ATTAR

Manage Your Assets

ACOUSTIC EMISSION TESTING

DETERMINE PLANT AND EQUIPMENT CONDITION WITH MINIMAL DISRUPTION, ENHANCED SENSITIVITY AND SIGNIFICANTLY REDUCED COSTS

ACOUSTIC EMISSION MONITORING

Operators face constant pressure to maximise productivity while keeping costs down. Maximising asset utilisation and minimising expensive inspections is one way to keep costs under control.

Technologies that monitor assets effectively while avoiding major shutdowns have become essential tools for operators. Advanced technologies such as Acoustic Emission Testing (AET) enable you not only to diagnose issues, but assess inherent risk - and optimise asset maintenance & capital expenditure through proactive management strategies.

- Effective & Reliable Inspections
- Cost Containment
- Technology that addresses safety, regulatory & environmental concerns
- Asset structural integrity and corrosion monitoring

Acoustic emission is a cost-effective and sensitive method for assessing the condition of pressurised systems and load-bearing structures.

Defects are detected and located using a targeted array of sensors applied to a structure under stress. These sensors listen for high frequency signals ('noise') generated by active defects e.g. cracking, corrosion, and leakage.

Structural integrity is evaluated in one test, with relatively little process interruption. If AET results are within acceptable levels, the vessel can then be placed back into service; otherwise, complementary NDT methods can be targeted to suspect areas. Assets are ranked in terms of damage and prioritised for maintenance - saving time and money.

Acoustic emission testing is unique to all other non-destructive testing methods in that it detects defect growth as it is occurring. It is of great importance to have such a non-destructive test method that can detect and locate discontinuities as early as possible: repair or replacement can take place long before a catastrophe occurs, preventing loss of life, environmental damage, loss of production and more costly repairs.

REASONS TO USE AE

Global inspection of the entire structure

- Defects are located and can be characterised
- Monitoring of in-service defects under differing operating conditions or changes over time

Minimal cost

- Cost is a fraction of the price of an internal NDT inspection
- No significant cleaning costs or environmental waste disposal; no need to empty tanks, pressure vessels, etc.
- Little disruption to plant operation/ minimal downtime

Results

- Early and rapid detection of a wide variety of defects e.g. corrosion, fracture, delamination, disbondment, deformations
- Results used to identify and prioritise

maintenance according to risk

- High sensitivity & Defect location
- Method accepted in Europe, Canada, US, South America, Middle East & Australasia
- Reveals strength, damage and failure
- Permanent, digital recording

Ease of Inspection

- Global inspection that does not require access to the whole examination area
- Sensors can be directly mounted on test specimens, or placed at distanced locations
- Minimal pre-inspection preparation, disturbance of insulation or disruption of the asset
- On-site or remote monitoring; potential for online inspection
- Inspections of difficult-to-access areas and Corrosion Under Insulation (CUI)
- May be used in accordance with high temperature processes as well as cryogenic vessels
- Turnaround time: AET can take a matter of hours

TYPICAL APPLICATIONS

- Tanks (atmospheric or pressurised storage, spherical, Fibreglass Reinforced Plastic (FRP)
- Pressure vessels (ambient, hot or cryogenic, metallic and FRP, spheres)
- Compressed-Gas Cylinders & Tube trailers (fixed or portable installation)
- Pipeline & high energy piping testing

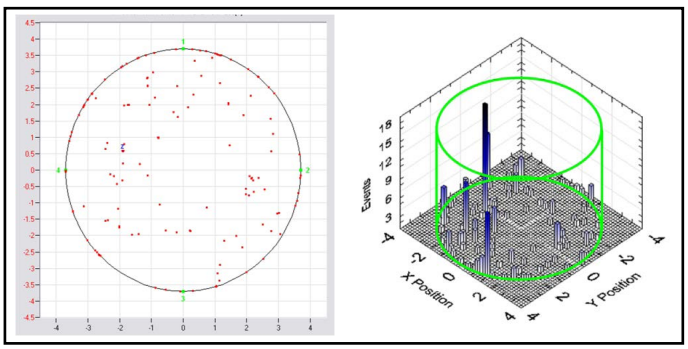
For more applications, refer to page 11.

ACOUSTIC EMISSION MONITORING: HOW IT WORKS

Acoustic emission is an elastic wave which results from a sudden release of energy within a material; these waves are generated by dislocation motions associated with materials under stress. Acoustic Emission Testing (AET) is based on the detection and conversion of these high frequency elastic waves to electrical signals. Sensors are coupled to the surface of the structure under test; they listen for signals ('noise') generated by active defects, corrosion processes, leaks, creep in steam lines, or strand failure in cable bundles.

Acoustic Emission (AE) Sources:

- Active cracks
- Plastic deformation of material
- Active corrosion and spalling of corrosion products
- Leak noise



Caption: A 3D view of the tank floor indicating the level and location of acoustic emission activity.

AET records energy emitted by a structure while it is being subjected to stress through either controlled stimulation of the structure, or on-line monitoring during 'normal' operation. ATTAR's ASNT SNT-TC-1A Level II and III AE technicians and engineers interpret the signals to classify the condition of the structure.

The signal generated by a sensor has many features commonly used to characterise it: amplitude, duration, rise time, decay time and AE counts.

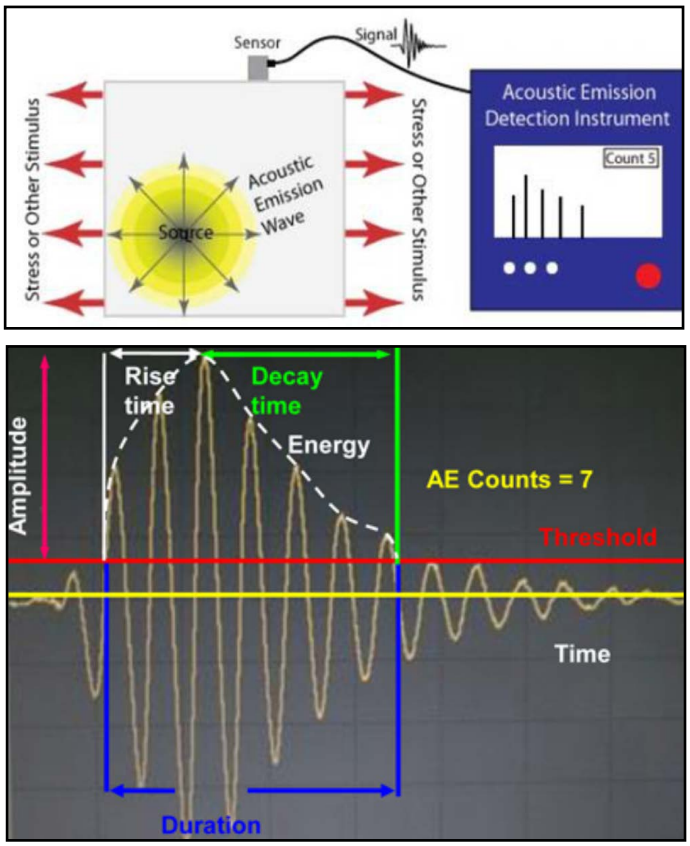
The sensitivity of AE sensors allows a single sensor to potentially monitor a large area. As typically full arrays of sensors are used, the system is provided with the versatility to test many types of structures, such as tanks, pressure vessels, gas cylinders, pipelines, bridges, jet airplanes...

Structural integrity is evaluated in one test, with relatively little process interruption. If AE results are within acceptable levels, the vessel can then be placed back into service; otherwise, complementary NDT methods can be targeted to suspect areas. Assets are ranked in terms of damage and prioritised for maintenance - saving time and money.

ANALYSIS AND REPORTING

Test results are analysed for any potential anomalies. ATTAR reports include a diagram of the subject indicating severity and location of acoustic emission activity, as well as an assessment or classification of the structure.

Caption: Class C tank floor plan view showing acoustic emission activity. AET indicates a medium level of activity on the tank floor that would indicate no immediate need for an internal inspection but should be retested in one year.



ACOUSTIC EMISSION TESTING STANDARDS

AE monitoring is recognised globally through various networks of Australian and International Standards, Pressure Vessel Codes and ASTM test methods. These include but are not limited to:

- AS 3788: Pressure Equipment. In-Service Inspections
- ASTM E1139: Standard Practice for Continuous Monitoring of Acoustic Emission from Metal Pressure Vessels

- ASME Boiler & Pressure Vessel Code: Article 12 – Acoustic Emission Examination of Metallic Vessels During Pressure Testing
- AS2030 SAA Gas Cylinders Code
- AS 2337 Gas cylinder test stations - Transportable gas cylinders - Periodic inspection and testing of composite gas cylinders
- AS 4748 Acoustic Emission Testing of Fibreglass-Insulated Booms on Elevating Work Platforms
- ASTM E569 Standard Practice for Acoustic Emission Monitoring of Structures During Controlled Stimulation
- ASTM E1067 Standard Practice for Acoustic Emission Examination of Fiberglass Reinforced Plastic Resin (FRP) Tanks/Vessels
- ASTM E1211 Standard Practice for Leak Detection and Location Using Surface Mounted Acoustic Emission Sensors
- ISO/DIS 16148 Refillable Seamless Steel gas Cylinders – Acoustic Emission Examination (AEE) for Periodic Inspection
- DIN EN 14584 Acoustic Emission – Examination of Metallic Pressure Equipment during Proof Testing
- ASME Boiler & Pressure Vessel Code – Article 11 – Acoustic Emission Examination of Fiber-Reinforced Plastic Vessels

ENSURING THE SENSITIVITY AND ROBUSTNESS OF AE

Background noise from weather, structure internals or processes, loading or pressurisation may occur. ATTAR staff has monitored crack growth inside jet trainer aircraft during hundreds of hours of flight, high pressure pipelines in operating power stations, and fibreglass pipelines carrying fluid; we understand the techniques necessary to remove background noise without compromising AE signals of interest.

Feasibility testing may be undertaken with real or artificial discontinuities of the type and size expected to demonstrate detectability and reliability, if desired by the client.

AE COMPARED TO OTHER NDT TECHNIQUES

Acoustic Emission

- Detects growth/movement of flaws
- Related to stress field generated by flaws
- Direct relationship to material failure
- Best suited for global monitoring
- Each loading is unique
- Less intrusive; easier access
- Applicability, technique depends on material
- Less dependent on local geometry

Limitations of Acoustic Emission

- Unstressed flaws will not emit
- Dependence on stress history
- Sound wave attenuation
- Background noise

Most Other NDT Methods

- Detects presence of flaws
- Relates to size and shape of flaw
- Indirect relationship to material failure
- Only suitable for local scanning
- Inspections are easier to repeat
- More intrusive; harder access
- Applicability, technique depends on material
- More dependent on local geometry

Limitations of Other NDT Methods

- Close access required
- Dependence on surface condition, geometry
- Some methods are limited to surface-breaking flaws
- Time and money spent removing flaws that may not be active in service

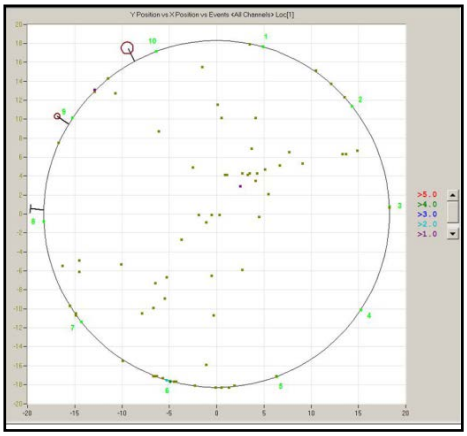
STORAGE TANKS

Acoustic Emission Testing (AET) of above ground storage tanks can add significant value to a risk based inspection. Prescribed in AS 1940 & API 653, AET can be used to justify postponing internal inspections or assist in prioritising tank maintenance planning, saving both time and money.

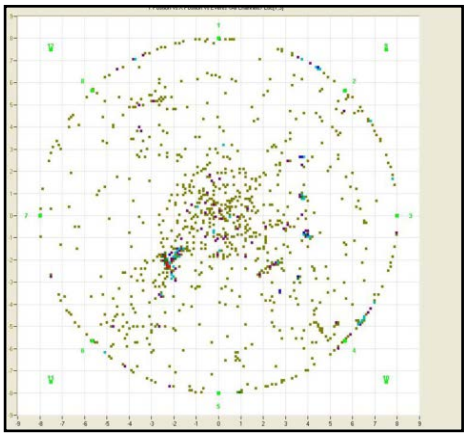
AET is a non-intrusive inspection method that enables the detection of active leaks, corrosion and cracking without the need to empty the tank and, as a consequence, reduces costs while incurring only a minor interruption to operational readiness. Both tank floors and whole tanks can be monitored, including cylindrical, FRP and cryogenic tanks.

Benefits of AET include:

- Justify decisions to continue in service use without further internal inspections and to open the tank and perform conventional NDT on localised areas (saves cost)
- Tank Inspection Economics where cost is a fraction of the price of internal inspections; no additional cleaning, contamination or environmental waste disposal costs/ issues
- Safety benefits: personnel do not need to enter the tank
- Sensitivity to and localisation of active defects
- Tanks may be placed back into service immediately following testing
- Little preparation required from the plant operator
- Data used for grading tank floor condition and detection of leaks



Good Tank



Bad Tank

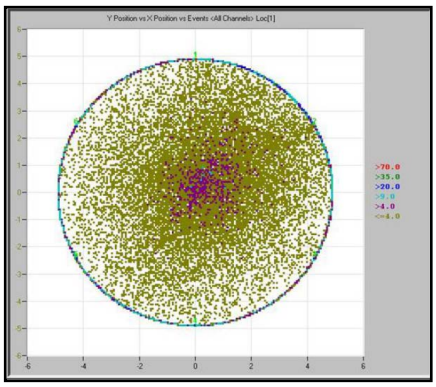
Testing Procedure

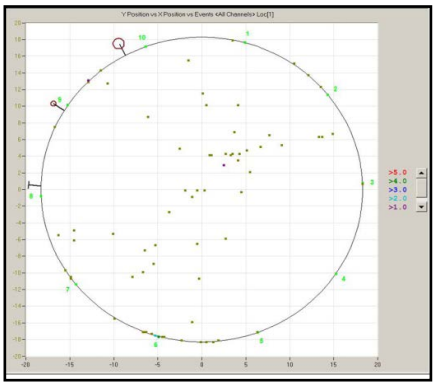
Sensors are mounted on the outside of the tank with acoustic emissions generated from the tank recorded over a period of a few hours. Preparation required is minimal: the tank should remain static for a short period of time prior to and during testing and after, ideally being filled to better than 70% capacity.

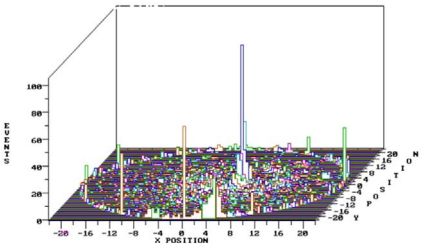
Report

Leaks, corrosion and crack indications are identified, localised and graded according to their severity. An output of the data can be shown as a map, indicating both the location of acoustic emission active sites and their level of activity.

Please note: AET does not determine remaining floor thickness or corrosion rate.







The overall condition of the tank floor is graded based on the level of Acoustic Emission activity. There are five tank classifications used by ATTAR, providing clear direction for clients to prioritise asset maintenance. Tanks are classified from A (very good) to E (very bad), clarifying which tanks to open and to perform conventional NDT on localised areas, and which tanks can be placed back into active service with no further internal inspection within a recommended time interval. Tank floors graded ‘level A‘ are characteristic of very low risk tanks which should be retested in five years. Higher risk tank floors are classed as Level E, which have very high acoustic emission activity and would normally initiate an immediate internal inspection.

PRESSURE VESSELS

ATTAR's experience in the application of AET on pressure vessels includes gas cylinders, LPG bullets, ammonia tanks, CNG, helium and hydrogen tubes as well as heat exchangers, spheres and other conventional pressure vessels. ATTAR is NATA accredited for AET and is a certified 'Gas Cylinder Test Station' in accordance with AS 2030 and AS 2337.

The cost of AE inspection cylinders is less than the price of complete surface UT, hydrotest and internal inspection. Based on the level of AE activity, advice is given to facilitate follow up NDT or maintenance if and where necessary.

AE COMPARED TO CONVENTIONAL HYDROSTATIC TESTING

Acoustic Emission

- Onsite or remote monitoring
- No Contamination
- Cost saving; minimal logistics
- Locates defects and targets areas where further inspection may be prudent (reduces cost)
- Vessel can be put back into operation immediately (dependent on risk classification)Less dependent on local geometry

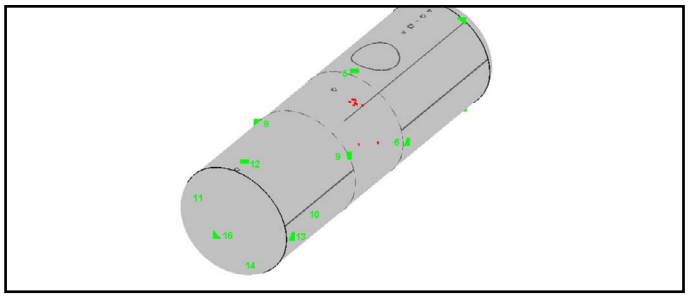
Hydrostatic Testing

- Usually offsite
- Contamination with H2O; must dry out vessel
- Costly logistics
- Only shows pass/fail status. Flaws may propagate during testing without detection
- Vessel out of action longer

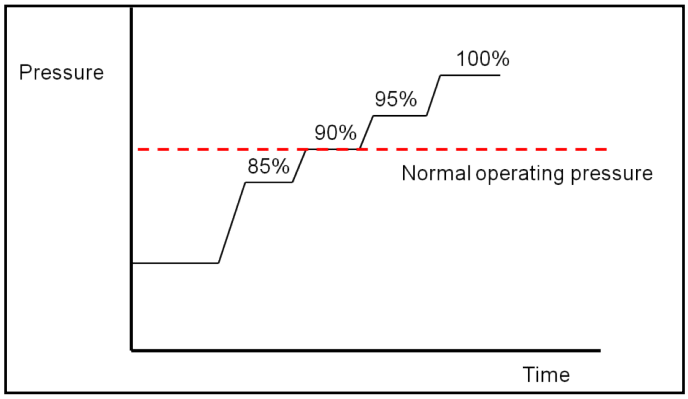
The cost of AE inspection is less than the price of complete surface UT, hydrotest and internal inspection.

Testing Procedures

Acoustic emission sensors are mounted on the outside of the vessel or cylinder with pressure applied in stages, normally to 10% above normal operating pressure. Continuous monitoring at normal operating pressure may also be possible.



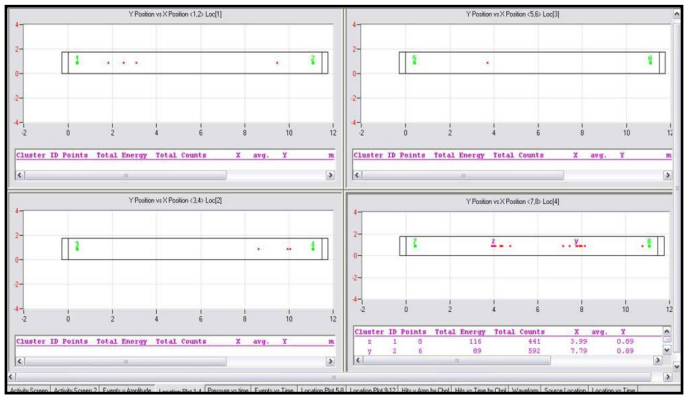
Sensors mounted over vessel ensuring source from any location can be detected and located. Number of sensors determined by the size of the vessel to be tested.



Vessel Pressurisation Sequence.

Report

ATTAR reports include a diagram of the subject indicating severity and location of acoustic emission activity.



Test results showing clusters.

CNG cylinders under test.

HIGH PRESSURE PIPELINES

IDENTIFYING CREEP AND OTHER DEFECTS VIA AE TESTING

Using state of art equipment, ATTAR can monitor for active defects such as creep and fatigue cracking in high pressure pipelines. Acoustic Emission Testing (AET) is not only more sensitive than conventional NDT methods, but offers significant cost savings.

With AET, entire structures/pipe “runs” can be assessed in one test and can be used to continuously monitor a structure while in service. Although AET is not specific in identifying defect types, it will locate and potentially indicate their significance, enabling more targeted inspections using other NDT methods (e.g. UT / Phased Array / TOFD, if “creep” is indicated, or Magnetic particle, for surface breaking defects, etc.)

Testing Procedure

Sensors are mounted on the pipeline either in direct contact or with wave guides for high temperature applications. The only preparation required is that paint and insulation in the areas where sensors are to be placed needs to be removed.

Testing is conducted to ASME V
Articles 12 and 13 as well as ASTM E569-07; Standard Practice
for Acoustic Emission Monitoring of Structures during Controlled Stimulation.

Reporting

Test results are analysed for any potential anomalies based on acoustic emission location plots. In the report, a diagram of the structure is provided indicating areas of acoustic emission activity. The report details any anomalies so that follow up inspection may be performed in specific locations identified by AET.

OTHER APPLICATIONS

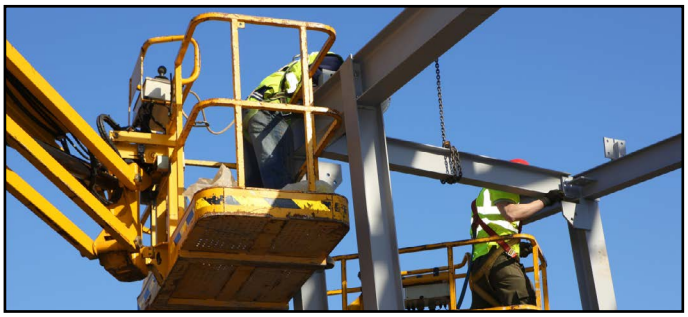
AE testing is a viable risk-based test method for a wide range of applications:

- Large Scale Structural Monitoring: Using an array of AE sensors to monitor large areas of a structure simultaneously during stimulated loading or in-service loading, AE testing can identify whether there are any active discontinuities which require further attention
- Used in the transmission and distribution electricity networks, AE testing of partial discharge within transformers allows early detection of insulation breakdown in oil-filled transformers
- Creep in steam lines can be an insidious problem with unexpected and consequential failure leading to costly repairs and shut downs. AE testing of steam lines provides information on the existence of creep activity to identify the location of and need for more definitive testing using Phased Array and/or TOFD test methods, then planning a cost effective replacement or repair program

- AE testing can be used to assist in the commissioning stage of various sections of plant, where the behaviour and response of a section of plant to new stresses is important
- Elevating Work Platforms (EWPs): AE testing satisfies the requirements for periodic inspection intervals of EWPs and can also be used for integrity inspection following the application of unusually high loads or if damage is experienced
- AE testing is used extensively in the aerospace industry to evaluate ageing aircraft, and also in laboratory research and development into materials and structure performance
- Ship and railroad tank car evaluations
- Bridges and other structures
- Advanced materials testing (composites, ceramics)
- Nuclear components inspections (valves, lift beams, steam lines)
- Rocket motor testing
- Production quality control, and more.

WHY CHOOSE ATTAR

- ATTAR offers complete AE testing services on a wide range of structures
- Equipment and software is cutting edge
- ATTAR undertakes research to better understand and validate the monitoring process
- Services available on National & International basis



Experience: ATTAR has been providing Acoustic Emission Testing (AET) since 1986, offering AET as both an alternative and complementary method to conventional NDT. ATTAR's experience in the application of AET includes tanks, gas cylinders, pipelines, bridges, spheres and other conventional pressure vessels, and Elevated Work Platforms (EWPs).

Qualifications of ATTAR Personnel: ATTAR staff are qualified to a minimum of ASNT SNT-TC-1A, Level II and III; ATTAR's Technical Director also has a PhD in Acoustic Emission. More often than not, ATTAR personnel carrying out this work are Materials Engineers with a good understanding of in-service defect development, welding and welding defects.

Accreditations: ATTAR is NATA accredited for AET and is a certified gas testing station, including AE testing of gas cylinders in accordance with AS 2030 and AS 2337.

CONTACT US

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