REVIEW OF THE EMISSIONS STANDARDS IN RCSA SECTION 22A-174-42

Background

The Regulatory Assistance Project (RAP), under a contract with the National Renewable Energy Laboratory (NREL), issued the "Model Regulations for the output of Specified Air Emissions from Smaller Scale Electric Generation Resources", aka RAP Rule, on October 2002. The RAP Rule was developed with an working group that included several states utility and air pollution regulators, representatives of the distributed resources industry, environmental advocates, and federal officials.

RAP Rule sets the emissions standards for smaller-scale electric generation technologies. The rule has been adopted by several states, including Connecticut, as Section 22a-174-42 of The Regulations of Connecticut State Agencies, effective January 1, 2005.

The model rule regulates five air pollutants: nitrogen oxides (NOx), particulate matter (PM), carbon monoxide (CO), sulfur dioxide (SO_2), and carbon dioxide (CO_2). Emission standards are output-based (pounds per megawatts). The rule identifies and applies standards to only two categories of duty-cycles – emergency and non-emergency. For emergency generators, the rule adopts the US EPA standards for off-road engines (converted to lbs/MWh). For non-emergency, the rule calls for the standards for each pollutant to be phased in three steps over a ten-year period.

RAP Rule Phase III - Emissions Standards

Phase III, which begun in 2012, includes emission standards that are considered "stretch goals" intended to push technology improvements. The Phase III emissions standards were based in large measure on the expected trajectories of technology performance over the period from 2002 to 2012.

The Phase III emissions standards for each pollutant are shown in the following table:

RAP Rule	Nitrogen Oxides		Particulate Matter		Carbon Monoxide	Carbon Dioxide
	Ozone Attainment Areas	Ozone Non Attainment Areas	liquid fuel reciprocating engines	liquid fuel only non-reciprocating engines		
Phase III (installed on or after 01/01/12)	0.15 lb/MWh	0.15 lb/MWh	0.03 lb/MWh	To be determined	1 lb/MWh	1,650 lb/MWh

- NOx – The Phase III NOx standard of 0.15 lb/MWh applies to machines in both attainment and non-attainment areas and has been selected at a level that is approximately 70 percent cleaner than the 2002 cleanest combustion-based distributed generator (DG) technology. The NOx emission limit was set very low, but within the range of reasonable expectations for technology improvements based on US DOE's Advanced Reciprocating Engine System (ARES) Program and the California Energy Commission's Public Interest Energy Research programs into environmentally-preferred advanced generation.
- SO_2 – The rule does not specify a limit for SO_2 since many DG technologies run on natural gas, which generally has a very low sulfur content. And for the diesel engines the SO_2 emission is controlled by allowing units' operation with only ultra low sulfur diesel (ULSD) fuel. As an additional benefit, low-sulfur fuels allow the use of catalyst-based control technologies for other pollutants, technologies that may otherwise be poisoned by sulfur in the exhaust stream.
- PM – Gas fired and dual-fuel generators are exempt from the rule; low PM output is assured since these units are also subject to the low-sulfur fuel requirements. The Phase III stringent limit of 0.03 lb/MWh for liquid fuel reciprocating engines (group including also diesel engines) is the 2007 federal limit for on-road engines, since it was expected that over a decade the stationary off-road engines design would improve and be brought in line with those of on-road. In addition, it was recognized that the PM limit would require improved combustion processes and use of

particulate traps. Also in the Phase III, there is no standard set for liquid-fuel only non-reciprocating engines (e.g., turbines) due to lack of reliable information.

- CO – The Phase III CO standard of 1 lb/MWh can be met without affecting the NOx reducing process by most of the turbines, and at lean-burn engines with an oxidation catalyst. For the rich-burn engines to achieve the emission standard significant technological advancements will likely be necessary.
- CO_2 – There are no currently practical after-treatment controls that remove CO_2 from an exhaust stream. However increasing efficiency lowers the CO_2 output. The Phase III standard of 1,650 lbs/MWh assumes an efficiency limit among the gas-fired technologies of at least 24%, and requires improvements in some small turbine models. Because increases in efficiency reduce a user's fuel costs, it is reasonable to expect that the needed improvements will be largely market driven.

The RAP Rule acknowledges that the Phase III standards are "stretch" goals intended to push technology improvements. However, given uncertainties about the state of DG technology ten years hence, the Rule recommends a technology review be performed before the Phase III standards went into effect.

Purpose of the Technology Review

This analysis evaluates whether the Phase III emission limits represent current technologies capabilities of currently available generators and emission control equipment.

Review Procedure

The review was performed on the same generators listed by RAP within Appendix B, including selected units (considered by RAP as typical) from three categories of DG units: Fuel Cells, Gas IC and Diesel Engines and Turbines. The RAP Model Rule Appendix B tables 1 and 2 have been updated with the units' current performance data (generator power output, heat rate and efficiency) and actual emission rates published by the manufacturers most recent, preferably within the last five years. If data is not available, theoretical assessments have been made, including whether to consider RAP listed values and/or to adjust them based on verified assumptions.

In performing this update, RAP Model Rule Appendix B tables 1 and 2 have been expanded by addition of several units of the same type, construction and size, made by the same manufacturer or different manufacturers, in order to replace the RAP listed units that became obsolete either by being withdrawn from manufacturing, or retrofitted to a newer version/configuration.

The first section (Data Collection and Emissions Assessment Notes and Procedures) of the analysis explains in detail the procedures adopted for data collection and emission assessment, including various performance specification and emission rates calculation formulas. For data validation, additional explanation notes and references have been provided.

Results

Table 1 summarizes the analyzed units' compliance with the RAP Model Rule Phase III Emission standards. An overview shows the following results for each emission standard:

- NOx limit of 0.15 lb/MWh is set too low. All units analyzed, except fuel cells, are non-compliant
- SO_2 - no emission standard is set, since in order to be in compliance the all DG units, except diesel engines, must operate with natural gas, and diesel engines with ULSD.
- PM emission standard set for liquid fuel reciprocating engines, of 0.03 lbs/MWh can be attained only by diesel engines configured to meet EPA's Nonroad Diesel Tier 4 Interim Standard.

- CO limit of 1 lb/MWh can be met by the fuel cells and most of the turbines, except microturbines, confirming RAP Rule prediction. All rich burn and lean burn engines analyzed, except the Caterpillar new Tier 4 Interim generator, are non-compliant.
- CO_2 limit of 1,650 lb/MWh - All units except the microturbines are complaint with RAP Phase III emission standard. This confirms the RAP prediction that improvements are required at small turbines to increase the gas-fired turbines efficiency to a minimum of 24%,

Table 2 (Fuel Cells), Table 3 (Gas IC and Diesel Engines) and Table 4 (Turbines) include current performance data and emissions rates, published by the manufacturers, of the units listed by the RAP Rule in Appendix B. New units are added in order to replace the Rule listed units that became obsolete either by being withdrawn from manufacturing, or retrofitted to a newer version/configuration.

The review indicates that RAP Model Rule Phase III emission standards must be reconsidered for NOx and PM and set to feasible limits attainable by the current technologies capabilities of the new generators and emission controls equipment.

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