ACOUSTIC EMISSION TESTING (AET)

FREQUENTLY ASKED QUESTIONS (FAQ)

Acoustic Emission Testing (AET) is a Non-Destructive Testing (NDT) method that is used to analyze emitted sound waves caused by defects or discontinuities. Because of the versatility of AET, it has many industrial applications (e.g. assessing structural integrity, detecting flaws, testing for leaks, corrosion, monitoring weld quality, etc.).

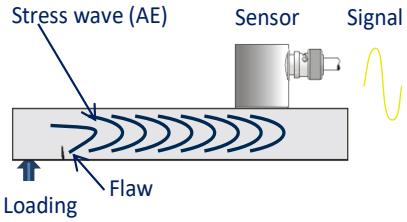
Over the years, **TechCorr** has gained extensive experience in inspecting Above Ground Storage Tanks (AST) for leaks, corrosion and inspecting for storage spheres for structural integrity using Acoustic Emission Testing.

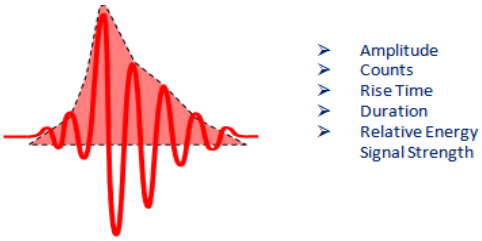
1. What is Acoustic Emission Testing (AET)?

Highly sensitive Acoustic Sensors are attached to the tank wall and the tank monitored, following a period of conditioning during which walls are closed and heaters / agitators turned off. The fracture of corrosion products is detected together with the leaks that are active during the actual monitoring period. The location of this data is located by triangulation but the most important information from a maintenance management point of view is the overall condition of the tank floor which is given a grading on an “A” to “E”.

2. What is the principle of AET?

Acoustic Emission Testing (AET) refers to the generation of transient elastic waves produced by a sudden redistribution of stress in a material. When a structure is subjected to an external stimulus (change in pressure, load, or temperature), localized sources trigger the release of energy, in the form of stress waves, which propagate to the surface and are recorded by sensors.





Highly sensitive Acoustic Sensors are attached to the tank wall (around the periphery on a predefined positions based on diameter) and the tank being monitored, following a period of conditioning during which valves are closed and heaters / agitators turned off. The acoustic events such as corrosion activity are detected together with the leaks that are active during the actual monitoring period. The location of this data is derived by triangulation but the most important information from a maintenance management point of view is the overall condition of the tank floor.

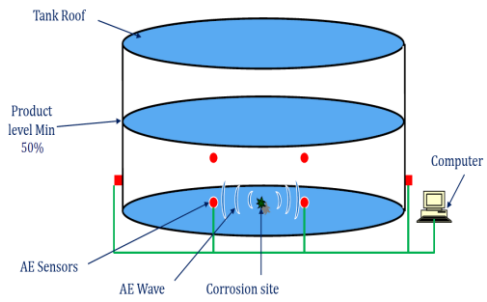
3. **What are the applications of Acoustic Emission Testing?**

Acoustic Emission testing (AET) is applied to inspect and monitor pipelines, pressure vessels, storage tanks, bridges, aircraft, and bucket trucks, and a variety of composite and ceramic components.

- To monitor the minor cracks caused by the temperature induced stress between the weld and the base metal caused during the welding process.
- Acoustic emission testing on pressurized jumbo tube trailers. A multichannel acoustic system is used to detection and mapped source locations.
- Welds, joints and connections, and a combination of load and environmental factors heavily influence damage mechanisms such as fatigue cracking and metal thinning due to corrosion. AET is used as a technique for inspection here.
- AET has found applications in monitoring the health of aerospace structures because sensors can be attached in easily accessed areas that are remotely located from damage prone sites.
- Real-time leakage test and location within various components (small valves, steam lines, tank bottoms).

4. **How is the tank testing done?**

Above Ground Storage Tank Inspection:



The tank bottom floor is a crucial component of large oil storage tanks, and its status has a pivotal impact on the integrity of the entire tank. Tank Bottom being in-accessible to inspect under service, Acoustic Emission (AE) monitoring has become internationally recognized on-intrusive method to be capable of assessing the tank bottom floor without the necessity of prior tank cleaning.

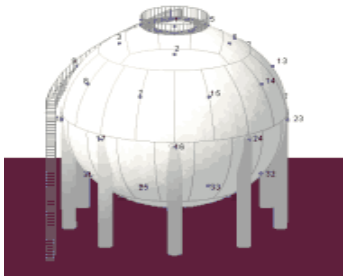
Prior to testing the tank shall be kept on still condition for few hours depending on diameter. Tank level shall be maintained at least 50% of its full operating level. AE Testing involves mounting 2 rows of High frequency AE Sensors on the 1st course of Tank Shell (near the bottom).

Data collection is carried out after the necessary calibration of sensors is done. Recorded data is analysed by surpassing the extreneous noise and charecterizing the source of emissions. Further to analysis tank bottom is graded on 'A to E' scale, Grade-A being minor activity and Grade-E being intense activity which needs immediate follow up to avoid surprise shutdowns. This way AET has become most vital method to categorize the tank bottoms and to prioritize for the maintenance without taking the tank for most costly and environmental impactive out of service inspections.

5. **How is Storage Spheres & Pressure Vessels inspection done using AET?**

Acoustic Emission (AE) as a non-destructive evaluation technique, offeringin-service, testing of pressurized spheres inspecting the whole structure, including welds and base metal. The inspection is carried out during initial hydro-test for new spheres, regular requalification hydro-test, or online,during operation with the normal sphere contents, without

removal from service. The whole test is a matter of 2-4 days including set-up, and results include recommendations for next inspection.



Similar to the Tank testing sensors are mounted on the sphere or vessel at calculated locations and load/pressure is applied during the data collection to record for acoustic emissions that comes from active anomalies. The mechanisms that can give rise to acoustic emission in are: fatigue crack nucleation and growth, plastic deformation, creep, fracture and decohesion of inclusions, stress corrosion cracking, hydrogen embrittlement, corrosion fatigue and others.

6. What is the procedure for AET inspection?

a) Preparation the background information concerning the tank to be tested is required.

b) Isolation of the tank in advance of the test, there must be no flow in or out; agitators and heaters must be switched off and contents allowed settling.

c) Settling time is recommended to be 24 hours for crude tanks, 12 hours for product tanks >15 meter and 6 hours for product tanks <15 meter diameter. All valves must be shut down and all steam heating and agitator systems turned off at start of settling. Removal of product from submerged nozzle during settling time causes minor / temporary disturbance only, and provided this is known and controlled is acceptable. All heated tanks require 24 hours settling time; ensure contents are still liquid at time of test.

d) Fluid level is recommended to be at least 50%. For bottom leak detection, it is required to fill the tank up to 60%.

e) Insulated tanks will require cut outs in the insulation of at least 200 mm diameter.

f) There will need to be two rows of AE sensors. The first bottom row will be 1 meter from the floor, and the second row is to be above the sludge line or min 2 meter.

g) AE sensors are then mounted in position and calibrated using the standard pencil break method. (0.5mm 2H).

h) AE data needs to be collected for a period on minimum of one hour.

i) AE data evaluation to be done by a Senior AE specialist.

j) Power suitable electrical power of 110 to 220 volt 15 amp single phase is required on site.

k) Background noise levels are assessed on all connecting pipe work using a portable instrument. Conditions must be effectively quiet.

l) No rain, high wind (sand blowing) ≥ 20 MPH.

m) No rapid heating or cooling. On completion of the test the AE sensors are removed and the data collection phase is considered complete.

9. How many hours does the tank need to be in the static mode and how much time does it take for inspection?

Since we are going to use HFAE we can be flexible in regards to the time that the tank needs to be in the static mode.

- For Tanks up to 20 feet in diameter we require that the tank stays 1 hour on static mode before the test. The test itself shouldn't take more than 2 hours the tank needs to be static during the test as well.
- For Tanks over 20 feet up to 40 feet in diameter we require that the tank stays 2 hours on the static mode before the test. The test itself shouldn't take more than 2 hours the tank needs to be static during the test as well

- For Tanks over 40 feet up to 60 feet in diameter we require that the tank stays 4 hours on the static mode before the test. The test itself shouldn't take more than 2 hours the tank needs to be static during the test as well.

7. What are the Site Requirements for Acoustic Emission Testing (Tank Inspection)?

1. In order to test each tank floor bottom, tank must be filled above 50% level and held still, quiet, out of service for at least 24 hours prior to testing plus two hours during testing. Also, ambient conditions which can cause noise such as mechanical, weather (precipitation, wind ≥ 24 mph, temperature ≤ 32°F) will prevent successful AE data acquisition an d subsequent AE evaluation will be delayed.
2. Tank shell plate temperature shall be at ambient temperature (less than 50°C) before mounting the AE sensors and during the inspection.
3. If lightning is seen work will cease until no lightning is seen for 30 minutes.
4. Precipitation will cause work to cease until the precipitation stops for thirty minutes.
5. Client shall provide the photographs, isometrics, drawing and any other related data of the Tank to TechCorr which shall be used to analyze its condition.
6. Power: 220V or 110V power shall be made available on site for running the equipment and the supply point shall be close to the tank (within 20ft). Amperage should be less than 50A.
7. Equipment needs to be stored inside an AC container or low temperature areas. We need portable shade arrangement or permit for the same, so we can run the analysis and avoid overheating of the AE computer. This needs to be the about 20ft from the tank.
8. Tank needs to be without any flow of product coming in and out of the tank for at least 24 hrs.
9. Every piping, pumps, etc. connected to the tank needs to be closed and isolated to reduce the background noise.
10. Clear access to work place shall be made available.
11. If required portable ladder arrangement shall be done by TechCorr for mounting the AE sensors.

In case of High Temperature Insulated Tanks:

1. Tank shell plate temperature shall be brought to ambient temperature (less than 50°C) before mounting the AE sensors and during the inspection.
   In case of any operational difficulties to lower the temperature of the shell plate up to ambient, waveguides shall be used as alternate method to mount the AE sensors. These waveguides shall be welded on external surface of shell plates.
2. Insulation pockets (Min. size of 300mm X 300mm) shall be created at AE sensors locations and the pockets shall be removed for mounting the AE sensors.
3. Suggested locations of insulation pockets for mounting AE Sensors on a tank diameter of 26m:
   a. First Row: Eight (8) AE sensors shall be mounted on the lower section of the tank at three (3) feet above the base/ chime, which are circumferentially distributed equally (8 clock positions).
   b. Second Row: Eight (8) AE sensors shall be mounted at six (6) feet level from the base/chime, which are circumferentially distributed equally (8 clock positions) above the first-row sensors at a vertical distance of three (3) feet.

12. How many sensors are fit on to the tank?

The number of AE sensors to be used on the tank to be tested is as follows:

Tank Diameter in Meters	No sensors
12.5 m	4
12.5 -25m	6
25-37m	9
37-50 m	12
50-62m	15
62-75m	18
75-87m	21
87-100m	24

10. What is HFAE and what is the difference HFAE and LFAE?

HFAE is High Frequency Acoustic Emission.

- For LFAE the tanks need to be on the static mode in between 8 to 12 hours prior the test unlike HFAE which has different duration for different diameters. The tank needs to be static during the test as well.
- HFAE is less affected by the background noise level when the frequency increases unlike LFAE.
- The HFAE test is limited to 60 feet diameter tanks because of the attenuation of the AE signal at higher frequencies unlike LFAE which can inspect any diameter of tanks.

11. What are the advantages of AET?

- **Non-intrusive & On-line Inspection:** Being in-service inspection avoids un-necessary investments on taking the tank or vessel out of operation even the structually sound in integrity. This will also eliminate possible environmental impact by prioritizing the system maintenance based on its condition.
- **Highly Productive:** Large structures or systems can be inspected within hours or days of work instead of months. Erecting scaffolding, 100% volumetric inspection in the same amount of time.
- **Global Monitoring**- Sensors detect AE signals from considerable distances, making this method ideal for global monitoring of large vessels and systems.
- **Minor Disturbance of Insulation** - Only small holes in insulation are required for sensor mounting. Waveguides are used to contact the surface. Sensors are then mounted outside the insulation.
- **Higly Economical-** High cost of un-necessary shutdown opearations are eleminated. Rapid production makes it most economical technique to inspect whole structure.
- **Field Proven-** Comparisions & follow ups raised customer's confidence. A highly reliable technique for assessing the equipment integrity.

12. What is the acceptance / rejection criteria?

There is no specific acceptance criteria that we will be used for AE of above ground tanks. The technician will categorize the bottom from Grade A to Grade E depending on the activity cluster and their energy significance. Grade A indicates the tank is in good condition and Grade E means the tank to be repaired. I have copied the grading system that we will be

using. However this is a broad classification and final recommendations will depend on the final data analysis and review by Level III.

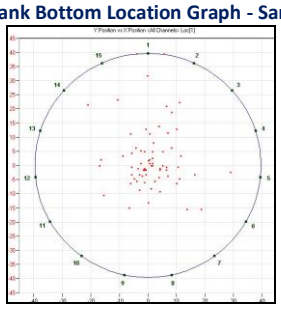
Grading Category	Color Code	Classification	Recommendations	Years to Next AE Test
A	Green	Very Minor	None	5
B	Blue	Minor Immediate	No Action Reportable	3
C	Orange	Active Immediate	Corrosion / Lean Potential Optional Follow Up	1
D	Red	Highly Active Poor	High Priority in Maintenance	After Repair

13. What is the surface preperation required?

There is no major surface preperation required. However the location where the sensors are fit need to be dry and free of grease or oils, loose scale, spatter, dirt, lint or any other substance that will hinder the results of the examination. This also depends on a case to case basis.

14. How is the inspection data represented?

AE Tank Bottom Location Graph - Sample

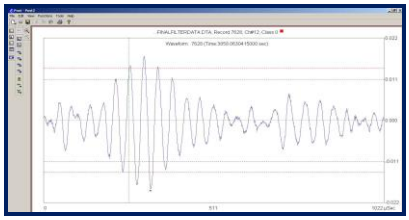


"Category Ranking System"

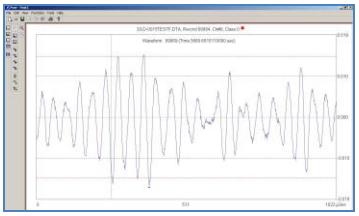
Rank	Color code	AE Energy Levels	Re-Test type/ Frequency
Category A	Green	No Energy	AE/ 5 to 7 years
Category B	Blue	Low Energy	AE/ 3 to 5 years
Category C	Orange	Low to Medium Energy	AE/ 1 to 3 years
Category D	Red	Medium to High Energy	Quantitative/ 6 to 12 months
Category E	Red	High to Very High Energy	Quantitative/ Immediately
Tank 33-D-0015 = C		AE RE-TEST / 2 Years	

AE Waveform Extraction

Waveform of Relevant AE



Waveform of Non-Relevant AE



67m CRUDE OIL tank, GRP liner