Technical Training Associates Presents

Commercial Refrigeration Equipment Servicing Part 1

By Jim Johnson

A Practical Approach To The Fundamentals Of Walk-Ins, Reach-In and, Display Cases: Restaurant, Convenience Store and Grocery Store Equipment

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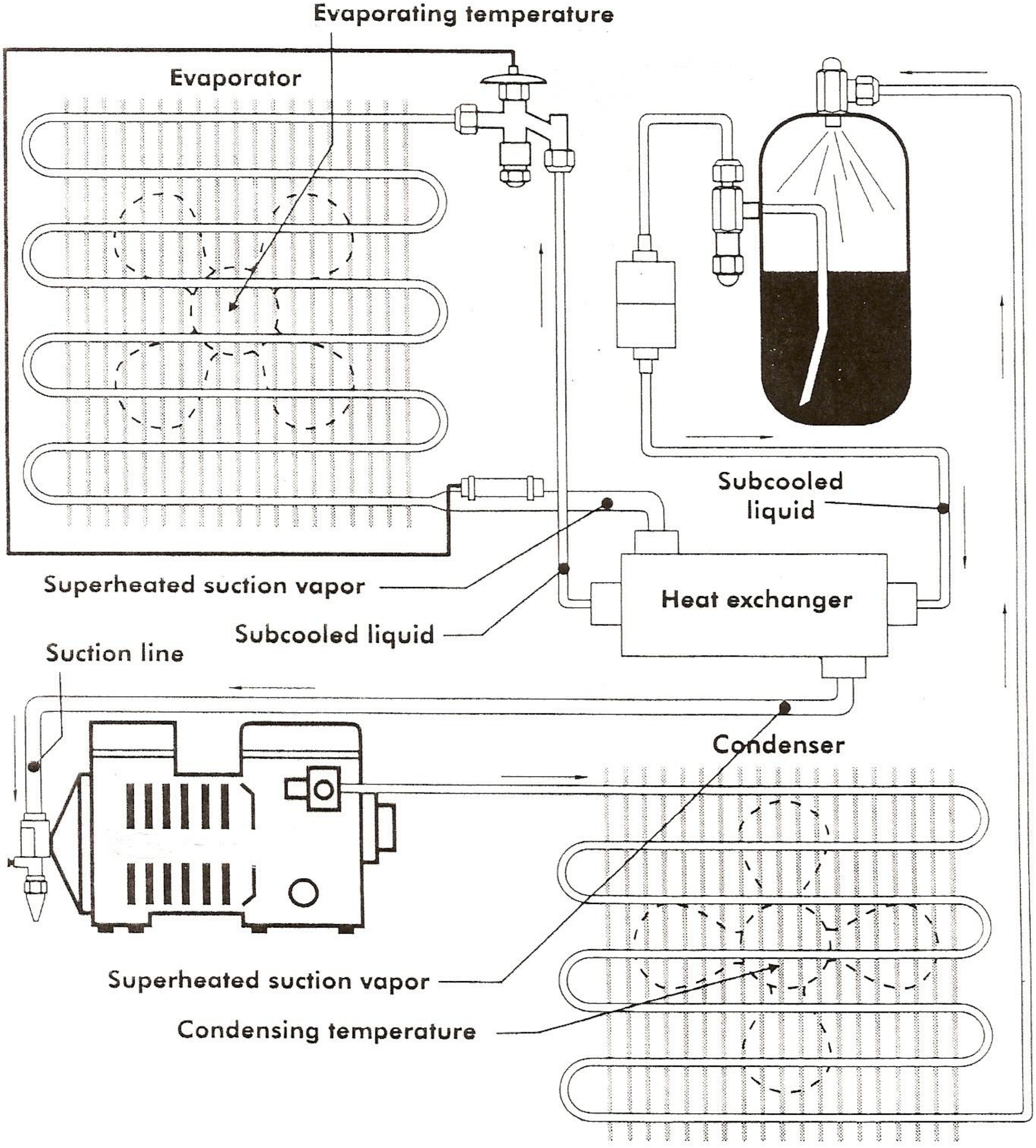
PART ONE

METERING DEVICES, PIPING, AND HEAT EXCHANGERS IN COMMERCIAL REFRIGERATION SYSTEMS

Troubleshooting commercial refrigeration systems is like troubleshooting anything else…..we need to know *what the unit is supposed to be doing in the first place* so we'll recognize "wrong" when we see it, and we need to be able to apply our knowledge of fundamentals that applies to any refrigeration system, while at the same time considering necessary modifications to those fundamental concepts. The reason, of course, for the modifications is to get the equipment to operate as efficiently as possible. In commercial equipment, piping and proper operation of the metering device is critical to the efficiency of the system.

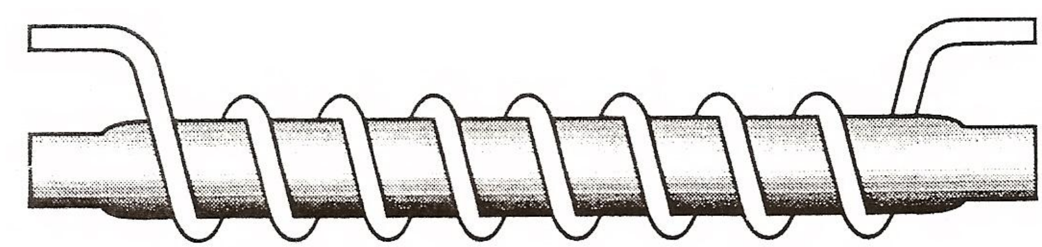
In domestic refrigeration systems such as the ones home appliance technicians are familiar with in refrigerators and freezers, for example, some method making contact between the suction line and the capillary tube is employed in order to get the refrigeration system to operate as efficiently as possible. Either the capillary tube-type metering device and the suction line will be soldered together, or the "cap tube" (to use some official refrigeration technician jargon) will be routed inside the suction line, then back out again so it can be connected to the evaporator. In either case, the reason behind this process is to allow a fractional horsepower refrigeration system to operate as efficiently as possible….the refrigerant entering the evaporator at just the right temperature and any liquid refrigerant that may be in the suction line being boiled off so the operation of the compressor won't be compromised.

And the same basic concept applies in commercial refrigeration systems where metering devices other than capillary tubes are used. (See Figure One)



Part One, Figure One

While heat exchangers may not be made up of a section of a cap tube and suction line soldered together, some method of allowing contact between the liquid refrigerant and the vapor refrigerant (in closed loops, of course) will be employed. In this particular case, the metering device of choice is the TEV, Thermostatic Expansion Valve because the system we're showing here is what we would classify as a large system that might be 10 tons in capacity or more. In some situations, the heat exchanger isn't as mysterious as the one we're showing in Figure One. Instead, it will be more obvious, such as one loop of tubing actually wrapped around another tubing segment, as we're showing in Figure Two.



Part One, Figure Two

In this illustration, we're proving in a different fashion the idea that the piping in both a domestic and a commercial refrigeration system has to be accomplished in the right way in order for the system (and the metering device) to operate properly. In a capillary tube metering device, such as you'll find in domestic refrigeration systems and in some commercial equipment such as a reach-in refrigerator, there are three segments, or, as they're sometimes referred to, phases, of the tube to consider.

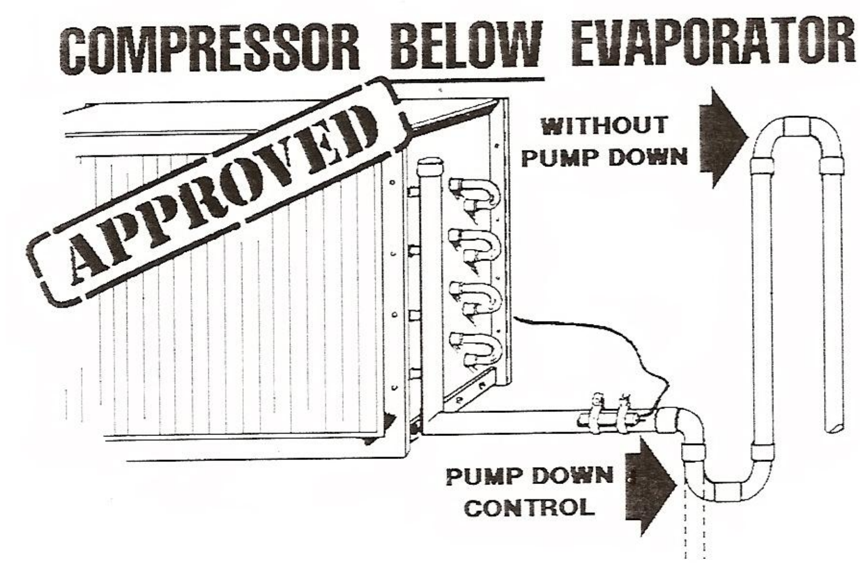
1. Liquid Length Phase
2. Bubble Point Phase
3. Two Phase

When refrigerant leaves the condenser, entering the capillary tube in a liquid state, this early phase of the metering device is referred to as the Liquid Phase or Liquid Length. While there is a pressure drop at this point, the refrigerant in this segment of the tube is still 100% liquid. As the refrigerant continues through the tube, the friction of the smaller tube eventually creates enough pressure drop to allow the refrigerant to reach what is known as saturation, and when that occurs, it's known as Bubble Point. It's at this point that flash gas becomes a factor.

As the refrigerant continues on its trip through the capillary tube, the amount of flash gas increases due to the continued drop in pressure. This increased restriction of fluid flow results in a further temperature drop of the refrigerant, and it enters the last segment of the capillary tube as more of a combination of liquid and flash gas…known as the Two Phase segment of the tube. Upon leaving this segment of the tube, the refrigerant will be at the correct temperature when entering the evaporator, providing any necessary heat exchangers are piped and operating properly, and if the suction line piping that allows free flow of refrigerant into the compressor is accomplished correctly.

What this means from a troubleshooting perspective is that in the event a capillary tube is replaced, it's critical that the correct size and length be used. If the cap tube is too large, the flow of refrigerant to the evaporator will be excessive. If the replacement cap tube is too small, liquid refrigerant will back up into the condenser and the condensing pressure (high side) will start to increase. In either case, the efficiency of the refrigeration system will be compromised, and the sometimes “standard fix” of adding refrigerant any time a unit is not performing correctly will do nothing to alleviate the problem. Also, if the piping of the heat exchanger is compromised (kinked tubing, loss of thermal contact, or loss of insulation of a heat exchanger assembly) there will also be a loss of efficiency, sometimes as much as 20%. And, as in the case of an incorrectly sized capillary tube, in either bore or length, no amount of “dumping in gas” will get the unit operating properly.

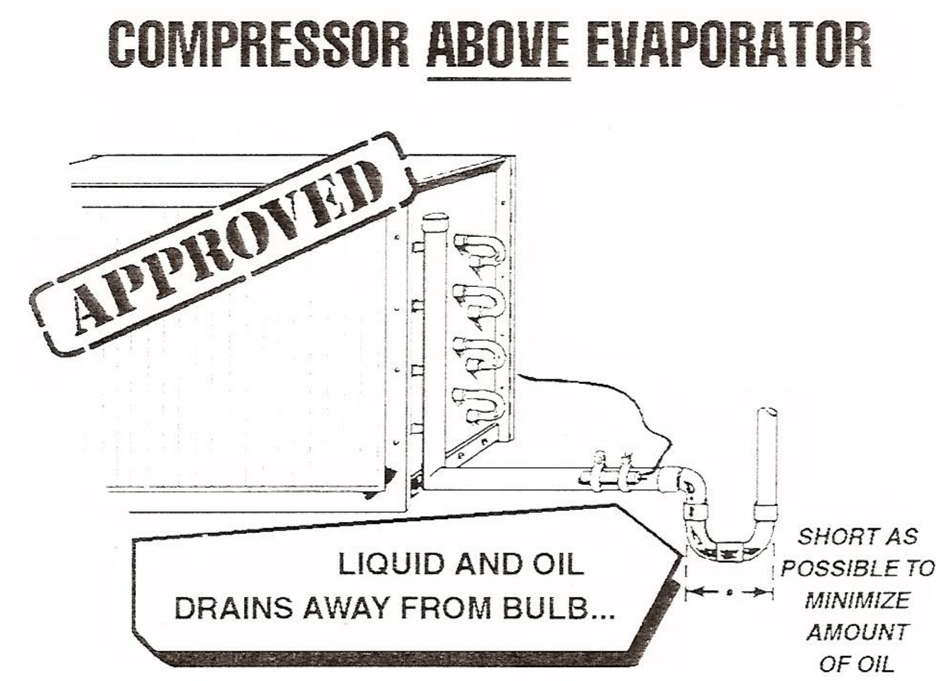
Another important piping consideration relative to proper metering device operation is in the case of the TEV and the various locations of the evaporator relative to the compressor. In the interest of maintaining good thermal contact between the TEV sensing bulb and the suction line, the bulb should be located on a horizontal section of tubing and the tubing should be pitched slightly downward from the evaporator. That’s the basic stuff relative to the proper operation of this metering device. However, when servicing commercial refrigeration equipment, you may find a situation in which there is more than one evaporator. This doesn’t mean that the fundamentals of refrigeration change, just that depending on whether the evaporator is above or below the compressor, there are some other factors to consider. (See Figure Three)



Part One, Figure Three

In a situation in which the compressor is below the evaporator, and no system pump down is used, a short trap and a vertical riser extending to the height of the evaporator should be used to prevent refrigerant from draining into the compressor during an off cycle. And, while it's tempting to use that convenient loop of tubing for mounting the TEV sensing bulb, the proper method of bulb attachment is still on a horizontal section of the tube close to the evaporator coil. And in the event that the system has pump down and the return tubing to the compressor simply drops directly down at a 90-degree angle as our illustration shows, the bulb still needs to go on a horizontal section of the tubing.

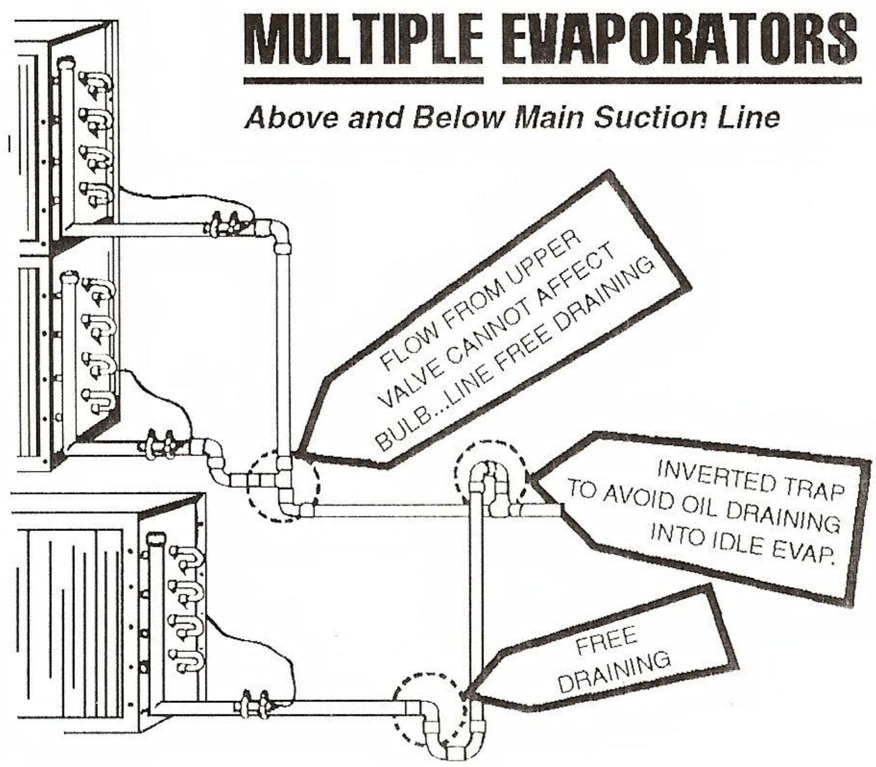
This rule also applies if the compressor is located above the evaporator as we're showing in Figure Four.



Part One, Figure Four

The purpose of the trap in these applications is to drain any liquid refrigerant that may affect the operation of the TEV. You'll note that we're showing the trap being constructed as short as possible to minimize the amount of oil that will be in that segment of the piping at any given time. When this type of trap is constructed of Street Ells, it will allow the segment to be as short as possible. When standard 90-degree Ells are used, it often means that the trap will be longer than it should be.

Still another situation in which the piping of a commercial refrigeration system must be accomplished correctly to facilitate proper metering device operation is in the case of multiple evaporators. (See Figure Five)



Part One, Figure Five

On multiple evaporators, what you want to look for is the suction line piping arranged so the flow of refrigerant and oil from one evaporator won't affect the feeler bulb operation of another evaporator. Often, in multiple evaporator systems, the main suction line is positioned as we're showing it, with one evaporator above and another one below. In these situations, an inverted trap at the point where the lower evaporator is piped to the suction line will prevent the migration of oil into the lower coil. Without this type of trap system, any oil migration will cause the temperature of the lower evaporator suction line to fluctuate. And, when this happens, the TEV will act as though it is hunting, opening too far too quickly, then shutting down too far. The end result of this process will, again, be a lower-than-normal efficiency of the refrigeration system overall, which will in the end cause a box temperature that will be above normal, even though the run cycles of the system seem quite long.

All of which boils down to the fact we mentioned at the beginning of this segment….that piping needs to be accomplished correctly in order for any metering device to operate properly, enabling the refrigeration system to accomplish maximum heat transfer.

And now that we've provided an overview on some of the fundamental things relative to the specifics of commercial refrigeration equipment, we'll move on to Part Two where we'll discuss the subject of TXV's (Thermostatic Expansion Valves) and superheat.