Using the MDL Program, EDMCalib.ma

Introduction

EDMCalib.ma is a MicroStation mdl program that will process EDM Calibration data files. The purpose of an EDM calibration is to determine the scale and constant error of a specific EDM using an NGS calibration baseline. EDMCalib.ma computes the scale and constant error based on the raw data, horizontal baseline distances, collected during an EDM calibration. The EDMCalib.ma uses the same data input file format as the NGS program calibrat. The raw data consists of the published horizontal distances between baseline monuments defined from either a user-defined data file or from one of the predefined NC calibration baselines. Another data file contains the measured horizontal distances between baseline monuments.

Preparing Data Files

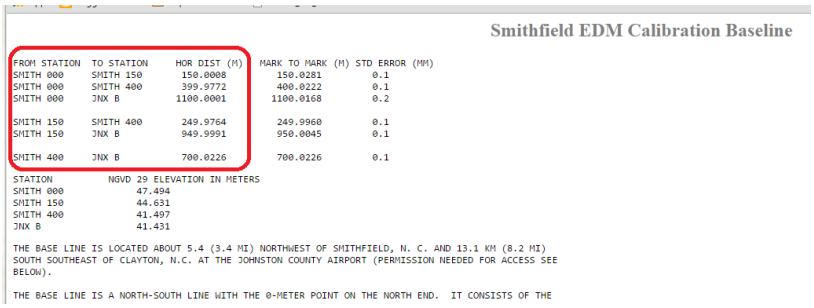
When processing an EDM calibration using the NGS file format, two data files need to be used; one data set contains the published baseline distances. Another data file contains the measured baseline distances. All the published NC baselines have been predefined in the program and are available to the user. Alternately, the published baseline data can be entered into an ASCII data file. Both the published and the measured data files use the same type records and format. Data records consist of three fields, The EDM station name, the prism station name, and the horizontal distance, either published or measured depending on the type of data file. The fields are separated by either commas or spaces.

If not using one of the predefined baselines, the published data files need to be created using an ASCII text editor such as Notepad or UltraEdit, The published data can alternately be input using the EDMCalib.ma user interface.

Following is an example of a data file containing the published data for a baseline. The station names in the following example are alphanumeric. There are no naming restrictions other than not using spaces or commas in the station names. Every station name found in the measured data file must exist in the published data file.

```
SMITH_0,SMITH_150,150.0008
SMITH_0,SMITH_400,399.9772
SMITH_0,JNX_B,1100.0001
SMITH_150,SMITH_400,249.9764
SMITH_150,JNX_B,949.9991
SMITH_400,JNX_B,700.0226
```

Following is a portion of the data sheet for the Smithfield NC NGS Baseline. Notice that the published horizontal distances match the distances in the above listing.



Smithfield EDM Calibration Baseline

FROM STATION	TO STATION	HOR DIST (M)	MARK TO MARK (M)	STD ERROR (MM)
SMITH 000	SMITH 150	150.0008	150.0281	0.1
SMITH 000	SMITH 400	399.9772	400.0222	0.1
SMITH 000	JNX B	1100.0001	1100.0168	0.2
SMITH 150	SMITH 400	249.9764	249.9960	0.1
SMITH 150	JNX B	949.9991	950.0045	0.1
SMITH 400	JNX B	700.0226	700.0226	0.1

STATION	NGVD 29 ELEVATION IN METERS
SMITH 000	47.494
SMITH 150	44.631
SMITH 400	41.497
JNX B	41.431

THE BASE LINE IS LOCATED ABOUT 5.4 (3.4 MI) NORTHWEST OF SMITHFIELD, N. C. AND 13.1 KM (8.2 MI) SOUTH SOUTHEAST OF CLAYTON, N.C. AT THE JOHNSTON COUNTY AIRPORT (PERMISSION NEEDED FOR ACCESS SEE BELOW).

THE BASE LINE IS A NORTH-SOUTH LINE WITH THE 0-METER POINT ON THE NORTH END. IT CONSISTS OF THE

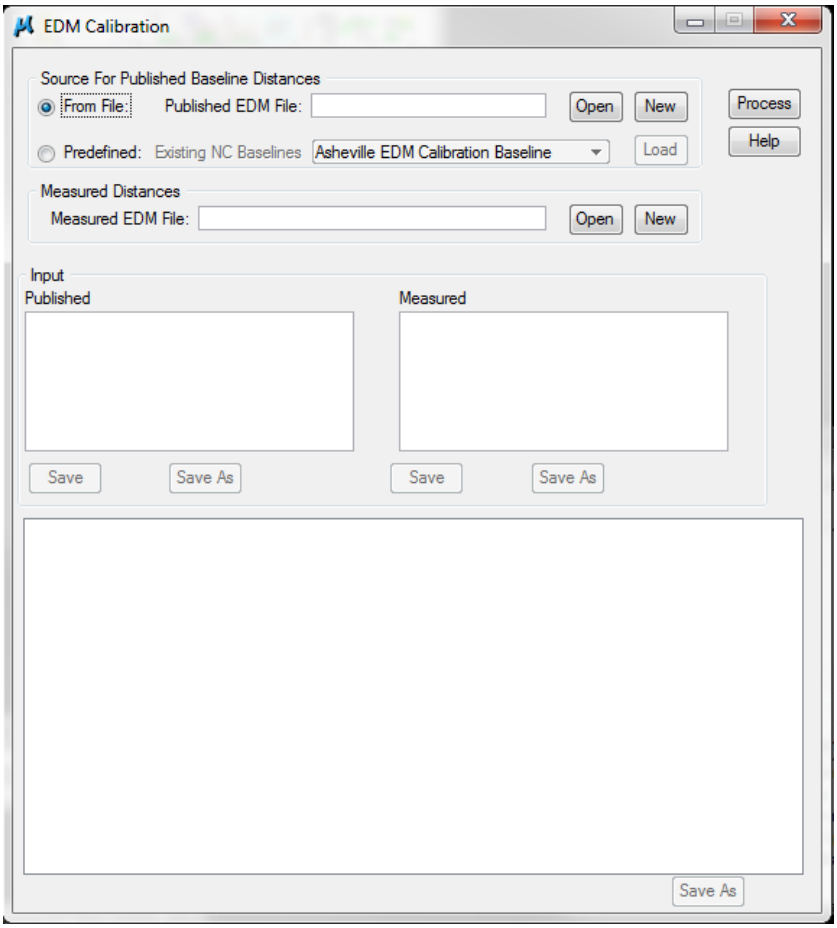
Following is an example of a data file containing the measured data. All the station names found in the measured file need to exist in the published data file. There needs to be a minimum of three baseline stations and three baseline measurements. All distances, both published and measured need to be horizontal distances. As with all least squares problems, the more measurements that are taken the more confidence you will have in the solution.

```
SMITH_0,SMITH_150,150.0048
SMITH_0,SMITH_400,399.9773
SMITH_0,JNX_B,1100.0032
SMITH_150,JNX_B,950.0025
SMITH_400,JNX_B,700.026
SMITH_150,SMITH_400,249.9762
SMITH_0,SMITH_400,399.9819
```

NGS publishes the baseline data in metric units. EDMCalib.ma is currently set up to only work in meters. When collecting the baseline distances collect them in meters or convert the distances to metric before processing.

Running EDMCalib.MA

From the Microstation Utilities menu, choose the **'MDL Applications'** option. From the MDL application launcher dialog box use the '**Browse'** button to browse to the location of the EDMCalib.ma program. Once you have launched the program the following dialog box is displayed.



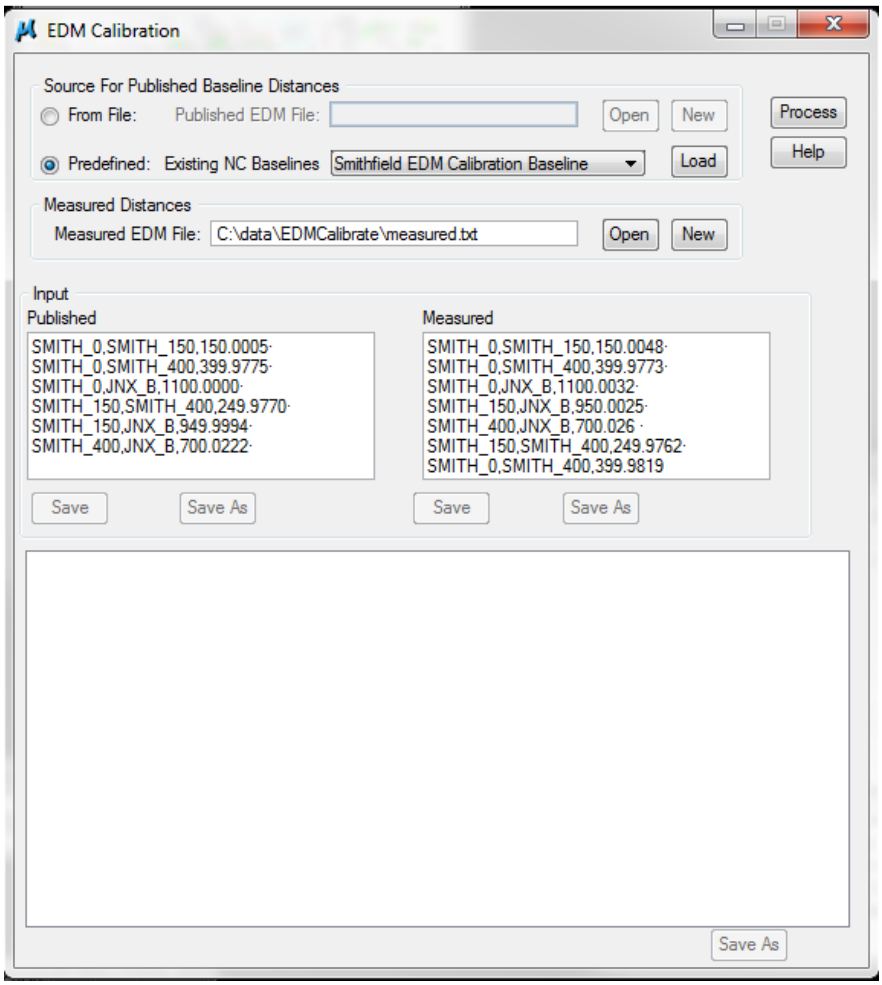
Designating Data Files

Both the published data and the measured data need to be designated:

> **Published EDM File**: The published data contains the station names and published horizontal distances for the calibration baseline being used. In most cases for NC DOT users the baseline being used will be available as one of the predefined baseline options. Alternately, the user can create a data file containing the published distances. If you are using one of the predefined baselines you will need to use the same point numbering scheme as the predefined baselines. If the user needs or wants to create a published baseline file he can use the 'Open' button to designate an existing file, or he can use the 'New' button to create a new data file. One of the conveniences of the NGS format is that most users will always be using the same calibration baseline. So the user typically only has to define the 'Published EDM File:' once.
>
> **Measured EDM File:** The Measured EDM file contains the station names and the measured horizontal distances between the baseline monuments. Use the 'Open' button to designate an existing data file .Use the 'New' button to create a new data file.

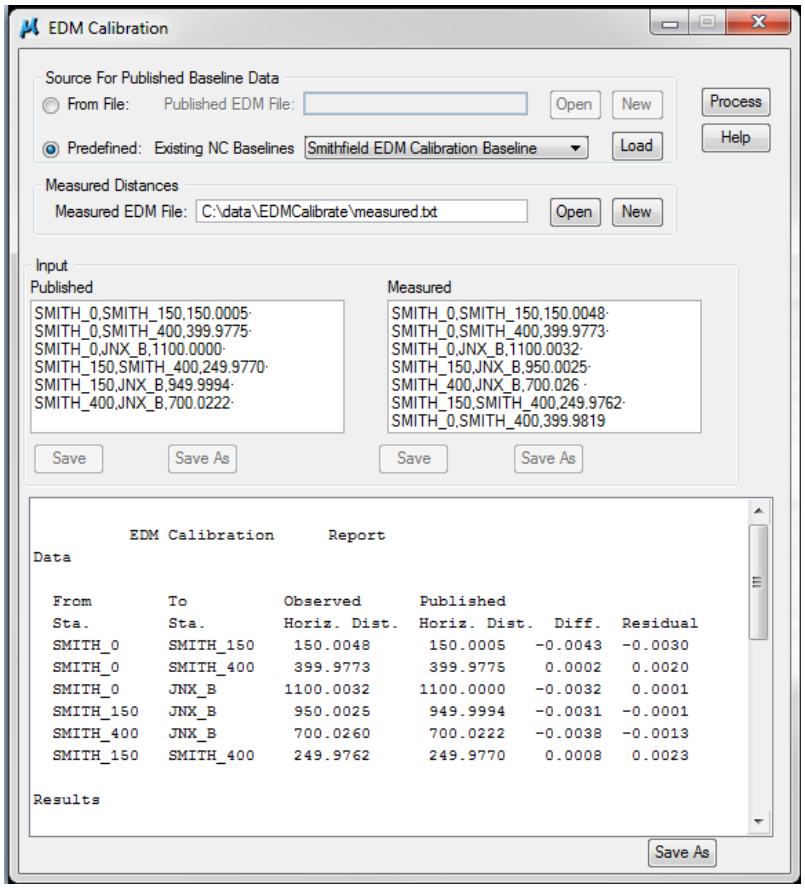
Following is the EDM Calibration dialog box after both the published and the measured data source have been chosen. If choosing one of the predefined baselines, first pick the 'Predefined' radio button. Then choose the correct baseline from the combo box list. Then press the 'Load' button. After choosing the

data source the contents are displayed in the edit fields. These values can be edited and saved to the same file using the ‘Save’ button or another file using the ‘Save As’ option. If a new calibration is being performed, use the ‘New’ button to designate the new data file name and then enter the data into the edit box and ‘Save’ the data once input is completed. The data file can alternately be created using any ASCII text editor.



Processing the Data

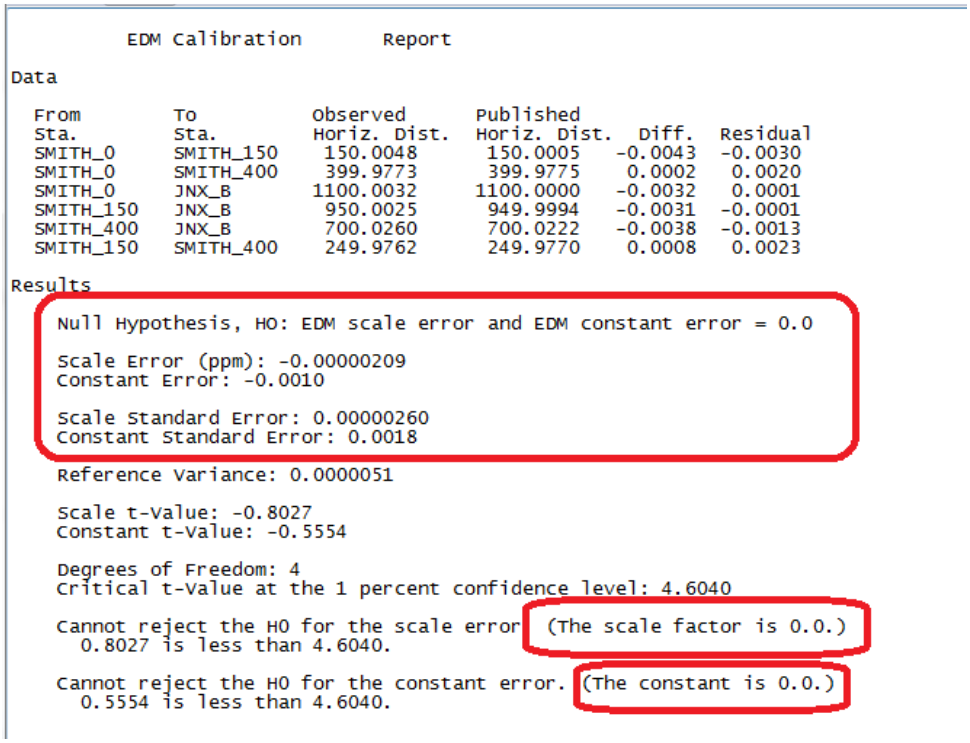
After both the published and measured data have been created and designated the **‘Process’** button is pressed, and an output report is created. The report is displayed in the lower portion of the dialog box.



To save the report to an ASCII text file press the **'Save As'** button on the bottom right of the dialog box and enter a file name.

The Report File

Following is a more complete view of the report as viewed in an ASCII text editor. The key items to review are circled in red.



```
          EDM Calibration       Report

Data

  From        To          Observed      Published
  Sta.        Sta.        Horiz. Dist.  Horiz. Dist.  Diff.    Residual
  SMITH_0     SMITH_150    150.0048      150.0005   -0.0043  -0.0030
  SMITH_0     SMITH_400    399.9773      399.9775    0.0002   0.0020
  SMITH_0     JNX_B       1100.0032     1100.0000   -0.0032   0.0001
  SMITH_150   JNX_B        950.0025      949.9994   -0.0031  -0.0001
  SMITH_400   JNX_B        700.0260      700.0222   -0.0038  -0.0013
  SMITH_150   SMITH_400    249.9762      249.9770    0.0008   0.0023

Results

   Null Hypothesis, HO: EDM scale error and EDM constant error = 0.0

   Scale Error (ppm): -0.00000209
   Constant Error: -0.0010

   Scale Standard Error: 0.00000260
   Constant Standard Error: 0.0018

   Reference Variance: 0.0000051

   Scale t-Value: -0.8027
   Constant t-Value: -0.5554

   Degrees of Freedom: 4
   Critical t-Value at the 1 percent confidence level: 4.6040

   Cannot reject the H0 for the scale error  (The scale factor is 0.0.)
     0.8027 is less than 4.6040.

   Cannot reject the H0 for the constant error. (The constant is 0.0.)
     0.5554 is less than 4.6040.
```

The above report shows that the EDM has a constant error of 1.0mm and 2.09 ppm. Statistically speaking you cannot distinguish those computed errors from 0 indicating that the EDM is operating within its specifications.

```
          EDM Calibration       Report

Data

  From        To          Observed      Published
  Sta.        Sta.        Horiz. Dist.  Horiz. Dist   Diff.   Residual
  SMITH_0     SMITH_150    150.0036      150.0005   -0.0031    0.0017
  SMITH_0     SMITH_400    399.9836      399.9775   -0.0061   -0.0012
  SMITH_0     JNX_B       1100.0058     1100.0000   -0.0058   -0.0004
  SMITH_0     SMITH_150    150.0048      150.0005   -0.0043    0.0005
  SMITH_150   SMITH_400    249.9830      249.9770   -0.0060   -0.0012
  SMITH_150   JNX_B        950.0038      949.9994   -0.0044    0.0009
  SMITH_0     SMITH_400    399.9822      399.9775   -0.0047    0.0002
  SMITH_150   SMITH_400    249.9831      249.9770   -0.0061   -0.0013
  SMITH_400   JNX_B        700.0268      700.0222   -0.0046    0.0005
  SMITH_400   JNX_B        700.0261      700.0222   -0.0039    0.0012
  SMITH_150   JNX_B        950.0059      949.9994   -0.0065   -0.0012
  SMITH_0     JNX_B       1100.0051     1100.0000   -0.0051    0.0003

Results

    Null Hypothesis, HO: EDM scale error and EDM constant error = 0.0

    Scale Error (ppm): -0.00000060
    Constant Error: -0.0047

    Scale Standard Error: 0.00000088
    Constant Standard Error: 0.0006

    Reference Variance: 0.0000012

    Scale t-Value: -0.6776
    Constant t-Value: -7.7115

    Degrees of Freedom: 10
    Critical t-Value at the 1 percent confidence level: 3.1690

    Cannot reject the HO for the scale error. (The scale factor is 0.0.)
      0.6776 is less than 3.1690.

    Reject the HO for the constant error. (The constant is not 0.0.)
      7.7115 is greater than 3.1690.
```

The preceding report was generated from data that was collected with an inappropriate prism. The user mistakenly used a prism that had the wrong offset for the total station that he was using. Note the following:

1) The constant error is 4.7mm's or .015'. Modern EDM's are certainly capable of measuring better than this. The ppm is .06, well within capabilities of modern EDM's.
2) Notice that the results of the t-test indicate that the null hypothesis is rejected for the constant error, i.e. the EDM has a systematic constant error.
3) Notice the 'Diff.' column and how there is a consistent negative value in the range of 3-6mm indicating a systematic error.
4) Notice the 'Residual' column. Notice that all the values are 1 mm or less with a roughly equal number of positive and negative values. This value is the corrected measured distance – the published distance. If distances are corrected using the computed scale and ppm error then decent results are obtained.
5) Look at the entire report. Do not just look at the results of the t-test. Look at the computed scale error, the constant error, the differences, the residuals and the results of the statistical tests. As with all least squares reports, there is never one single value that can be relied on to determine if you have an adequate analysis. The report has to be reviewed in whole.