MaxR100™ Pullman Rail Car A/C Testing Procedures

Introduction:

The MaxR100™ has characteristics that are known to enhance the operating efficiency of air conditioners, heat pumps, freezers, chillers and other similar heating and cooling devices. This test procedure is designed to develop a figure of merit for the increase in the efficiency of specific roof top air conditioners when treated with MaxR100™.

Test Objectives:

Most all heating and cooling devices of this type are powered by a source of electric energy. This can be a single phase source or a three phase source. The higher powered units are powered by a three phase energy source.

The basic unit of electric energy is the kWh (kilowatt-hour). One kWh of electric energy is consumed by a load having a constant one kW (one kilowatt) demand operating for one hour. A one horsepower load is about three quarters of a one kilowatt load. One kilowatt hour = 3,412.1 BTU of heating or cooling work at 100 percent efficiency. Also, a one horsepower load, operating for one hour would produce 2,544.4 BTU of cooling or heating work at 100 percent efficiency.

Developing the figure of merit for the MaxR100™ efficiency test requires measuring both the daily kWh electric energy consumption and the daily BTUh cooling work done by the air conditioner over a number of days, both before the addition of MaxR100™ and following the MaxR100™ treatment.

The figure of merit is simply the average BTUh/kWh per day of usage both before and after the treatment. All of the daily measurements before treatment can be averaged and compared with the average of the measurements following treatment for the same number of days.

BTUh cooling work is proportional to the difference in Enthalpy between the outlet air space and the inlet air, and once the Enthalpy difference is known, the BTUh cooling work can be calculated from the following equation:

BTUh = 4.5*(Enthalpy change)* CFM
Where CFM is the cubic foot per minute of air flow through the unit

The outlet air space temperature is usually thermostatically controlled using the dry bulb temperature and as long as the air conditioner capacity is adequate to cool the outlet air space under worse case conditions, then the outlet air space dry bulb temperature will be within a couple of degrees of the thermostat setting.

By measuring the dry and wet bulb temperatures of the inlet and outlet air on an hourly basis for each day of the test, we consult a psychometric chart to determine the enthalpy of the inlet and outlet air masses for each hour of the test. We can calculate the BTUh cooling work from the above formula however we need the CFM air flow to do it.

The field installation of a roof top air conditioner does not permit the fixture(s) required to accurately measure the inlet or outlet air flow. The best that can be done here is to replace or clean all of the air filters and air flow passages and use the manufacturer's air flow value from the design or installation manual.

In order to ensure that the air flow is the same at the beginning and end of the testing, an anemometer is used to measure the velocity of the outlet air flow.

For relatively stable pre and post treatment temperature differentials, the kWh energy consumption should decrease by 10 to 30 percent following MaxR100™ treatment. The air conditioner run time duty cycle will also decrease by a similar figure.

Test Instrumentation:
Inlet and outlet air space dry and wet bulb temperatures or relative humidity can be measured through the use of recording thermometers and relative humidity instruments, available from a number of sources (see HOBO instruments).

Measuring the kWh energy consumption requires installing a kWh meter in series with the AC power source to the air conditioner. The kWh meter can include an internal profile energy log or it can be equipped with a kWh output pulse that is connected to an independent data pulse recorder.

Regardless of which type of meter is used, a method must exist to query the meter or recorder and collect the profile energy pulse data on a daily basis. This can be a telephone line, an infrared optical probe, or an RF or internet link of some type.

The preferred equipment configuration (see figure 1 on the following page) consists of a kWh meter connected to a pulse data recorder with a telephone connection for profile pulse data collection. From the collected pulse data, the daily kWh consumption can be easily determined.

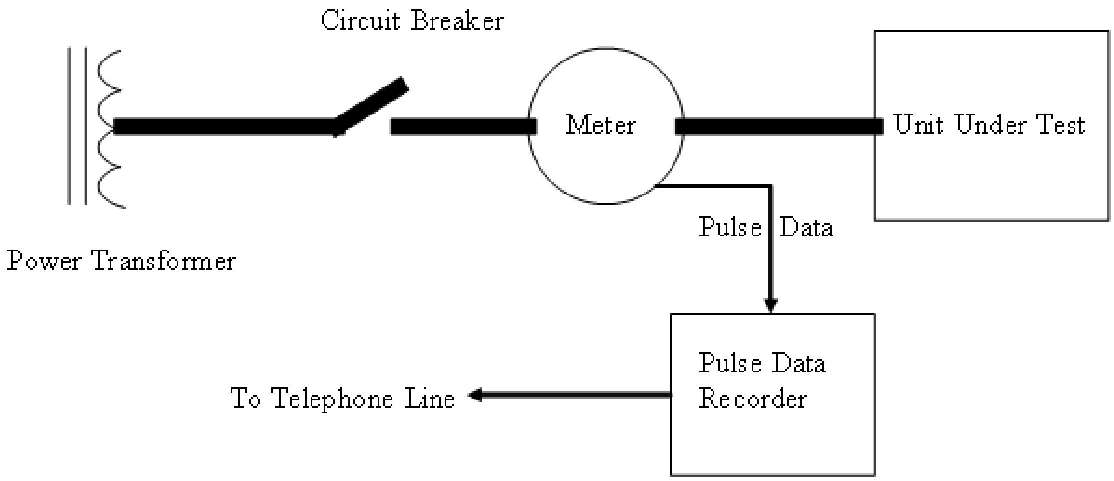

FIGURE 1

Figure 1 above is a simplified diagram showing the kWh metering equipment connections. In order to select the metering equipment, information about the existing power source to the air conditioning equipment is needed. Table 1 (below) should be used to collect the information needed to select the metering equipment for the unit under test.

Detailed Test Procedure

1. Take a sample of the compressor oil for analysis before the start of the test, if not a hermetically sealed unit.
2. Install the test instrumentation to measure the kWh energy consumption, and the
3. dry-bulb temperatures of the supply and return air masses and the outside air mass temperature within 3 feet of the roof top unit.
4. Also, install wet bulb temperature measurement or relative humidity measurement instrumentation to measure the wet bulb temperature or the relative humidity value of the supply and return air masses.
5. Clean or replace the air filters and clean the air flow passages;
6. Position an anemometer to measure the outlet air flow;
7. Restore the levels of refrigerant and compressor oil to within manufacturer's recommendations;
8. Energize the unit under test and record the anemometer air flow reading;
9. Record beginning dry and wet bulb temperatures, anemometer readings, input voltages and kW readings and determine that the unit is operating according to the requirements of the manufacturers installation and/or operating manuals;
10. Allow unit to run for two weeks while temperature, relative humidity and kWh values are recorded on a contiguous five minute interval basis.
11. After a two week PRETREATMENT run, stop unit and install recommended MaxR100™ treatment oil;
12. Restart unit and allow to run for a POST-TREATMENT period of two weeks while all - measurements continue to be recorded;

13. At this point the recorded data should be analyzed to determine the benefits of MaxR100™ treatment;
14. Allow unit to run for another two months to determine the long term benefits of MaxR100™ treatment. Following this run, all recorded measurements should be analyzed to determine the long term benefits of MaxR100™ treatment;
15. At this point, the unit under test can be shut down and a sample of the oil take for analysis;
16. After the refrigerant and oil levels are restored, the unit can be returned to continuous service;
17. END OF TEST PROCEDURE
18. Issue test results and report to customer directly by testing engineering firm;

Table 1: Test Unit Information			
Customer Name		**Equip Type**	
Tester Name		**Equip Make**	
Tonnage of Unit		**Equip Model #**	
Refrigerant Type		**Equip Serial #**	
Stated Air Flow		**Location**	
Oz of MaxR100™		**Elevation**	

Details of Test		
	Before	**After**
Date of Test (yyyy/mm/dd)		
Volt Phase 1 (White/Red)		
Volt Phase 2 (Red/Black)		
Volt Phase 3 (Black/White)		
Total Amp Phase 1		
Total Amp Phase 2		
Total Amp Phase 3		
Compressor 1 Amp Phase 1		
Compressor 1 Amp Phase 2		
Compressor 1 Amp Phase 3		
Compressor 2 Amp Phase 1		
Compressor 2 Amp Phase 2		
Compressor 2 Amp Phase 3		
Head Pressure		
Flow Rate Thru Evaporator		
Outside Air Temperature		
Outside Air Relative Humidity %		
Inlet Air Temperature of Evaporator		
Outlet Air Temperature of Evaporator		
Inlet Air RH% of Evaporator		
Outlet Air RH% of Evaporator		