

Measurement Precision Calculator Users Guide

For Use with Test Method 1.9, Measurement Systems Analysis for Variables Data

(IPC Measurement Precision Task Group (7-11a), Version 1.0)

Introduction

Welcome to the Measurement Precision Calculator. This utility will help perform the calculations for Measurement Systems Analysis (MSA) described in the IPC Test Method IPC-TM-1.9.

This software is useful in cases where the measurement data is recorded as variables data and recorded on a continuous scale. The calculations allow for up to five repeated readings, taken on each of up to 10 samples by up to 10 test laboratories or test conditions.

Please refer to the test method before beginning the study. The test method defines the terms and equations used in detail. This User Guide provides detailed instructions for analyzing the MSA data on the Measurement Precision Calculator, and how to draw conclusions from the metrics.

This software is an Excel workbook and includes the following:

- A blank spreadsheet to enter measurements
- A spreadsheet with example data
- A form for manual data entry, if desired
- Further information on the K factors used in the calculations

The goal in preparing this workbook was to keep it as simple and easy to implement as possible, but still provide a good basic MSA. This procedure has been used many times and can often be completed with as little as an hour's work on each of three consecutive days. This method provides a good initial assessment. It is quick and easy enough to be used on all tests, current and new. It can help isolate cases where further analysis is needed. It is useful both on current production tests and as a test validation review for new designs.

This spreadsheet has been tested with the Excel versions included with Office 97 and Office 2000. It does not use macros, so compatibility problems have been minimized. The sheets were formatted to print on 8-1/2 by 11 pages on most laser and ink jet printers.

Preparing for the study

Begin by determining the measurement processes to be evaluated. All measurements are candidates for a study. In every case where we perform a measurement, we deserve to know the precision of the measurement. Every measurement could be followed by a " $\pm X$ ", where "X" would represent the tolerance of the measurement.

The secret to performing a good MSA is to prepare well. The first step in preparing the MSA is to identify all the MSA candidates. Begin by identifying the measurements being performed. List the equipment needed, the parts tested, and the set-ups required. For each piece of equipment, note the ranges used. The complete list of MSA candidates includes all combinations of all tests, equipment, set-ups, ranges and all products.

As in many cases, this list probably includes far more potential candidates for an MSA than time or budget restrictions will allow. So one must identify the top candidates and make sure they begin with the most critical first.

So, the second step in preparing the MSA is to prioritize the candidates. The best ranking method for one's situation will probably be unique, but there are several factors to consider.

Beside each potential MSA candidate we could note information needed to help assess criticality. This information could include the following:

- Issues identified as critical to customer (CTC) or quality (CTQ)
- Test cost
- Time required for test
- Unit cost of product being tested
- Planned production quantities
- Past test yields
- Cost to analyze test rejects
- Rework costs
- Scrap costs
- Warranty returns caused by issues with this test

Having this information, it is possible to then devise a prioritizing scheme that would identify critical test issues. Some have used the planned production quantities and past test yields to calculate potential costs of rework and scrap. A different prioritizing scheme might use knowledge of issues critical to the customer or past warranty claims.

The third step in preparing the MSA is to take the rank ordered list and prepare an action plan. Given the time and budget allowed, decide on the tests to be included in the first round of MSAs. After the first group has been analyzed, one can then consider the second group, etc.

Setting-Up the MSA

The test method gives more detailed instructions. Some rules of thumb and general pieces of advice are discussed below.

Many MSAs are discussed, but never completed. There are several reasons. For some the procedure is confusing. Hopefully, we have helped streamline it here. For others, the process is too time consuming and expensive. While it is true that more samples and more testers will yield more precise estimates; nevertheless, an incomplete study is useless.

Therefore it is recommended that MSAs start small and efficient. Pick the highest priority test and design an MSA which can be performed quickly with the time and resources available. If this initial study shows the need for improvement, then call in an expert practitioner and design a more extensive study and begin corrective action.

In many cases, a good basic study may involve just five parts, two to three testers, and three or four measurements on each part by each tester. Each tester could measure each part once a day for several days.

Begin with the highest priority test first, then continue with the rest. Many have found that a small effort continued over the long term can accomplish more than a massive initiative. Develop a plan to reassess the MSA on a regular basis. It is important to track the effect of the MSA efforts, both in term of the performance metric involved and in cycle time and cost savings. Choose a representative group of samples for the MSA. Choose samples that cover the part type, range and set-up under consideration. Be sure to use testers who represent those who will actually do the test during production.

Be sure the parts are presented to the testers in a manner which prevents them from knowing the prior measurements. This prior knowledge may influence their current measurement and compromise the study.

Try to design a study so that all tests result in actual measurements. Try not to stress products beyond normal test limits, so secondary effects do not occur. Do not set a part aside if it happens to result in a noncompliance. Continue taking measurements. The estimates are more representative if the MSA is balanced, with equal numbers of test results all around.

Do not ignore any measurement taken, unless there was a special cause of variation that is clearly identified and preventative action has been taken.

Using the Spreadsheet

Header Section

Begin by completing the yellow area in the header. Fill in as completely as possible to prevent confusion later. The header section is shown below.

Measurement Precision Study: Information Sheet

Version 1.0, April 2002

Enter data into yellow areas.

Test Method	
Parameter Measured	Gasket Thickness
Company	
Name of Study Organizer	
Study Completion Date	
Instrument	
Measurement Units	mm
Lower Specification Limit, LSL	0.6
Upper Specification Limit, USL	1
Number of Test Conditions, m	3
Number of Samples, n	10
Number of Repeat Readings, k	2

K ₂	2.7
K ₃	1.62
K ₁	4.57

The spreadsheet calculates the appropriate value of the K-factors, and displays them to the right of the section with the header information. Here, the example involves measuring the thickness of gaskets. They chose to have two testers measure the thickness of four samples once a day for four days.

The MSA data can be entered in the next section. Again fill in the yellow areas. Be sure and check that the data was recorded correctly and verify it is transcribed into the spreadsheet accurately. The analysis will be of little worth if there are typos.

