The quality of any tank assessment depends on the accuracy of measurements as well as the probability of detection

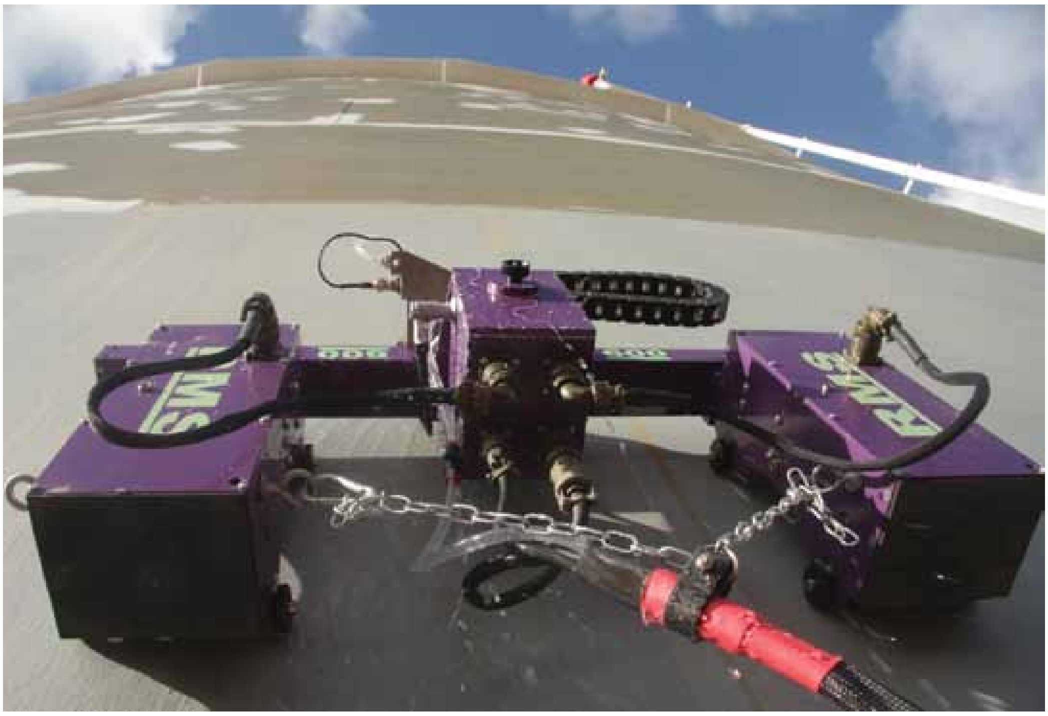
'Rubbish in equals rubbish out'

Storage tank corrosion inspection is an essential part of asset management, being used not only to certify safe operation, but also to predict expected lifetime, devise a repair strategy and assess the impact of different contents stored.

In specifying the inspection to be performed, and in assessing the quality of the final report, it is important that engineers understand the key measurements made in terms of accuracy and reliability. It is an old adage for any system that 'rubbish in equals rubbish out', and this applies equally to tank inspection.

API 653 and other standards are well established to determine tank condition, using input data collected from inspection equipment, operated by inspection personnel. If the key data is of poor quality, then the assessment is also likely to be of poor quality.

The type of equipment used in the inspection is therefore critical to good assessment and subsequent operational decisions. The goal is to have a high quality inspection completed in a reasonable amount of time. Time is a fairly well understood factor, but considering the 'quality' aspect is more complex. This is broken down into two distinct factors: accuracy of measurement and probability of detection.



RMS600 system producing a C-scan of the tank wall

Accuracy of measurement (AoM)

This determines the tolerance on a particular measurement of corrosion at a given point, and this is initially based on the accuracy of measurement of the basic instrument, but is then affected by actual on-site conditions. Ultrasonic testing is often used to measure corrosion and in theory, this can be highly accurate, with gauges giving readings +/- 0.01mm. However, when this is applied to actual defects, with difficult surface condition and typical corrosion as opposed to manufactured test defects, this accuracy often reduces to +/- 0.5mm or worse. To understand the achievable accuracy, the basic instrument is considered and then de-rated accordingly depending on the practical application.

Probability of detection (PoD)

Tanks are very large structures and tank floors can have a very large area that needs to be inspected. Inspections are attempting to find the 'needle in the haystack', looking for the thinnest section a few millimetres in diameter within a tank diameter of 80m plus. The probability of detection assessment is a measure of the likelihood of a defect of a certain size being found with the whole test area. Obviously the key factors here are the actual percentage area covered by the inspection, and the ability of the instrument to detect the minimum defect. The greater the area covered, the greater the chance of finding the defect; however this can take a significant amount of time given the total area to be scanned, so a fast coverage method is needed, such as magnetic flux leakage (MFL).

In practice only two of the three criteria can be met by a single system. For example, high accuracy and detection is possible, but this will take significant time. High detection is possible in less

Sample data report from Silverwing Floormap3D showing defect indications on the tank floor

time, but with less accuracy. Alternatively, high accuracy is possible quickly but with low detection probability.

These challenges have been known for many years and the original work completed by D.H. Saunderson in 1988 resulted in the combination of MFL tank floor scanners and ultrasonic flaw detectors. The MFL system provided fast scanning over a high percentage of the tank floor, indicating areas that should be measured more accurately, albeit at a much slower pace, by ultrasonic devices.

This has continued to be the most widely used process, with the latest MFL scanners mapping the area and storing the results for analysis and then typically using ultrasonic measurement on a sample of defects, say 20% of the total. The MFL increases the probability of detection and UT provides the hoped for accuracy.

Manufacturers of test equipment, such as UK-based Silverwing, are continually working to improve both the PoD, and the AoM, coupled with efficiency of inspection.

The latest system has a much higher PoD for a small amount of wall loss over the whole range of plate thicknesses. MFL systems achieve high detection rates as they are less sensitive to surface condition and shape of the defect than ultrasonic, and the inherent speed of scanning allows for very high percentage of coverage. The disadvantage has been the inability to reliably convert a percentage loss of plate thickness into remaining plate thickness, as can be achieved with ultrasonic testing. Ongoing research into MFL characterisation is showing positive results in this respect.

Corrosion on walls

When analysing corrosion on the walls, it is just as difficult to decide which methods are best.

Very large areas could contain small defects, but in practice corrosion tends to occur in bands around the tank just above the fluid level, so it is often possible to accept thickness measurements at a defined number of radial points with readings taken vertically.

Access can be difficult and time-consuming, due to the need for scaffolding if measurements are done by hand, but magnetic ultrasonic crawlers can overcome this. Often only a limited number of readings are taken per course, which whilst 'accurate' in measurement of thickness, gives a very low PoD. It is quite possible that the sample readings miss any corroded bands and give a false impression of tank integrity.

To overcome this, systems such as the Silverwing Scorpion crawler can take measurements in a continuous line and record the information for review. This significantly increases PoD of corrosion, and hence improves the tank assessment. Other more advanced scanners such as the Silverwing RMS can give 100% coverage in a band up to 600mm wide from the base to the top of the tank wall, increasing PoD significantly.

One factor affecting both accuracy and detection is the competence of inspection technicians. Modern inspection systems remove a lot of operator interpretation of readings, particularly using MFL, but a level of skill is still required to ensure the maximum area of the tank is scanned in the most efficient manner.

Good technicians are also able to perform internal and external visual inspections, which can then focus detailed inspections into the right areas.

The quality of any tank assessment is dependent on the quality of measurements, which include not only accuracy, but also the PoD. The engineer should consider both these factors when specifying the inspection to be done, and ensure that inspection teams use the appropriate methods. This will normally be a combination of fast scanning systems for detection, backed up by targeted higher accuracy measurements. Equipment manufacturers are working to improve both of these aspects, improving the overall quality of data, and hence tank assessment, while taking as little time as possible.

How newer technology can improve detection of smaller defects:

Plate thickness	Percentage wall loss				Percentage wall loss			
	80%	60%	40%	20%	80%	60%	40%	20%
6mm	100%	100%	100%	100%	100%	100%	100%	20%
8mm	100%	100%	100%	100%	100%	100%	100%	20%
10mm	100%	100%	100%	80%	100%	100%	100%	40%
12mm	100%	100%	100%	40%	100%	100%	100%	40%
	Silverwing Floormap3D				Silverwing FloormapVS2i			

For more information:

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