Measurement Of Net Versus Gross Power Generation

For The

<u>Allocation Of NOx Emission Allowances</u>

Submitted by FirstEnergy Corp.

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The following presents an overview of issues related to the policy decision of whether to utilize gross or net electric output for the distribution of NOx emission allowances. The issues discussed include how and where output is monitored, as well as the policy considerations of utilizing net or gross output to determine the allocation of allowances.

Power Plant Metering of Electric Output:

"Gross" electric output at a generating plant is typically a direct measurement of the electrical output of the electrical generator. "Net" electric output is typically a reported value "net" of all electrical power utilized in the plant by auxiliary equipment such as pumps, motors and pollution control devices. These auxiliaries typically utilize 3 to 6% of a plant's gross output, but a plant's use of its' own electricity can range as high as 12% if the plant is equipped with extensive pollution control equipment such as precipitators, scrubbers, NOx controls and cooling towers.

Three types of electrical devices are typically utilized for the metering of power produced by an electrical generator, irrespective of whether it is a gross or net measurement. Potential transformers (PT) and current transformers (CT) are the two types of instrument transformers that measure the voltage and amperage, respectively, of power flowing through a conductor. Instrument transformers transfer a linear signal to an electrical meter, which translates these signals and maintains a cumulative record of power produced.

Potential transformers and current transformers are specialized types of transformers, which are typically tested originally by the manufacturer and certified within a specific range of accuracy. If no physical changes are made to the number of windings within these transformer types, they never need recalibration.

Potential transformers and current transformers can be of two accuracy classes. Relay accuracy class instruments are designed to be utilized in a protective relay or control scheme at a facility, and typically have an accuracy range of plus or minus (+/-) 0.6% at test conditions. Metering accuracy class instrumentation is specifically designed to accurately measure power flow and therefore has been developed to achieve a test accuracy range of (+/-) 0.3%. Metering accuracy class instrumentation is generally specified in instances where power is bought and sold and accurate metering is needed for accounting purposes. In the past this has typically been at the utility-customer interface but deregulation is spurring the delineation of utility generation, transmission and distribution functions. As each of these three elements becomes a seller and/or buyer of power, there is an increasing need for accurate metering where electric power is transferred among them.

The third type of instrument involved in measuring electric output is the kilowatt meter itself. Older style electromechanical meters utilizing rotating disks achieve an accuracy of (+/-) 0.3%. Electromechanical meters are typically recalibrated every two years. Newer solid state meters generally have a similar accuracy, but need less frequent recalibration.

As a total system, relay class metering is generally presumed to have an overall system accuracy of (+/-) 2%, if the errors in each individual component are all assumed to be in the same direction. Metering class instrumentation is generally presumed to have a corresponding overall accuracy of (+/-) 1%.

Either "relay class" or "metering revenue class" instrumentation achieve a high level of accuracy in measuring electric output that is far superior to the estimation of heat input to the boiler. Boiler heat input has been estimated by either of two means historically: by metering fuel flow to the boiler and performing fuel analyses to determine the average heat content of the fuel, or more recently, by the use of Continuous Emission Monitoring Systems (CEMS). CEMS have a well-documented tendency to overstate heat input by as much as 22%, due in part to the compounded effects of test bias, calibration error and flow biases associated with gas swirl and stack wall effects.

Electric output metering is well developed and numerous industry standards have been developed to maintain and safeguard the performance of this instrumentation. Instrument transformers (PT's and CT's) fall in part under IEEE Standard No. 57.13 and ANSI Standard No. C93.1. Meter performance and calibration fall in part under ANSI Standards No. 12.10 and 12.16.

Measuring "Net" Versus "Gross" Electrical Output:

Gross electric output is typically understood to be a measurement of the kilowatt-hours directly produced by a given generator or set of generators. Gross electric output is measured close to the generator output terminals through the utilization of the instrument transformers and metering devices described above, prior to the extraction of some of that power to run plant auxiliary electrical equipment. The vast majority of generators were originally installed with relay accuracy metering, primarily for system control purposes, and much of that original equipment remains in service today.

Conversely, net generation, as defined by the Energy Information Administration (EIA) in the directions for the Form 767 Report, "is the total amount of electric energy generated, measured at the generator terminals, less the total electric energy consumed at the generating station". Net generation may be measured directly, or can be extrapolated from metered gross generation by deducting metered or calculated power consumed by plant auxiliaries.

Net power generation is the marketable product of a commercial power plant, and as the power industry moves into a deregulated environment, there is a strong impetus to even more accurately measure net output to the electrical grid. It is expected that one "point of sale" of this product will be the interconnection between the power plant and the transmission grid. This connection point is generally accepted to be at the high voltage side of the step-up transformer, net of all plant auxiliary use of electricity and transformer losses.

As utility services are unbundled into distinct generation and transmission entities, the independent transmission organizations which are currently forming will be developing new performance standards for the accurate metering of electricity. FirstEnergy has established a corporate-wide standard for unit-level net MWh output in anticipation of these requirements. These industry upgrades to net output metering will proceed due to market forces concurrent with deregulation, independent of any separate environmental regulatory initiatives.

Net Versus Gross Output Considerations

1. Data Reporting and Collection:

EPA could readily develop a protocol to access electric output information electronically from plants subject to Title IV of the Clean Air Act. Continuous Emission Monitoring Systems (CEMS) are currently installed on utility power plants under the Acid Rain Program. CEMS utilize a generator output signal as an indication of unit load as part of the data substitution routine. It would be relatively straightforward as an element of one of the periodic CEMS software upgrades to modify the CEMS software to utilize this signal to track kilowatt-hours generated.

Electric output information has also been reported for both utility and non-utility sources in a number of EIA reports. These existing reports could potentially be utilized as a reporting mechanism.

2. Unit-level Data Availability:

While a distinction exists today, deregulation is driving generators of electricity towards unit-level measurement of net electric generation. Electric power plants have always been designed and constructed with direct metering of gross electric output, an important operating control parameter, at individual generating units.

Electric power plants typically have not directly measured net MWh output. However, as they commence selling electricity to transmission organizations, accurate and reliable measurement of net electric output becomes equally or perhaps of even greater importance than gross output. Plants can and some already do directly measure unit-level net MWh output at the step-up transformers where voltage levels are increased at the connection point with the grid. For reliability purposes, each generating unit typically has its own step-up transformer that allows metering instrumentation to be installed for unit-level measurement of net MWh output. Direct metering of unit-level net MWh output is not completely in place but is an inevitable result of a deregulated marketplace.

3. Data Accuracy and Consistency:

As previously discussed, metering of MWh output is far more accurate than the estimates of heat input which have been used in past allocations of emission allowances. One advantage of net MWh output measurement is the greater precision and accuracy of modern "metering accuracy instruments." These solid-state meters and "metering accuracy instruments" being installed by the generating industry can provide consistent and accurate net output data. The principal disadvantage is that installation of net metering devices is a work-in-progress that may not be completed for a few years.

Gross MWh output measuring devices span a wide-range of metering technologies depending on the age of the unit and the replacement or upgrading of metering equipment over the unit's operating history. Testing and calibration frequency can also impact the accuracy and consistency of measurement since electromechanical meters are typically used to measure gross MWh output. Gross MWh output measurement has the exact opposite trade-offs, the devices are in-place and collecting data but there are slight inconsistencies between units due to the varying accuracy levels which is determined by the type of metering equipment and testing and calibration frequency.

4. Pollution Control Devices:

Auxiliary power usage by pollution control devices varies between electric generating plants. Many plants are equipped with one or more devices to control stack emissions--precipitators, baghouses, scrubbers—which may utilize from 2 % to 6 % of the plant's gross MWh output depending on the system design. Most plants will be required to install additional NOx controls--SNCR or SCR—which may further reduce plant output. At least two viewpoints have been expressed regarding the impact of gross v. net measurement on pollution control devices. One view is that decisions to install devices that reduce emissions are penalized by a net MWh output allocation. Another view is that allocating based on net MWh output puts all generating sources on equal footing and results in the most efficient pollution reduction decisions. For instance, renewable generating sources (hydro, solar, wind, etc.) have no auxiliary power usage for pollution control and would be disadvantaged by a gross output allocation.

5. Efficiency Incentives:

The use of net MWh output as the basis for allocation of emission allowances creates an additional incentive to limit auxiliary power usage. However, the existing market already rewards the industry for minimizing the internal use of power to the extent possible, and any additional efficiency incentive created by a NOx allocation system may not be significant compared to the current marketplace.

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