Disposition for Workpaper PGECOHVC174: Multiple Speed Unitary Air-Cooled Commercial Air Conditioners and Heat Pumps >= 65 kBtu/h

California Public Utilities Commission, Energy Division

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Contents

1 Review Scope

This disposition provides a technical review of a single workpaper and related submitted documents listed below.

Workpaper ID	Rev	Workpaper Title	Submittal Details	Official Submittal Date
PGECOHVC174	0	Multiple Speed Unitary Air-Cooled Commercial Air Conditioners and Heat Pumps >=65 kBtu/h	Revised workpaper plan	11/15/2017
PGECOHVC174	0	Multiple Speed Unitary Air-Cooled Commercial Air Conditioners and Heat Pumps >=65 kBtu/h	Workpaper document and impacts tables	10/16/2017
PGECOHVC174	0	Multiple Speed Unitary Air-Cooled Commercial Air Conditioners and Heat Pumps >=65 kBtu/h	Additional model details and sample of model input and output files	12/14/2017

2 Detailed Review

2.1 Workpaper Scope

The submitted workpaper proposes a group of measures defined by capacity range, unit energy efficiency ratio (EER) and integrated energy efficiency ratio (IEER). EER and IEER, in each capacity range, is the same information that defines the existing DEER packaged HVAC efficiency measures. The proposed parameters for the workpaper measures overlap those same parameter values in the current adopted DEER measures, thus the workpaper proposes to replace existing DEER measures with new values derived from different baselines and calculations. Direct replacement of DEER measures is not allowed in workpapers. Proposed new measures must utilize the DEER modeling methods and assumptions for the baseline and the development of measure assumptions must follow DEER methods to ensure compatible results.

The workpaper update plan[1] described the scope of the workpaper to be limited to units that exceed the part load efficiency of existing DEER measures and are not represented by the current DEER models. The workpaper plan indicated that new measures would be evaluated for equipment that include technology enhancements or additions such as multiple compressor stages or variable speed compressors and/or condenser fans. To obtain approval of this workpaper and the proposed equipment measures and values the original intent must be followed.

[1] WPP Unitary Large High IEER (w 135-239kBtuh Example) v4 20171114 - For PGE.docx

The workbook[2] accompanying this disposition includes details of the workpaper proposed equipment models, sample simulation results from the models provided in the workpaper supporting documents as well as some of the relevant DEET baseline and tier efficiency values.

2.2 Performance Map Sample Size and Analysis

The submitted workpaper tier level definitions appear to be based on only one equipment model, and all equipment is from a single manufacturer. Such a limited investigation of the market and performance of equipment is not consistent with the DEER methodology for establishing typical equipment performance representation and is not acceptable. The workpaper plan stated that simulations would be performed on units from multiple manufacturers for each tier level. As was communicated to PG&E staff and workpaper consultants in the past, as well is in initial discussions during the planning for this workpaper project, the full range of "enhanced" equipment offerings in the market must be cataloged, performance maps developed, and energy savings estimated for each in order to select a typical expected performance for a given set of equipment characteristics. This is critical to ensure that the equipment selected to represent typical performance will provide typical savings values to represent the expected program participation and does not under- or over-estimate savings for most systems available in the market that will be eligible for incentive support and savings claims.

If a given measure tier is proposed to be applicable to more than one technology (e.g. multiple speed compressors and variable speed compressors), then several samples of each technology need to be evaluated to ensure that the proposed measure performance is typical of the range of performance available in the market for those same technologies. Additionally, the eligibility criteria must be clearly stated in terms of the equipment features not simply an EER and/or IEER rating value that may not ensure any equipment enhancements that would justify use of non-DEER values.

For perspective, Table 1 below lists the number of complete performance maps that were developed as the basis for the existing DEER packaged HVAC efficiency measures. For each row in Table 1 a single equipment model was selected to be the basis for the DEER measure in that category. This selection was based on set of simulations that encompassed all equipment models, sixteen climate zones and two building types (small office and large retail). Each simulation used performance curves from a specific equipment model, but other performance parameters (such as equipment efficiency and fan power) were input as averages across all samples in the group. The equipment model with simulation results that were closest to the average simulation result was selected as the source for performance curves for that group.

This, and any other similar workpaper development effort needs to follow a similar process to ensure that the selected performance map is representative of equipment in the market. An updated plan for the workpaper shall be submitted address the issues raised in this disposition including with a list of equipment models that will be evaluated and descriptions of the high performance technologies employed by each unit.

[2] PGECOHVC174_DispositionDataReview_2018-02-23.xlsx

Table 1 Performance Map Samples for DEER Large Packaged HVAC Measures

Size, Tons	Fan Control	Equipment Models	Manufacturers
6 to 11	2 Speed	28	5
12 to 19	2 speed	21	5
20 to 65	2 speed	29	4
20 to 65	VAV	24	3

2.3 Model Parameters vs. Measure Definition

In some of the measure tiers included in the submitted workpaper, the as-modeled efficiency was greater than the efficiency specified for the measure. For example, the Tier 1 measure for 65 to 134 kBtu/hr equipment is listed as 12.0 EER in the measure description, but the model was simulated with an efficiency of 12.2 EER. The as-modeled efficiency must match the value specified in the measure.

2.4 Indoor Fan Power and Air Flow

In the development of the DEER large packaged HVAC measures, evaluation of rated indoor fan power for each equipment category in Table 1 led to the conclusion that there was not a significant relationship between rated fan power and unit efficiency. Fan power, in a specific installation, is also a parameter that will vary based on the design specified external static pressure; this requirement will lead to alternative product model selections other than the specific unit or model that was used in the AHRI rating. For these reasons, rated fan power is held constant across measure tiers for a given equipment category while fan controls and part load performance is allowed to vary. In the submitted workpaper, rated indoor fan power varies significantly between tiers. Fan power shall be held constant within a given equipment size category unless data can be provided to demonstrate that specific technologies in a measure result in lower (or higher) fan power than the baseline equipment and that variation would typically be seen in field installation with the same design criteria or equipment purchase specification based performance requirements.

Design air flow for each measure level was not listed in the submitted documentation. Design air flow is dependent on space loads, which would not change with HVAC measure technologies. Thus, design air flow (e.g. cfm/ton) must be held constant across measure tiers, and this needs to be documented in the workpaper submittal.

2.5 Electric Input Ratio Calculation

The electric input ratio (EIR) for the equipment is calculated by removing the effects of indoor and outdoor fan power from the total unit efficiency. The EIR values used for the workpaper models were included in the submitted data, but the calculations behind these values were not submitted. Since unit EIR has a first order effect on measure savings, it is important that the calculation be done correctly and that it be documented. A description of the correct calculation of unit EIR is as follows:

$$CoolEIR = \frac{(TotUnitW - TotFanW) * 3.413}{GrossCap} = \left[\frac{3.413 * (1 - ID\_FanEIR)}{EER} - ID\_FanEIR - OD\_FanEIR\right]$$

Where:

TotUnitW = total rated power consumption of the unit, including all fans

TotFanW = total rated power consumption of indoor and outdoor fans

GrossCap = total rated capacity in Btu/hr of indoor coil, not adjusted for fan heat
(i.e. GrossCap = NetRatedCap + (ID_FanKW * 3.413))

ID_FanEIR = total rated power consumption of indoor fan (W) * 3.413 / GrossCap

OD_FanEIR = total rated power consumption of outdoor fan (W) * 3.413 / GrossCap

EER = rated energy efficiency ratio of the unit

2.6 Outdoor Fan Rated Power

Outdoor fan power entered into the DOE2 model must be provided in units of Watts per unit of gross rated capacity. Submitted files shall demonstrate that this is calculated correctly.

2.7 Cycling Loss

Cycling loss is a system inefficiency that occurs due to cycling of the compressor at part load conditions. Cycling loss occurs whenever *any* compressor is cycling. Thus, when a system has one compressor operating continuously and a second compressor cycling (stage 2 operation), the cycling compressor will experience cycling loss. In the DEER performance maps, cycling loss during stage 2 operation is embedded into the EIR-fPLR curves. This stage 2 cycling loss appears to be neglected in the workpaper performance curves, which show a 1:1 or better relationship between EIR and PLR.

Data submitted for the workpaper need to show the intermediate calculations in which cycling loss is incorporated into the curves.

2.8 Coil Bypass Factor

Values for coil bypass factor vary widely in the submitted run parameters file. Bypass factor can be calculated from AHRI total and sensible cooling capacities and rated conditions. Submitted data needs to show these calculations for each equipment model, and the model input value shall be calculated as an average of the models in an equipment category (as per DEER) unless market analysis indicates certain features result in significantly different values.

2.9 Performance Curves

Since some curves do not follow expected trends (EIR-fPLR and BF-fT), the integrity of the curve development requires detailed review and verification which is not possible as the source data from which the curves were developed was not supplied. Thus, raw data must be submitted along with intermediate calculations for all performance curves. The source of the raw data must also be identified; for example, AHRI lab testing, manufacturers modeling that extends or extrapolates AHRI lab test data, or other methods. It is expected that the data will have been confirmed via lab testing.

2.10 Basis for Packaged Variable Volume (VAV) Systems

The Manufact.xls file that was submitted with performance data did not include columns for the packaged VAV systems. Data must be submitted for those measures. It is not acceptable to model

packaged VAV systems using packaged single zone performance maps since DX condensing unit performance is typically strongly influenced by airflow rates across DX coils.

2.11 Hot Gas Bypass vs. Cycling Control

Hot gas bypass is sometimes used in variable air volume (VAV) systems in lieu of cycling at low loads to enable more stable operation. Submitted documentation of the individual systems evaluated shall indicate whether the units were intended to operate with hot gas bypass or with cycling, and the simulations must incorporate the correct control method.

2.12 Indoor Fan Minimum Speed

The workpaper analysis used minimum air flow values that are significantly lower than the DEER baselines and measures. Submitted documentation shall provide documentation for assumptions of minimum air flow for multispeed systems: i.e. list of manufacturer/model numbers and the air flow at each speed level.