



## Usage of the AirCare Plus Database to Inform RTU Fault Distributions for the PG&E Quality Maintenance Work Paper

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### Introduction and Rationale:

The AirCare Plus Program is a tune-up program for rooftop units that has been active in PG&E's service territory since 2006. Since 2006 approximately 44,000 RTUs have been serviced in the program. Technicians use a PDA to record as found conditions, treatments performed, and as left conditions. Fault remediation activities that were tracked in ACP resulting in energy savings in the program include:

#### Thermostat and Scheduling:

- Non-programmable thermostat replaced with programmable thermostat
- Thermostat schedule adjusted to more closely match occupied hours
- Unoccupied set points adjusted
- Unoccupied fan control changed from always on to intermittent operation

#### Economizer controls

- Repair of a non-operational economizer including linkage repairs, damper motor replacement, replacement of failed control module, replacement of failed sensors, etc.
- Replacement of inadequate changeover sensors such as snap disc outdoor air sensors
- Adjustment of adjustable changeover sensors to optimum setting with wiring updated to allow for alternating integration if needed

#### Refrigeration system and airflow adjustments

- Filter change, evaporator cleaning, fan cleaning and debris removal, belt drive maintenance, or fan speed adjustments resulting in increased airflow
- Refrigerant removal if overcharged
- Refrigerant addition if undercharged
- Other faults were optionally and sometimes noted but data is not consistent

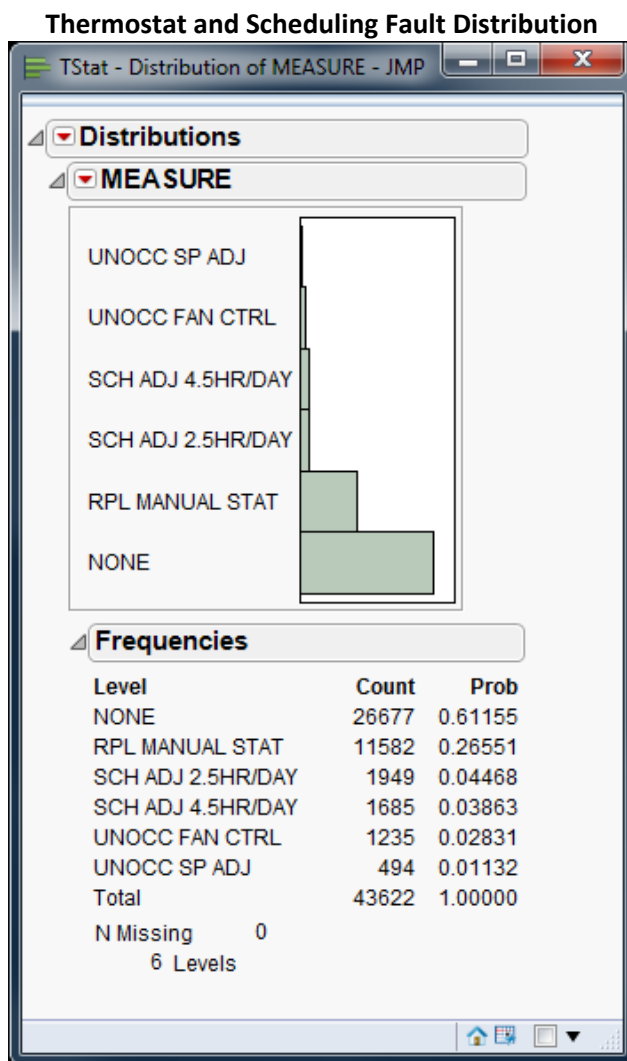
In the ACP program fixing as found faults or deficiencies is strongly encouraged and incented monetarily, but is not mandatory.

In the Quality Maintenance program all energy related faults are required to be fixed and documentation and or measurements that confirm repairs are also required before savings are claimed for a unit and before incentives are paid. A desk QA/QC process is performed on all units serviced and a field QA/QC process is performed on a portion of the units serviced. These processes are under continuous improvement and should be fairly robust by the end of the year with more automation and clear requirements in place.

Because of the requirement to repair faults that are found the analysis of the ACP data focuses on faults that were present in the units rather than repairs that were actually performed when possible. This is a possibility for the thermostat and scheduling measures and the economizer control measures. For measures that made corrections to airflow and refrigeration systems we don't have an indication of the faults that were found, only the repairs that were made.



The distributions that were developed based on the ACP analysis for use in the PG&E Quality Maintenance Work Paper are shown below. Beneath each image is a bulleted list outlining the general analysis methodologies used and the application of the distribution to simulated savings.

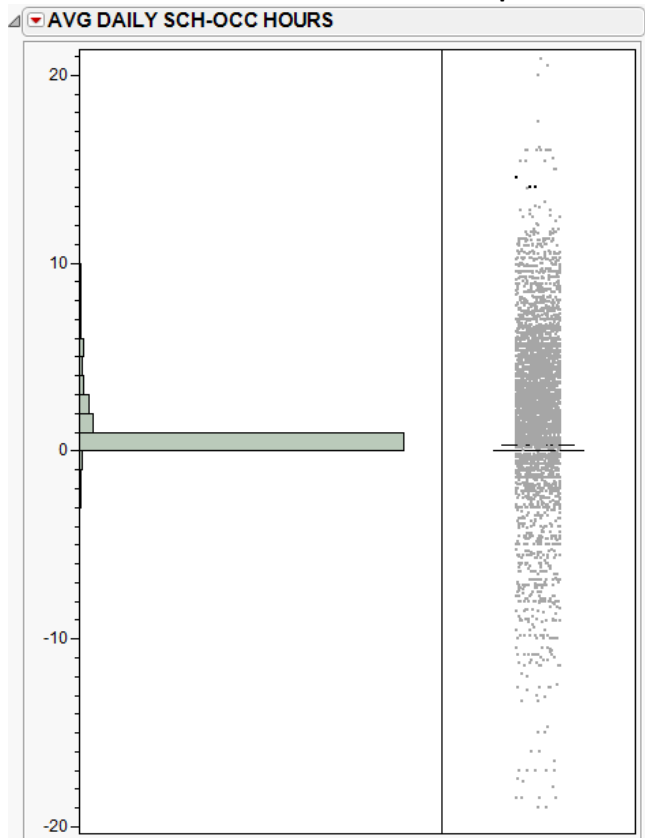


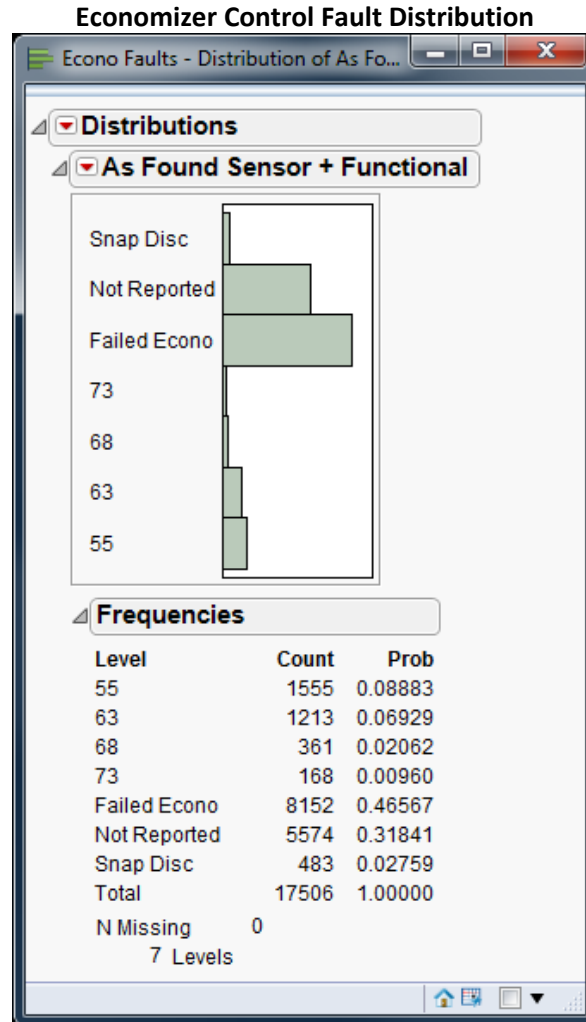
- Frequency of units with a non-programmable thermostat installed was determined using technician input for thermostat type
- Of the units with programmable thermostats or EMS units in which the fan was run continuously during the unoccupied period was determined using technician input for unoccupied fan control
- Of the units with programmable thermostats installed and intermittent fan control during the unoccupied period the distribution (distribution follows) of as found programmed occupied hours versus building occupied hours was determined and the 2.5 hour and 4.5 hour adjustment bins were chosen to bin these into measure categories for representation in simulations.
- The 2.5 hour bin is used for schedules that were >1 hour longer than occupied hours and <3 hours longer than occupied hours. The 4.5 hour bin was used for schedules that were >=3.5 hours longer than occupied hours.



- Finally, a distribution for the lowest saving measure, unoccupied setpoint adjustments, was developed. The frequency of this fault is very low and not including it in the simulation is being considered.

### Distribution of Scheduled Hours – Occupied Hours

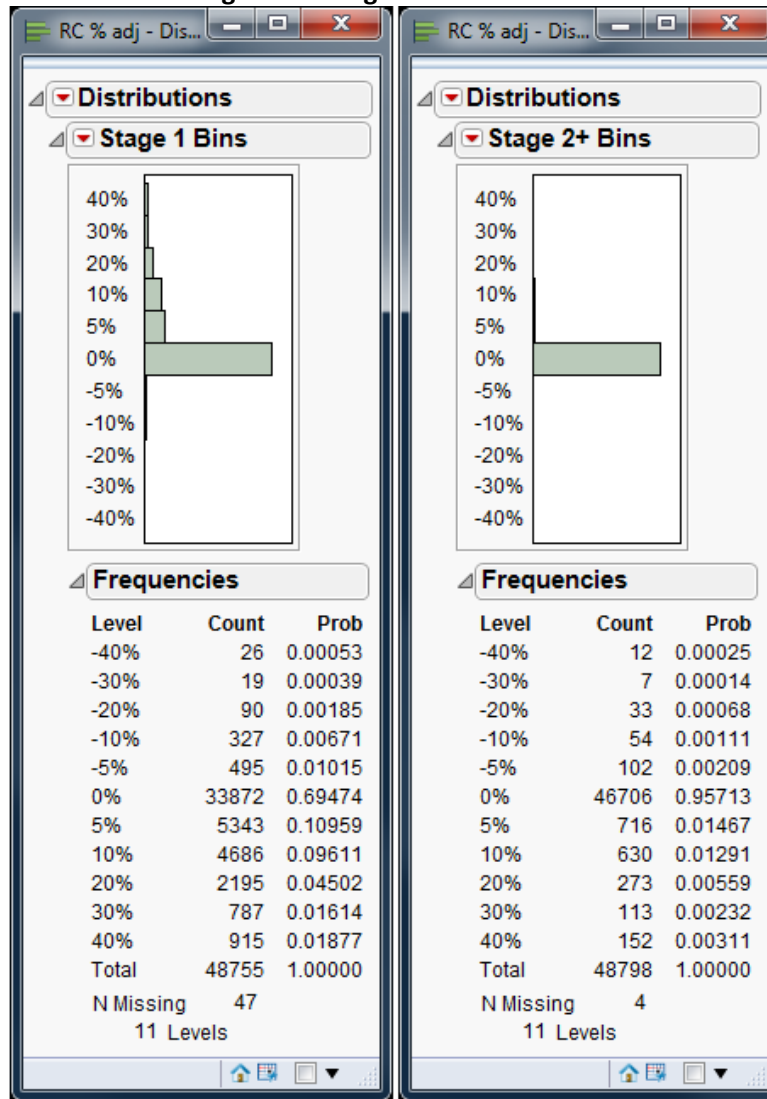




- Frequency of units with an economizer that failed the functional test was found
- For the units that passed the functional test the changeover type and set point was analyzed and bins were developed to represent each as found changeover in simulations. Bins are:
  - 55: changeover temp 50 to 59, enthalpy D setting, snapdisc
  - 63: changeover temp 60 to 66, enthalpy CD and C setting
  - 68: changeover temp 67 to 69, enthalpy BC and B setting
  - 73: changeover temp 70 and higher, enthalpy A setting



### Refrigerant Charge Fault Distributions



- For RCA we are using charge adjustment as a percentage of nominal charge for simulations. Our simulations are based on the Mowris data and are very similar to the DEER simulations. The WP will, of course, have more discussion on that
- In ACP techs did not enter the nominal factory charge weight, just the weight added or removed
- To estimate nominal charge the charge weight was looked up for several of the most frequently encountered units in the program
- Models for which we determined actual charged were matched with their actual charge
- For other models we assumed the average oz/ton from the models that we looked up
- % charge adjustment was determined by oz added or removed/actual or estimated nominal charge oz
- Bins were constructed as follows:



Simulated Adjustment	Bin Range
40%	35% to 100%
30%	25% to 35%
20%	15% to 25%
10%	7.5% to 15%
5%	0% to 7.5%
0%	No Adjustment
-5%	0% to -7.5%
-10%	-7.5% to 15%
-20%	-15% to -25%
-30%	-25% to -35%
-40%	-35% to -100%

- Adjustments were determined for each individual stage
- The adjustments were then grouped by single stage and multi stage units
- Distribution of stages shown below
- An adjustment method has been developed to adjust savings for multistage units in post processing step. Discussed in WP.

### Distribution of Number of Stages for Units Served

