ACFM
FOR MANUAL WELD INSPECTION

ACFM is widely used for detection and sizing of surface-breaking cracks in structures such as oil and gas platforms, process plant, pressure vessels, storage tanks, bridges and theme park rides. It is used for general area inspection, thread inspection, applications at high temperatures or in radioactive environments, but its main use remains the inspection of welds, particularly in ferritic steel.

ACFM meets the need for fast, low cost, non-destructive inspection without sacrificing performance. Its use has been approved by Certifying Authorities around the world, including Lloyds, DNV, BV and ABS.

This document shows some of the weld inspection applications for which ACFM has been used, and highlights some of the advantages ACFM has over MPI including:

➲Cost savings up to 70%

- ➲ Usable on coated surfaces
- ➲ Higher Probability of Detection for significant defects
- ➲ Lower false call rates
- ➲ Auditable results
- ➲ No toxic or flammable consumables

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The a.c. field measurement (ACFM) technique is a non-contacting electromagnetic technique for detection and sizing of surface-breaking defects.

The sizing capability arises from the use of a unidirectional input field, which also results in lower sensitivity to lift-off and material property changes compared to eddy current techniques. The insensitivity to lift-off has led to the increasing use of ACFM in place of magnetic particle inspection, especially underwater and on painted or coated structures, where significant time savings can be made through not having to clean off rust or remove and reapply the coating. The insensitivity to material property differences makes ACFM ideal for detecting and sizing fatigue cracks at weld toes in ferritic or austenitic steel or in transition welds between the two.

Figure 1. ACFM Inspection of pressure cylinder.

The ACFM technique is normally deployed using a single operator who both scans the hand-held probe along the weld under inspection, and interprets the data collected on a standard laptop PC connected to the ACFM instrumentation. Figure 1 shows manual probe deployment on a painted pressure vessel. Figure 2 shows deployment on a painted section of jack-up.

In one-man operation, where access allows, ACFM can provide large cost savings compared to magnetic particle or dye penetrant inspection, even on uncoated surfaces. The examples below compare one-man inspection of 100 separate 1m long welds where it is assumed that there is an average of one significant defect (>1mm deep) per weld. Comparisons are made between ACFM and MPI (the latter used in conjunction with ACPD or UT to provide depth information on the defects) for both unpainted and painted welds. The depth information is needed to allow decisions on subsequent removal of cracks to be made. If no other technique is used in conjunction with MPI to give depth information, it is usual to grind about 1mm at a time and re-inspect between grinds to check if the crack has disappeared. In this case, the extra time spent grinding is even longer than that spent depth sizing.

Figure 2. ACFM Inspection of painted jack-up leg

COST COMPARISON BETWEEN ACFM AND MPI

Case Study. 100-off 1m welds, each containing 1 defect. One-man inspection.

MPI - unpainted surface	days	rate	Cost £
Remove rust (150mm either side of weld)	2	150	300
Carry out MPI with yoke	3	200	600
Measure crack depths (ACPD or UT, hired in)	2	350	700
TOTAL			**£1600**

MPI - painted surface	days	rate	Cost £
Remove paint (150mm either side of weld)	4	150	600
Carry out MPI with yoke	3	200	600
Measure crack depths (ACPD or UT, hired in)	2	350	700
Reapply paint (2 coats)	2	150	**300**
TOTAL			**£2200**

ACFM either surface	days	rate	Cost £
Collect data (3 passes @ 50mm/sec = 90 secs /weld)			
Analyse data and size defects (120 secs / weld)			
Redeploy to next weld (120 secs / weld)			
TOTAL	1.5	400	**£600**

Savings in this case are between 60% (unpainted surface) and 70% (painted surface).

The above figures are backed up by feedback from service companies experienced with both techniques. One such company reported that ACFM is typically 2-3 times faster than MPI, and up to 5 times faster for large inspection jobs on painted structures. For example, 200m of weld on a painted pressure vessel was inspected in 1.5 days with ACFM, compared to 6 days with MPI.

Figure 3. Abseiler inspecting crane

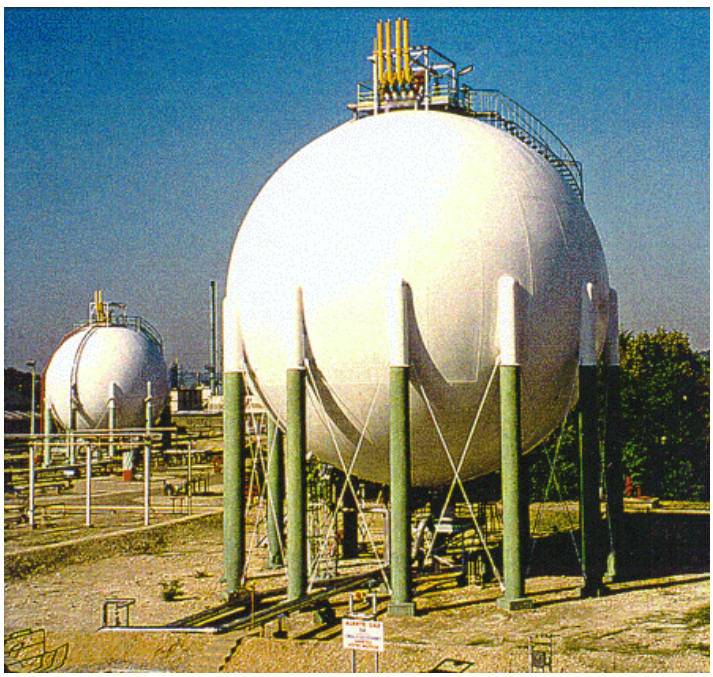
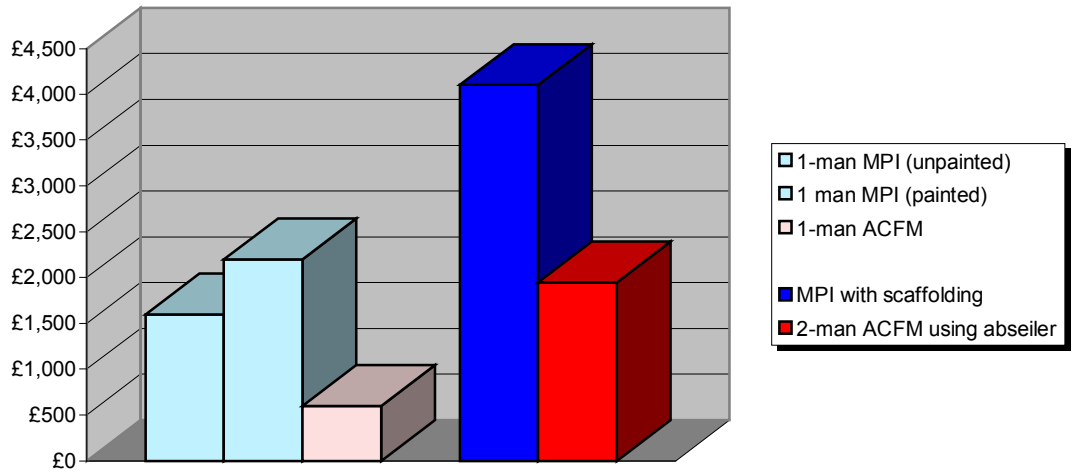


Figure 4. LPG Sphere. Inspected with abseiler

In situations where it is not possible to get easy access with man and equipment, it is common to deploy MPI from temporary scaffolding. With the ACFM technique, it is simpler and cheaper to use a 2-man operation, with one man operating the probe only, deployed using abseiling techniques, while the ACFM operator is sited with the laptop on the ground or a nearby platform. The probe operator does not need any previous training or experience, because approved ACFM operators receive training on how to demonstrate probe deployment to an inexperienced probe operator. Communication between the two can be by radio communication if necessary. Examples of 2 man operation are shown in Figures 3 and 4. The extra cost of a probe operator is more than outweighed by the cost of hiring in scaffolding for the duration of the job, so for difficult access situations, the money saved can be even greater, as indicated in the graph below.

Cost comparison for inspecting 100 1m welds, with defect removal



Much of the extra time taken on MPI inspection of welds is spent on evaluating the large number of "indications" found. On a large job, it is not unusual to find several hundred indications, of which only 10-20% may turn out to be due to real cracks. The rest will be caused by slag inclusion, undercut etc., and it takes a certain amount of experience to differentiate between the two. On the other hand, an inexperienced operator may falsely call many of these indications as cracks. ACFM has the advantage of giving a response proportional to crack depth, so signals from undercut, slag inclusions etc. are non-existent or too small to be called.

As well as having a low false call rate, ACFM has been shown in independent trials to have not only a high Probability of Detection rate, but one that increases with crack depth – an ideal situation for a practical NDT technique. Thus, as well as the direct savings achievable in inspecting welds with ACFM, indirect savings arise from the higher POD achieved compared to MPI, reducing the number of costly shutdowns caused by missed defects and/or increasing the time interval between inspections.

ACFM is also used extensively for underwater inspection where the savings become much greater. For every 1 hour of underwater MPI/ACPD inspection, about 10 hours are needed to clean the structure down to bright metal. ACFM requires only heavy marine fouling to be cleaned, and works with no cleaning through anti-fouling paints.

Finally, as well as cost savings, ACFM benefits the environment by avoiding the use of toxic and flammable consumables. These two factors combined are leading to ACFM being used very extensively as the front-line inspection tool for weld inspection.