocating compressor: When used with reciprocating compressors, the oil return solenoid is energized same time as compressor contactor, and oil is returned to the compressor crankcase. If parallel piped compressors are used, the oil return solenoid energizes with the first compressor on and de-energizes with the last compressor off.

Coalescing oil separator: Coalescing oil separators filter out a very high percentage of oil, even during minimal load conditions. The filter element occasionally needs to be replaced when the pressure differential across the filter goes over 10PSI.

Screw compressors: When using refrigeration screw compressors with external oil separator, oil level and oil flow are monitored by JTS controller. With compact screw compressors, the endbell of the compressor is an oil separator, optical oil level is monitored, as is the filter clog switch.

ECONOMIZER

An Economizer is used to subcool liquid refrigerant, the flash gas is used to cool the compressor. Typically an ecomomizer solenoid is energized 30-60 seconds after the compressor starts to allow the system to find steady state.

ACCUMULATOR LEVEL SWITCH:

An optional optical level switch is a digital input and opens when liquid is present. Alarm and lockout when tripped.

REFRIGERATION COMPRESSORS:

JTS uses a variety of compressors including reciprocating, scroll or screw compressors. Each type of compressor has advantages in certain applications, and each requires it's own special set of features.

SINGLE STAGE RECIPROCATING COMPRESSOR:

Single stage reciprocating compressors are designed for medium and low temperature applications, ranging from 45F down to -40F suction temperature. Reciprocating compressors have an internal safety that stops the compressor if internal temperatures get too hot or if the compressor overloads (INT69). In the larger Frascold compressors, "V", "Z" or "W", oil lubrication is monitored with an oil pressure switch (INT250FR or Delta P II). Some low temperature applications with high temperature refrigerants (like R448A) may require liquid injection to keep the compressor cool.

Single stage reciprocating compressors monitor and alarm on the following:

- High discharge pressure - instant trip
- INT69 – internal overload – instant trip
- Oil failure INT250FR – loss of lubrication – instant trip
- Low condensing pressure – time delay trip.
- High condensing pressure – time delay trip.
- Low suction pressure – time delay trip.
- High suction pressure – stime delay trip.
- Low / high superheat – time delay trip.
- High discharge temp – time delay trip.
- High amperage – optional, trip if exceed MRA of compressor.

TWO STAGE RECIPROCATING COMPRESSOR:

Two stage reciprocating compressors are designed for low and ultra low temperature applications, ranging from -20F down to -86F suction temperature. Two stage compressors utilize an economizer that subcools liquid and injects cool vapor into the interstage of the compressor. Two stage compressors should also utilize liquid injection motor cooling. Reciprocating compressors have an internal safety that stops the compressor if internal temperatures get too hot or if the compressor overloads (INT69). In the larger Frascold two stage compressors, "V" & "Z" models, oil lubrication is monitored with an oil pressure switch.

Two stage reciprocating compressors monitor and alarm on the following:

- High discharge pressure – instant trip
- INT69 – internal overload – instant trip
- Oil failure – instant trip
- Low condensing pressure – time delay trip
- High condensing pressure – time delay trip
- Low suction pressure – time delay trip
- High suction pressure – time delay trip
- Low / high superheat – time delay trip
- High discharge temp – time delay trip.
- High amperage – optional, trip if exceed MRA of compressor.

SCROLL COMPRESSOR:

Scroll compressors could be used in high, medium or low temperature applications. Typically scroll compressors are used on smaller systems, though they could be used in multi-circuit or parallel applications. Larger scroll compressors contain an overload module (SE-B2). Low temperature scroll compressors may require liquid or vapor injection to keep the motor cool. When used in a rack application, electronic oil level regulators could be used to supply oil and also alarm if low oil level conditions are present.

Scroll compressors monitor and alarm on the following:

- High discharge pressure – instant trip
- SE-B2 – internal overload – instant trip
- Oil failure – optional, instant trip
- Low condensing pressure – time delay trip
- High condensing pressure – time delay trip
- Low suction pressure – time delay trip
- High suction pressure – time delay trip
- Low / high superheat – time delay trip
- High discharge temp – optional, time delay trip.
- High amperage – optional, trip if exceed MRA of compressor.

COMPACT SCREW COMPRESSOR:

Compact screw compressors are typically used in medium and high temperature applications. Compact screw compressors contain an internal oil separator also slide valve for capacity control. With certain refrigerants it is desirable to use an external oil separator because too much oil can carry over, out of the internal oil separator. The slide valve can be configured with steps of unloading 50%, 75%, 100%), or stepless capacity control (infinite from 50% to 100%). With a stepped scheme, the unloading signal is help constant the whole time it is needed. With stepless, the solenoids are pulsed, pulsing one solenoid loads the machine, while pulsing the other unloads the machine – energizing both at same time moves slide to its middle position (75%). Screw compressors are typically started with part winding start.

Compact screw compressors monitor and alarm on the following:

- High discharge pressure – instant trip
- INT69 – internal overload – instant trip
- Oil filter clog switch – instant trip
- Optical oil level in crankcase – time delay trip
- Low condensing pressure – time delay trip
- High condensing pressure – time delay trip
- Low suction pressure – time delay trip
- High suction pressure – time delay trip
- Low / high superheat – time delay trip
- High discharge temp – time delay trip.
- High amperage – trip if exceed MRA of compressor.

REFRIGERATION SCREW COMPRESSOR:

Refrigeration screw compressors are typically used in low temperature applications. Refrigeration screw compressors rely on external oil management – an oil separator with reservoir, optical oil level of reservoir, oil flow

switch, oil heaters and oil coolers may be required. Refrigeration screw compressors are available with steps unloading; it is desirable to start and stop the compressor in its fully unloaded state to balance internal pressures. Only 1 step of unloading should be used if unloading with an economizer (or EEV required on economizer). Screw compressors are typically started with part winding start.

Refrigeration screw compressors should monitor and alarm on the following:

- High discharge pressure – instant trip
- INT69 – internal overload – instant trip
- Oil flow switch – instant trip
- Optical oil level in reservoir – time delay trip
- Low condensing pressure – time delay trip
- High condensing pressure – time delay trip
- Low suction pressure – time delay trip
- High suction pressure – time delay trip
- Low / high superheat – time delay trip
- High discharge temp – time delay trip
- High amperage – trip if exceed MRA of compressor.

DEFROST

In air cooling and freezer applications where the suction temperature is 28F or lower, frost will build on the evaporator. Frost acts as an insulator and inhibits heat transfer, thus the need for defrost. There are 3 common types of defrost: air, electric or hot gas defrost. In each case, defrost is handled a little differently.

Defrost initiation

Internal time clock: JTS standard configuration includes an internal timer logic for defrost initiation. A user adjustable "defrost frequency" is set for how often defrost occurs (set in hours). The internal logic will be accumulative, meaning that it only counts when the compressor is running – after so many run hours, defrost is initiated.

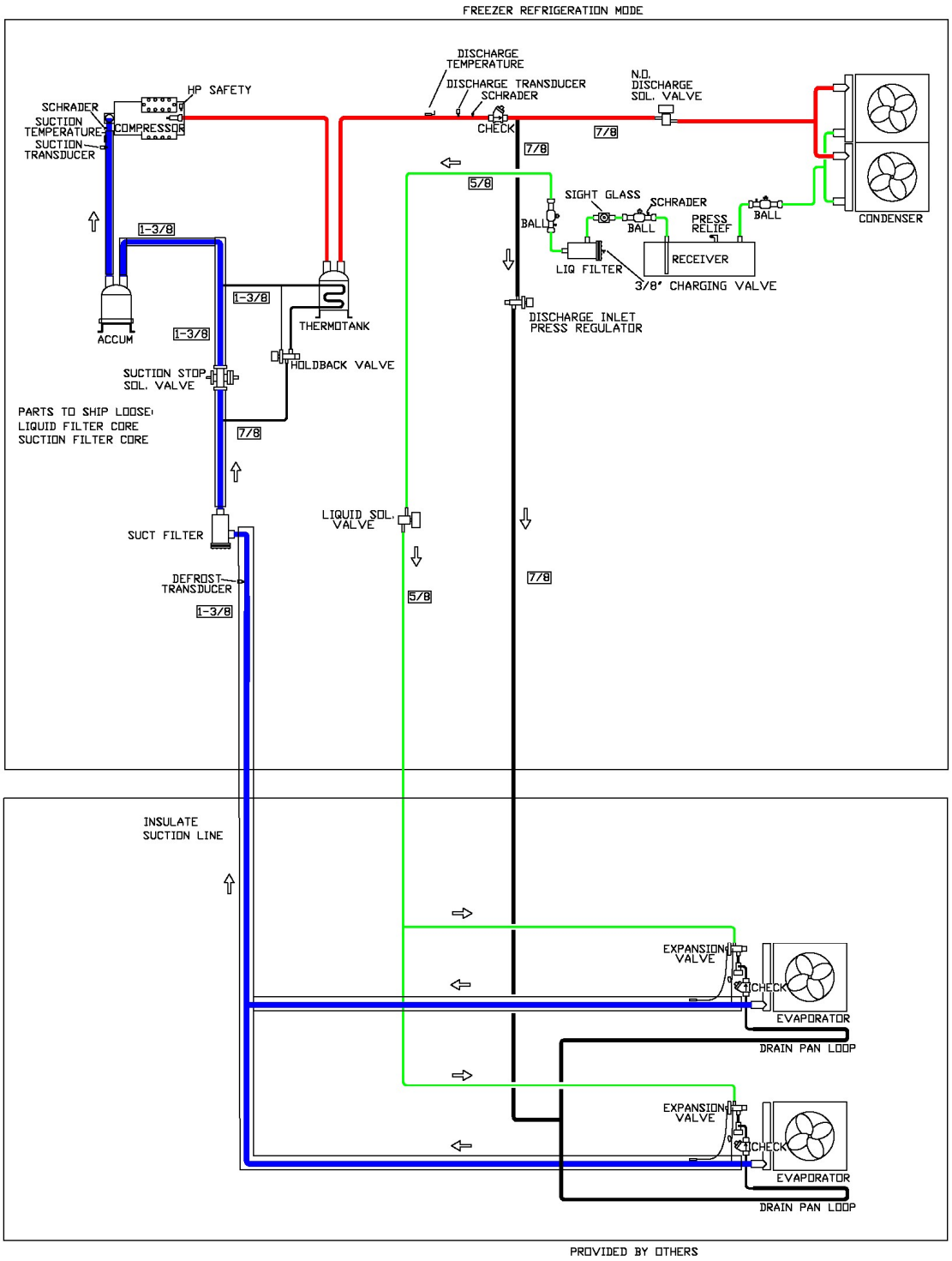
Start defrost digital input: In some cases it is desirable for a field installed automation system to start defrost. JTS controller is configurable to receive a digital input for defrost signal coming from others.

Types of defrost

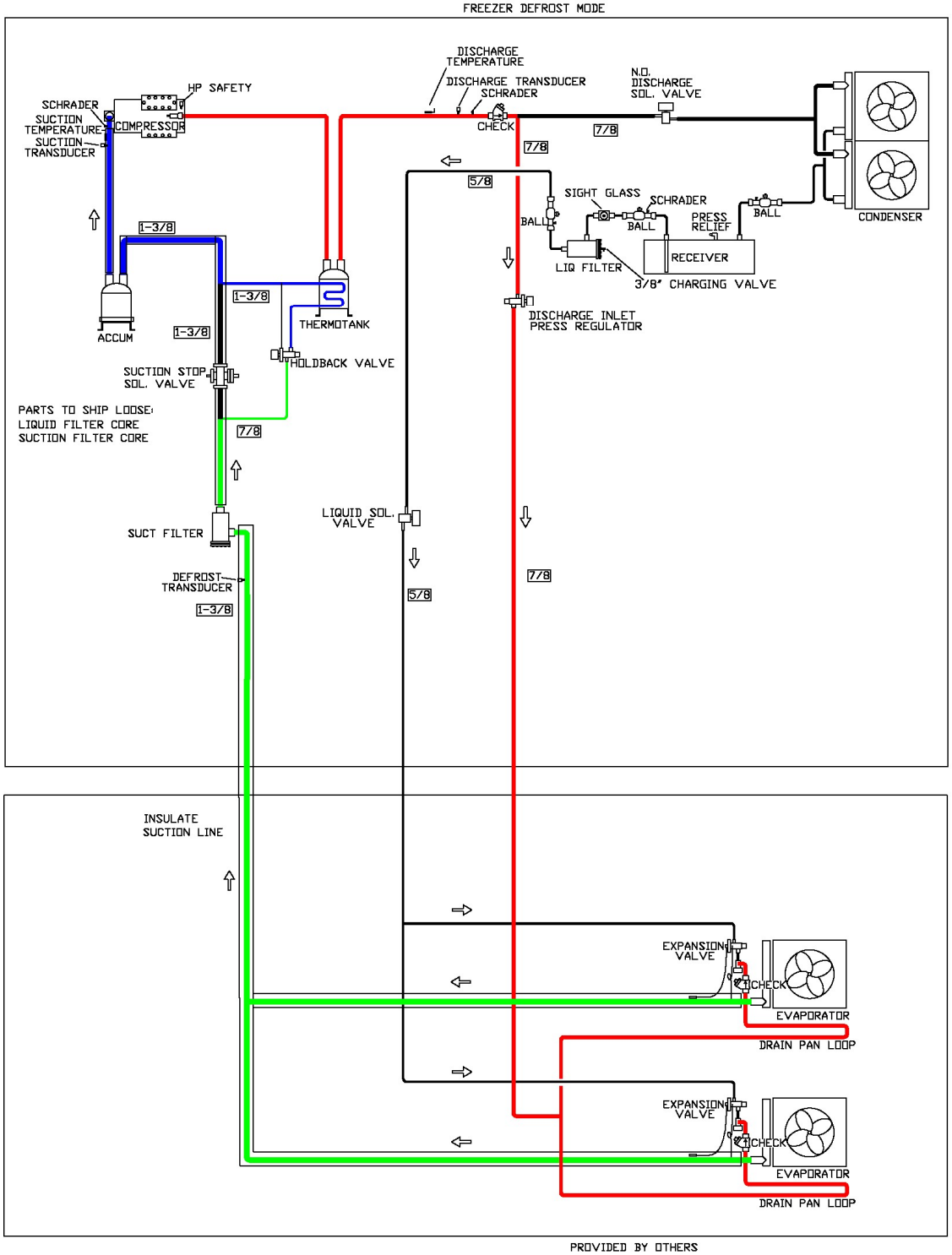
Air defrost: Air defrost is used in medium temperature applications where the controlled space's temperature is typically 38F or above. In air defrost applications, the evaporator fans are powered by others and typically always run (unless required by Title 24 or another jurisdiction). In either case, when defrost is initiated, the compressor stops, meanwhile the evaporator fans stay on, pulling warm air across the frosted coil. After enough off cycle time, the compressor is allowed to restart.

Electric defrost: Electric defrost is used in medium and low temperature applications. In electric defrost applications the evaporator fans and heaters will be powered and controlled thru the JTS unit. When defrost is initiated, the compressor is stopped, pumpdown is required; once the compressor stops, the evaporator fans are stopped, and the defrost heaters are energized. Defrost temperature is measured on the evaporator and termination is achieved when a user adjustable setpoint temperature is reached. If multiple evaporators are on the same circuit, defrost is terminated on individual evaporators as they achieve termination temperature (individual contactors), but the JTS controller doesn't exit defrost until the last evaporator has achieved defrost termination temperature. After the last evaporator has terminated, the liquid line opens and the compressor starts, but the evaporator fans remain off for user adjustable time delay – the fan delay allows any moisture to re-freeze on the evaporator before the fans start.

3 pipe hot gas defrost: Hot gas defrost could be used in medium or low temperature applications. JTS 3 pipe hot gas defrost utilizes a thermal mass of water / glycol mixture in the Thermotank. During refrigeration mode, the discharge line heats the Thermotank; during defrost mode the Thermotank becomes the heat source for re-evaporatoration of any returned liquid. Defrost is initiated from an accumulative, user adjustable, “defrost frequency” (set in hours). Likewise, “defrost duration” is user set for the maximum amount of time the system could stay in defrost (set in minutes). The Thermotank temperature must be at a minimum of 80°F to ensure adequate heat is available for defrost. Defrost is terminated when defrost pressure hits a termination pressure of at least 200PSI. After defrost a post defrost cycle is used to pump out and re-evaporate any remaining condensate in the suction line – once post defrost pressure setpoint has been achieved the evaporator fans are re-started and the machine is allowed to go back to refrigeration mode.



FREEZER DEFROST MODE



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