MIL-STD-1916 (Acceptance Sampling for Variables)

Summary

MIL-STD-1916 is a standard sampling methodology that has been established for the acceptance or rejection of lots based on the evaluation of item measurements. A sample of *n* units is taken from a batch or lot containing *N* units. If the sample contains no nonconforming units and the sample mean and sample standard deviation yield acceptable quality indices, the batch or lot is accepted. Otherwise, the batch or lot is rejected. To calculate the quality indices, either one or two specification limits for the measurements must be entered.

The MIL-STD-1916 standard specifies the appropriate sample sizes for different verification levels, which are usually specified by contract. It also contains rules for switching between normal inspection, tightened inspection, and reduced inspection, based on the results of recent samples.

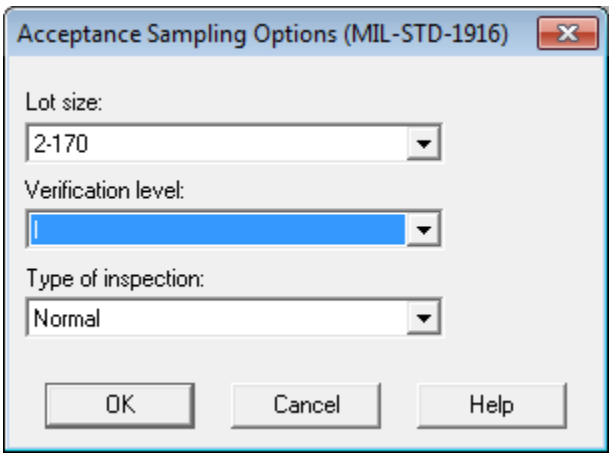
This procedure calculates the required sample sizes. It also plots operating characteristic curves to compare alternative sampling plans.

Full details of the standard may be found in the publication titled Department of Defense Test Method Standard: DOD Preferred Methods for Acceptance of Product.

Sample StatFolio: *milstd1916V.sgp*

Data Input

The initial dialog box displayed when the procedure is selected is shown below:

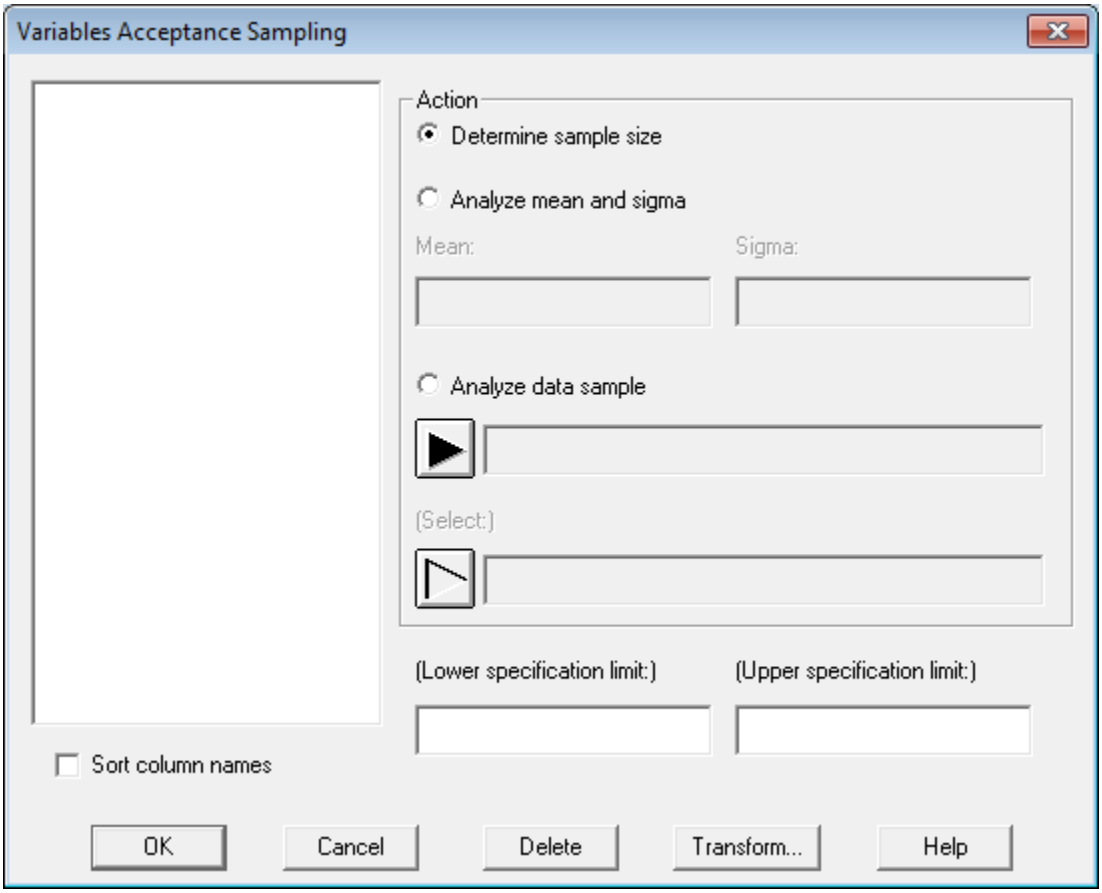


- **Lot size:** the size of the lot or batch from which units will be randomly selected.

- **Verification level**: the verification level to be used. The standard describes seven verification levels. Larger verification levels require larger sample sizes. Usually, the verification level is specified by contract.

- **Type of inspection**: *normal*, *tightened*, or *reduced*. When beginning a sampling scheme, normal inspection is used. Tightened inspection is implemented when recent inspection results have been poor. Reduced inspection is implemented when recent inspection has been very good. The MIL-STD-1916 standard includes rules for switching between the three types of inspection.

The second dialog box displayed indicates the desired action and other information:



- **Action:** There are 3 choices:
    - *Determine sample size*: displays the required sample size prior to the collection of any data.
    - *Analyze mean and sigma*: determines whether to accept or reject the lot based on the values of the mean and standard deviation of *n* units sampled from the lot.
    - *Analyze data sample*: determines whether to accept or reject the lot based on a column of measurements made on *n* items sampled from the lot.
- **Lower and upper specification limits:** the specification limits upon which acceptance or rejection of the lot is to be based. In order to accept or reject the lot, at least one specification limit must be entered.

Each action is illustrated below.

Action 1: Determine Sample Size

Prior to the collection of data from the lot, the required sample size may be determined. The example in the previous section indicates a lot size between 2 and 170, inspection level I, normal inspection. Given this information, the following is displayed by the program:

MIL-STD-1916 (Variables)
Lot size: 2-170
Verification Level: I
Type of inspection: Normal

Sampling plan: (code A)

Sample size	n=4
Minimum allowable k-criterion	k=1.210
Maximum allowable F-criterion (double-sided only)	F=0.370

The sampling plan is generated by:

Step 1: Assignment of sample size code letter

Based on the lot size and verification level, a sample size code letter is assigned. The code may be either A, B, C, D, or E.

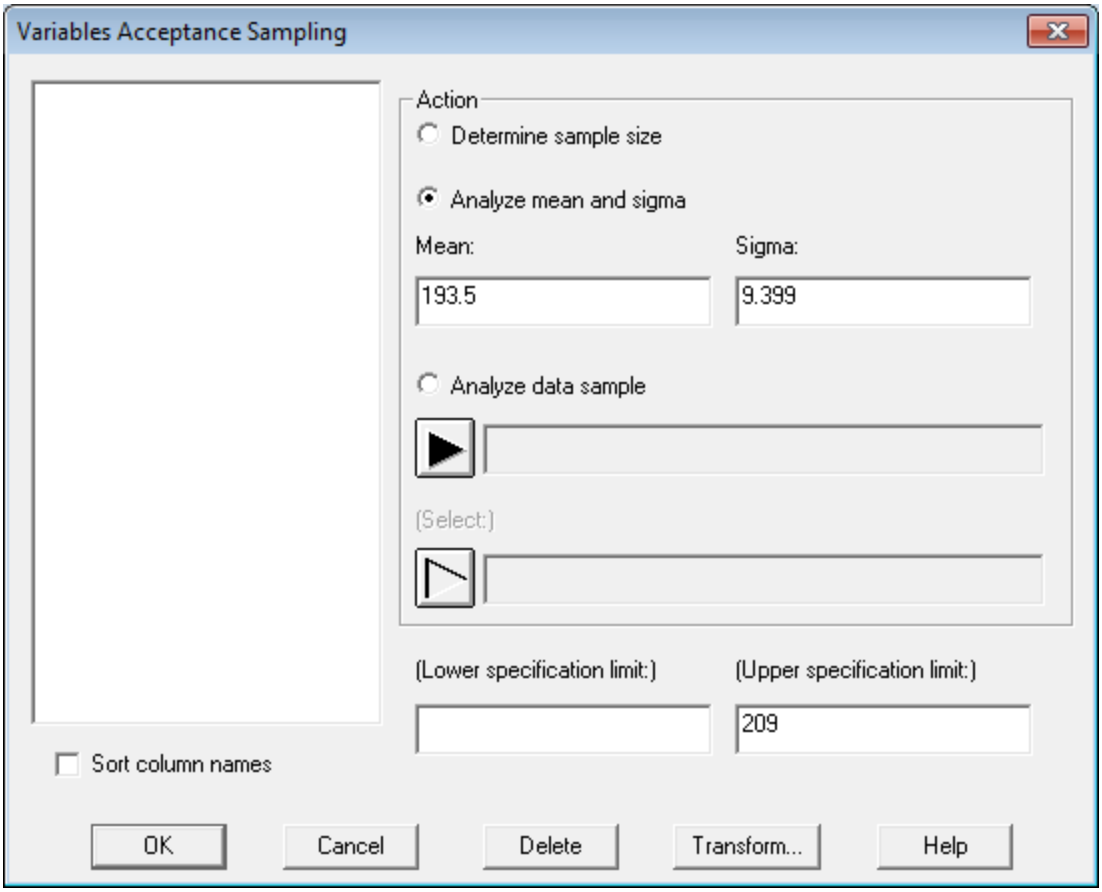
Step 2: Determination of sample size and maximum allowable k and F criteria

Based on the assigned sample size code letter, the verification level, and the type of inspection, the required sample size is determined. The program also determines the critical values of two acceptance criteria, *k* and *F*, which are described in a later section.

For the example, the assigned code letter is “A”. This requires taking a sample of $n = 4$ units from the lot.

Action 2: Analyze Mean and Sigma

After the sample of *n* units is collected, the mean and standard deviation of the measurements made on those units may be entered as shown below:



- **Sample mean**: the sample mean

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} \tag{1}$$

- **Sample standard deviation**: the sample standard deviation

$$s = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}} \tag{2}$$

- **Lower specification limit** (if any): the minimum allowable value *L* of the characteristic being measured.

- **Upper specification limit** (if any): the maximum allowable value *U* of the characteristic being measured.

At least one specification limit must be entered.

When the *OK* button is pressed, an analysis window is displayed containing the following *Analysis Summary*:

MIL-STD-1916 (Variables)
Lot size: 2-170
Verification Level: I
Type of inspection: Normal

Sampling plan: (code A)

Sample size	n=4
Minimum allowable k-criterion	k=1.210
Maximum allowable F-criterion (double-sided only)	F=0.370

Sample results

		Quality index (k)	*F Value*
Sample mean	193.5		
Sample std. deviation	9.399		
USL	209.0	1.649	
Sample F Value			N/A

Since the quality index is greater than or equal to 1.21, the lot is accepted (provided all of the measurements are within the specification limits).

To determine whether to accept or reject the lot, quality indices *k* are first calculated from:

$$k_L = \frac{\bar{x} - L}{s} \tag{3}$$

and

$$k_U = \frac{U - \bar{x}}{s} \tag{4}$$

If two specification limits have been entered, an additional index *F* is also calculated from:

$$F = \frac{s}{U - L} \tag{5}$$

The lot is accepted if all of the following conditions are met:

1. All of the *n* measurements are within the specification limits.

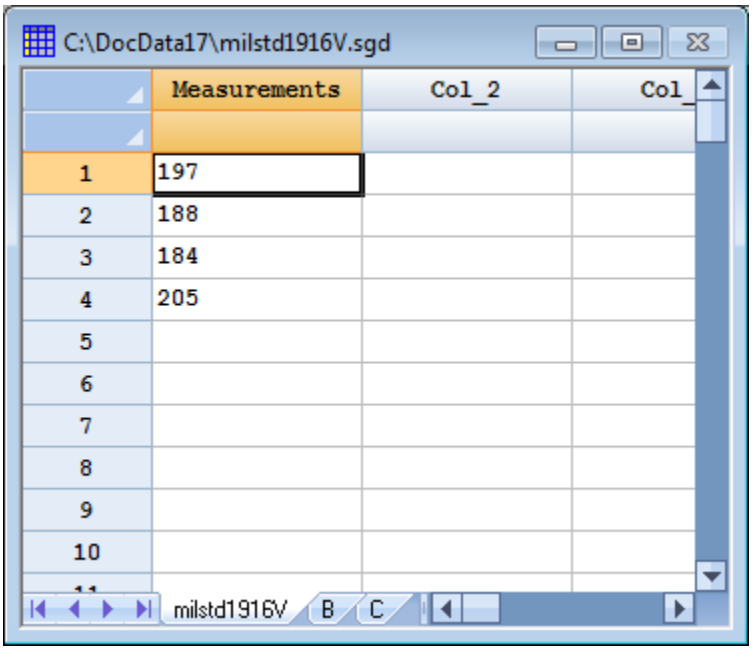
2. The smaller of the two *k* indices (or single index if only one specification limit has been entered) is greater than or equal to the *minimum allowable k-criterion*.

3. If two specification limits have been entered, the *F* value is less than or equal to the *maximum allowable F-criterion*.

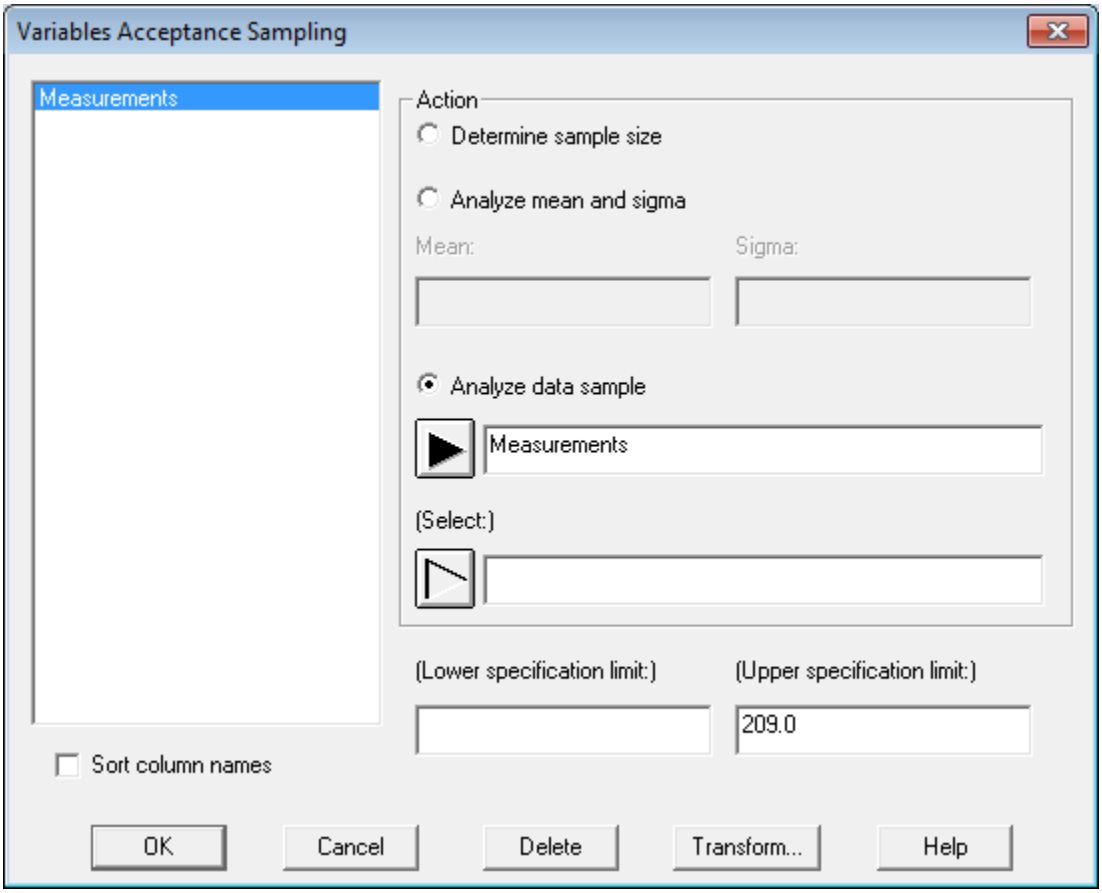
In the example, only an upper specification limit $U = 209$ has been entered. Assuming than all 4 measurements are less than 209, the lot would be accepted, since the value of k = 1.649 is greater than or equal to the minimum allowable value of 1.21.

Action 3: Analyze Data Sample

After the sample of *n* units is collected, the individual measurements may be entered instead of the sample mean and standard deviation. Suppose the sample was as follows:



The second dialog box would then be completed as shown below:



When the *OK* button is pressed, the program will calculate the sample mean and sample standard deviation and display the following:

MIL-STD-1916 (Variables)
Lot size: 2-170
Verification Level: I
Type of inspection: Normal

Sampling plan: (code A)

Sample size	n=4
Minimum allowable k-criterion	k=1.210
Maximum allowable F-criterion (double-sided only)	F=0.370

Sample results
Data variable: Measurements

		Quality index (k)	*F Value*
Sample mean	193.5		
Sample std. deviation	9.39858		
USL	209.0	1.649	
Sample F Value			N/A

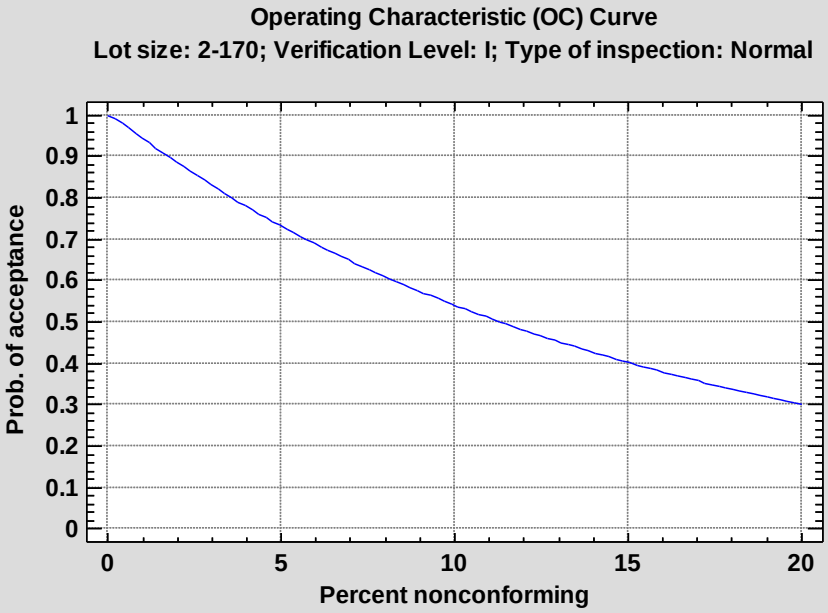
Since all of the measurements are within the specification limits and the quality index is greater than or equal to 1.21, the lot is accepted.

Except for some slight differences due to rounding, the output is the same as when the sample mean and standard deviation were input directly.

Note: If the individual measurements are entered, the program will also check to be sure that all of the measurements are within the specification limits.

Operating Characteristic Curve

This pane displays the OC Curve, which shows the probability that a lot will be rejected using the derived sampling plan given various values for the true percent of nonconforming units in the lot.



For example, if the lot contains 5% nonconforming units, then the probability of accepting the lot is approximately 0.73 or 73%. This OC curve may be compared to that of other sampling plans.

