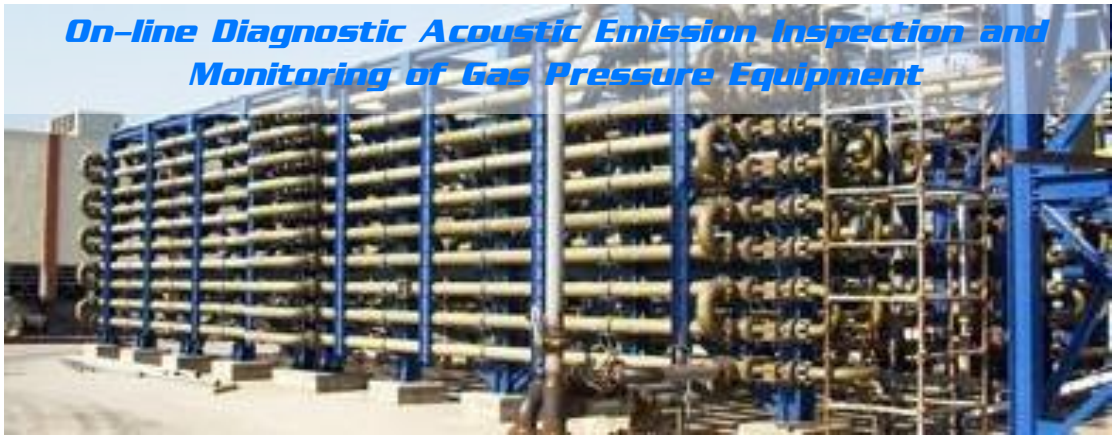


Integrity Diagnostics provides inspection and monitoring services of **gas pressure equipment** including **pressure vessels**, **storage tanks**, **reactors** and **piping systems** using **Diagnostic Acoustic Emission** technology. Inspection and monitoring are performed during **normal operation** of the gas equipment and/or during hydro-static tests.

Diagnostic Acoustic Emission inspections performed according to ASTM, ASME and ISO codes such as:

1. ASTM E1139: Standard Practice for Continuous Monitoring of Acoustic Emission from Metal Pressure Boundaries.
2. ASME Standard: Section V, Article 13, Boiler & Pressure Vessel Code, Continuous Acoustic Emission Monitoring.
3. ASTM E1211: Standard Practice for Leak Detection and Location Using Surface-Mounted Acoustic Emission Sensors.
4. ASTM E569: Standard Practice for Acoustic Emission Monitoring of Structures during Controlled Stimulation.

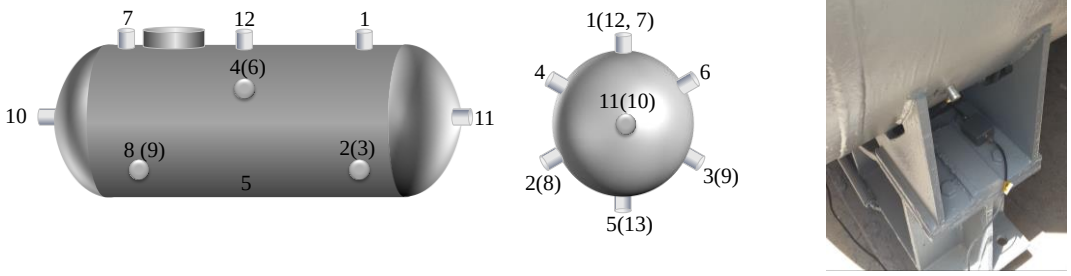
DAE Capabilities:

DAE is used to inspect and monitor 100% of gas equipment structure and:

- Detect flaws such as general electrochemical corrosion, pitting, cracks of different nature including stress corrosion cracking and others.
- Evaluate rate of flaw propagation.
- Assess sensitivity of the revealed flaw to different pressure levels.
- Reliably detect and quantify gas leaks out of valves or connections.

AE System Installation and Inspection. AE vs. Others NDE Methods:

DAE system installation and inspection is performed during normal work of vessels, without scaffolding by climbers while entire vessel is simultaneously inspected and monitored (see example of AE sensors on a pressure vessel). In case of insulated vessels small openings in insulation are made to mount AE sensors which later are re-insulated and sealed. Whenever significant indications revealed, other NDE methods can be applied to confirm AE findings. However ultrasonic, radiography, magnetic particles and other methods that are used for evaluation of pressure vessels and storage tanks, normally do not cover 100% of structure, requires expensive shutdown of operation, cleaning, and scaffolding. All these are avoided using DAE.

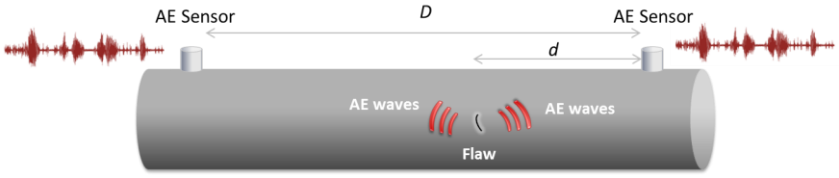


Example of AE sensors installed on a pressure vessel

What is Acoustic Emission?

Diagnostic Acoustic emission technology is based on detection and analysis of *acoustic emission* (stress) waves radiated during elementary crack propagation, local plastic deformation development around stress concentrators such as inclusions or other. Once emitted, acoustic emission waves propagate along the inspected structure for distances of meters and then are detected by special acoustic emission sensors that convert mechanical disturbance produced by AE waves into electrical signals.

Special analysis of detected AE signals is then performed to locate acoustic emission flaw sources, identify flaw type, evaluate rate of flaw propagation and it sensitivity to load/stress/operational changes.



$$d = \frac{1}{2}\left(D - \Delta T \cdot V\right)$$

d = distance from first hit sensor

D = distance between sensors

V = wave velocity

Other mechanical sources of Acoustic Emission (AE) are friction and impacts, detection and analysis of which are used to identify leaks, friction, vibrations and others.

Multi-channel AE System

AE sensors and preamplifier