Appendix: Modelling Program

The following pages give the code used for fitting Model 2 to a set of BN data. The principal steps used to determine the fitting parameters are listed below, with the program unit names given in parentheses.

1. The real data are read as (s, y) pairs, where s is the applied field or current, and y the RMS noise voltage (MAIN).

2. The background noise level is found by dividing the y axis into 'bins' and counting the number of s points falling into each bin. The mean background noise is obtained from those points falling in the most highly populated bin and the three bins above and three bins below it on the y axis (NOISE).

3. The onset of the BN peak (S_b) is identified by finding the position at which the background noise is exceeded by a critical amount (BASEL).

4. The s-axis is divided into bins and the mean y value within each bin calculated. Comparison of these values enables determination of whether the data set contains a single peak, double peak or shoulder, and the approximate position of the centres of these. This method is only successful if the number of bins is appropriate; it was found by trial and error that 20 was a suitable number. Following successful identification, the exact s values of the peaks can be found (MAXY2).

5. The peak s value thus identified are used as starting values for the centres of the distributions $e^{<x>} + S_b$ and $< S >_2$. If only a single peak is found by MAXY2, the starting $< S >_2$ is obtained by incrementing $e^{<x>} + S_b$ by a small amount (STARTS).

6. Each peak is fitted separately to obtain A and ΔS_2 or Δx values, using only the data from around that peak, and fitting a single-distribution model, which is log-normal for the lower-field peak and normal for the higher-field peak (ADLOG, ADLIN).

7. The starting values obtained by these procedures are sent into the double-peak model for fitting of all seven parameters S_b, $< x >$, $< S >_2$, Δx, ΔS_2, A_1 and A_2 to obtain the best combination of these parameters (TWOPEAK).

The fitting in (6) and (7) is an iterative process. The starting values of the fitting parameters are used to calculate a Barkhausen voltage value for each s value. The error in fitting compared to the real y data is calculated using Equation 5.60. One of the fitting parameters is adjusted at a time. If its original value is Q_i, $(Q_i + 1)/100$ and $(Q_i - 1)/100$ are calculated and the new fitting errors obtained. If one of these gives a smaller error than did Q_i, it is adopted as Q_{i+1}. The process is repeated until a Q value is found whose error is smaller than that for either $(Q + 1)/100$ or $(Q - 1)/100$, *i.e.* a minimum error is found. The next parameter is then adjusted in the same way. When all the parameters have been fitted, the whole cycle is repeated. It was found by experience that it was necessary to force the program to iterate the cycle at least ten times to avoid spurious solutions appearing after one or two iterations.

In the case of Model 1, the procedure was very similar. The calculation for the lower-field peak used a normal rather than a log-normal expression, and the parameter S_b did not appear in the program since it is not necessary to specify such a value for a normal distribution. The 'arbitrary peak-fitting' in Chapter 5 used the same fitting method as Model 1, with the only difference being in the details of the model calculation.

Tests have shown that the same values of the fitting parameters could be obtained using arbitrary starting parameters varying over several orders of magnitude. It therefore appears that steps (4) and (5) are not strictly necessary, although they may reduce computation time. They do not appear to be useful in preventing unphysical solutions from being calculated, since

this has occurred occasionally using this program. Now that a large number of real data have been fitted, producing consistent values of the fitting parameters, a more informed choice of starting parameters can be made. This may be as good as, or better than, the use of steps (4) and (5) from the point of view of speed and accuracy.