State of Utah
Department of Commerce
Division of Public Utilities

FRANCINE GIANI
Executive Director

THOMAS BRADY
Deputy Director

CHRIS PARKER
Director, Division of Public Utilities

GARY HEBERT
Governor

SPENCER J. COX
Lieutenant Governor

ACTION REQUEST RESPONSE

To: Utah Public Service Commission

From: Utah Division of Public Utilities

Chris Parker, Director

Artie Powell, Energy Section Manager

Justin Christensen Utility Analyst

Sam Liu, Utility Analyst

Date: May 28, 2015

Re: **Recommendation – Acknowledgement, RMP Fossil Fuel Energy Efficiency Standard Plan for 2015**

Docket No. 15-035-49 (06-999-03), Rocky Mountain Power's Fossil Fuel Heat Rate Improvement Plan - The Division's Review and Recommendation - Acknowledgement.

RECOMMENDATION

The Division of Public Utilities (Division) has reviewed this filing for the 2015 Rocky Mountain Power Fossil Fuel Heat Rate Improvement Plan (HRIP) and concludes that it complies with the intent of the Public Service Commission of Utah (Commission). The Division recommends that the Commission acknowledge Rocky Mountain Power's 2015 HRIP.

ISSUE

On August 10, 2007, the Commission issued its Determination Concerning the PURPA Fossil Fuel Generation Efficiency Standard and adopted the PURPA Fossil Fuel Generation Efficiency Standard with a filing due date of March 31 each year. On November 25, 2010, the Commission modified the filing schedule to May 1 each year. In Commission Order dated September 3, 2014 in Docket No. 14-035-56, Rocky Mountain Power (Company) was to convene a meeting with Commission staff and interested parties by February 1, 2015, to receive further input on the plan. According to our knowledge, this meeting did not take place.

On April 29, 2015, in accordance with Commission order, the Company filed its Fossil Fuel Energy Efficiency Standard Plan or Heat Rate Improvement Plan. On April 30, 2015, the Commission issued a Notice of Filing and Comment Period, with comments due on or before May 29, 2015 and reply comments may be submitted on or before June 16, 2015. This memorandum represents the Division's response to the Commission's Notice of Filing.

DISCUSSION

For the HRIP 2015 report, the Company has developed its plan, which is intended to provide more useful information focused on key heat rate improvement initiatives. The 2015 plan includes Company owned and operated combined cycle gas plants.

Fossil fuel generation fleet efficiency can be improved by following three main activities;

1- Maintaining an emphasis on the continuous improvement of existing generating fleet efficiency.
2- Adding new fossil fuel generation with improved efficiency.
3- Retiring old and less efficient fossil units.

Power Plant Cycles

1. **The Steam-Water (Rankine) Cycle**

   A conventional power plant utilizing the Rankine cycle consists of the following systems: boiler, turbine, cooling, and condensate/feedwater. The goal of combustion is to get as much heat transfer to the boiler, minimizing heat losses. These heat losses can occur through flue gas, incomplete combustion (unburned carbon) and radiation. On the turbine side the goal is to maximize the amount of energy being pulled from the steam while minimizing the use of auxiliary power and other losses, such as leaks, missing insulation, etc.

2. **The Combustion Turbine (Brayton) Cycle**
   The basic combustion turbine consists of a compressor, a combustion section, and a turbine section. Air is drawn into the compressor which raises the air pressure by a factor of 12 to 18:1. The temperature of the air also increases with compression, and may be as high as 600F (316°C) at the compressor discharge.
3. **The Combined Cycle**
   Combined cycle refers to a power plant in which a combustion turbine is integrated with a Rankine Cycle. The Rankine Cycle makes use of much of the heat in the combustion turbine exhaust gases. Thermodynamically, the combined cycle can be represented by joining the high temperature Brayton cycle with the moderate pressure and temperature Rankine Cycle.

Factors Effecting Optimum Heat Rate:

1. **System efficiency losses due to equipment degradation:**
   Turbine: Deposition, Solid Particle Erosion, Mechanical Damage, Internal Seal Leakage, Cycle Isolation, and Non-Recoverable Losses.
   Boiler: Dry Gas Losses, Excess Air, Fuel Properties, Air Heater Seal Leakage, Boiler Tube Surface Fouling, and Casing Leakage.
   Condenser: Condenser Pressure, Cooling Water Inlet Temperature, Heat Load, Circulating Water Flow, Tube Fouling and Air-in Leakage.
   Feedwater Heaters: Feedwater Heater Out of Service.

2. **Controllable Losses:**
   Main Steam Pressure and **Main Steam Temperature:** Main steam temperature is one of the most important of the operator controllable parameters relating to heat rate.
   Hot Reheat Temperature: As with main steam temperature, a higher temperature yields higher steam enthalpy and more energy available to the turbine.

Reheat and Superheat Spray Flows: Reheat and superheat spray flows have different effects on unit performance, both increase heat rate and unit output.

Excess Air: The additional amount of air will carry the part of combustion heat to increase the exit gas temperature. Maintaining the proper exit gas temperature is a balancing act.

Condenser Pressure: A decrease in condenser pressure improves turbine efficiency and output.

Final Feedwater Temperature: Lower feedwater temperature to the economizer requires additional fuel to raise the water in the boiler to the saturation point.

Auxiliary Steam Flow: Auxiliary steam flow from a lower pressure location in the turbine train is typically more efficient than extraction from the boiler area because power is provided in the high pressure turbine section while reducing the pressure to the required steam supply conditions.

Auxiliary Power: Auxiliary power affects the amount of electricity that is available at the switchyard for sale.

3. **Dispatch:**

   The figure of Typical Heat Rate vs Load Curve, on page 12 of 32, shows heat rate normally increases with lower loads.[1] If a unit is dispatched to a lower load due to any system condition, then unit efficiency will decrease.

Heat Rate Management Process:

Heat rate or thermal efficiency of the thermal generating units is affected by many factors including fuel quality, unit original design, load profile, unit operation, unit maintenance, weather, system conditions, and economics. The overall objective of heat rate management is to maintain the best possible unit heat rates given changing factors.

[1] A lower heat rate is more efficient than a higher heat rate.

The Company's heat rate management and improvement is based on the following key principles and concepts:

1. An emphasis on operating as near optimum efficiency as practical given fuel quality and maintenance schedules. Control software has been installed to help operators assess the efficiency impact of sub optimal operation on a real time basis.
2. Units that are not dispatched at maximum output should always be operated in a manner that results in the lowest heat rate.
3. The load profile of each unit is dictated by the economic dispatch of the generating units to meet the system load.
4. Unit and equipment performance is monitored on a continuous basis where practical.
5. Design upgrades to existing units when they become available through improved technology. Economically justified improvements are incorporated into the capital budget and unit overhaul plans.
6. Consistent heat rate reporting is essential for budgeting and regulatory requirements and is coordinated at the corporate level.
7. Good feedback on the unit heat rate and equipment performance is essential for plant personnel to control and manage heat rate.
8. Unit heat rate will tend to become optimized as plant personnel increase their knowledge of equipment performance and testing.

The discussion of heat rate management in the HRIP is primarily from a coal plant perspective, if there are specific problems and mitigation measures for the CCCTs, the Division requests that those are included in future reports.

Maintenance Overhaul

The efficiency of generating units, primarily measured by the heat rate degrades gradually as components wear over time. During operation, controllable processes are adjusted to optimize the unit's power output compared to its heat input. Turbine, boiler and balance of plant improvements contribute to improved efficiency and increased availability, and are included during planned overhauls. The Division requests that future plans include expanded discussion of the controllable parameters referenced on page 11 of the report under Heat Rate Management and Improvement.

Heat Rate Index

The Commission's Order, dated July 11, 2013, directed the Company to provide the calculations of the "Heat Rate Index." As shown in the report, the Heat Rate Index is the ratio of the actual measured Heat Rate divided by the designer's calculated Heat Rate (adjusted for deviations from design boundary conditions).

In the HRIP a heat rate index is calculated for each power generation unit by measuring the actual total fuel energy burned during the period (BTU) and dividing this by total net product output for the period (kWh). The resulting value is then divided by the design heat rate adjusted for the external boundary conditions such as the ambient air temperature, pressure, ambient relative humidity, fuel temperature, and fuel constitutes. This section also provides an explanation of the major factors causing the deviation between the design and actual efficiency of its thermal resources.

This 2015 HRIP report includes a summary of the 2014 FERC Form 1 data and 10 year summary data (2004 ~ 2014). The Table and two charts on page 24 of 29 represent both 10 year historical and 10 year forecast heat rates for each of the PacifiCorp owned and operated plants.

Conclusion

The Division has reviewed this filing for the 2015 Rocky Mountain HRIP and concludes that it complies with the intent of the Commission. The Division recommends the Commission to direct the Company to set up a meeting with interested parties for an expanded discussion of items listed in the 14-035-56 order. The Division recommends that the Commission acknowledge Rocky Mountain Power's 2015 HRIP.

CC Bob Lively, Rocky Mountain Power
Michele Beck, Office of Consumer Services