

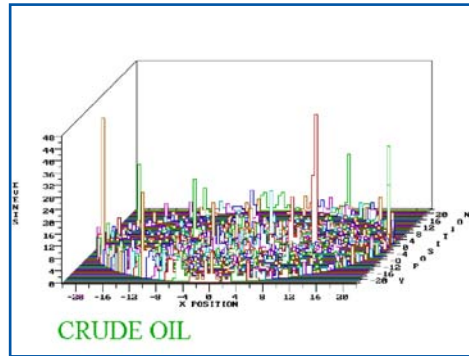
- **No Emptying/Cleaning**
- **Rapid**
- **Large Database**
- **Objective Evaluation**

The cost of shutting down and cleaning storage tanks to ready for internal inspection is high, and can exceed \$250,000 for a large crude oil tank once sludge disposal is accounted for. If no repairs are required, the costs have been largely wasted and could have been better spent elsewhere, or not at all.

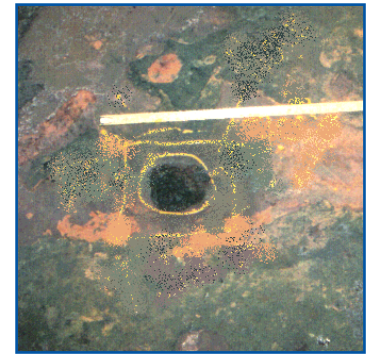


Physical Acoustics, together with its major customers, have developed a method of evaluating overall floor condition without removing tanks from service. The evaluation is based on experience from follow-up internal inspection and, in many cases, floor scanning of tanks monitored under carefully controlled conditions.

The plots to the right show one of the AE analysis on a crude-oil tank, and an example of the internal damage found. The tank needed a completely new floor due to the extensive corrosion damage. Although tanks may have many holes after cleaning, it does not mean the tank was leaking in service, since the sludge and debris can often prevent actual leakage.



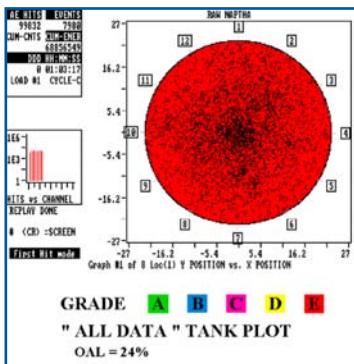
AE 3D view of an "E" grade crude oil tank



On of the 20+ holes after cleaning

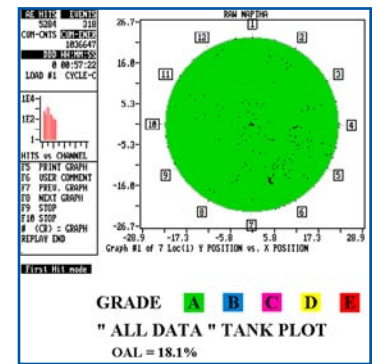
TANKPAC™ is not an inspection method, but a "sorting" system that separates "good" tanks from "bad" and directs maintenance to where it's most needed. Highly sensitive acoustic sensors are attached to the tank wall and the tank is monitored, following a period of conditioning during which valves are closed and heaters/agitators turned off. The fracture of corrosion products is detected along with leaks that are active during the actual monitoring period. A percentage of this data is located by triangulation, but the most important information gained from a maintenance management point of view is the overall condition of the floor which is

given a grading on an scale of "A" to "E."



Naptha tank before repair "E" grade

The tank to the left was one of 10 tested at the same time. The AE test indicated the tank to be in poor condition and as a result, it was removed from service for inspection. The internal inspection resulted in repairs being made and the tank was returned to service. The tank was then re-tested to obtain a "baseline" for future comparison, the result being the "A" grade shown on the right.



Naptha tank following repair "A" grade

TANKPAC™ -- Experience, Limitations, Statistics

TANKPAC™ helps to set inspection priorities and intervals based on floor condition, and fits in well with risk-based inspection strategies. Figure 1 shows the emission results from corrosion scale fracture and debonding, demonstrated by “listening” to a piece of corroding metal from a tank wall with a TANKPAC™ sensor.

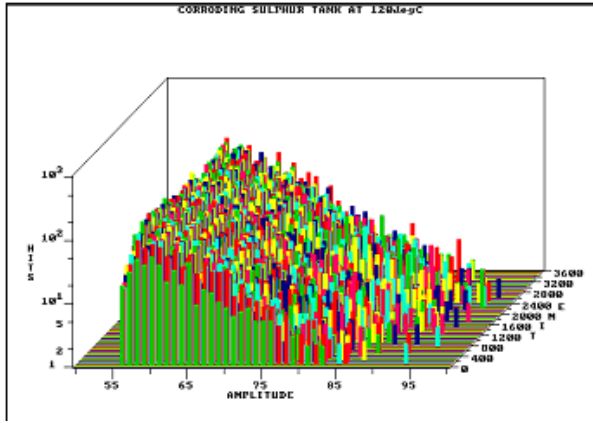


Figure 1: Acoustic emission from a corroding tank.

Based on experience from tests shown in Figure 2, the tank grade indicates overall floor condition. This grading compensates for size, contents and sludge height. The recommendations and re-test interval depend on both overall and localized activity. The TANKPAC™ statistics graph below (Figure 2) shows the % of tanks having a particular overall grade for tanks tested.

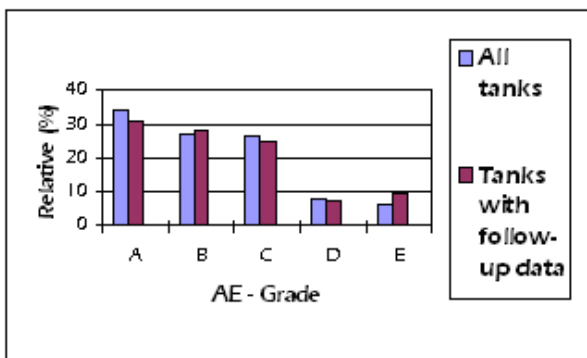


Figure 2: Percentage distribution of tanks vs. Physical Acoustics' AE overall tank floor grade for all tanks, and for those for which follow up data was obtained.

Correlation of the TANKPAC™ overall grade with actual follow-up internal inspection (Figure 3) shows the reliability of the method. In this case, the inspection/repair result is rated as follows:

- 1-No damage, no repair
- 2-Minor damage, no repair
- 3-Damage, some repairs
- 4-Major damage, many repairs or new floor

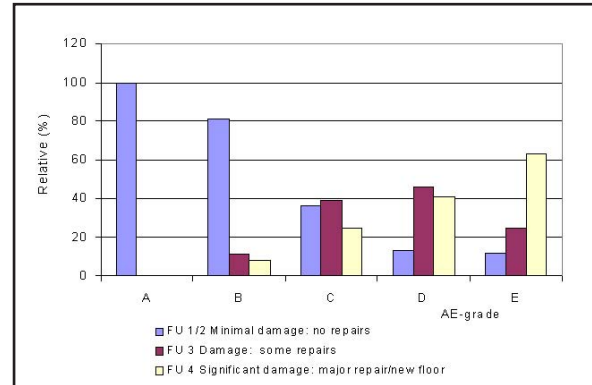


Figure 3: Correlation between AE grades and assigned follow-up grades.

Careful review of all the TANKPAC™ information, and not just the “overall”, improves the reliability. The method is being continually refined and improved as a result of customer feedback. It is best suited to tanks that are in the same service long-term. Additional monitoring may be needed if the conditions in the tank are subject to changes as these may start/ stop the corrosion process.

Cost Savings depend upon tank condition. Saving the cleaning costs on 50% of your crude tanks can amount to millions. And, on very clean product tanks, where many need no repair, savings can be huge when the overall cost of shutdown, cleaning, and internal inspection are taken into account.

A complete distribution terminal can be tested using TANKPAC™ in a weekend.

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