Question 17.2

Topic: Load and Heat Input Rate Determination for Combustion Turbines and Cogenerators

Question: For combustion turbines, how do I report unit load and heat input rate? Are there any special considerations for cogeneration facilities?

Answer: Report all of the hourly heat input to the unit and report a consistent measure of unit load.

Heat Input Rate Reporting

Report unit heat input rate, as follows:

(1) For a simple-cycle combustion turbine (CT) without a heat recovery steam generator (HRSG), or a for a combined-cycle turbine that has an HRSG but does not have auxiliary firing, report the hourly heat input rate to the CT; or

(2) For a combined-cycle turbine that has both an HRSG and auxiliary firing (e.g., a duct burner), report the combined hourly heat input to the CT and the auxiliary combustion source.

Unit Load Reporting

Report the unit load as follows:

(1) For a simple-cycle turbine, report the electrical output (in megawatts) from the generator that serves the CT; or

(2) For a combined-cycle unit (with or without auxiliary firing), if a single generator serves both the CT and the HRSG, report the electrical output (megawatts) from this generator; or

(3) For a combined-cycle unit (with or without auxiliary firing), if separate generators serve the CT and HRSG, add the electrical outputs (megawatts) from these generators[1]; or

(4) If the HRSGs of two or more combined cycle units (CCUs) share a common steam turbine, then, for each CCU, add the electrical output (megawatts) from the generator that serves the CT to an apportioned fraction of the electrical output from the shared steam turbine.

Apportion the combined electrical load from the common steam turbine to the individual CCUs according to the fraction of the total steam load contributed by each unit. Alternatively, if the turbines are *identical*, you may apportion the combined electrical load from the common steam turbine to the individual CCUs according to the fraction of the total heat input contributed by each unit.

Example 1: Suppose that combined-cycle units CT1 and CT2 share a

common steam turbine. For a particular hour, the electrical loads at the generators serving CT1 and CT2 are 100 and 150 MW, respectively, and the electrical load at the common steam turbine is 120 MW. If the measured steam loads from the heat recovery steam generators of CT1 and CT2 are 200,000 and 300,000 klb/hr, what unit loads should be for CT1 and CT2?

To determine the load for CT1, add the load from the generator serving CT1 to a fraction of the load at the common turbine, apportioned by steam load, i.e., 100 MW + (200,000/500,000)(120 MW), or *148 MW*. Similarly, for CT2, the reported unit load should be 150 MW + (300,000/500,000)(120MW), or *222 MW*.

Example 2: Suppose that the turbines in Example 1 are *identical*. If, for a particular hour, the heat inputs to CT1 and CT2 are 1000 and 1500 mmBtu, respectively, the heat inputs to the duct burners are 200 and 300 mmBtu, respectively, and the electrical loads are the same as in Example 1. What unit loads should be reported for CT1 and CT2?

First, determine the fraction of the total heat input associated with each unit. The total heat input is 1000 + 1500 + 200 + 300 = 3000 mmBtu. The fraction of the total heat input contributed by CT1 is (1000 + 200)/3000, or 0.40, and for CT2 it is (1500 + 300)/3000, or 0.60. To determine the load for CT1, add the load from the generator serving CT1 to 0.40 times the load at the common steam turbine, i.e., 100 MW + (0.40)(120 MW), or *148 MW*. Similarly, for CT2, the reported unit load should be 150 MW + (0.60)(120 MW), or *222 MW*.

For cogeneration facilities, where part of the output is electrical load and part of it is steam load, consistency in reporting unit load is essential. The owner or operator may either convert the steam load portion to an equivalent electrical load and report the unit load in megawatts, or may convert the electrical output to an equivalent steam load and report the unit load in klb/hr of steam[2].

For combined cycle combustion turbines that use the combustion turbine to generate electricity and use the HRSG to produce steam which is not used for electrical generation, one acceptable way to convert the steam portion of the load to an equivalent electrical load is to use the following equation:

$$L_{eq} = K\ \eta_{hrsg}\ [(1 - \eta_t)(HI_t) + HI_a]$$

Where:

L_{eq} = Equivalent electrical load for the steam generated by the HRSG (MW)

η_{hrsg} = Efficiency of the HRSG in converting heat input to electricity (Use either the actual, measured efficiency or a default value of 0.30)

η_t = Efficiency of the combustion turbine in converting heat input to electricity (Use either the actual, measured efficiency or a default value of 0.33)

HI_t = Heat input rate to the turbine (mmBtu/hr)

HI_a = Heat input rate to the HRSG (if any) from an auxiliary combustion source, e.g., a duct burner (mmBtu/hr)

K = Conversion factor (0.293 MW-hr/mmBtu)

References: § 75.57(b)

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