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October 28, 2011

Pennsylvania Public Utility Commission
Attention: Secretary
P.O. Box 3265
Harrisburg, PA 17105-3265.

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SECRETARY'S BUREAU

RE: **Docket Number M-00051865**

On behalf of the Pennsylvania Ski Area Association (PSAA), we propose the attached **Snowmaking Addition** to the **PUC TRM Annual Update Tentative Order, dated September 22, 2011, Docket Number M-00051865.**

Please contact me with any questions or concerns.

Sincerely,

Phil Philip K. Jones

Philip K. Jones
Vice President, Green Business Solutions

2011 OCT 31 AM 11:42
PA.P.U.C.
SECRETARY'S BUREAU

cc- Ms. Barbara T. Green, President, PSAA
Ms. Linda Irvin, Executive Director, PSAA

Attach.: Proposed addition to the TRM Annual Update Tentative Order, dated September 22, 2011
Snowmaking Measure Supporting Information

Reference: Docket Number M-00051865
Proposed addition to the TRM Annual Update Tentative Order, dated September 22, 2011

Snowmaking

Description

Measures that reduce snowmaking energy requirements. This measure applies to new construction, equipment replacement and retrofits.

Snowmaking is an industrial process in which water is converted to snow by injecting droplets of water into a stream of flowing air. The end-product, acre-feet of snow, is directly proportional to the water usage. Efficient snow guns use less compressed air than conventional models, resulting in electric savings at the air compressor motors.

Due to the diversity of the equipment employed to make snow at a particular site, the protocol to measure the electric savings is site-specific. However, it can be determined from compressor nameplate and operating data, final stage water pumping flow data and unit testing of snowmaking conversion equipment using the algorithm below.

The savings can be verified using the snowmaking unit testing, seasonal water pump flow data, compressor hours and correlation of the compressor plant with electric meter data.

Algorithms

Energy Savings

$kWh_{savings}$ =	$(kW_{base} - (GPM_{post}/GPM_{base}) \times kW_{post}) \times CHr_{max} \times C_{df} \times P_{df}$
kW	CFM x kW/CFM or kW for snow fans that do not use central compressor for compressed air supply
kW/CFM	Total compressor plant horsepower converted to kW divided by total compressed air output of plant from verified nameplate information
GPM_{post}/GPM_{base}	Factor to normalize any differences between base production water conversion rate and post-installation conversion rate for population of guns being replaced or upgraded in order to comparing like-production levels
CHr_{max}	Compressor hours for most used compressor, which forms the maximum snowmaking production window supported by the compressor plant
C_{df}	Compressor Duty Factor, which is the sum of all compressor hours divided by CHr_{max}
P_{df}	Pumping Station Duty Factor, which is the total seasonal snowmaking water Flow divided by the sum of all final stage water pumping capacity

Demand Savings

N/A Snowmaking does not reduce the summer peak demand

Persistence

The persistence factor is assumed to be one.

Installed Cost

Site specific.

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Operation and Maintenance Savings

N/A

Lifetime

15 years

RE: Docket Number M-00051865
Snowmaking Measure Supporting Information

Supporting Information

Background

There are at least 22 ski areas as well as other recreation businesses that manufacture snow in Pennsylvania for on-site use. Ski Areas generate about $300M in annual revenue in the state of Pennsylvania.

Ski areas rely almost exclusively on snow that is made at the ski area because natural snow is not available in significant quantities. Snowmaking across the state consumes more than 75 million kilowatt hours with a maximum demand of 175 Megawatts.

The devices that manufacture snow have evolved significantly, resulting in efficiencies for new equipment that save 75% or more of the compressed air energy needed to make snow. If all ski areas could upgrade their equipment, they could save the Commonwealth more than 50 million kWh per year.

Snowmaking is an industrial process in which water is converted to snow by injecting droplets of water into a stream of flowing air. The end-product, acre-feet of snow, is directly proportional to the water usage, approximately 180,000 gallons/acre-feet of snow. Efficient snow guns use less compressed air than conventional models, resulting in electric savings at the air compressor motors.

Due to the diversity of the equipment employed to make snow at a particular site, the protocol to measure the electric savings is site-specific. However, the energy savings can be determined using the proposed algorithm

The savings can be verified using snowmaking unit testing, seasonal water pump flow data, compressor hours and correlation of the compressor plant with electric meter data.

The methods for savings calculations and for measurement and verification were adapted from methods developed in Vermont to meet their savings standards, as indicated in the Vermont TRM User Manual No. 2009-54. pp. 219-20. Snowmaking energy savings are also accepted energy savings in New York and other states.

Snowmaking Processes

Snowmaking consists of providing the two raw materials, chilled compressed air and chilled water, to snowmaking units placed or installed on the ski slopes. Currently most snowmaking units are installed at regular intervals on each ski trail. The snowmaking units combine the compressed air and water to make snow at about the point of release from the unit. The units are known as snow guns. A ski areas may have 50 to 2000 snowmaking guns.

The snow guns are connected to one or more central compressor plants through a common air distribution piping system. The snow guns are connected to water pumps through a separate common water pumping distribution system. Each compressor plant consists of one or more compressors. Each compressor is typically in the 500 to 1500 horsepower range. Water pumps are typically in the 50 to 200 gpm range.

One type of snow gun does not require externally supplied air. It is equipped with its own compressor on-board. The energy use for this type of compressor simply does not need to have CFM converted to kW. The kW can be measured directly and compared with the CFM converted to kW by the snow guns that use the central compressor.

Assumptions

1. The central compressor plant consists of one or more compressors operating simultaneously that share a common air distribution system. Compressor plants include compressor cooling and discharge air cooling equipment.
2. Since the snowmaking equipment generates snow continuously through open nozzles, other than the initial charging of the lines involves the continuous flow of air, and therefore, continuously loads the compressors. Further, snow guns are activated to use all the compressed air available (until the pressure drops to level insufficient to make snow). Therefore, the duty cycle can be assumed to be essentially 100%.
3. Typically all air compressors are operated to maximize snow production while the weather conditions support snowmaking. However, individual compressor meters and/or logs provide the data to calculate an overall compressor plant duty factor, which is used when establishing the compressor electric consumption (kWh).
4. All compressors used in the baseline case are used in the post-installation except where the compressor is part of the energy saving measure. In this case, the difference in electric consumption is treated as an independent variable and subtracted from the snow gun electric savings determination.
5. Variations in snowmaking conditions will impact the amount of energy each snow gun uses. However, from an energy comparison perspective, the variations are partially mitigated by all guns having similar water and air consumption trends relative to the snowmaking conditions. The ski area has been operating since 1978 and has a good perspective on weather conditions throughout each season over many seasons. While one year may be a weather anomaly, over the operating life of the system (15+ years), the typical conditions used in the calculation will normalize.
6. The standard water content per acre-ft of snow is 180,000 gallons of water for good snow quality. The water content varies in different parts of the country, but is the accepted standard for ski areas in the eastern U.S. Since the comparisons in the energy saving calculations are based on like snow quality and water pumping energy is a constant between the base and proposed cases, calculations are not sensitive to differences in this constant.

Measurement & Verification

The site-specific Measurement & Verification (M&V) Plan is established using a range of available measurement systems in place supplemented by additional field data collection. The objective of the M&V Plan is to verify the claimed savings according to the savings equation below:

Savings Equation:

$kWh_{savings}$ =	$(kW_{base} - (GPM_{post}/GPM_{base}) \times kW_{post}) \times CHr_{max} \times C_{df} \times P_{df}$
kW	CFM x kW/CFM or kW for snow fans that do not use central compressor for compressed air supply
kW/CFM	Total compressor plant horsepower converted to kW divided by total compressed air output of plant from verified nameplate information
GPM_{post}/GPM_{base}	Factor to normalize any differences between base production water conversion rate and post-installation conversion rate for population of guns being replaced or upgraded in order to comparing like-production levels
CHr_{max}	Compressor hours for most used compressor, which forms the maximum snowmaking production window supported by the compressor plant
C_{df}	Compressor Duty Factor, which is the sum of all compressor hours divided by CHr_{max}

P_{df} Pumping Station Duty Factor, which is the total seasonal snowmaking water Flow divided by the sum of all final stage water pumping capacity

This measurement and verification process is consistent with the methodology used by Efficiency Vermont in its successful submissions for snowmaking energy saving to the Vermont Public Service Board. In their process, they look at

1. The compressor operating hours by compressor (nameplate)
2. How many gallons of water are run though the old versus new snow guns
3. Temperature profile for ski area by determining hours in each temperature range (6 bins)
4. Air total for the season from compressors (1 above).
5. Upgrade classification as market opportunity or retrofit

The meters and test setup for snowmaking tests used are the same as those used for comparison testing of snowmaking equipment energy efficiency by Efficiency Vermont

Determining Compressed Air Electric Demand (kW/CFM)

The compressor plant demand (kW) will be determined from direct measurement, metering, analysis or a combination of one or more methods. Direct measurement consists of appropriate kW or Amp meters that establish the power draw under full production conditions. Alternatively, the demand can be determined from appropriate metering of the compressor plant in isolation or by means where other loads on the meter are sufficiently incidental and can be appropriately quantified.

Compressed air output is determined from compressor nameplate data verified by in-situ rise and surge tests, such as those done as part of compressor servicing.

Ski Areas generally do not use Variable Frequency Drive (VFD) compressors. Use of VFD drives can alter the validity of the compressor plant demand assumptions, requiring either direct measure over multiple production shifts to establish a use pattern and/or use production logging of the VFD compressor(s) hours and demand level.

Determining Water Conversion

Tracking the water converted is critical to establishing the production output from which the energy saving can be established. Ski Areas typically track water use in snowmaking using flow meters located after the pumping station in the main trunk to the water distribution system for the snow guns. Total seasonal flow is required. Meters used in the determination are verified by annual calibration.

Determining Snowmaking Equipment Efficiency

The efficiency of the snowmaking guns will be determined from spot measurement or short term monitoring of the snowmaking equipment. Spot measurement is defined as an instantaneous reading taken when the system being measured is in a steady state condition. Short term monitoring is defined as a series of measurements taken over a period of approximately one hour to capture any short term cycling that may occur in the process. Variables requiring spot measurement and/or monitoring are described in Table 1. below.

Most ski areas have acquired snowmaking equipment over a long history. Due to the high capital costs, snowmaking equipment is typically upgraded on a trail by trail basis, rather than the full ski area in a single investment. As a result, the ski area has a mix of equipment and the upgrade consists of a change in the snowmaking equipment mix. This approach provides a benefit to the M&V by continuing to have examples of both the replacement equipment and base equipment available both before and after the upgrade.

RE: Docket Number M-00051865
Snowmaking Measure Supporting Information

Snow Gun air flow can be established using an average of the snow gun tests conducted for different wet bulb temperature (Twb) bins so long as the bins are representative and balanced across the pre-season and in-season Twb for the ski area. Alternatively, the Twb bins can be quantified for a complete pre-season and in-season and the performance to establish a weighted average for the seasonal characteristics. Weighted averages must be substantiated.

Snow Production Test

Test Design

The objective of the snow gun comparison is to measure and verify snowmaking gun performance for the base versus upgrade cases. Each type of snow gun has characteristics relative to how much water (dependent variable which defines its snowmaking output) it processes versus how much compressed air (dependent variable which defines its relative energy efficiency) it requires to make snow for a given wet bulb temperature (independent variable). The water (snow) output versus air requirement can be expressed as an energy efficiency ratio.

Measuring the energy saved from the snowmaking upgrade requires measurement of four parameters:

- Wet Bulb Temperature, which is the independent variable affecting snowmaking performance
- Water converted to snow, which establishes the production volume of snow produced
- Compressed Air Supply, which defines the variable energy, or relative efficiency, of most snowmaking equipment
- Electric current for particular relatively new type of snowmaking equipment that has the compressed air created locally at the snow gun rather than from an external source separate from the snow gun.

For the measurement and verification, each base snow gun type and each energy efficient upgrade snow gun type were measured making snow. The following parameters were measured (as listed in Table 1.1, below):

Table 1. Measured snowmaking variables

Variable	Relevance
Compressed Air Flow	Proportional to electric consumption for the same air supply system
Water Flow	Snowmaking output
Ambient Temperature	Used to calculate Wet Bulb Temperature along with Relative Humidity
Relative Humidity	Used to calculate Wet Bulb Temperature along with Air Temperature
Current	Electric current draw for snow fans that are powered by electric rather than compressed air
Compressed Air Temperature	Control to ensure valid comparison*
Water Temperature	Control to ensure valid comparison*
Air Pressure	Control to ensure valid comparison*
Water Pressure	Control to ensure valid comparison

* Due to snowmaking weather conditions, these measuring devices are subject to freeze-up. Alternative measurement of these variables should be acceptable.

COMMONWEALTH OF PENNSYLVANIA
PENNSYLVANIA PUBLIC UTILITY COMMISSION
P.O. BOX 3265, HARRISBURG, PA 17105-3265

November 9, 2011

IN REPLY PLEASE
REFER TO OUR FILE NUMBER
M-00051865

PHILIP K JONES
EMS ENVIRONMENTAL INC
4550 BATH PIKE
BETHLEHEM PA

Dear Mr. Jones:

We are returning your comments, dated October 28, 2011 and November 7, 2011, to you because an original signature is required to process your comments. An original signature is required pursuant to 52 PA Code 1.35. Please fill in the information requested and return to the address listed at the top of this letter.

Once we receive the comments with the information required we will be able to process your comments. Thank you for your cooperation in this matter.

Very truly yours,

Rosemary Chiavetta

Rosemary Chiavetta
Secretary

Enclosures
RC: wjz

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