

Sikorsky Comments on CT DEEP's June 2015 Draft of Section 22a-174-22 Stack Testing

Summary:

Sikorsky is concerned that its turbine will, at some point, not meet the minimum 90% of design maximum rated heat input capacity during a NOx RACT stack test. As others have commented, 90% can be difficult to achieve when testing a turbine during the summer, as turbine performance varies with ambient conditions. The reverse could also be a problem: firing at over 100% during the winter. Sikorsky is also concerned that its 1950s boilers may not reach 90% of nameplate capacity during a stack test. Sikorsky wants to avoid an NOV, or any further restriction in turbine or boiler operation if the 90% level cannot be achieved.

ISO Explained:

Ambient conditions affect the performance of a gas turbine. Altitude and temperature affect the performance of a gas turbine. To eliminate such misunderstandings, the gas turbine output and performance is specified at standard conditions called the ISO ratings. These are specified as per ISO standards 3977-2 (Gas Turbines - Procurement - Part 2: Standard Reference Conditions and Ratings). The three standard conditions specified in the ratings are Ambient Temperature - 15 deg C, Relative Humidity - 60 % and Ambient Pressure at Sea Level. These conditions affect the air density, which affect the gas turbine output and performance as follows:

The compressor section takes in a fixed volume of air for each rotation of the blades. The mass of the air depends on the air density. As the ambient temperature increases, the density of the air decreases. Consequently the air mass flow rate into the turbine decreases. As a result, the mass fuel flow rate correspondingly decreases to keep the air to fuel ratio constant, which results in a reduced gas turbine power output.

Likewise, when the ambient temperature decreases, the density of the air tends to increase, and the inlet air mass flow rate of the compressor increases. As a result, the fuel mass flow rate will increase and the power output increases.

Sources:

<http://www.brighthubengineering.com/power-plants/25425-what-is-iso-rating-of-gas-turbines/>

<http://www.turbomachinerymag.com/blog/content/factors-influence-gas-turbine-performance>

<http://www.diva-portal.org/smash/get/diva2:744746/FULLTEXT01.pdf>

EPA Stack Test Guidance and Turbine Rules:

The following sources were noted to accommodate the effect of ambient conditions on turbine firing. Several EPA rules regulating gas turbines allow for correction to ISO conditions and are summarized below.

a. EPA stack test guideline

<http://www.epa.gov/ttnemc01/guidlnd/gd-050.pdf>

This guideline does not reference a 90% level, and allows for unsafe conditions.

Sikorsky Comments on CT DEEP's June 2015 Draft of Section 22a-174-22 Stack Testing

“The following are factors that should be considered in developing the plan for a performance test that challenges to the fullest extent possible a facility’s ability to meet emissions limits.

- For a facility operating under an emission rate standard (e.g., lb/hr) or concentration standard (e.g., $\mu\text{g}/\text{m}^3$), normal process operating conditions producing the highest emissions or loading to a control device would generally constitute the most challenging conditions with regard to the emissions standard. If operating at maximum capacity would result in the highest levels of emissions, operating at this level would not create an unsafe condition, and the facility expects to operate at that level at least some of the time, EPA recommends that the facility should conduct a stack test at maximum capacity or the allowable/permitted capacity.
- A facility is not required automatically to retest if the initial test does not represent the range of combined process and control measure conditions under which the facility expects to operate, or if the test does not challenge to the fullest extent possible the facility’s ability to meet applicable emission standards without creating an unsafe condition. Furthermore, the facility is not required automatically to retest if the facility’s operating conditions subsequently vary from those in place during the performance test. The delegated agency must determine whether retesting is warranted; however, in both instances, the facility is responsible for demonstrating to the satisfaction of the delegated agency that the facility is able to continuously comply with the emissions limits when operating under expected operating conditions, taking into consideration the factors discussed above in this section. “

b. NSPS, subpart KKKK **40 CFR Part 60, Section 4400, Paragraph (b)**

This rule allows for correction to ISO conditions.

“(b) The performance test must be done at any load condition within plus or minus 25 percent of 100 percent of peak load. You may perform testing at the highest achievable load point, if at least 75 percent of peak load cannot be achieved in practice. You must conduct three separate test runs for each performance test. The minimum time per run is 20 minutes.

- (1) If the stationary combustion turbine combusts both oil and gas as primary or backup fuels, separate performance testing is required for each fuel.
- (2) For a combined cycle and CHP turbine systems with supplemental heat (duct burner), you must measure the total NO_x emissions after the duct burner rather than directly after the turbine. The duct burner must be in operation during the performance test.
- (3) If water or steam injection is used to control NO_x with no additional post-combustion NO_x control and you choose to monitor the steam or water to fuel ratio in accordance with §60.4335, then that monitoring system must be operated concurrently with each EPA Method 20 or EPA Method 7E run and must be used to determine the fuel consumption and the steam or water to fuel ratio necessary to comply with the applicable §60.4320 NO_x emission limit.

Sikorsky Comments on CT DEEP's June 2015 Draft of Section 22a-174-22 Stack Testing

(4) Compliance with the applicable emission limit in §60.4320 must be demonstrated at each tested load level. Compliance is achieved if the three-run arithmetic average NO_x emission rate at each tested level meets the applicable emission limit in §60.4320.

(5) If you elect to install a CEMS, the performance evaluation of the CEMS may either be conducted separately or (as described in §60.4405) as part of the initial performance test of the affected unit.

(6) The ambient temperature must be greater than 0 °F during the performance test.”

“Peak load means 100 percent of the manufacturer's design capacity of the combustion turbine at ISO conditions.”

“ISO conditions means 288 Kelvin, 60 percent relative humidity and 101.3 kilopascals pressure.”

c. NSPS, Subpart GG

This rule also allows for correction to ISO conditions.

40 CFR Part 60, Section 335, Paragraph (b)(1)

“(1) For each run of the performance test, the mean nitrogen oxides emission concentration (NO_x) corrected to 15 percent O₂ shall be corrected to ISO standard conditions using the following equation. Notwithstanding this requirement, use of the ISO correction equation is optional for: Lean premix stationary combustion turbines; units used in association with heat recovery steam generators (HRSG) equipped with duct burners; and units equipped with add-on emission control devices:

“Peak load means 100 percent of the manufacturer's design capacity of the gas turbine at ISO standard day conditions.”

“ISO standard day conditions means 288 degrees Kelvin, 60 percent relative humidity and 101.3 kilopascals pressure.”

40 CFR Part 60, Section 335, Paragraph (b)(2)

“(2) The 3-run performance test required by §60.8 must be performed within 5 percent at 30, 50, 75, and 90-to-100 percent of peak load or at four evenly-spaced load points in the normal operating range of the gas turbine, including the minimum point in the operating range and 90-to-100 percent of peak load, or at the highest achievable load point if 90-to-100 percent of peak load cannot be physically achieved in practice. If the turbine combusts both oil and gas as primary or backup fuels, separate performance testing is required for each fuel. Notwithstanding these requirements, performance testing is not required for any emergency fuel (as defined in §60.331).”