Automation of Target / Reference Values in Automated QC Checks

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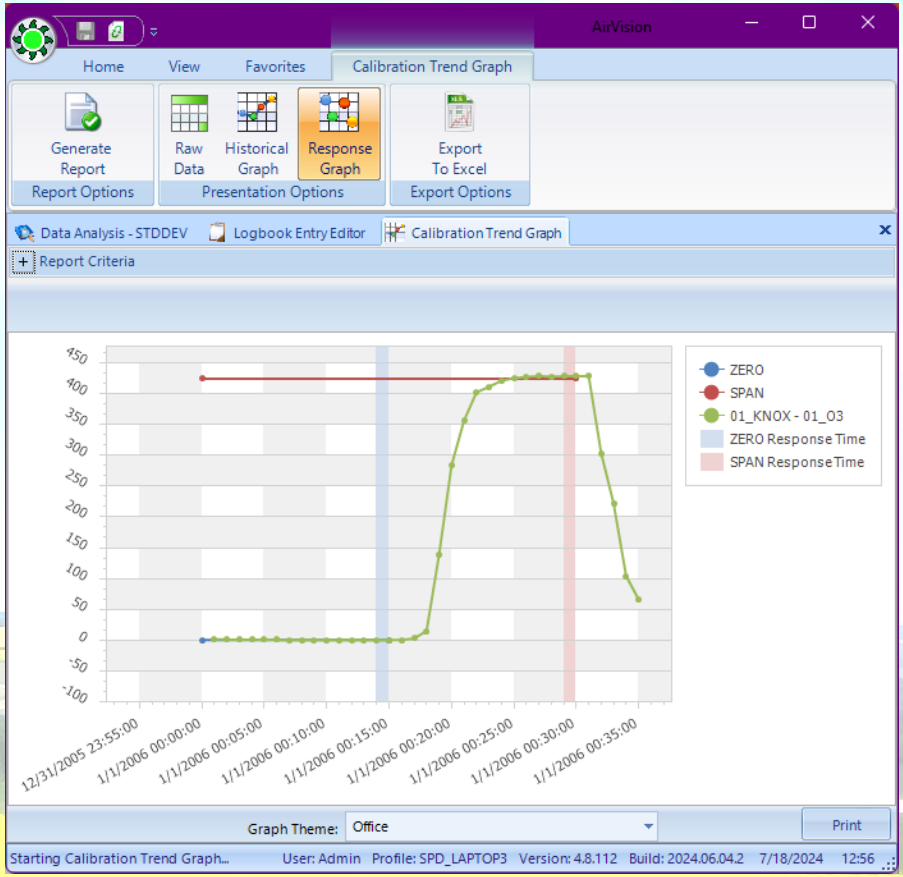
Why?

For many years, agencies would program a fixed target (expected) value into the calibrator, put the same number into the DAS, and that was good enough for most high level checks (e.g., ~ 400ppb for ozone, NO, etc)

Lower concentration precision checks and lower potential sensor ranges have challenged this older approach.

As we moved to digital connections to the calibrators, we gained the ability to access 'actual concentration' or flow rates of cal gas and diluent gases.



Two Methodologies

1. **If the calibrator offers an 'actual concentration' over its digital interface ,we can use that.**

2. **If the calibrator doesn't offer it, or we don't trust it, we can calculate using diluent and cal gas flows:**

C_actual = (gas bottle conc) * (CGF) / (CGF+DAF+O3F)

CGF = cal gas flow (from bottle)
DAF = dilution air low
O3F = O3 generator flow

Acquiring The Data

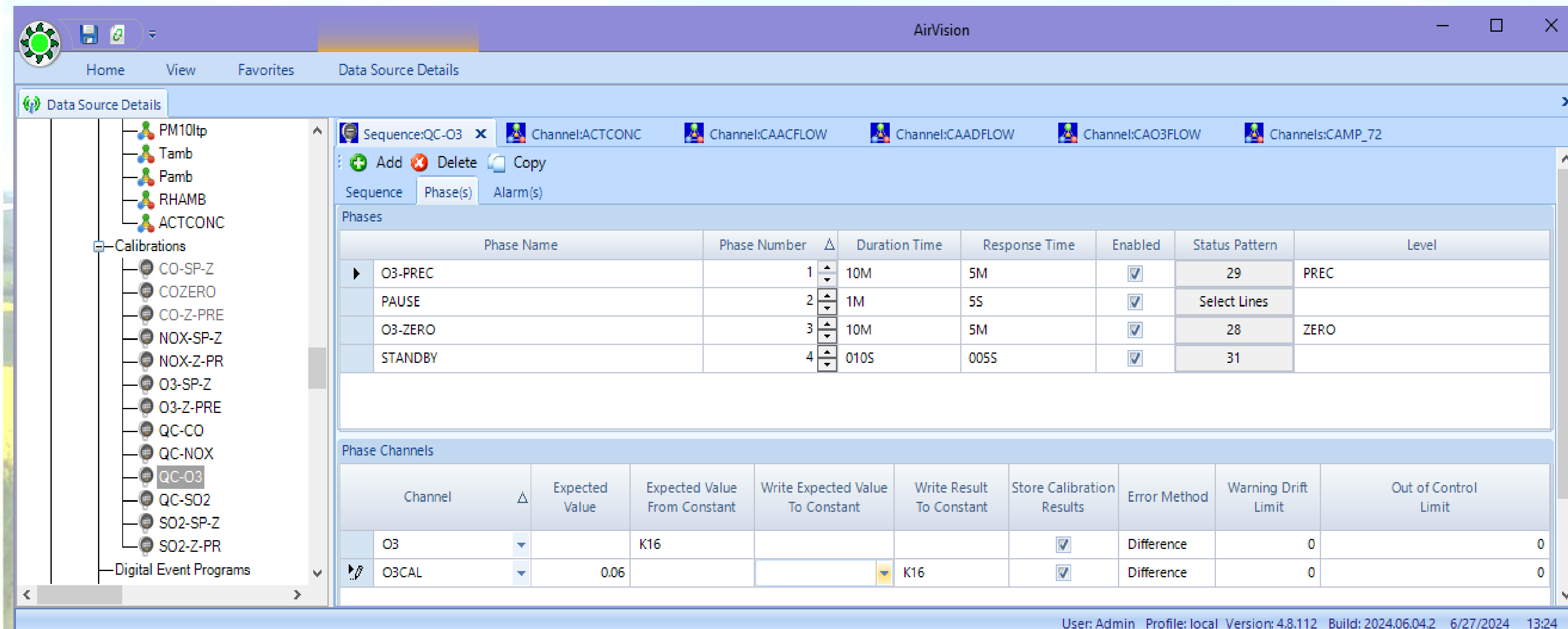
Method 1 for common dilution calibrators:

Calibrator Brand	Ethernet/Modbus?	RS-232
Teledyne T70x series	**Ozone only (Modbus)** **Gas concentrations via http interface only**	**ACTCONC**
Thermo 146i / iQ series	**Yes**	146i – *gas conc* iQ – N/A
Serinus	**Yes**	N/A
Environics 6103	Not available	**CONC OZONE ACTUAL?** **CONC GAS ACTUAL?**

Method 1

The DAS should have a way to set recording the target value in the calibration record. For AirVision / 8872, “math constants” are used as internal holding registers to record target values, and then to store them as the reference/expected values in the record.

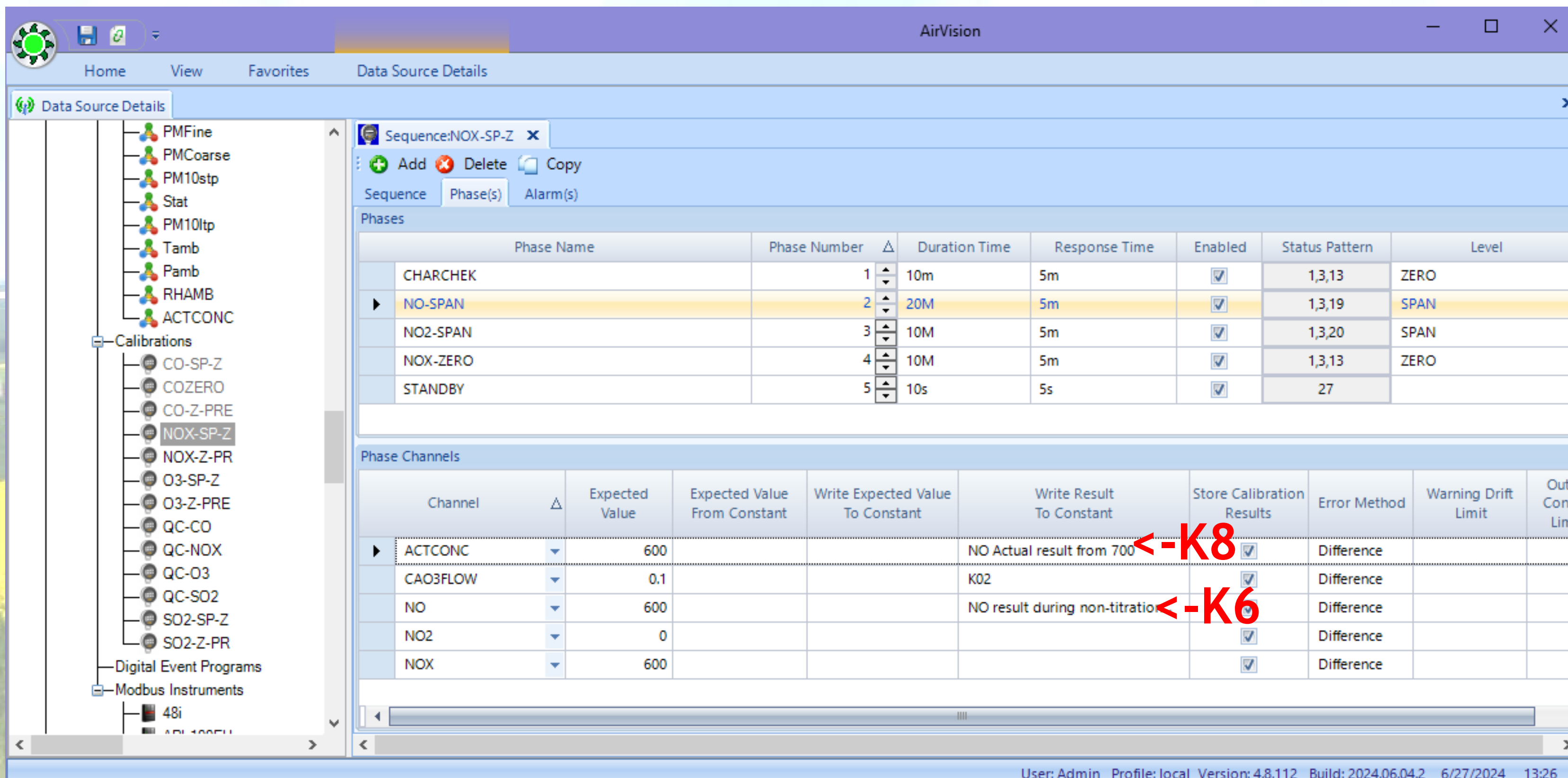
This can get tricky if calibrator digital interface is in ppm, but you report in ppb. “Scaling Factor” setting in the channel may need to be used to put calibrator parameter into correct units.



NO / NO2 GPT Checks

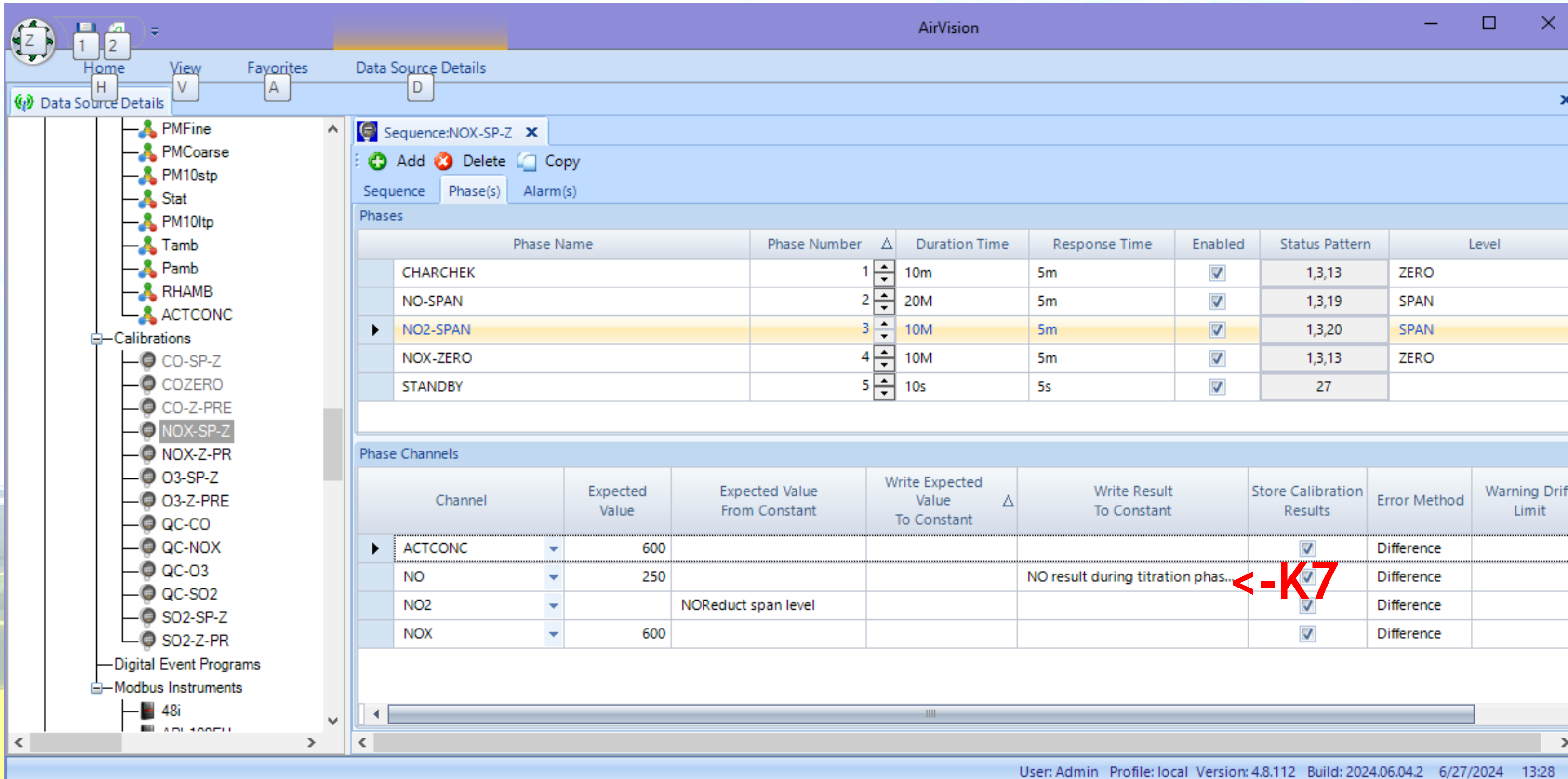
Things get a little different when doing GPT checks, as we want to 'carry over' measurements from previous phases/steps to determine the NO2 target based on the analyzer response.

Here, we are storing the actual NO conc from the calibrator and the the NO result from the analyzer.



NO / NO2 GPT Checks

We use a math channel to calculate the target (“NOreduct span level”) and use that as the expected / target value for NO2.



$$NO2\_target = (K8/K6)*(K6-K7) \quad \text{or}$$

$$= (NOACT\_700 / NOmeas[1]) * (NOmeas[2] - NOtitrate)$$

NO / NO2 GPT Checks

Example:

During NO span:
- Calibrator reports NO = 600
- Analyzer response NO = 580

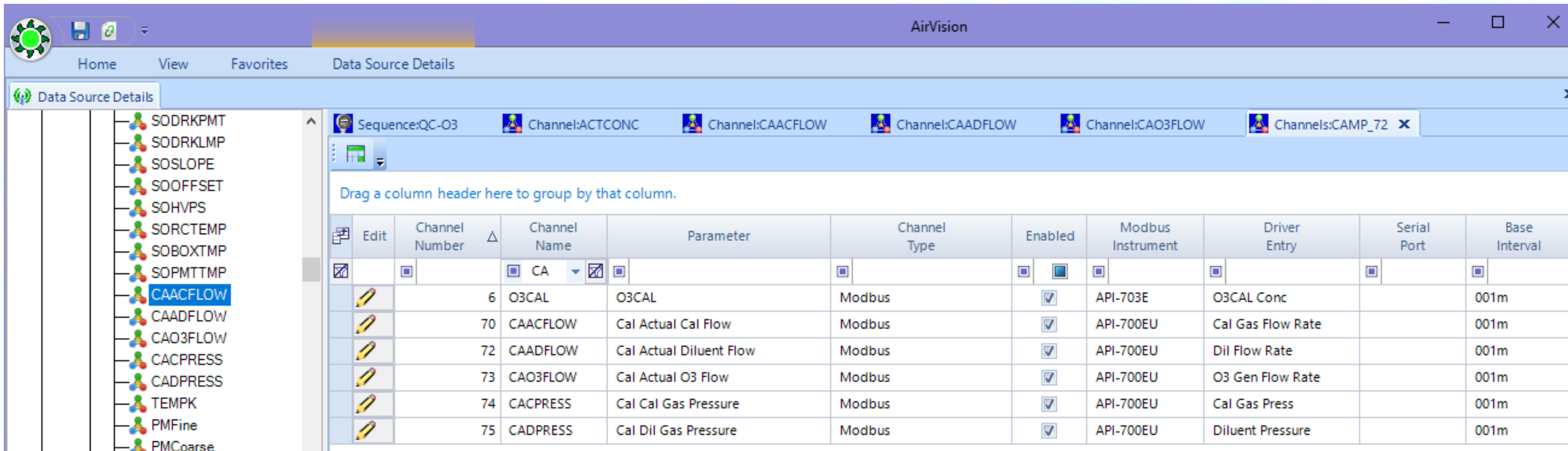
During NO2 span:
- Analyzer response NO = 230

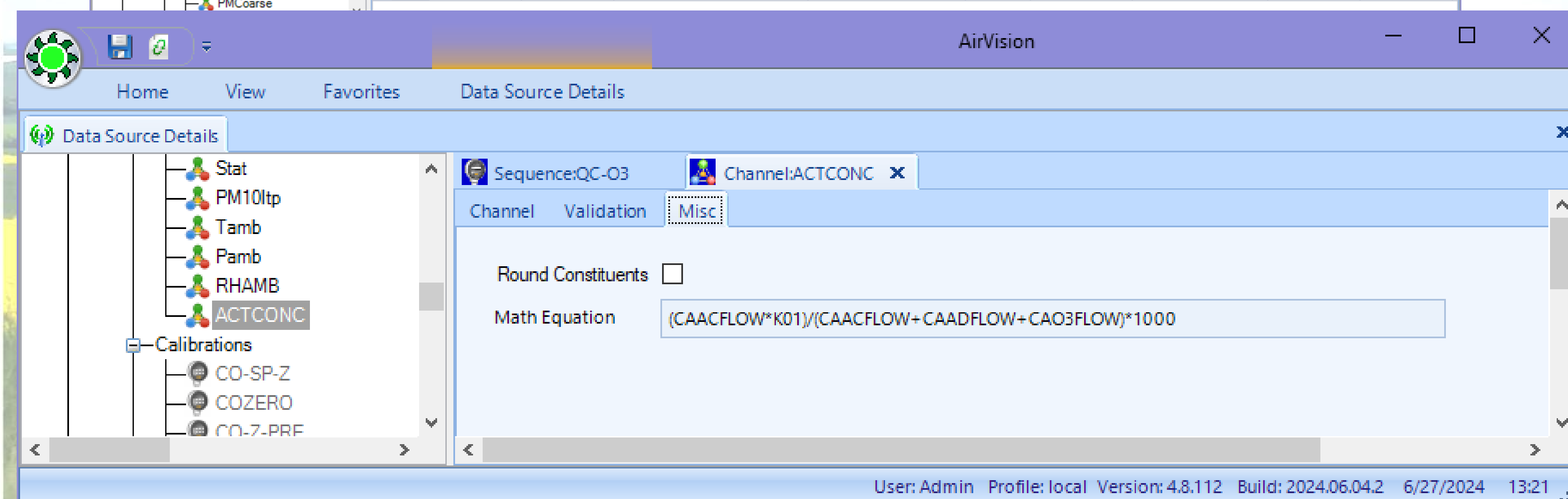
NO2_target = (600/580) * (580-230) = 362.1

NO2_target = (K8/K6)(K6-K7) or*
*= (NOACT_700 / NOmeas[1]) * (NOmeas[2] – NOtitrate)*

Method 2

We acquire our three gas flows, and implement a math function in the logger to calculate the actual concentration from the bottle conc.:

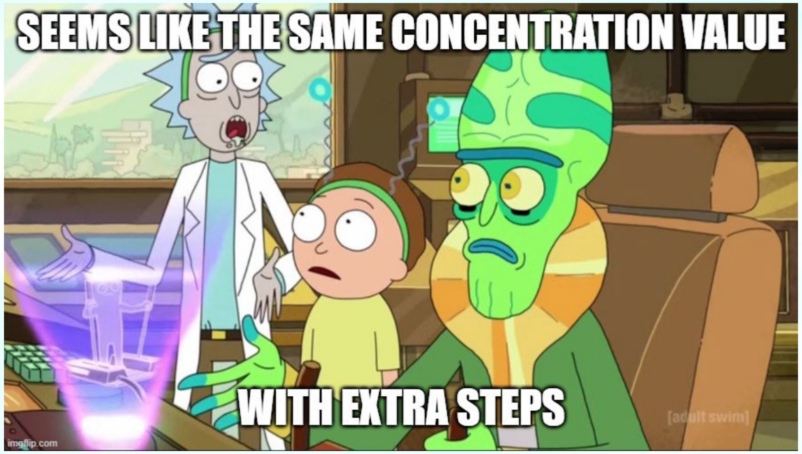




Method 2

Why this method?

- The RS-232 method (and potentially the HTTP method) from the T700 may not offer enough digits of precision since it's parsed from text.
(as opposed to Modbus = full floating point representation).



Also note that it's been found that O3 flow may not go perfectly to zero during non-titration. One solution is to use the "Secondary Value" on math constants as a multiplier for O3 flow, e.g.:

DILFLOW + CALFLOW + K07*O3FLOW (K3=1 during GPT, 0 otherwise)

Thanks to Erick Mattson and Phillip Stauffer at Colorado Department of Public Health and Environment for 'in the field' details.

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Questions?

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