The testing procedures are derived in part from the "Test Procedures for Water Heaters" outlined by the Federal Register, Title 10 of the Code of Federal Regulations (CFR), Part 430. These regulations provide a standard for fair comparison between energy efficiency, energy use, and the annual operating cost of water heaters produced by different manufacturers. The testing procedures estimate annual efficiency based on a typical use cycle, and test results are reported in terms of "energy factor" and "first hour rating" that may be difficult for the common consumer to understand.

Okaloosa Gas will be comparing water heaters that are in production and available on the retail market. Therefore, the performance rating tests prescribed in the Federal Register have already been conducted on these units and reliable "energy factor" and "first hour rating" data is already available. The purpose of tests conducted by Okaloosa Gas is not to verify these manufacturer ratings, but rather to provide a "side-by-side" comparison of three water heating technologies. Therefore, the federal testing standards have been modified to provide comparison test results that can be easily interpreted by the average consumer.

Okaloosa Gas, under the engineering direction of Exelon Services Federal Group, has elected to place three types of water heating systems in parallel. These three systems are to be tested at the Okaloosa Gas District Training Center in Ft. Walton Beach, Florida. The test environment was purposely selected so that the operating parameters for *Ambient Air Temperature*, *Supply Water Temperature*, and *Supply Water Pressure* would replicate the actual conditions of the customers in the Okaloosa Gas service territory.

The three types of water heating systems to be tested by Okaloosa Gas are defined as follows:

System No.	Manufacturer	Model No.	Description
1	Rheem	81V40D D	Electric, 40-gallon water heater
2	Rheem	21V40-38	Natural gas-fired, 40-gallon water heater
3	Rinnai	V2532FFU	Natural gas-fired, instantaneous water heater

For all three water heating systems, the supply water temperature and pressure is identical as they all receive supply water from the same incoming source. All three water heating systems are installed in the same conditioned space, therefore ambient air temperature will be maintained at ± 1°F for each system. For all three water heating systems, cold water inlet and hot water outlet temperatures will be measured using gauges installed according to the 10 CFR Part 430 testing protocol (with instrument precision of ± 0.2°F).

Flow meters and manual balancing (globe) valves will be installed on the outlet piping to ensure all three water heating systems are tested under the same flow conditions. Prior to conducting the tests, the flow meters should be checked for accuracy. This can be accomplished by adjusting the globe valve on outlet piping of each water heater so that the flow meter indicates a volumetric flow rate of 3.0 gallons per minute (GPM). Prior to beginning a test procedure, water flowing from the outlet pipe should be

collected in a volumetric basin over a timed interval. The measured volume of water (gallons) should then be divided by the time required to collect the water (minutes) to calculate the flow rate (gallons per minute, or GPM). The calculated flow rate should then be compared to the meter reading to verify accuracy.

Energy meters (electric meter for water heating System No. 1, natural gas meter for water heating System No. 2 and electric and natural gas meters for System No. 3) will be installed to measure the total energy consumption by each water heating system. In order to comply with the "Electrical and/or Fossil Fuel Supply" procedures of the CFR, the following procedures will be satisfied for each testing procedure:

Electric

Electrical supply voltage shall be maintained within ± 1% of the center of the voltage range specified by the water heater manufacturer.

Natural Gas

Natural gas supply pressure shall be maintained in accordance with the water heater manufacturers' specifications (if the supply pressure is not specified, a supply pressure of 7-10 inches of water column shall be maintained). For all testing procedures, natural gas shall have a heating value of approximately 1.025 Btu per standard cubic foot.

If electrical supply voltage varies by more than ± 1% or natural gas heating value varies significantly from the specification, an amount of error will be introduced into the procedure and calculations may be required to "correct" test results.

WATER HEATER TESTING PROTOCOL

The following testing procedures shall be used, identically, for all three water heating systems in order to determine the energy usage requirements and water heating system capabilities for each water heating system:

Test Procedure No. 1

Purpose: The following test procedure simulates monthly residential hot water usage for a typical family in the Okaloosa Gas service territory. This procedure was derived from the consumption profile provided in Chapter 48, page 10 of the *1999 ASHRAE Applications Handbook* in Figure 10, titled "Residential Average Hourly Hot Water Use". This test procedure can be conducted to measure the average energy use of water heater system(s) during a typical 30-day period. These testing procedures can either be done simultaneously or individually for each of the three water heaters since *Ambient Air Temperature*, *Supply Water Temperature*, and *Supply Water Pressure* will be the same during each test.

Duration: *9 and ½ hours per day, 5 days per week for 30 consecutive days*

Required Personnel: *1 person for the duration of the test*

Responsibilities: *In the time intervals specified by the schedules given in* ***Appendix A****, record the time of occurrence, time of duration for each draw, water flow meter readings, inlet and outlet temperatures and energy meter readings*

Protocol: This testing procedure will draw a total of 1,896.0 ± 10.0 gallons from each water heater over the course of a 30-day period according to the daily schedules given in **Appendix A**. This procedure will draw a specified quantity of hot water from the water heaters every ½ hour on Monday through Friday (workdays) from 7:00 a.m. until 4:00 p.m., excluding one hour of each day. This will generate 17 individual draws from each water heater during the course of each workday for a total of 21 workdays. The last day that hot water will be drawn from the water heaters will incur 3 additional draws that will occur in ½ hour increments follows the preceding 17 draws. No draws will be taken the final testing day which will be used to ensure that the water heaters have fully recovered from the final draw which was administered on the previous day. The total quantity of draws shall equal 360, which is equal to half of the number of available hours in a 30-day period. The hot water draw schedules, which are given in **Appendix A**, have been assembled to simulate typical monthly residential hot water usage as would be realized by the water heaters. While these schedules ensure that hot water draws will only occur during normal workday operating hours, the methodology in which they will be applied will simulate actual residential hot water usage to a high degree of accuracy (± 5%).

1. **Set each water heater to provide an outlet temperature of 135° F ± 5° F.** Adjust tank temperature setting to provide a temperature reading as close as possible to 135° F on the outlet temperature gauge. It may be necessary to open the hand valve on the outlet piping to induce a small flow of heated water across the temperature probe. After Step 1 is completed, *allow water heaters to fully recovery from any losses before proceeding to Step 2.*

2. **Begin test.** After completing Step 1, allow water heater to return to standby mode (wait for gas burner to cease firing or electric element to de-energize). After standby mode is verified, record the time and date and energy meter reading (in the case of electric meters, they can be reset to zero also at the beginning of the test for simplicity), also reset the totalizing flow meter to zero. This is the start of the test.

3. **Hot water draws.** Following the schedules as outlined in **Appendix A** for the corresponding water heater, open the hand valve on the water heater discharge line to provide a flow rate of 3.0 GPM ± 0.25 GPM and draw the specified quantity of water from the heater as outlined in the daily schedules. Using a stopwatch, measure the amount of time it takes to perform each hot water draw. After each draw, record the amount of time it took to complete the draw, the totalizing flow meter reading, which should be approximately equal to the "Cumulative Quantity Drawn" in the schedules in **Appendix A**. After the water heater recovers from the draw (returns to standby mode), if necessary, record the reading from the energy meter.

4. **Final Draw.** As indicated in the schedules in **Appendix A**, the amount of water drawn during the final draw on day 29 of the test (the 21st workday) should be an amount that will bring the cumulative total to 1,896.0 gallons. After the final draw, the water heater should be allowed to recover and enter standby mode. To ensure that the water heater fully recovers, leave the water heater overnight and return the following day at the same time at which the test was initially started and record the totalizing flow and energy meter readings.