Fall-Of-Potential Calculations Using MALZ

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As a means to check the validity of the soil and ground grid model used in a grounding analysis study, the calculated fall-of potential curve is compared to the measured curve. The CDEGS MALZ module is generally used for large systems grounding analysis. Unlike MALT, MALZ does not have a built in feature to calculate fall-of-potential plots. This article will focus on the procedure on calculating a fall-of-potential plot using MALZ.

To illustrate the process, data taken from a medium sized substation, Station "OK", is used. The size of Station "OK" is 250 ft. X 215 ft. Figure 1 shows the general layout of the station grounds and equipment. Figure 2 shows where the soil resistivity and grid resistance fall-of-potential measurements were taken.

With soil resistivity data taken with a Megger DET-2/2 soil resistance meter, a four layer soil model is derived with RESAP. Figure 3 shows the RESAP plot. The calculated curve is very close to the measured curve.

In energizing the MALZ model, 1 amp was injected at a location inside the station yard. In addition, 1 amp was returned at the remote stake. Figure 4 shows the command mode portion of the MALZ file and Figure 5 to Figure 6 depicts the screen shots of the Input Toolbox for the same input file illustrating the different settings used. Profile points were taken at the surface along the fall-of-potential path at 25 ft. intervals for a total of 950 feet. The starting and ending frequency was set to 150 Hz, the same frequency used by the meter at the time of the measurement.

Once the MALZ run is completed, the potential rise of the injected conductor is noted from the F09 output file. In this case, the potential rise is 0.3743 volt with a 169.16 degree angle. From the Output Toolbox module of the plot/report portion of CDEGS, touch potential is computed using the potential rise magnitude and angle as the user defined values with a setting for 2D plots. Figure 9 shows the Output Toolbox Computation screen.

Before clicking on the draw button, some flags need to be made under the Advance setting in order to save the report file. Click on advance button on the Computation screen and then check the selection for "Generate Report on to File" with the selection of "All Selected Points". Figure 10 shows the Zoom and Profiles tab settings. Click on OK to return to the main menu and click on the draw button. Under the plot tab, a fall-of-potential curve is created and under the report tap, the touch potential points are listed. Figure 11 shows the resulting profile plot. This should look like a typical fall-of-potential curve. After closing up the Output Toolbox, the report files are saved as a CS_*XXXX*.F17 file where *XXXX* is the run ID.

From here, I can now plot the measured fall-of-potential resistance data versus the calculated points. Using the plotting feature in Microsoft EXCEL, three columns are listed. The first is for distance, second for the measured data and last is for the calculated data. One thing to note is that the calculated results from MALZ are in volts. Since I used 1 amp as my injected current, the resulting touch voltages are the same as the point resistances.

Figure 12 shows the resulting curves. This case, the curves match closely. So, this appears to be a valid model. Several things to consider in the event that the match is not close may be due to poor ground grid model, bad soil resistivity data, or grid resistance data. The bad data may be caused by buried pipeline interference or even coupling between the probe leads.

In closing, background information on measuring and hand plotting the grid resistance of a station is covered in the "How To…." engineering guide on large suburban stations (SUBURBAN.PDF) as well as several other publications.

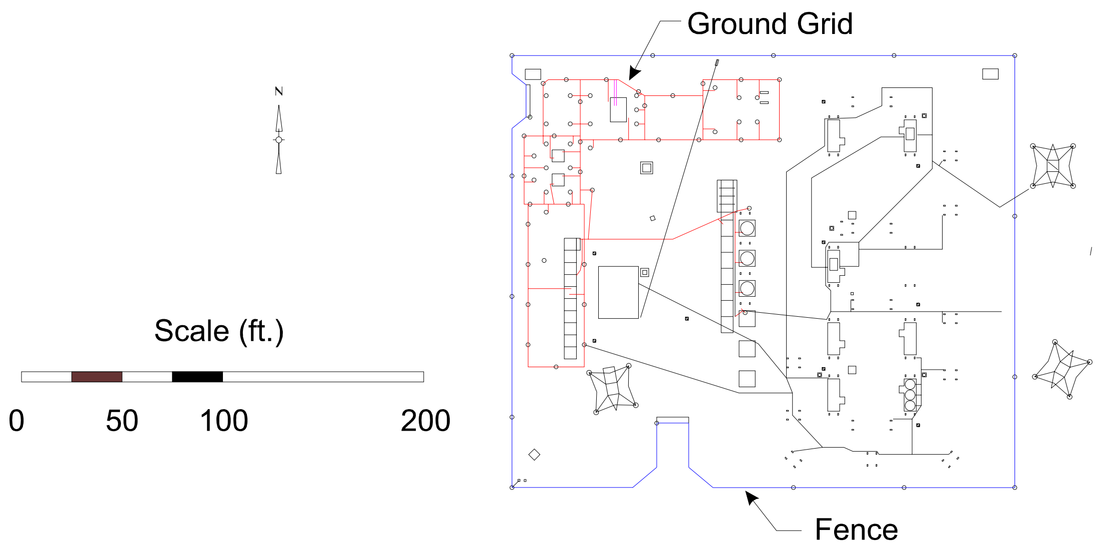


Figure 1 General arrangement of equipment and ground grid of Station "OK"

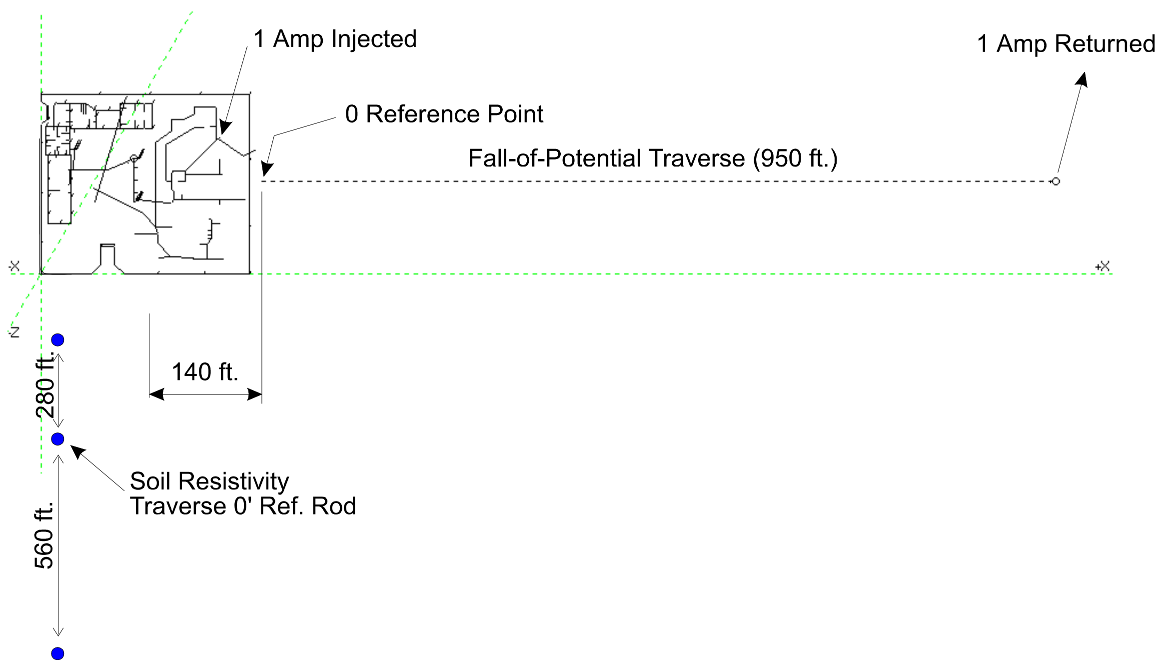
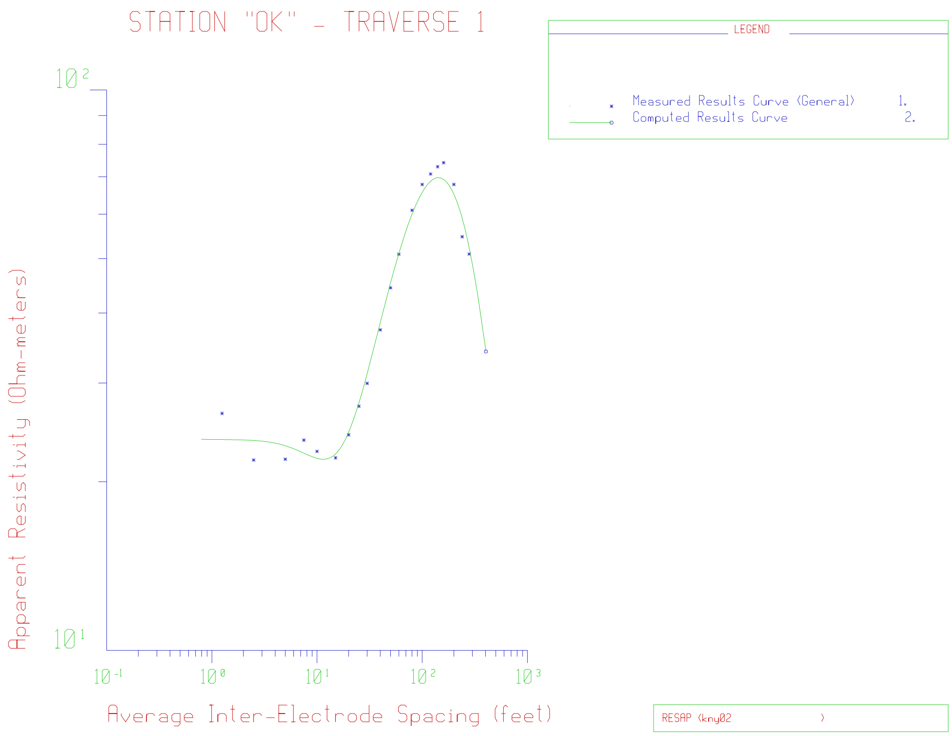


Figure 2 Location of fall-of-potential and soil resistivity measurements



Layer Number	<--- LAYER CHARACTERISTICS --> Resistivity (ohm-m)	Thickness (Feet)	Reflection Coefficient (p.u.)	Resistivity Contrast Ratio
1	infinite	infinite	0.0	1.0
2	23.80000	7.500000	-1.0000	0.23800E-18
3	15.00000	13.30000	-0.22680	0.63025
4	261.8000	56.10000	0.89162	17.453
5	10.30000	infinite	-0.92429	0.39343E-01

Figure 3 RESAP plot

```
MALZ
TEXT,Simulation of Step and Touch Potentials at Station “OK”.
TEXT,Four layer soil model. - Traverse 1
TEXT,Fall-of-Potential Curve
OPTIONS
  UNITS,INCH-RADIUS
  RUN-IDENTIFICATION,OLD0B
SOIL-TYPE,MULTILAYER
  HORIZONTAL
    LAYER,TOP,23.8,7.5
    LAYER,CENTRAL,15.0,13.3
    LAYER,CENTRAL,261.8,56.1
   LAYER,BOTTOM,10.3
COMPUTATIONS
  DETERMINE,POTENTIAL
  OBSERVATION-POINTS
    PROFILES,39,265.,110.,0.,25.,0.,0.
  FREQUENCY,150,150
SYSTEM
  ENERGIZATION,REFERENCE,1.,
  ENERGIZATION,,-1.,
SYSTEM
  NETWORK
    MAIN-GROUND
      CONDUCTOR,0,0,0,1,216.5,118.5,1.5,214.,118.5,1.5,.2875,1
      CONDUCTOR,0,0,0,2,1215.,110.,.5,1215.,110.,1.5,.3125,1
      CONDUCTOR,-1,0,0,0,111.,112.,1.,111.,127.,1.,.4065,1
           “       “         “        “        “         “
“        “
      CONDUCTOR,-1,0,0,0,48.,203.,1.,48.,192.,1.,.2875,1

ENDPROGRAM
```

Figure 4 MALZ command mode input file

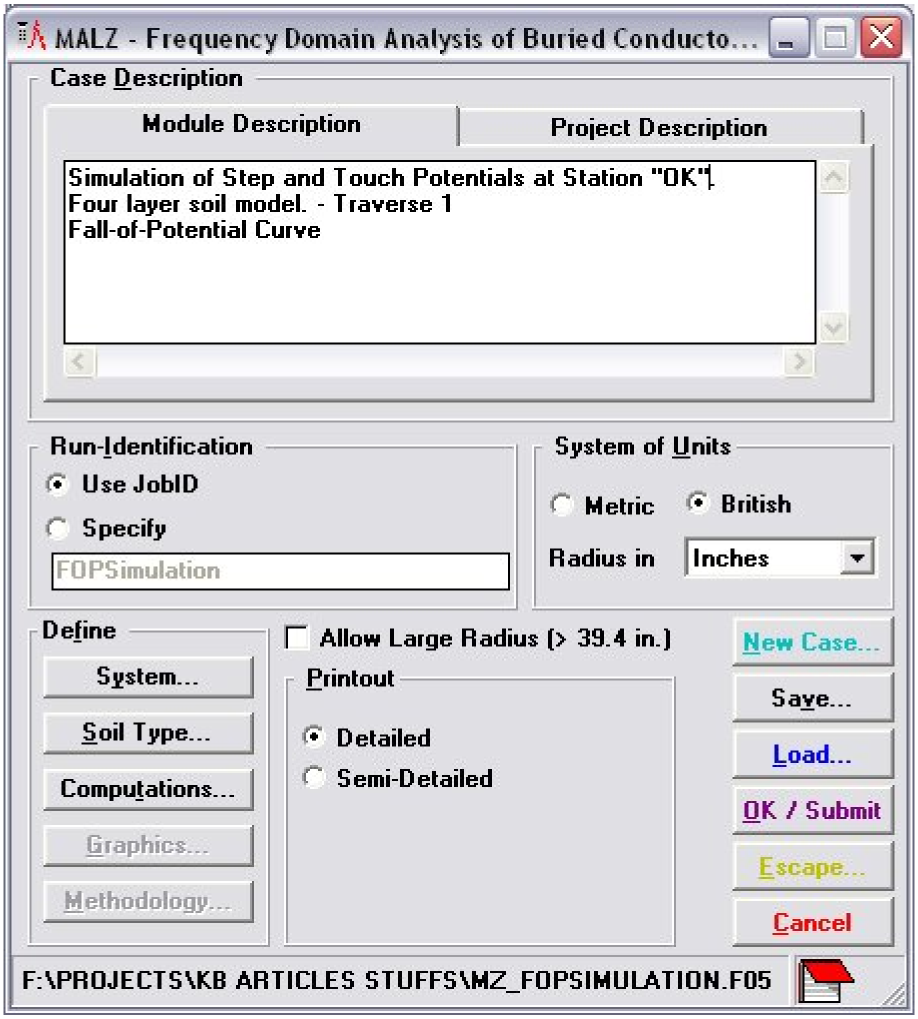


Figure 5 Screen shot of the main MALZ Input Toolbox screen

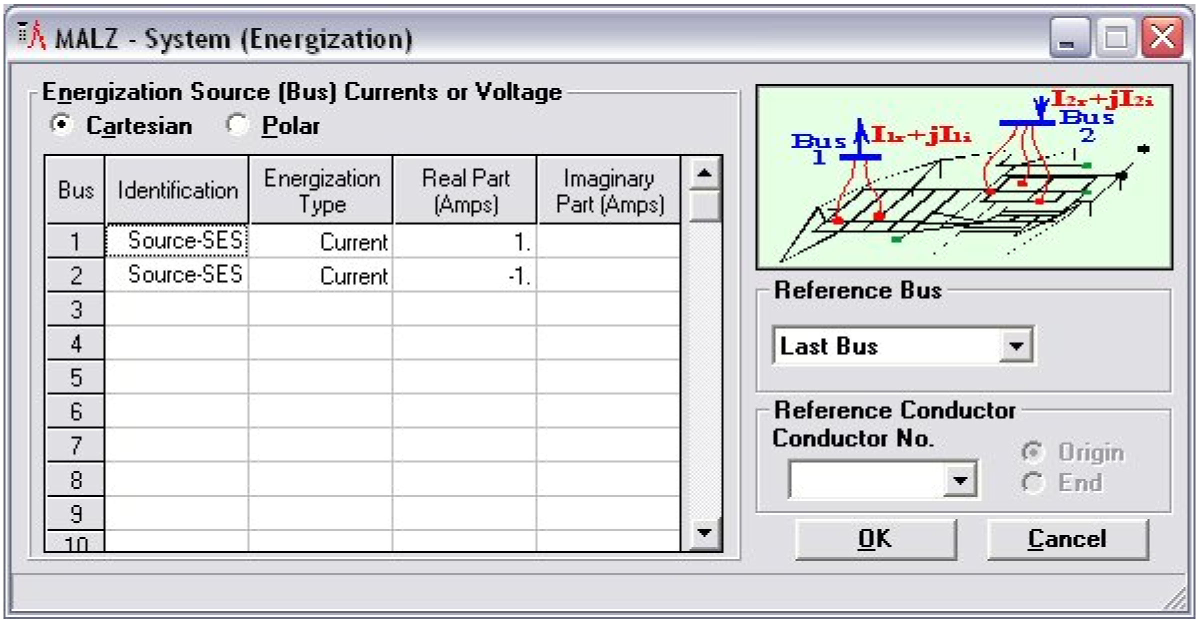


Figure 6 Screen shot of the MALZ energization system settings

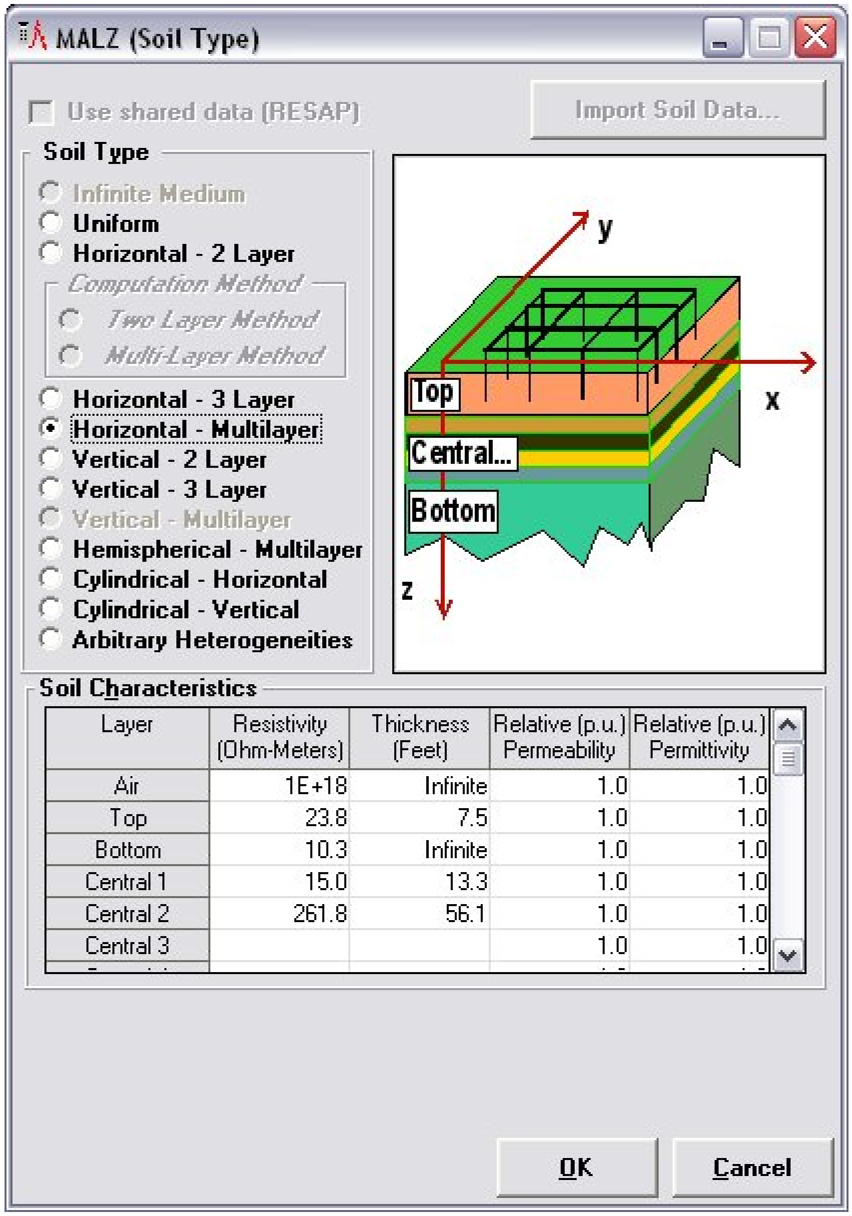


Figure 7- Screen shot of the MALZ soil type settings

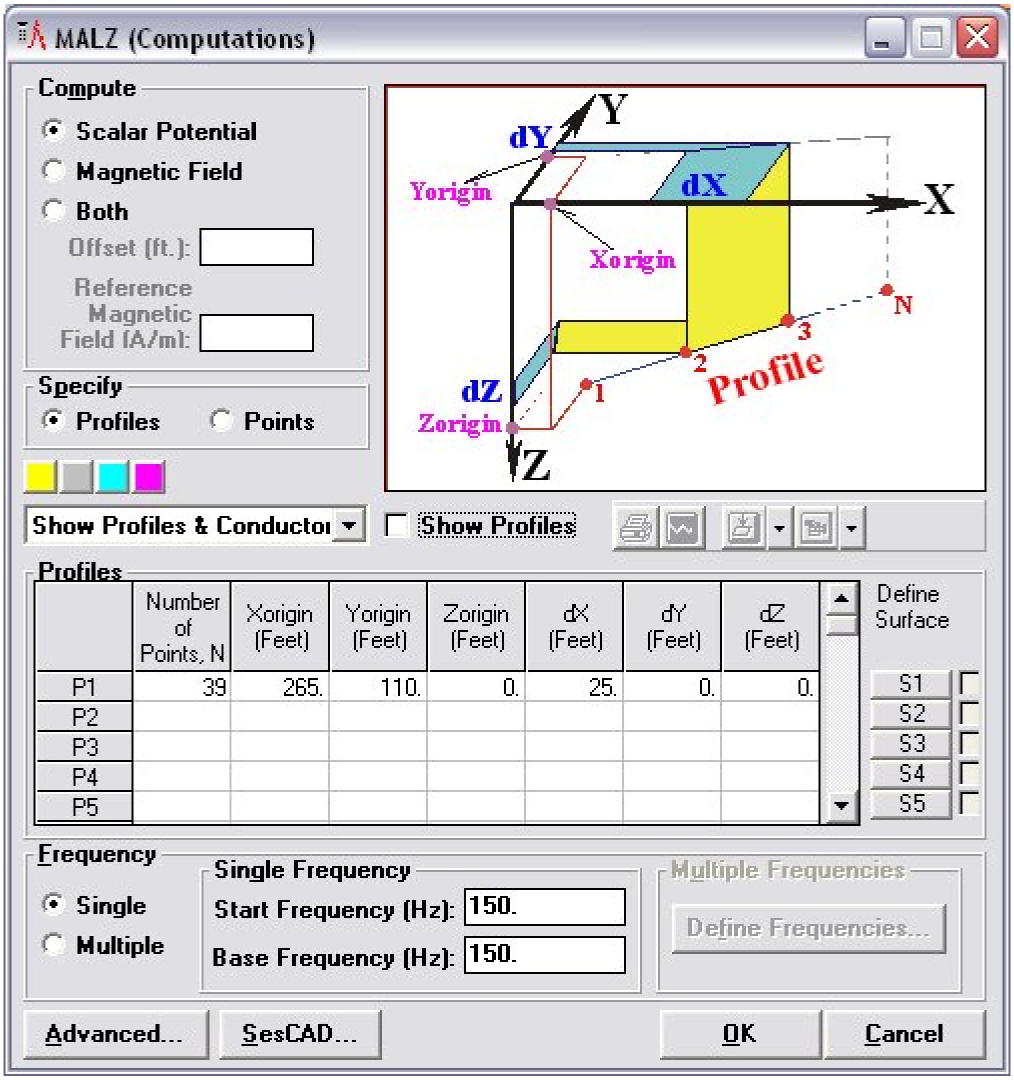


Figure 8 Screen shot of the MALZ computation settings

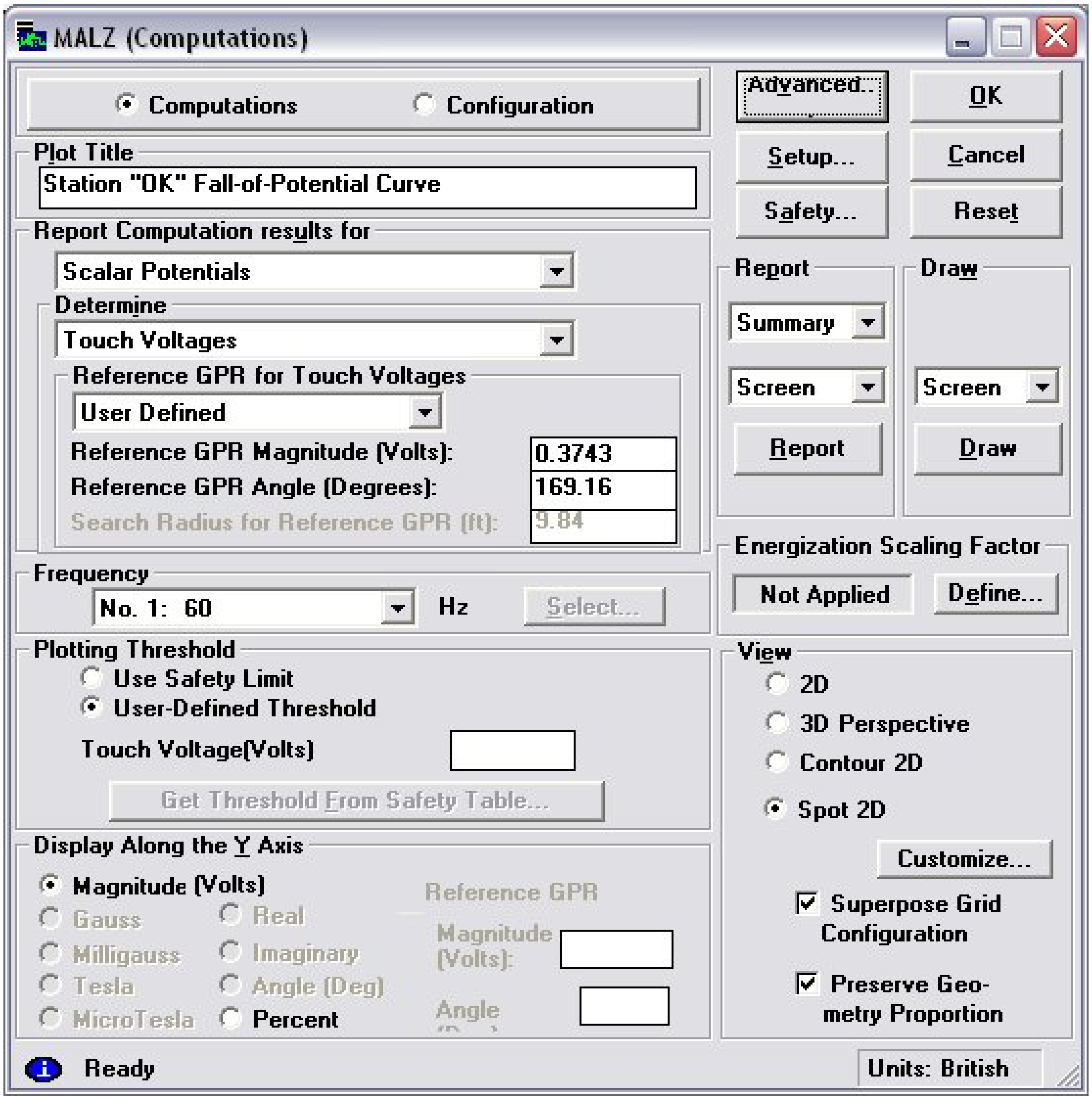


Figure 9 Output Toolbox Computation Screen

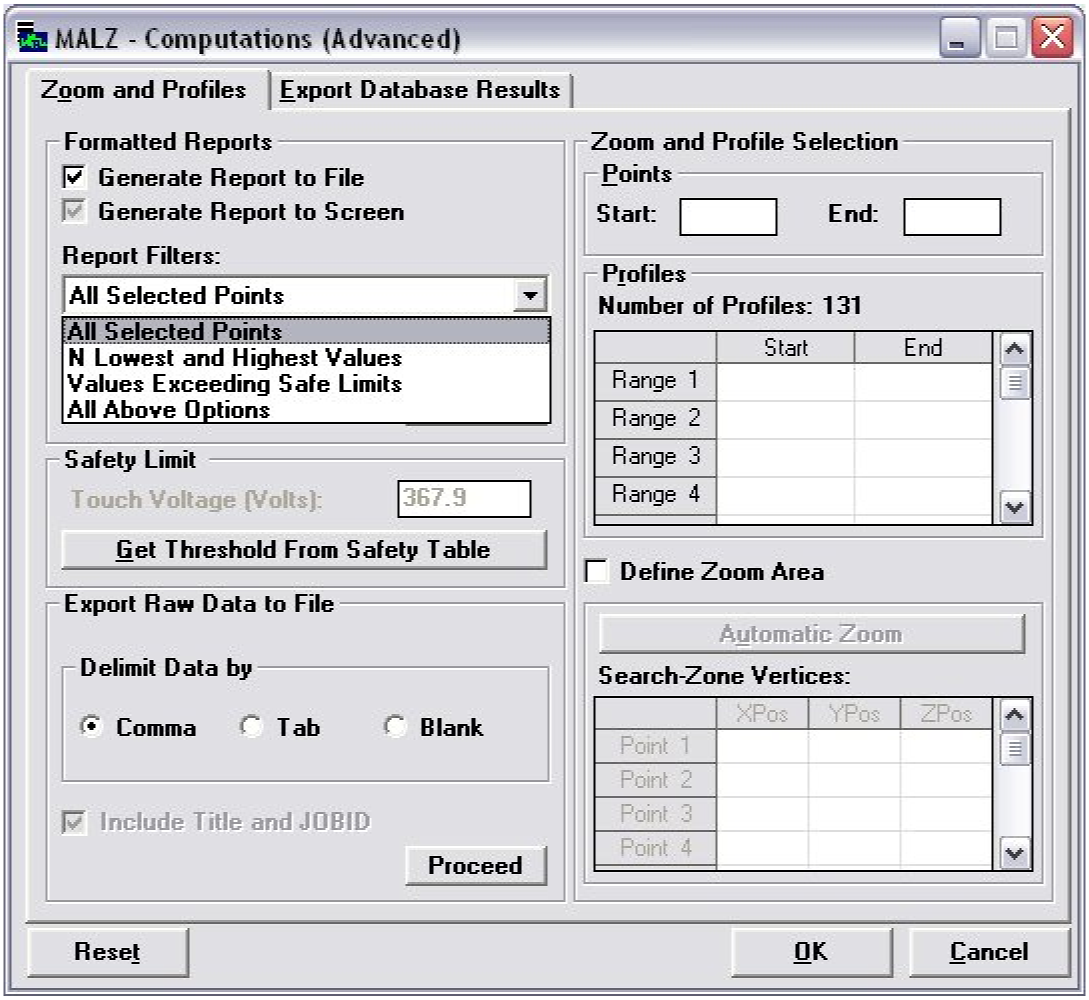


Figure 10 Advance Computation Screen

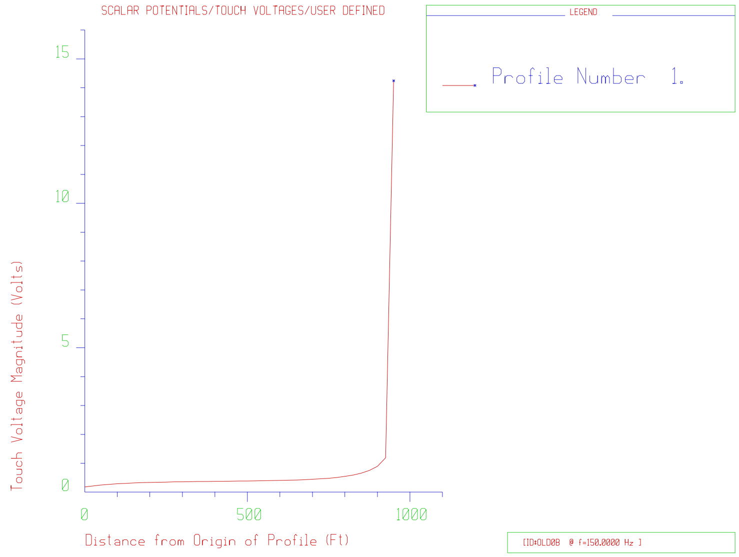


Figure 11 Potential Curve

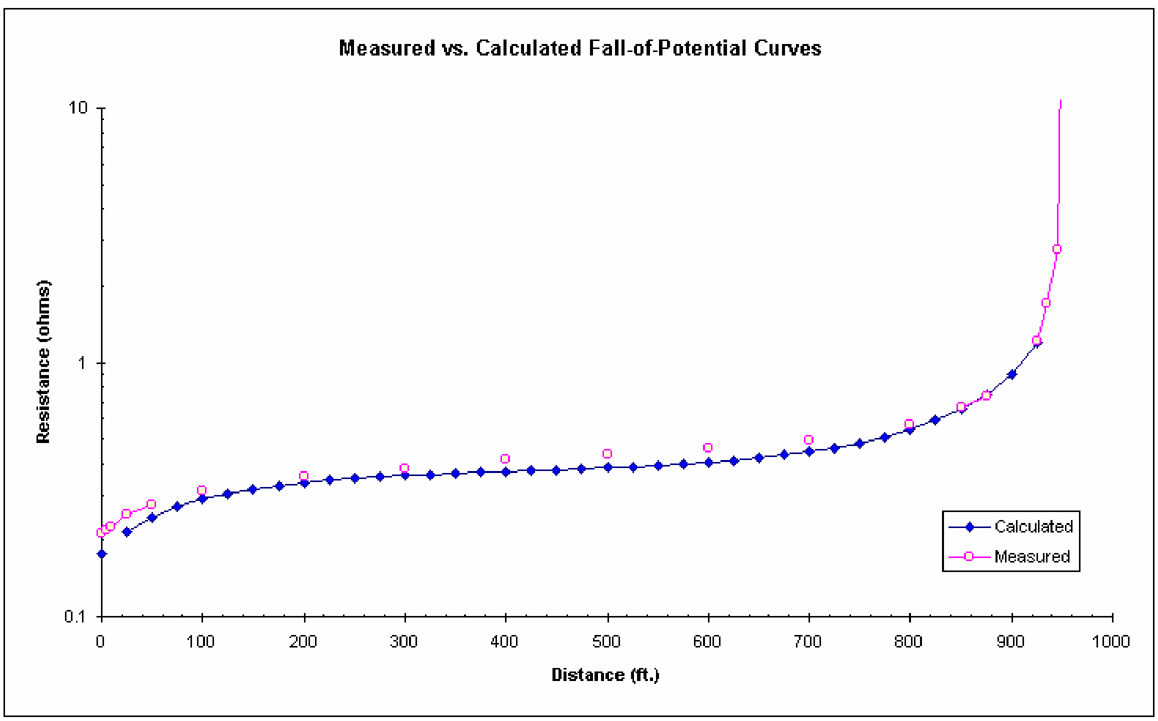


Figure 12 Fall-of-Potential curve comparison.