

Ithaca WWTP – Database Notes

Table 1 Database Notes

Data Collection	<u>Data Logger:</u> <u>Data Collection Interval:</u> <u>Collection Method:</u>	Ithaca WWTP BMS System 1 – Minute Nightly FTP upload to CDH servers
Site Information	<u>Cogeneration Units:</u> <u>Nameplate Capacity:</u> <u>Heat Recovery Medium:</u> <u>Heat Recovery Uses:</u> <u>Excess Heat:</u>	Capstone CR-65 Microturbines (4x) 65 kW each Hot Water Digester, supplemental building heat Rejected to atmosphere using integrated bypass damper
DG/CHP Generator Electrical Output	<u>Engineering Units:</u> <u>Energy Measurement (net/gross):</u> <u>Measurement Type:</u>	kWh Gross Power Measurement – Sum of power Shark 200 power meter measurement from each microturbine. Accumulated kWh
DG/CHP Generator Electrical Output Demand	<u>Engineering Units:</u> <u>Measurement Type:</u>	kW Calculated : Sum of each units accumulated kWh/int * # intervals
DG/CHP Generator Fuel Input	<u>Engineering Units:</u> <u>Measurement type:</u>	CFH Magnetrol thermal mass flow meters with analog 4-20 mA output.
DG/CHP Useful Heat Recovery	<u>Engineering Units:</u> <u>Heat Measurement Type:</u>	- -
DG/CHP Unused Heat Recovery	<u>Engineering Units:</u> <u>Heat Measurement Type:</u>	- -
DG/CHP Status/Runtime	<u>Engineering Units:</u> <u>Measurement Type:</u>	- -

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Facility Purchased Energy	<u>Engineering Units:</u> <u>Measurement Type:</u>	- -
Facility Purchased Demand	<u>Engineering Units:</u> <u>Measurement Type:</u>	- -
Other Facility Gas Use (Flare Gas)	<u>Engineering Units:</u> <u>Measurement Type:</u>	CFH Magnetrol thermal mass flow meters with analog 4-20 mA output (sum of flare gas meter and boiler gas meter).

Table 2 Event Timeline

Date	Event
June 2, 2015	Ithaca WWTP control system begins uploading data files. Files are blank after June 3, 2015, however are still being uploaded.

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Range Checks

Table 3. Range Checks

Data Point	Units	Hourly Data Calculation Method	Database Lower Range	Database Upper Range	Notes
DG/CHP Generator Output (WG_d)	kWh/int	Sum	0	75	<i>Pulse output from 4x power meters, summed together</i>
DG/CHP Generator Output Demand (WG_KW_d)	kW	Max	0	300	<i>WG_KW_d = WG_d * # Intervals</i>
DG/CHP Generator Gas Use (FG_d)	cf/int	Sum	0	3000	
Total Facility Purchased Energy (WT_d)	kWh/int	-	-	-	
Total Facility Purchased Demand (WT_KW_d)	kW	-	-	-	
Other Facility Gas Use (FT_d)	cf/int	Sum	0	2500	
Useful Heat Recovery (QHR_d)	MBtu/int	-	-	-	
Unused Heat Recovery (QD_d)	MBtu/int	-	-	-	
Status/Runtime of DG/CHP Generator (SG_d)	hr	-	-	-	
Ambient Temperature (TAO)	°F	Avg	-20	130	<i>WUG Airport Code - ITH</i>

Notes:

1. This table contains values from *Ithaca_wwtp.csv*

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Relational Checks

Table 4. Relational Checks

Evaluated Point	Criteria	Result
WG_KW_d	FG_d > 700 and WG_KW_d < 30	DQ flag WG_KW_d = 2
WG_d	FG_d > 700 and WG_d < 30	DQ flag WG_d = 2
FG_d	FG_d < 100 and WG_KW_d > 30	DQ flag FG_d = 2

Notes:

1. This table contains values from *relational_checks.pro*

Data Quality Checks

Three types of data quality checks (DQ) are performed on the raw data collected; data existence, range checks, and relational checks. The following definitions are used when describing data quality checks for clarity:

Interval data – raw data collected from a monitoring site, typically at a short time step interval (1-minute, 5-minute, 15-minute, etc).

Hourly data – data in the DIS website database, created from manipulation of the interval data

Data existence and range checks, are performed on the interval data prior to conversion to hourly data for inclusion in the DIS database. Relational checks are performed on the hourly data.

Table 1. Data Quality Definitions

Data Quality Levels	Description	Definition
0	Data Does Not Exist	This is a placeholder for maintaining a contiguous database only.
1	Data Exists	Hourly data passes <i>data existence</i> when 75% or more interval records in an hour are present. Hourly data that do not pass <i>range</i> or <i>relational</i> checks are flagged as “ <i>data exists</i> ”
2	Passes Range Checks	Hourly data passes <i>range</i> checking when 75% or more interval data records in an hour also pass their individual range checks.
3	Passes Relational Checking	Hourly data passes <i>relational</i> checks when compared to the values of other related hourly data. Hourly data that passes relational checks also passes <i>range</i> and <i>data exists</i> tests. This is the highest quality data in the data set.

The order of DQ checking is as follows:

1. Data quality levels for interval data are set to zero.
2. For each record where interval data exists, the DQ level is changed to 1. If interval data does not exist the DQ level remains 0.
3. Only interval data values with DQ level 1 are evaluated with range checks. If an interval data value passes range checks the DQ level is changed to 3. If the interval data value does not pass range checks, then DQ level remains 1.
4. Interval data are then aggregated to hourly data using the methodology in the following section. The resulting DQ level (corresponding to the final hourly data) is set to 1 or 3 based on the percentage of data collected.
5. Finally, hourly data are checked using relational tests. Hourly data failing relational test have their DQ reduced to DQ level 2. Relational test are only performed on the hourly data to prevent excessive false positives from occurring when evaluating data of shorter time-steps.

Aggregating to Hourly Data

There are three options when aggregating the interval data into hourly data: average, sum, and max. These options determine how the hourly data are calculated from the interval data. Hourly data are defined as beginning at 0:00 and ending at 0:59 each hour. Note that aggregation to hourly data occurs prior to relational checking.

Average

- Average data are used for measurement from analog sensors (temperatures, flows), or other data resulting in a continuous data trend (calculated BTUs).
- If 75% or more of the hour's interval data points have DQ level 3:
 - Interval data with DQ level 3 are averaged into one hourly data value.
 - Interval data with DQ level 1 or lower are ignored.
 - The DQ level for the entire hour is set to DQ level 3.
- If less than 75% of the of the hour's interval data points have DQ level 3:
 - Interval data with DQ level 1 or greater are averaged into one hourly data value.
 - The DQ level for the entire hour is set to DQ level 1.
- The following is an example, using 5-minute interval data, where the 75% threshold equals nine or more passing records per hour. Records that fail the range check are highlighted in yellow.

Example: 75% of interval data passes range checks
 Low range: 0 kW
 High range: 105 kW

Time Stamp	Power (kW)	DQ Level
0:00	100	3
0:05	97	3
0:10	95	3
0:15	98	3
0:20	105	3
0:25	110	1
0:30	104	3
0:35	102	3
0:40	99	3
0:45	98	3
0:50	100	3
0:55	98	3

Average of 11 poin 99.6
 Final DQ Level 3

Example: 75% of interval data fail range checks
 Low range: 0 kW
 High range: 105 kW

Time Stamp	Power (kW)	DQ Level
0:00	104	3
0:05	107	1
0:10	110	1
0:15	115	1
0:20	108	1
0:25	104	3
0:30	102	3
0:35	100	3
0:40	99	3
0:45	100	3
0:50	101	3
0:55	100	3

Average of 12 poi 104.2
 Final DQ Level 1

Sum

- Summed data are used for measurement from sensors with discrete pulse outputs (gas pulses, kWh pulses, etc), or other data resulting in a step-wise data trend.
- Operations for summing to hourly data are similar to averaging, except the interval data are summed.
- If 75% or more of the hour's interval data points have DQ level 3:
 - Interval data with DQ level 3 are summed into one hourly data value.
 - Interval data with DQ level 1 or lower are ignored.
 - The DQ level for the entire hour is set to DQ level 3.
- If less than 75% of the of the hour's interval data points have DQ level 3:
 - Interval data with DQ level 1 or greater are averaged into one hourly data value.
 - The DQ level for the entire hour is set to DQ level 1.

Max

- Max data are used for either continuous analog or discrete pulse sensors. For discrete pulse sensors, the measured value is converted to a rate using the interval data timestamp. Max data are used to represent a single maximum measurement occurring in a one-hour time period.
- If 75% or more of the hour's interval data points have DQ level 3:
 - The maximum value of interval data with DQ level 3 is selected.
 - Interval data with DQ level 1 or lower are ignored.
 - The DQ level for the entire hour is set to DQ level 3.
- If less than 75% of the of the hour's interval data points have DQ level 3:
 - The maximum value of interval data with DQ level 1 or greater is selected.
 - The DQ level for the entire hour is set to DQ level 1.

Hourly Relational Testing

For relational testing, values in pairs of data channels are compared to gauge the overall level of relational validity. Only the aggregated hourly data are evaluated using relational testing, as the short time-step interval data may be influenced by low pulse density data for discrete measurements, or transients at startup/shutdown that would result in an excessive number of false positives. It is assumed that on the hourly time-step level, both system operation and data collection issues are sufficiently damped out to allow for reasonable relational testing.

The following shows the results of relational testing. For the first example, both natural gas consumption and power generation are present at the hourly level, and all hours pass the relational test of comparing gas consumption to periods of power production.

For the second example, the natural gas data is intermittent, resulting in both the power and natural gas data being flagged with DQ level 2 (passing range checks, but failing relational checks – highlighted in yellow). Note that zero is a valid number for the gas data channel, and is not flagged as “missing” with a DQ level 0.

Example: Hourly gas data checked against power data for relational validity. All points pass relational check.

Time Stamp	Power (kW)	Gas (CF)	Power DQ Level	Gas DQ Level
0:00	100	1330	3	3
1:00	97	1290	3	3
2:00	95	1260	3	3
3:00	98	1300	3	3
4:00	105	1390	3	3
5:00	110	1460	3	3
6:00	104	1380	3	3
7:00	102	1350	3	3
8:00	99	1310	3	3
9:00	98	1300	3	3
10:00	100	1330	3	3
11:00	98	1300	3	3

All points pass relational check

Example: Hourly gas data checked against power data for relational validity. Intermittent gas data result in failing relational check. Note that **zero** is a valid gas value, and does not get flagged as missing data.

Time Stamp	Power (kW)	Gas (CF)	Power DQ Level	Gas DQ Level
0:00	100	1330	3	3
1:00	97	1290	3	3
2:00	95	0	2	2
3:00	98	1300	3	3
4:00	105	0	2	2
5:00	110	0	2	2
6:00	104	0	2	2
7:00	102	0	2	2
8:00	99	1310	3	3
9:00	98	1300	3	3
10:00	100	1330	3	3
11:00	98	1300	3	3

All points pass relational check