Subject: PTC 12.2 – 1998, Appendix D Systematic and Random Uncertainties

Background: Appendix D - Guideline: Example Calculations, item D.4.1.2, does not show how to calculate the Bias Limit and the Precision Index.

Comment: The paragraph states that the bias limits (systematic uncertainty) and precision indices (standard deviations) must be determined in accordance with PTC 19.1. Despite the listed year of the 12.2 Code, it however predated PTC 19.1-1998. To harmonize their nomenclature with other test uncertainty codes, the 1998 edition of PTC 19.1 elected to call what was previously known as the precision index, standard deviation. They further combined the standard deviation in with the bias for a total instrument uncertainty. As a result, the Precision Index term disappeared from PTC 19.1.

The bias limit is a fixed, unknown (hidden) error that is a constant for repeated measurements. It can be estimated as an expected uncertainty if based on past experiences with the same measurement method. Thus bias errors are best estimates or engineering judgments based on experience with the particular instrumentation/method. Table D.5 shows what might be considered upper limits in order to have a PTC 12.2 Code test that meets the total uncertainty requirement of Section 1.3. Of course, it would be better to select instruments that improve on that and we certainly urge you to do so if possible.

Random errors or precision indices are separate from the bias errors and are statistical errors quantified from the data taken as shown in the example of D.4.1.3. The Precision Index (i.e., the standard deviation) arises from a poorly controlled variable during the test that has its source the instrument or measurement system uncertainty. Usually precision errors are much smaller than the bias errors. Both types of errors however are related to previous experience with the instrument or measurement system. In the case of a pre-test uncertainty analysis, precision indices are the associated standard deviations computed from the expected statistical scatter of the future test data and the instrument’s random inaccuracy based on previous experience. Since precision indices are usually relatively small compared to the bias, within the pre-test analysis, it is often assumed they are negligible. The final values of precision indices (standard deviation) after a test however depend on the actual number of instruments, the number of readings and the data scatter.

Clearly, test experience with each instrument or values from a text on measurements, etc. will be needed to assign values of Bias Limit and any pre-test estimates of the Precision Index.

**Question 1:** Do the bias limit or Precision index depend of the calibration of measurement equipments or these parameters shall be calculated? If so, how is it calculated? ASME PTC 19..1 does not shown there how to calculate it?
Answer 2: As indicated above, they do depend on the calibration of the measurement instrument and so the calibration history must be known. The precision index or test measurement scatter does however include the number of measurements your test uses when computing the standard deviation. See PTC 19.1 for determining standard deviation.

Question 2: Is the steam flow Bias limit parameter always 2.5% (indicated Table D.5) of the condensate test flow?
Answer 2: No. The value depends on how the parameter is measured or determined. If for example, a flowmeter was used, the calibration bias and inherent precision of that instrument would be used. If however the steam flow was calculated from a heat balance, other values of bias and precision would apply.

Question 3: Is the CW water flow Bias limit parameter always 3.5% (indicated Table D.5) of the CW test flow?
Answer 3: No. Please see above.

Question 4: Is the steam flow Precision Index parameter always 0.21% (indicated Table D.5) of the condensate test flow?
Answer 4: No. Please see above.

Question 5: Is the steam flow Bias limit parameter always 0.3% (indicated Table D.5) of the CW test flow?
Answer 5: No. Please see above. In addition, unless the plant is of a “standard design,” the steam flows and CW flows are not related.

Question 6: How are the rest of the parameters of table D.5 calculated?
Answer 6: As indicated above, you would need experience and a calibration history with the instrument and a test plan of approximately how many measurements you would take with each instrument to estimate the Bias Limit and Precision Index. The Sensitivity Factor would come from the derivatives displayed in Appendix E in accordance with Section 5.4.2.

Question 7: Do you have a PTC 12.2 calculation spread sheet where these two values are calculated that could help us?
Answer 7: No.

"ASME procedures provide for reconsideration of this interpretation if additional information is available which the inquirer believes might affect the interpretation. Further, persons aggrieved by an interpretation may appeal to the cognizant ASME committee or subcommittee. As stated in the foreword of our standards, ASME does not "approve", "certify", "rate", or "endorse" any item, construction, proprietary device or activity."