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ACFM In Detail

The Technique

The alternating current field measurement (ACFM) technique was developed by TSC during the 1980s from the alternating current potential drop (ACPD) technique to combine the ability of ACPD to size crack depth with the ability of eddy current techniques to work without electrical contact. This is achieved by maintaining the uni-directional input current of ACPD (but induced rather than injected) and measuring the magnetic fields above the specimen surface instead of the surface voltages. (For more detailed information about the ACPD technique follow this link.)

In ACFM, on the other hand, use can be made of all three components of the magnetic field, although usually only two components are needed. The three components are defined in Figure 1.

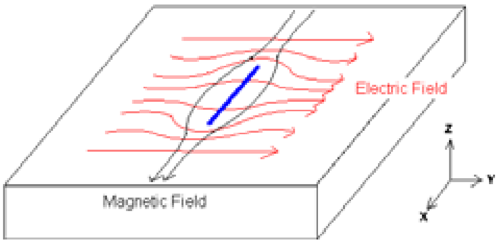

Figure 1. Definition of field directions and co-ordinate system used in ACFM

The 'Y' component, By, is parallel to the input current, the 'X' component, Bx, is perpendicular to the current and parallel to the metal surface, and the 'Z' component, Bz, is perpendicular to the metal surface. For deployment on fatigue cracked weld toes for example where a crack is parallel to the weld, the x-direction will be parallel to the crack edge.

With no defect present and a uniform current flowing in the y-direction, the magnetic field is uniform in the x-direction perpendicular to the current flow, while the other two components, By and Bz, are zero. The presence of a defect diverts current away from the deepest part and concentrates it near the ends of a crack. The effect of this is to produce strong peaks and troughs in By and Bz (above the ends of a crack), while Bx shows a broad dip along the whole defect. An example of the Bx and Bz signals above a crack is shown in the chart recorder plot on the left in Figure 2, while a qualitative explanation of the signals is shown in Figure 3.

ACFM probes generally measure Bx and Bz, the former being used to estimated crack depth and the latter giving an estimated of crack length

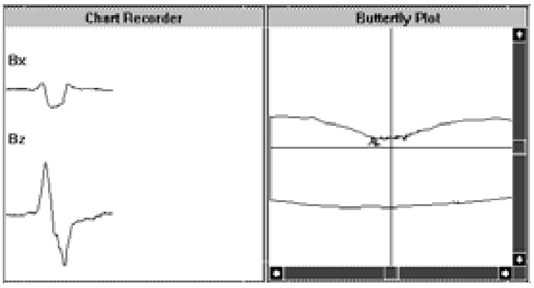

Figure 2. Example of chart recorder and **butterfly plots** from a defect

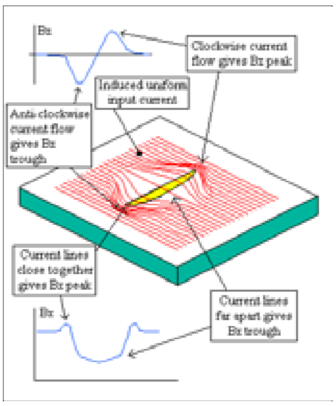

Figure 3. Qualitative explanation of the nature of Bx and Bz above a notch

The use of a unidirectional input current provides a number of advantages:

- On metals with a small **skin-depth** (such as ferritic steel), the interaction between the current and a defect has been extensively modelled so that defect sizes can be obtained without resorting to **calibration on slots**.
- Currents will be forced to flow further down a crack face (compared to circular currents). This means that deeper cracks can be sized.
- Input current strength and magnetic field perturbations decay relatively slowly with height above the surface. This means that the technique is less sensitive to changes in lift-off and can be used to inspect through coatings 6mm (1/4") or more thick.

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