

# Residential Compliance Testing Protocol



## Groton Generation Station Basin Electric Power Cooperative Groton, South Dakota

August 2006



**Residential Compliance Testing Protocol  
Groton Generation Station**

**Prepared for:**

**Basin Electric Power Cooperative  
Bismark, North Dakota**

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**BURNS & McDONNELL ENGINEERING COMPANY  
ENGINEERS-ARCHITECTS-CONSULTANTS**

## Table of Contents

1.0	SCOPE .....	1
2.0	INSTRUMENTATION.....	1
3.0	TEST PROCEDURE.....	2
4.0	REFERENCES.....	7

### **APPENDICES**

Appendix A: Specified Sound Levels

Appendix B: Measurement Point Location



## **1.0 SCOPE**

The procedures herein define the methods that will be used to measure and evaluate the sound emissions from the General Electric (GE) scope of supply equipment for the new combustion turbine at the Basin Electric Groton Generation Station (Facility) at the nearest occupied, existing residence not owned by Basin Electric Power Cooperative. The resulting final A-weighted  $L_{10}$  sound levels, after corrections for environmental influences, instrumentation tolerances and measurement uncertainty, will be compared to the specified sound level limits as provided in Appendix A.

The combustion turbine at the Groton Generation Station is a General Electric (GE) LMS100 Gas Combustion Turbine (CT) with an exhaust stack that operates in simple cycle mode. The summary noise report will include the measured noise levels at the nearest occupied, existing residence to the Groton Generation Station from the contractor supplied turbine, exhaust stack, and other equipment.

The following industry standards were used in the development of this procedure: ANSI S1.4, ASTM C423, ANSI S12.36, ANSI S12.34, ANSI B133.8, ISO 6190, ISO/DIS 8297, ANSI S1.11, ANSI S1.6, ANSI S1.40, and ANSI/ASME PTC 36. Any deviations from this test procedure that may significantly impact the intent of this procedure must be documented in the summary report.

## **2.0 INSTRUMENTATION**

### **2.1 General**

#### **2.1.1 Sound Level Meter**

Sound level measurements shall be made with a sound level meter that meets the requirement of the latest revision of ANSI S1.4 for a Type 1, Precision Sound Level Meter. A one-half-inch microphone is recommended. The sound level meter shall have the capability of determining the equivalent A-weighted sound level over a specified measurement period. An Order 3 extended-range octave-band filter set that meets the requirements of the latest revision of ANSI S1.11 shall be used to make measurements. An acoustical calibrator that meets the requirements of the latest revision of ANSI S1.40 shall be used.

A microphone windscreen shall be used for all measurements. The windscreen shall not affect the response of the sound level meter by more than  $\pm 0.5$  decibel (dB) at frequencies below 2,000 Hertz (Hz) and  $\pm 1.0$  dB at frequencies from 2,000 Hz to 10,000 Hz.

#### **2.1.2 Anemometer/Weather Instruments**

Instrumentation shall be used to monitor wind speed, wind direction, temperature, and relative humidity.

## **2.2 Calibration**

Instruments shall be acoustically calibrated using a sound level calibrator or pistonphone of known sound pressure level and accuracy of  $\pm 0.5$  dB. The standard reference sound pressure shall be 20 micropascals.

Calibrations shall be performed before and after each measurement series and upon any significant change in recording conditions (i.e. battery change operation). The calibration frequency shall be 1,000 Hz. The calibrator shall be checked annually to verify compliance with the U.S. National Institute of Standards and Technology specifications.

A calibration level change exceeding  $\pm 1.0$  dB will require that the measurement series be repeated.

## **3.0 TEST PROCEDURE**

### **3.1 General**

#### **3.1.1 Qualifications**

Sound level measurements shall be measured by qualified personnel.

#### **3.1.2 Technique**

Sound level measurements shall be made with the sound level meter mounted on a tripod or held in the hand of the observer in such a way that the microphone is at least one-half meter from the observer's body, with the microphone pointed at the proper angle relative to an imaginary line to the source. The angle of incidence of the sound on the microphone shall be as specified by the manufacturer as that angle for which the microphone has the most uniform frequency response. The observer shall not stand between the microphone and the source, and shall stand behind and to one side of the microphone.

Care shall be exercised to assure that the measurement position is free from excess reflections due to walls, columns, or other equipment, and from significant shadowing effects. Care shall also be taken to minimize the effects of vehicles and other non-Basin Electric Power Cooperative extraneous noise sources.

The A-weighting filter network shall be used for all sound level measurements.

The equivalent A-weighted sound level, octave bands, and  $L_{10}$  values shall be recorded at the measurement location for all steady sounds. If the measured operating sound level fluctuates over a wide range during the period of observation, the reading shall be taken again. The observation periods shall be one minute, or long enough to obtain a representative sound level reading at the nearest residence. Measurements shall be taken during daytime and nighttime. Measurements shall be taken for a minimum of four measurement

periods during the day and four measurement periods during the night. Measurement periods shall be spaced at least two hours apart with four measurements taken during each measurement period. Care shall be taken to eliminate (as much as is practicable) extraneous noises from sources other than the new combustion turbine and associated equipment. The daytime periods may start as follows: 6 AM, 10AM, 2 PM, and 6 PM, but should be adjusted accordingly to not coincide with noises emitting activities near the facility. The nighttime periods should start as follows: 10PM, Midnight, 2 PM, and 4 AM, but should be adjusted accordingly to not coincide with noise emitting activities near the facility.

The “slow” meter characteristic shall be used with the sound level meter. The measured Environmental Sound Level in each octave band with center frequencies from 31.5 to 8,000 Hz will be recorded. The “fast” time weighting characteristic may be used to check that interfering events are not influencing the sound level measurements.

All equivalent A-weighted sound levels and  $L_{10}$  levels shall be visually observed and recorded by reading the digital or analog output of the sound level meter. The data may also be documented on a graphics printer to provide a permanent record of the measured sound level.

All final sound level data shall be reported to the nearest dB.

### **3.1.3 Combustion Turbine Operation During Noise Testing**

The residential sound level measurements shall be made with the combustion turbine operating at baseload under steady state conditions for one set of measurements, and may operate at other loads for a second set of measurements.

All turbine enclosure and package doors shall be in their normally closed positions during all sound tests.

Care should be taken to minimize extraneous noise during the noise test that may impact the results of the test. Where possible, the equipment that is not permitted as part of the combustion turbine project shall not be operating during the tests (i.e. auxiliary emergency equipment and mobile construction equipment).

### **3.1.4 Background Sound Level Survey**

Background equivalent A-weighted sound level measurements shall be obtained at each measurement location used for the operating sound level measurements at the same time periods as the daytime and nighttime measurements for the operational measurements. For the background sound level survey, the following conditions shall be met:

- a) None of the supplied equipment, nor the CT should be in operation; and

- b) Extraneous noises shall be excluded from the measurements as much as is possible. Notes on extraneous noises shall be documented.

### **3.2 Residential Noise Test**

The residential noise test will consist of sound level measurements near the closest residence (Appendix B).

#### **3.2.1 Microphone Locations**

##### **3.2.1.1 Height**

The microphone shall be located at a height of 5 feet (1.5 meters) above the ground.

##### **3.2.1.2 Distance**

The microphone shall be located not more than a distance of 100 feet (30.5 meters) in the horizontal plane towards the new combustion turbine from the nearest residence, as shown in Appendix B. Distance shall be measured using a proper calibrated measuring device.

##### **3.2.1.3 Location**

Residential sound level measurements shall be made at a location that is free of reflective surfaces, not adjacent to other noise sources, has a clear line-of-sight to the new combustion turbine, and is deemed a safe working environment for the field engineers.

##### **3.2.1.4 Exclusions**

Sound measurements shall not be made at locations that are affected by noise produced from equipment not considered to be part of this project unless appropriate corrections are applied to the measured data.

### **3.3 Atmospheric Conditions**

If possible, sound measurements shall not be made when the average wind velocity during the measurement exceeds 7 mph (3 m/s) measured 5 feet (1.5 meters) above the ground.

Sound measurements shall not be made under any condition that allows the instrumentation to become wet (i.e. when raining or snowing).

### **3.4 Data Reporting**

The following information shall be recorded and included in the test report.

#### **3.4.1 Noise Testing**

- 3.4.1.1 As a minimum, report the following CT operating conditions during the noise testing:
  - a. Megawatt output
- 3.4.1.2 Report any non-standard CT operating conditions, including but not limited to the following auxiliary equipment:
  - a. Turbine enclosure exhaust fans and louver positions;
  - b. Mechanical package systems;
  - c. Electrical package air conditioning system;
  - d. Pumps and other equipment;
  - e. Fin fan cooler fan operation; and
  - f. Transformer cooling fan operation.
- 3.4.1.3 Date (including the day of the week) and time of measurements.
- 3.4.1.4 Extraneous noises that are not from the new combustion turbine project.

### **3.4.2 Acoustical Environment**

- 3.4.2.1 Site plan showing all units on the contractor supplied equipment list and sound level measurement locations.
- 3.4.2.2 Identification of non-supplied equipment determined to be potential noise sources or that may affect the sound level measurements at any position.
- 3.4.2.3 Ambient conditions during sound level measurement periods including temperature, relative humidity, wind speed and direction and cloud cover (if any).
- 3.4.2.4 Name, manufacturer, model number, serial number, ANSI type and last calibration date of all sound measuring instrumentation utilized.
- 3.4.2.5 Names of all personnel who performed and/or observed the sound level measurements.
- 3.4.2.6 Relevant remarks on the subjective impression of noise (i.e. time variations of sound level, audible discrete tones, spectral content, background sound from other sources, etc.)



3.4.2.7 Any deviations from this test procedure that may significantly impact the intent of this procedure, as agreed upon by Owner and Contractor.

3.4.2.8 Extraneous noise noted during the measurement.

### **3.4.3 Sound Level Data**

3.4.3.1 Observed  $L_{10}$  A-weighted sound level for each measurement taken.

3.4.3.2 Observed background  $L_{10}$  A-weighted sound levels for each measurement taken, with equipment not operating.

## **3.5 Test Method**

### **3.5.1 Operational Sound Level Measurements**

Sound level measurements shall be made at the proper location, height and distance in accordance with Section 3.2. Sound level measurements may be repeated two or more times during the daytime and nighttime in order to obtain a representative sound level for each period

Distances shall be determined with a tape measure or other measuring device and be accurate to within one-half foot (0.15 meters). If it is not feasible to make sound level measurements at the proper location, height, and distance, alternative locations may be selected as long as they are noted in the remarks associated with the data reporting.

### **3.5.2 Environmental Corrections for Measured Sound Levels**

The environmental conditions that exist at a specific test location may have an effect on the measured sound levels. These environmental influences, which include background sound from nearby sources not in the contractor scope of supply and the effects of other structures, shall be evaluated. Corrections for these effects shall be made to all measured data in accordance with guidelines contained in the referenced documents.

#### **3.5.2.1 Background Sound Level**

The A-weighted background sound level shall be measured at the test location determined previously at the nearest occupied existing residence. Measurements shall be made in accordance with Section 3.1.4.

Background sound level measurements may be performed before or after operational sound level measurements are obtained.

Any measurements taken to determine background sound levels shall be exclusive of air craft, railway and to the extent possible, traffic noise. If background levels exceed the noise criteria

specified in Appendix A, the measurement point may be moved to avoid extraneous noises.

#### 4.0 REFERENCES

ANSI S1.4 – “Specification for Sound Level Meters”.

ASTM C423 – “Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method”.

“Measurement of Sound Absorption in Rooms”, *Journal of Acoustical Society of America*, Vol. 61, No. 2, February 1977.

ANSI S12.36 – “Survey Methods for the Determination of Sound power Levels of Noise Sources.”

ANSI S12.34 – “Engineering Methods for the Determination of Sound Power Levels of Noise Sources for Essentially Free-Field Conditions over a Reflecting Plane”.

ANSI B133.8 – “Gas Turbine Installation Sound Emissions”.

ISO 6190 – “Acoustics – Measurement of Sound Pressure Levels of Gas Turbine Installations for Evaluating Environmental Noise – Survey Method”.

ISO/DIS 8297 – “Acoustics – Determination of Sound Power Levels of Multi-Source Industrial Plants for the Evaluation of the Sound pressure Levels in the Environment – Engineering Method”.

ANSI S1.11 – “Specification for Octave Band and Fractional Octave Band Analog and Digital Filters”.

ANSI S1.6 – “Preferred Frequencies and Band Numbers for Acoustical Measurements”.

ANSI S1.40 – “Specification for Acoustical Calibrators”.

ANSI/ASME PTC 36 – “Measurement of Industrial Sound”.

**APPENDIX A**  
**SPECIFIED SOUND LEVELS**

APPENDIX A

**SPECIFIED SOUND LEVEL LIMIT AT  
NEAREST OCCUPIED, EXISTING RESIDENCE  
FOR GROTON GENERATION STATION**

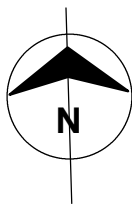
<b>Time of Day</b>	<b>Limit (L<sub>10</sub>)</b>
Daytime	60 dBA
Nighttime	55 dBA

**APPENDIX B**  
**MEASUREMENT POINT LOCATION**



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0 250 500 1,000 Feet



Appendix B  
Measurement Point Location  
Groton Generation Station

Source: USDA Aerial Photography, 2004.