Descriptions of Methods for Software Verification and Validation

Codes for Validation		Descriptions
A	Software inspection	Review the software. Is it clear and does it make sense? Are there instructions for use? Are data entry fields labeled and color coded? Is it obvious what procedure is being used? Is there adequate documentation for a metrologist who is trained in this procedure to know what and where data is entered? Are they able to ensure that no data entry is inadvertently left out? Is the spreadsheet "blank" when opened to make sure old data is not accidentally used? Is there traceability to the specifications document (often an SOP)? Are cells formatted appropriately? Are unused cells locked? Are unused sheets removed? Are worksheets named appropriately? (Basically, were good spreadsheet design concepts followed?) Evidence: describe the review that was conducted in a few sentences.
B	Mathematical specification	Is the correct SOP used? Are the correct formulae selected? E.g., SOP 2 for air density has 2 formulas and one is recommended – which one was used? Is it the one you want used at the reported level of precision/uncertainty? Is there direct traceability of the equations? Evidence: Include a "documentation" worksheet in your workbooks that identify which SOP and equations are used.
C	Code review	Compare the cells with the formulae line by line in the spreadsheet versus the SOP. Do they match exactly? Are repeated calculations copied exactly or appropriately referencing the correct cells? Is rounding done at the appropriate locations in the file? Evidence: Save one of the worksheets in your workbook with the equations showing and notes included to show that they were evaluated – include a "reference" column to show which section of the SOP was compared. E.g., "compared to equation 3.2.2. in SOP 4." Include a graphic capture of the equation to support the comparison further.
D	Numerical stability	Most metrologists will not need to or be able to evaluate this aspect of Excel. Unless you have evaluated the stability using a referenced example, this should be entered as Not Applicable as a code in the Excel inventory. See the NPL example in Best Practice Guide Number 1. See also file: "BPG1 Numerical Instability

		Example.xls".
E	Component testing	Components include things like Pass/Fail tests, color coding, automatic look-ups for standards or uncertainties from a master list/table or master file. They might include automatic report generation macros. Depending on the component, you will need to create different kinds of approaches for the components and the evidence may include a description or saved examples. Have you tested the functionality of each functional macro? each command/button? combinations of interdependent macros? accuracy of plotted graphs? printing of each printable worksheet/report? Pass/Fail: intentionally enter good or bad data to see if the criteria changes. Conditional color formatting: most often used as a pass/fail or marginal flag – enter good, bad, and marginal data to determine the response. Look up tables: sample (or do 100% evaluations) the look up tables to make sure items are selected from the right row, column, cell, and workbook. Make sure data is transferred accurately for automation from laboratory instruments and transferred accurately to the final calibration report.
F	Numerical reference results	Two aspects need to be considered here: 1. All data in tables and lists match their reference sources exactly; and 2. All values with automatic look up features need to select the correct row, column, cell, and workbook. Do look up tables and lists match the latest calibration report? Do uncertainties match the latest Scope? If values reference another workbook or spreadsheet, is it dated – and if you update the date on a master list of standards, does the file reference a default value, old value, or zero instead of an error message? Evidence: print reference values and do line by line comparisons to ensure they match. Alternatively, scan a graphic and do the line by line comparison in the workbook.
G	Embedded data evaluation	Sometimes conversion factors, reference values, or other mathematical factors are included in a calculation. E.g., air density and water density equations have a number of standard multipliers with many decimal places. Conversion factors need to be the most accurate ones available and need to be

		rounded, when appropriate, to the right number of digits to avoid impacting the final results. Even without look-up values, some values for standards or uncertainties may be embedded in a working file and the accuracy of those values must be ensure. Evidence: identify all embedded values in a list (ideally within the spreadsheet) and compare them to the correct reference values and note the date of the comparison. The dates will help ensure that if subsequent conversion factors are used or standards are calibration the right values are entered.
H	Back-to-back testing	Data that is published in an SOP, generated by the laboratory, used for a proficiency test, or even simply created for testing purposes may be used. Do two spreadsheets – created by different people – perhaps in different software – agree? Does a newer spreadsheet agree with an older spreadsheet down to the level of intermediate calculations? If there are differences, do they agree well beyond the level where they could impact the uncertainty of the calibration? Evidence: be sure to save both spreadsheet files and note file names and dates of evaluation.
I	Analysis without computer assistance (data sets)	Data that is published in an SOP, generated by the laboratory, used for a proficiency test, or even simply created for testing purposes may be used. Do hand calculations with a scientific calculator (hand or "computer calculator") agree with those generated by the spreadsheet? Evidence: be sure to save the spreadsheet file and a copy of the hand-written notes; record the dates of evaluation.
J	Security	Can a metrologist accidentally delete equations and calculation cells that should be protected? Can cells be accidentally moved around? Is it possible for an untrained metrologist to "correct" something by mistake because passwords are readily available? How are all files backed up? Is there a source of the back-up files maintained in an alternate facility/location? Can the files on network drives accidentally be deleted? If a computer fails (or facility damaged where the computer can no longer be used, is there a back-up somewhere? Evidence: describe the review that was conducted in a few sentences.