Calibration notes

These notes are based on the results obtained from a standard Lc300 cell (serial number 020) and show the measurement uncertainties that are obtained when using the standard test technique for the measurement of emissions in GTEM-type cells.

The calibration of the Lc300 is performed using a reference source (ERS), traceable to NPL (UK). The ERS is placed in 12 locations in the cell covering one quadrant of the EUT volume. The symmetry of the cell means that these results represent 27 locations throughout the whole volume. Measurements are taken every 2MHz.

The results are plotted in figure 1.

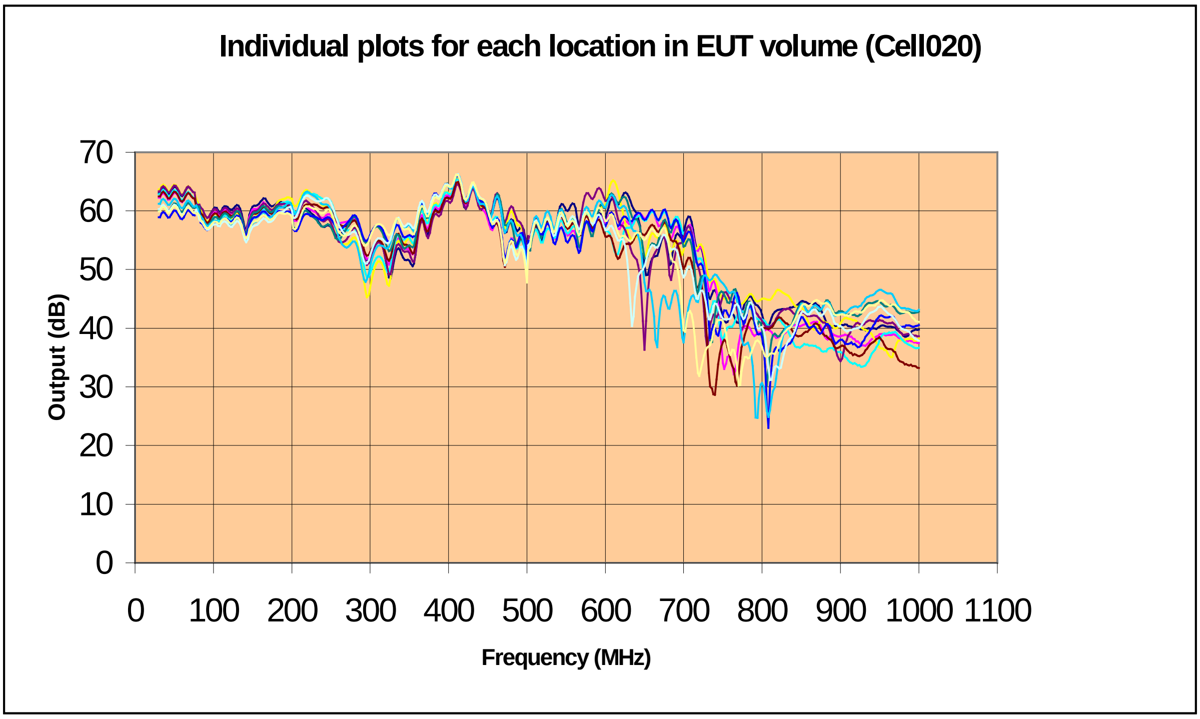

Figure 1. Measurements of the ERS at 12 locations in one quadrant of the test volume.

The ‘antenna factor’ (A.F.) or ‘correction data’ or calibration factor’ can be calculated for each location by using the calibration data for the ERS.
At each 2MHz frequency step:

AF(cell) = ERS(dB) - cell(dB)

So if the ERS has been measured as 56dBuV/m on the NPL 3 metre test site, and the ERS is measured as 62dB in the test cell, then the cell A.F. is 56 - 62 = -6dB.

Figure 1 shows how especially at higher frequencies, each location gives different results. This is a common feature of GTEM and similar cells. It happens when the wavelength becomes comparable with the physical dimensions of the cell. In particular note how narrow ‘dropouts’ occur when the cell effectively becomes less sensitive. These represent small ‘dead’ zones in the test volume. The standard technique to ensure that these do not cause significant measurement errors is to scan the EUT several times, each scan with the EUT is a different location. The final result is taken as the peak reading at each frequency step across all the scans.

To calculate the cell calibration, the following procedure is used:

For each frequency step....

List all 12 measurements (corresponding to the 12 locations) and discard the 4 lowest.

Average the 4 highest readings.
Check that the highest reading is within 4dB of the average.
Using the average and the ERS data, calculate the A.F. of the cell.

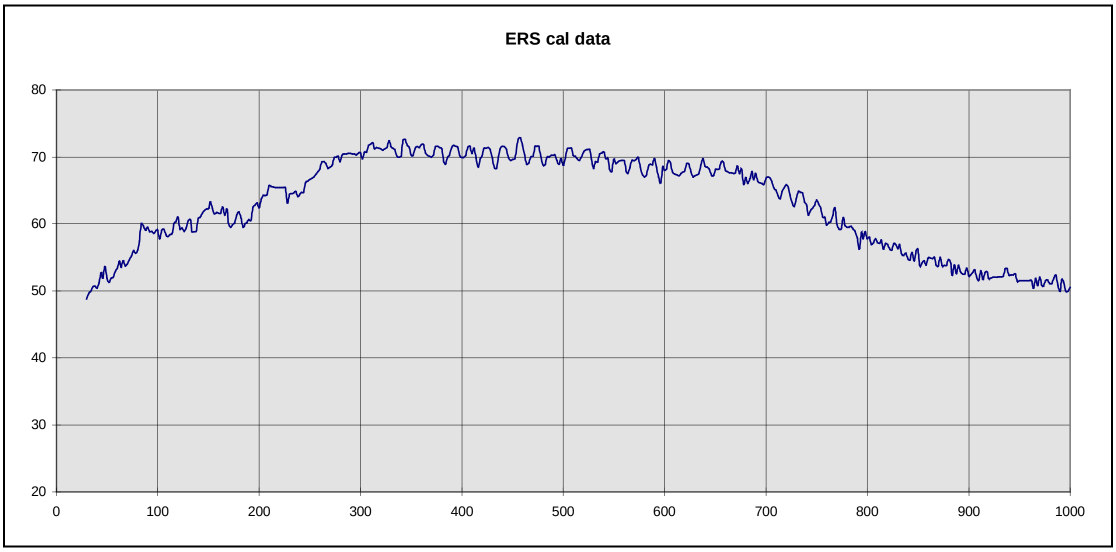

Figure 2. ERS calibration data

The ERS data used for the calibration is shown in figure 2.

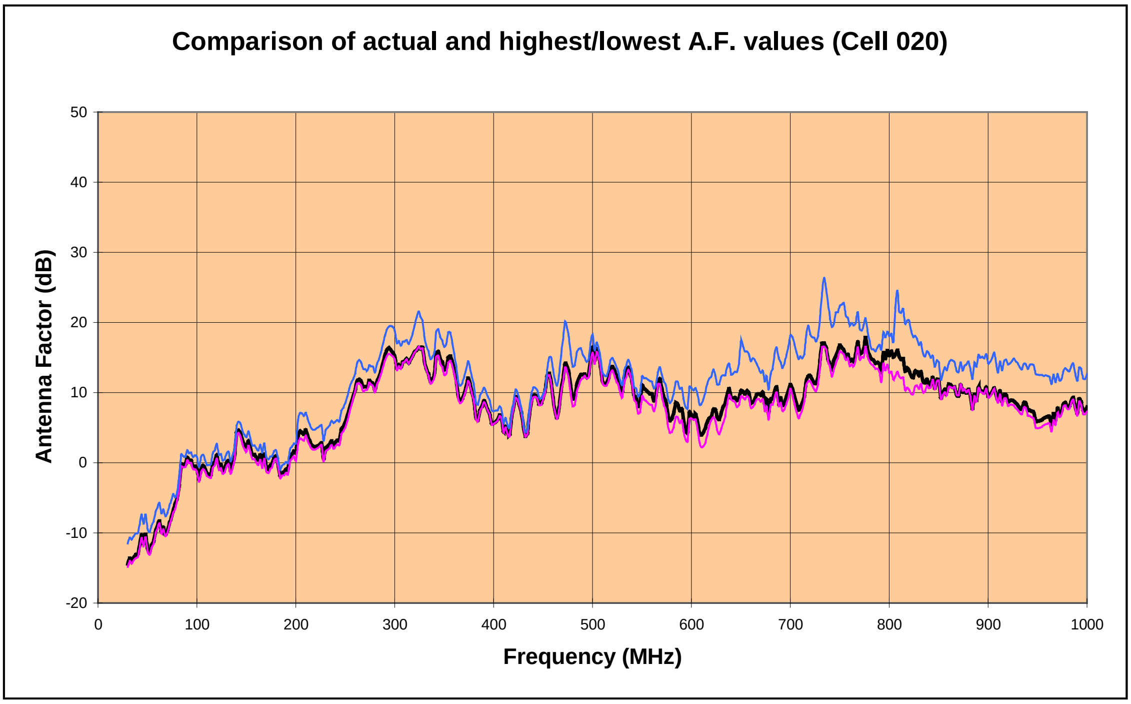

Figure 3. Cell Antenna Factor for 3 metre OATS

The thick line shows the cell A.F. as calculated using the above procedure. The lower thin line is the A.F. calculated using the highest reading and the upper thin line is the A.F. calculated using the lowest reading after discarding the 4 lowest.

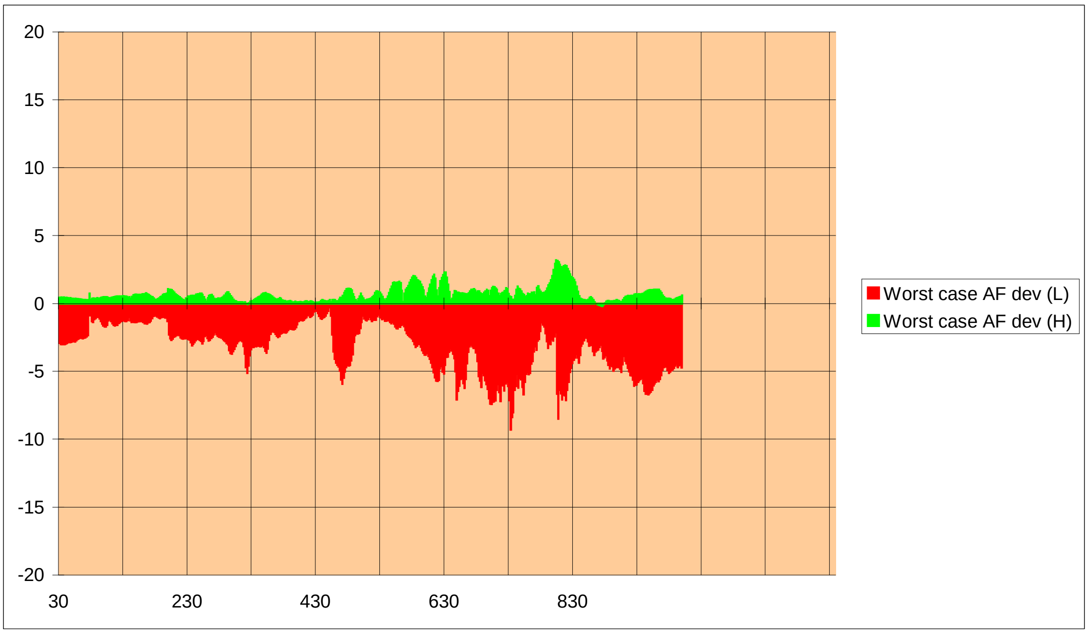

Figure 4.
This shows the maximum errors as derived from figure 3. As can be seen, in no circumstances can a high readings of more than 4 dB be obtained, however, low readings over 10 dB are possible above 600MHz. It is these errors which require the use of several scans in order to avoid obtaining false results.

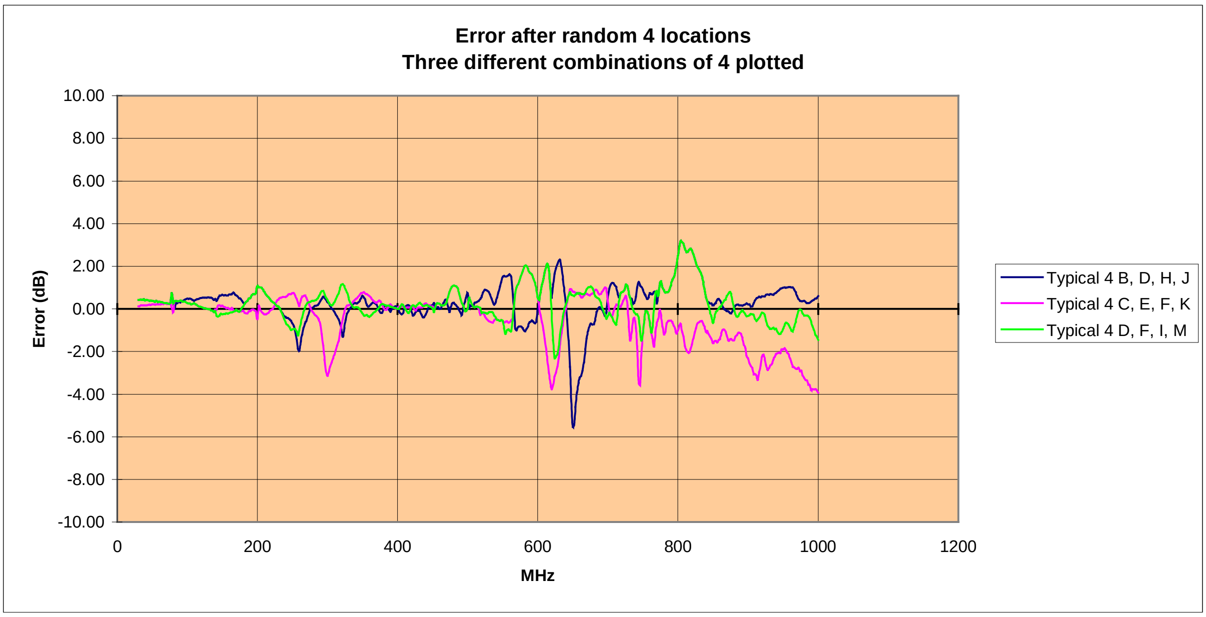

Figure 5
This shows the results of taking 4 scans with the EUT in different locations for each scan and applying peak hold across all 4 scans. This test has been repeated 3 times, each with a different combination of locations, selected at random. The 4 locations selected for each test are shown on the plot (e.g. B, D, H, J)
As can be seen, measurement uncertainty below 600MHz is now 2dB and above 600MHz it is now around 4dB. These results are comparable with those obtainable on the best OATS sites.

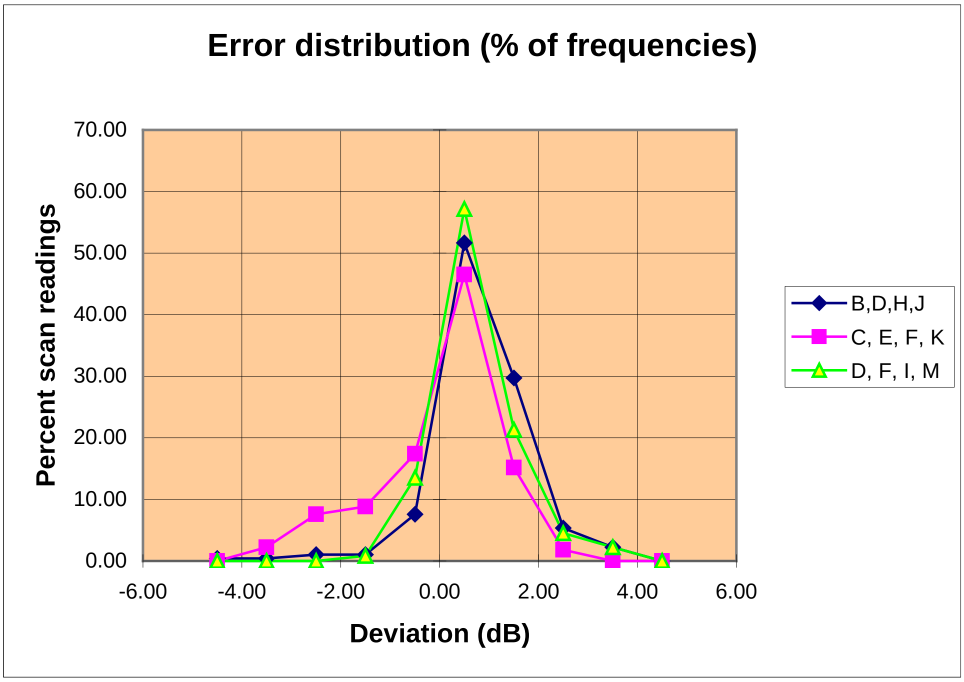

Figure 6

This shows the error distribution for each of the three tests above.

The percentage of results within 2dB of the actual is 89.96%, 87.91% and 92.83% respectively and within 3dB the figures are 96.31%, 97.34% and 97.34%. This shows that the choice of locations within the volume will have an effect on the results, but as figure 6 graphically shows, the effect is marginal. Taking more that 4 scans (4 locations) will improve the results, but the law of diminishing returns will apply.

All the above tests have been undertaken with a compact source (the ERS). An EUT with cables or larger distributed sources would increase the measurement uncertainties. The degree of increase is entirely dependant on the detail of the EUT, cables and the rigour with which the testing is accomplished.

We would be most interested in comparing these results with other GTEM and compact cells that are on the market.