# **Context**

METEC performs post processing of data sampled at 1hz to identify “events”. Events may include zero or multiple controlled releases. The location(s), flow level(s) and flow setpoint(s) of controlled releases downstream of a given flowmeter remain constant for the duration of an event. Each row entry in the event csv data file represents one controlled release at a specific emission point (denoted by EPID) during one event (denoted by EventID). Multiple controlled releases may occur simultaneously during a single event, resulting in multiple rows with the same EventID. Multiple events may occur with overlapping times, where the separate EventIDs provide information from different flowmeters for the same time period.

## **Units**

Unless otherwise noted, units provided in the output of the timeseries and in the summary files are as follows:

* Pressure: units of kPa (absolute)
* Temperature: Units of degrees Celsius
* Flow: SLPM (Standard Liters per Minute) uses the CGA standard temperature and pressure of 70° F and 1 atm.
* Wind Direction: Degrees from N, clockwise
* Wind Elevation: Degrees from horizontal. Positive indicates wind is moving upward.
* Wind Speed: m/s

# Column Headers

The column headers in this section describe the data associated with each row.

## **ExperimentID**

Unique identifier for this experiment, if any. An experiment can have any amount of events specified by EventID. For automated experiments, the format of the ID is YYYYMMDDXXX where XXX is the number of the experiment performed that day.

## **EventID**

A new EventID is defined each time the controlled release location(s) (denoted by EPID), flow level(s) (denoted by EPFlowLevel), or flow setpoint(s) (denoted by EPFlowSetpoint) downstream of a single flowmeter are changed. Once the transition from a previous event to a new event is completed the location(s), flow level(s) and flow setpoint(s) of controlled releases downstream of the flowmeter remain constant for the duration of the event. An event may include multiple controlled releases if they are occurring at the same time and both are metered by the same flowmeter. In this case, METEC may include a reference event (denoted by RefEventID) where a controlled release is metered individually at the same location under the same flow level or setpoint.

## **ActiveEPCount**

The number of unique emission points metered by the flowmeter referenced in FlowmeterID during the event.

During events with multiple active emission points (ActiveEPCount > 1) flowmeter measures the combined flowrate. The flowrate of an individual controlled release may be estimated from a reference event where the same emission point is operated at the same flow level under the same controller pressure and temperature.

During events with one active emission point (ActiveEPCount = 1) the flowrate of the individual emission point is metered directly. These events may be used as a reference event for the same emission point at the same flow level under the same controller pressure and temperature.

Events with zero active emission points (ActiveEPCount = 0) may include a nonzero flowmeter reading. This is due to the turndown limit of the thermal mass flowmeters used at METEC.

## **EPID**

Unique identifier of the emission point location at METEC.

## **EPLatitude**

Latitude of the emission location in decimal degrees using the WGS 84 reference system.

## **EPLongitude**

Longitude of the emission location in decimal degrees using the WGS 84 reference system.

## **Emission Category**

What category this emission would fall under if it were a part of an actual operating unit in the field. E.G. leak, Pre Test (for calibration/reference events), vent, etc.

## **Emission Intent**

What this specific emission is intended to represent if it were a part of an actual operating unit in the field.

## **UTCStart**

tStart in datetime format (yyyy-mm-dd\_hh:mm:ss) UTC.

## **UTCEnd**

tEnd in datetime format (yyyy-mm-dd\_hh:mm:ss) UTC.

## **Duration**

The duration of the event from tSettled to tEnd in seconds.

## **BFE, BFU, BFT**

The best flow estimate (BFE), uncertainty (BFU), and type (BFT) for this event.

“**Current Metered Event**”: With events that surpass a duration of 20 seconds (to allow for settling) and that also only contain one active emission, this is the average flow and uncertainty for this event, and is categorized as a “Current Metered Event.

“**Reference Metered Event**”: If the above criteria is not met, and the event has a reference (IE a previous metered event that matches the flow setpoint and emission point), the BFE/BFU is the RefFlowAvg/RefFlowUncertainty for that event. The BFT is “Reference Metered Event”, and more information about that event can be found by referencing the RefEventID later on that line.

“**Indeterminate Event**”: For emissions that are below the duration threshold, are a part of an event that contains multiple emissions, and that have no reference events, the BFE/BFU is blank and the BFT is an “Indeterminate Event”.

**“Zero Emission Event”**: If there are no active emissions during this event, the BFE is 0, and the uncertainty is the FlowAvg, signifying that there should be no flow from any emission points but that the meter will likely have some non-zero flow reading due to the mechanism of measurement of the meter as well as some noise with respect to the sensor data collection. The BFT is “Zero Emission Event”

## **QCFlags**

QCFlags provide warnings where further review of data associated with a particular controlled release is recommended. QCFlags are provided as a binary string representation where each digit corresponds to a specific flag. A ‘0’ in that position indicates that flag is absent, and a ‘1’ indicates that flag is active. A complete list of flags can be found below:

|  |  |  |
| --- | --- | --- |
| Digit from left | QC Title | Quality Control Meaning |
| 0 | MissingRef | No reference event available |
| 1 | PartialExp | An experiment exists for this event, but this event doesn’t fit squarely within that experiment. Likely either the event starts before the experiment ends (or vice versa), or this event overlaps multiple experiments. |
| 2 | MeterSpanMax | Metered flowrate approached or exceeded meter span during the event. By default this flag is thrown when one or more meter readings between tSettled and tEnd are greater than 90% of full span. |
| 3 | MeterSpanMin | Metered flowrate approached or exceeded meter turndown during the event. By default this flag is thrown when one or more meter readings between tSettled and tEnd are less than 10% of full span. |
| 4 | MeterFlowDft | Metered flowrate drifted during the event. By default this flag is thrown when the absolute value of the difference between the average metered flowrates during the first 10% and last 10% of the time period between tSettled and tEnd exceeds 10% of the FlowAvg. |
| 5 | CtrlrPresDev | Average absolute pressure of controller during the event, OrificeControllerPAvg, deviated from the average pressure of controller during reference event by 10% or more. |
| 6 | CtrlrTempDev | Average absolute temperature of controller during the event, OrificeControllerTAvg + 273.15, deviated from average absolute temperature of controller during reference event by 10% or more. |
| 7 | SettledMissing | tSettled not identified. Reported equal to tTransitioned. |

## **tStart**

The time, in UTC epoch (seconds after 00:00, Jan 1, 1970 UTC), at which a change in the location, flow level, or mass flow controller setpoint of controlled releases are initiated for a new event.

## **tTransitioned**

The time, in UTC epoch, at which all changes in location, flow level, or mass flow controller setpoint of all controlled releases are completed for a new event. Changes in location, flow level, or mass flow controller setpoint which occur within 5 seconds of the most recent change are considered part of the transition from the previous event to the current event.

## **tSettled**

The time, in UTC epoch, when the flow measurement is assumed to have stabilized at the new flow level. tSettled occurs after tTransitioned to account for the response time of the flow metering system. Averages and standard deviations of flowrate, temperature, and pressure data are computed for each event using 1 hz data from tSettled to tEnd.

tSettled is reported as the first time (starting at tTransitioned) at which the standard deviation of the next 30 flow measurements falls below a threshold (default of 1% of the full span of the flowmeter). If standard deviation of 30 flow measurements never falls below the threshold during the event, tSettled is reported equal to tTransitioned and QCFlags SettledMissing digit is thrown.

## **tEnd**

The time, in UTC epoch, at which a change in the location, flow level, or mass flow controller setpoint of controlled releases occurred, triggering the end of the current event and the start of the next.

## **UTCTransitioned**

tTransitioned in datetime format (yyyy-mm-dd\_hh:mm:ss) UTC.

## **UTCSettled**

tSettled in datetime format (yyyy-mm-dd\_hh:mm:ss) UTC.

## **FlowmeterID**

The unique flowmeter that controlled releases are metered on during the event. The FlowmeterID matches the column heading in the timeseries data file where the 1hz data can be found.

## **FlowAvg**

The time average metered flowrate in slpm whole gas. This field is computed using the 1 Hz data in the timeseries file from tSettled to tEnd for the flowmeter identified in FlowmeterID. Note, this field represents the total flowrate to all active emission points listed for the event.

## **FlowStDev**

The standard deviation of metered flowrate in slpm whole gas. This field is computed using the 1 Hz data in the timeseries file from tSettled to tEnd for the flowmeter identified in FlowmeterID.

## **FlowUncertainty**

The overall uncertainty in FlowAvg considering the accuracy of the flowmeter, the variability in the metered flowrate from tSettled to tEnd, and uncertainty in the gas composition.

If FlowmeterID is a thermal mass flow meter, this field is calculated as:

Where:

* is the uncertainty in the average metered flow corrected for thermal conductivity of the gas composition;
* is the average metered flow without correction for gas composition affects;
* is the average correction factor to account for the difference in thermal conductivity of the actual gas and the gas used to calibrate the thermal mass flow meter;
* is the standard deviation of the metered flow without correction for gas composition affects;
* is the stated accuracy of the mass flow meter;
* is the standard deviation of the correction factor to account for the difference in thermal conductivity of the actual gas and the gas used to calibrate the thermal mass flow meter.

If FlowmeterID is a laminar flow element, this field is calculated as:

Where :

* is the average correction factor to account for the difference in absolute viscosity of the actual gas and the gas used to calibrate the laminar flow element;
* is the standard deviation of the correction factor to account for the difference in absolute viscosity of the actual gas and the gas used to calibrate the laminar flow element.

## **C1FlowAvg**

The time average metered flowrate in slpm methane. This field is calculated as the product of FlowAvg and C1MolFracAvg.

## **C1FlowUncertainty**

The overall uncertainty in C1FlowAvg considering the accuracy of the flowmeter, the variability in the metered flowrate from tSettled to tEnd, and uncertainty in the gas composition.

This field is calculated as:

Where

* is the uncertainty in the average metered methane flow corrected for thermal conductivity or absolute viscosity of the gas composition
* and are the average and standard deviation of the correction factor to account for the difference in thermal conductivity or absolute viscosity of the actual gas and the gas used to calibrate the meter.
* and are the average and standard deviation of the mol fraction of methane in the gas

## **C2FlowAvg**

The time average metered flowrate in slpm ethane. This field is calculated as the product of FlowAvg and C2MolFracAvg.

## **C2FlowUncertainty**

The overall uncertainty in C2FlowAvg considering the accuracy of the flowmeter, the variability in the metered flowrate from tSettled to tEnd, and uncertainty in the gas composition.

This field is calculated similar to C1FlowUncertainty using the mol fraction of ethane in the gas.

## **C3FlowAvg**

The time average metered flowrate in slpm propane. This field is calculated as the product of FlowAvg and C3MolFracAvg.

## **C3FlowUncertainty**

The overall uncertainty in C3FlowAvg considering the accuracy of the flowmeter, the variability in the metered flowrate from tSettled to tEnd, and uncertainty in the gas composition.

This field is calculated similar to C1FlowUncertainty using the mol fraction of propane in the gas.

## **C4FlowAvg**

The time average metered flowrate in slpm butane. This field is calculated as the product of FlowAvg and the sum of iC4MolFracAvg and nC4MolFracAvg.

## **C4FlowUncertainty**

The overall uncertainty in C4FlowAvg considering the accuracy of the flowmeter, the variability in the metered flowrate from tSettled to tEnd, and uncertainty in the gas composition.

This field is calculated similar to C1FlowUncertainty using the mol fraction of butane in the gas.

## **THCFlowAvg**

The time average metered flowrate in slpm Total Hydrocarbons (THC). This field is calculated as the product of FlowAvg and the sum of C1MolFracAvg through C6MolFracAvg.

## **THCFlowUncertainty**

The overall uncertainty in THCFlowAvg considering the accuracy of the flowmeter, the variability in the metered flowrate from tSettled to tEnd, and uncertainty in the gas composition.

This field is calculated similar to C1FlowUncertainty using the mol fraction of total hydrocarbons in the gas.

## **OrificeControllerID**

The identifier of the orifice-based controller to which the controlled release at EPID is connected.

## **OrificeControllerPAvg**

The time average absolute pressure, in kPa, for the controller in OrificeControllerID. This field is computed using the 1 Hz data in the timeseries file from tSettled to tEnd for the pressure transducer at the inlet manifold to the controller ({OrificeControllerID}.PT-1). This field represents the average of gas pressure measurements upstream of the orifice set during the event. The average pressure at the controller from the transition time to the end of the event, reported in PSIA.

## **OrificeControllerPStd**

The standard deviation of the absolute pressure, in kPa, for the controller in OrificeControllerID. This field is computed using the 1 Hz data in the timeseries file from tSettled to tEnd for the pressure transducer at the inlet manifold to the controller ({OrificeControllerID }.PT-1). This field represents the variability in the gas pressure measurements upstream of the orifice set during the event.

## **OrificeControllerTAvg**

The time average temperature, in °C, for the controller in OrificeControllerID. This field is computed using the 1 Hz data in the timeseries file from tSettled to tEnd for the thermocouple at the inlet manifold to the controller ({OrificeControllerID }.TC-1). This field represents the average of gas temperature measurements upstream of the orifice set during the event.

## **OrificeControllerTStd**

The standard deviation of the temperature, in °C, for the controller in OrificeControllerID. This field is computed using the 1 Hz data in the timeseries file from tSettled to tEnd for the thermocouple at the inlet manifold to the controller ({OrificeControllerID }.TC-1). This field represents the variability in the gas temperature measurements upstream of the orifice set during the event.

## EPEquipmentGroup

Unique identifier of the equipment group at which the controlled release is located.

## EPEquipmentUnit

Unique identifier of the equipment unit at which the controlled release is located.

## **EPDescription**

A brief description of the emission point location and/or characteristics.

## **EPAltitude**

Altitude, in meters, of the emission location reported as the height above ellipsoid (HAE) and using the WGS 84 reference system.

## **EPFlowLevel**

The flow level (an integer) of the controlled release at the emission point identified in EPID during the event. The flow level corresponds to which gas shutoff valves are open during the event to supply gas to the emission point. Each shutoff valve is fed by a precision orifice which restricts the gas flowrate to the emission point. In general, for a given emission point operating at a given controller pressure, a higher flow level corresponds to a higher flow rate.

This field only applies if flow control is provided by a METEC orifice-based controller.

## EPFlowSetpoint

The flow setpoint, in slpm, of the controlled release at the emission point identified in EPID during the event.

This field only applies if flow control is provided by a mass flow controller.

## **RefEventID**

EventID of the reference event. During the reference event the emission point identified in EPID is operated and metered individually at the same flow level and under the same controller pressure setpoint as the current event. The reference calibration event therefore provides an approximation of the flowrate to an individual emission point when the current event includes multiple active emission points (ActiveEPCount > 1).

## **RefFlowAvg**

The FlowAvg, in slpm whole gas, calculated for the emission point EPID in the event RefEventID.

## **RefFlowUncertainty**

The FlowUncertainty, in slpm whole gas, calculated for the emission point EPID in the event RefEventID.

## **RefPRatio**

Ratio of OrificeControllerPAvg for emission point EPID during this event to OrificeControllerPAvg for the same emission point during event RefEventID.

If this ratio is less than 0.9 or greater than 1.1 the QCFlags CtrlrPresDev digit is thrown as a warning that the flowrate in RefFlowAvg may not be indicative of the flowrate of the emission point during this event due to a different gas pressure upstream of the flow control orifice.

## **RefTRatio**

Ratio of OrificeControllerTAvg for emission point EPID during this event to OrificeControllerTAvg for the same emission point during event RefEventID.

If this ratio is less than 0.9 or greater than 1.1 the QCFlags CtrlrTempDev digit thrown as a warning that the flowrate in RefFlowAvg may not be indicative of the flowrate of the emission point during this event due to a different gas temperature upstream of the flow control orifice.

## **GCSampleCount**

**The number of repeated samples performed on the gas chromatograph to determine the average and standard deviation of mol fractions and gas properties.**

## **N2MolFracAvg**

The average mol fraction of nitrogen in the gas chromatography results from GCSampleCount repeated samples.

## **N2MolFracStd**

The standard deviation of the mol fraction of nitrogen in the gas chromatography results from GCSampleCount repeated samples.

## **CO2MolFracAvg**

The average mol fraction of carbon dioxide in the gas chromatography results from GCSampleCount repeated samples.

## **CO2MolFracStd**

The standard deviation of the mol fraction of carbon dioxide in the gas chromatography results from GCSampleCount repeated samples.

## **C1MolFracAvg**

The average mol fraction of methane in the gas chromatography results from GCSampleCount repeated samples.

## **C1MolFracStd**

The standard deviation of the mol fraction of methane in the gas chromatography results from GCSampleCount repeated samples.

## **C2MolFracAvg**

The average mol fraction of ethane in the gas chromatography results from GCSampleCount repeated samples.

## **C2MolFracStd**

The standard deviation of the mol fraction of ethane in the gas chromatography results from GCSampleCount repeated samples.

## **C3MolFracAvg**

The average mol fraction of propane in the gas chromatography results from GCSampleCount repeated samples.

## **C3MolFracStd**

The standard deviation of the mol fraction of propane in the gas chromatography results from GCSampleCount repeated samples.

## **iC4MolFracAvg**

The average mol fraction of i-butane in the gas chromatography results from GCSampleCount repeated samples.

## **iC4MolFracStd**

The standard deviation of the mol fraction of i-butane in the gas chromatography results from GCSampleCount repeated samples.

## **nC4MolFracAvg**

The average mol fraction of n-butane in the gas chromatography results from GCSampleCount repeated samples.

## **nC4MolFracStd**

The standard deviation of the mol fraction of n-butane in the gas chromatography results from GCSampleCount repeated samples.

## **iC5MolFracAvg**

The average mol fraction of i-pentane in the gas chromatography results from GCSampleCount repeated samples.

## **iC5MolFracStd**

The standard deviation of the mol fraction of i-pentane in the gas chromatography results from GCSampleCount repeated samples.

## **nC5MolFracAvg**

The average mol fraction of n-pentane in the gas chromatography results from GCSampleCount repeated samples.

## **nC5MolFracStd**

The standard deviation of the mol fraction of n-pentane in the gas chromatography results from GCSampleCount repeated samples.

## **C6MolFracAvg**

The average mol fraction of heptane+ in the gas chromatography results from GCSampleCount repeated samples.

## **C6MolFracStd**

The standard deviation of the mol fraction of heptane+ in the gas chromatography results from GCSampleCount repeated samples.

## **KLambdaAvg**

The average thermal conductivity correction factor for use with thermal mass flowmeters from GCSampleCount repeated samples. Thermal mass flowmeters at METEC are calibrated using nitrogen and the value of KLambdaAvg is calculated to correct for the difference in thermal conductivity of the actual gas composition as measured by the gas chromatograph relative to nitrogen.

## **KLambdaStd**

The standard deviation of the thermal conductivity correction factor for use with thermal mass flowmeters from GCSampleCount repeated samples.

## **EtaAvg**

## KEtaAvg

The average viscosity correction factor for use with laminar flow elements from GCSampleCount repeated samples. Laminar flow elements are used in AliCat Mass Flow Controllers at METEC. The value value of KEtaAvg is calculated to correct for the difference in absolute viscosity of the actual gas composition as measured by the gas chromatograph relative to the gas selected in the AliCat Mass Flow Controller at the time of the experiment. KEtaAvg = 1 if pure gases are used and the correct gas is selected in the controller at the time of testing.

## KEtaStd

The standard deviation of the viscosity correction factor for use with laminar flow elements from GCSampleCount repeated samples. KEtaStd = 0 if pure gases are used and the correct gas is selected in the controller at the time of testing.