4.3.1 Achieving Equivalent Efficiency while Charging at Low Outdoor Temperatures

In order to provide a method for verifying refrigerant charge at low temperatures, it is first important to identify the goal of the verification. Given that Title 24 is an energy efficiency building standard, the appropriate goal is achieving efficiency.

This study investigated a possible low outdoor temperature refrigerant charge protocol. Virtually all the air conditioners sold in California today have Thermostatic Expansion Valves (TXVs). A TXV is a constant superheat valve that adjusts its resistance to refrigerant flow to obtain a constant superheat.

The basic problem with low temperature refrigerant charging of TXV air conditioners using current procedures in the 2008 Title 24 is that the valve adjusts to its fully open position. The fully open position occurs when the pressure across the TXV is insufficient to push the required volume of refrigerant through the valve to maintain a stable superheat. This problem exists at low outdoor temperatures when the condenser saturation temperature and pressure are low. By increasing the condenser saturation temperature and pressure, the TXV can function within its design parameters and provide proper refrigerant control. In commercial building air conditioners this is accomplished by slowing down the condenser fan speed (or reducing the number of operating condenser fans).

Various test methods have been attempted to increase condenser pressures and temperatures in cold weather. The two prominent methods are: 1) a tent covering the condenser unit causing recirculation of expelled warm air through the condenser and 2) blocking part of the condenser coil entrance. These two methods have generally proven unsatisfactory. The first causes major alterations in the temperatures entering the coil and the latter produces irregular flow or heat transfer through the refrigerant circuits.

Lennox Corporation currently allows blocking part of the condenser coil entrance to charge some of their TXV models in the winter.

The Condenser Air Exit Restriction (CAER) Protocol overcomes these issues. Restricting the outlet from the condenser fan without disturbing the inlet conditions has proven to be a viable method of low temperature testing. Bringing the pressure drop across the TXV to at least 160 psi for R-410A has the same effect as higher test temperatures. An example of a CAER is shown in Figure 2.

Figure 2. An Example of a Condenser Air Exit Restrictor

The sequence of each proof test at Intertek consisted of:

- Baselining the efficiency of two air conditioners at standard conditions with refrigerant adjusted to the manufacturer's specification.
- Undercharging and Overcharging the units to obtain a 5% loss in Sensible Efficiency
- Lowering the indoor temperature and outdoor temperature to provide severe winter conditions.
- Restricting the outflow from the condenser fan without disturbing the inlet to the coil.
- Recharging (adding or removing refrigerant) to produce the manufacturer's specification with the unit in the cold/restricted condition.
- Bringing the units back to standard conditions and determining the sensible efficiency of the units charged using the CAER protocol.
- Rerunning the unit with baseline charge adjustment for final comparison.

The results of the testing as illustrated in Figure 3 and Figure 4 below and detailed in 7.2 Appendix B: Steady State Test Summaries are used to produce a protocol that limits the sensible efficiency effect of refrigerant charge to substantially less than 5%.

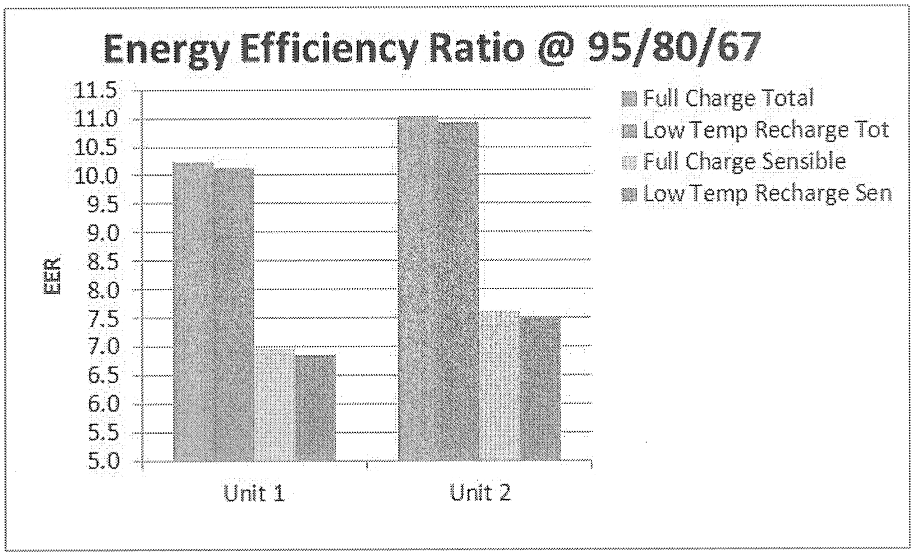
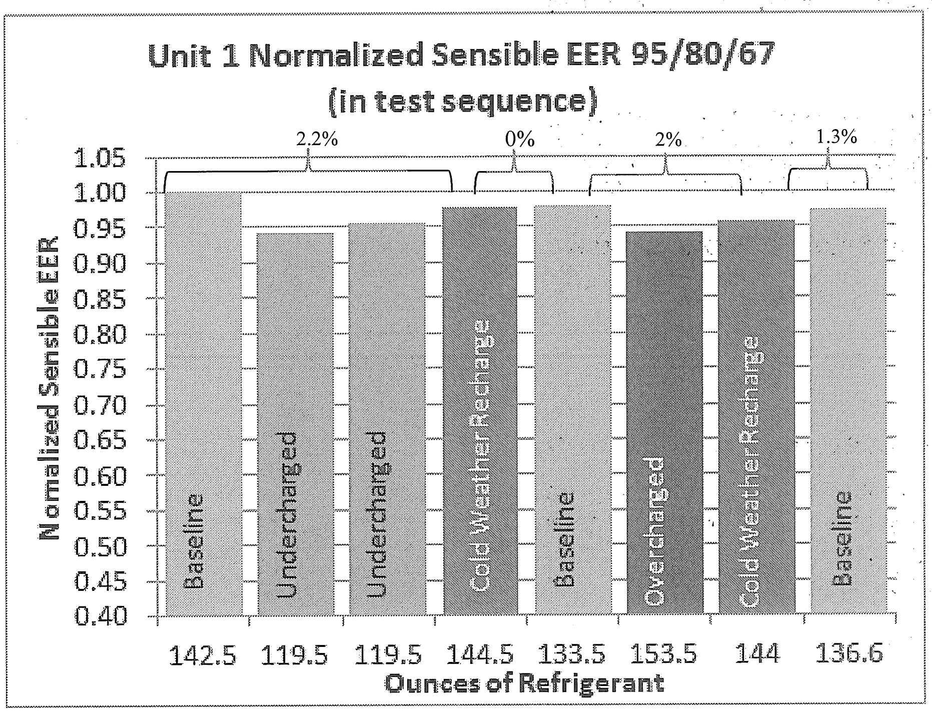


Figure 3: Energy Efficiency Ratio Comparison: Standard and Low Temperature Methods

The efficiency of both units adjusted using the Condenser Air Restriction Protocol (Cold Weather Recharge) was less than 2% different from the average baseline efficiency of those units adjusted with the standard (summer) protocol.



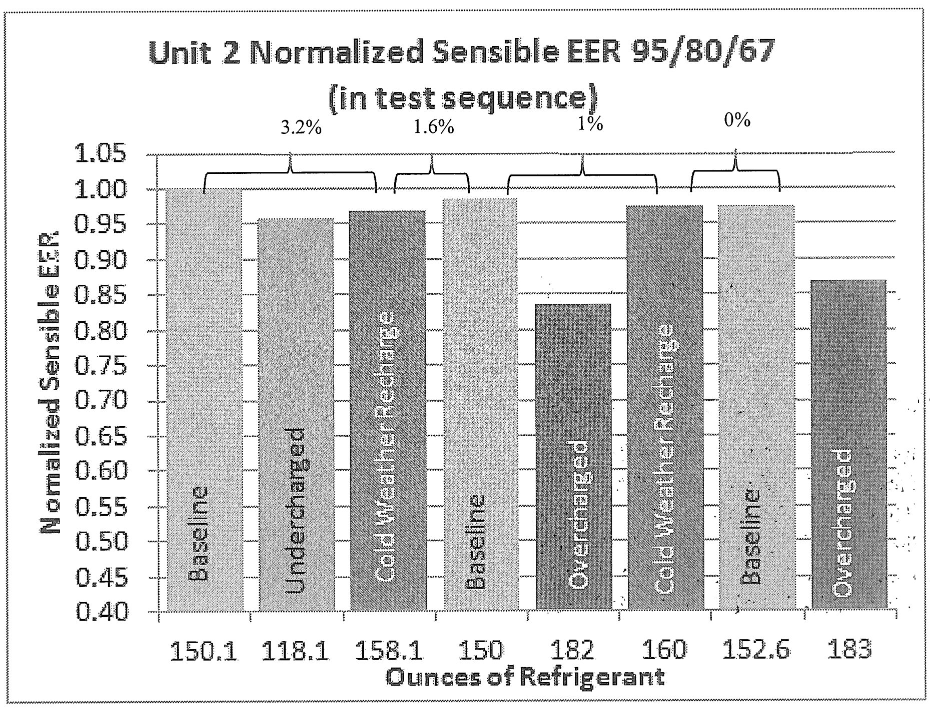


Figure 4: Detailed Energy Efficiency Ratio Comparison: Standard and Low Temperature Methods, Unit 1 and Unit 2.