Acoustic Emission Testing of Pressure Vessels

1. Scope

According to ISO 24367:2023 and GB/T 18182-2025 standards, this document describes the acoustic emission testing and result evaluation methods for metal pressure vessels under load.

This document applies to the acoustic emission testing of active defects in metal pressure vessels under construction and in use. Acoustic emission testing of boilers, pressure pipelines, and other metal components should be performed using this method as a reference.

2. General Principle

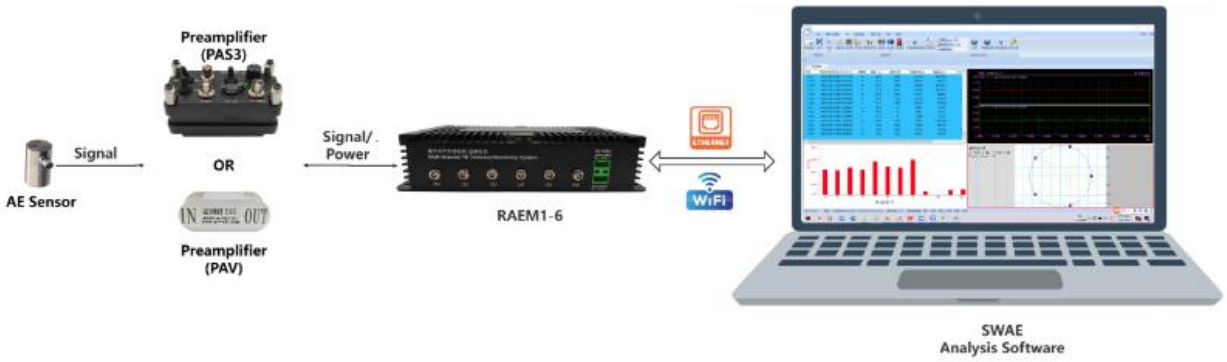
The main purpose of acoustic emission testing (AE) is to detect acoustic emission sources generated by discontinuities on the surface and inside the shell, welds, and connecting components of metal pressure vessels or other inspected parts, determining the location of these sources and classifying their overall grade.

AE testing of metal pressure vessels should be conducted during loading. Load application typically involves pressurization, which generally includes pressure increase and holding. Acoustic emission sensors are placed on the surface of the inspected part to receive transient elastic waves from active defects and convert them into electrical signals. The AE testing system identifies, processes, displays, records, and analyzes the location of the acoustic emission sources and the characteristic parameters of the acoustic emission signals, and classifies the overall grade of the acoustic emission sources.

The detected acoustic emission sources should be re-inspected using other non-destructive testing methods based on the overall grade classification results.

3. Test Equipment Recommendation

An AE system consists of an AE instrument including software, AE sensors, preamplifier (internal/ external), interconnecting cables and mounting devices holding the sensors.



3.1. Acoustic Emission Sensor

According to the standard, the resonant frequency of the wall plate acoustic emission sensor should be within the range of 100kHz~400kHz. So we recommend the resonant sensor of 150kHz (frequency range of 60kHz to 400kHz, resonant at 150kHz).

Model type recommended: **G150** (general sensor,should work with preamplifier). Or **GI150** sensor (integral sensor with built-in 40dB preamp).

3.2. Preamplifier

The external preamplifier should be used after the general AE sensors. We have two types preamp for you to choose.

- PAS3: switchable 20/40/60dB gain, and switchable analog filter.
  https://aendt.com/acoustic/products/Preamplifier/351.html
- PAV: fixed 40dB gain, no filter, compact size.
  https://aendt.com/acoustic/products/Preamplifier/188.html

3.3. Acoustic Emission Signal Cables

The AE signal cable is used to connect AE sensor to preamp and it should not exceed 2m. The signal cable from preamp to AE system (DAQ) can be any longer length, 100m or more.

3.4. Couplant

Couplant is required to use in between the sensor and the surface to be measured. The used couplant shall provide an effective coupling quality so that the sensor tracks the motion of the surface.

Common couplant for acoustic emission testing can be vacuum grease, Vaseline, butter, quick-drying glue and other ultrasonic couplant. Due to transportation and export requirements, we cannot export the couplant. So customers will need to source the couplant locally in their country.

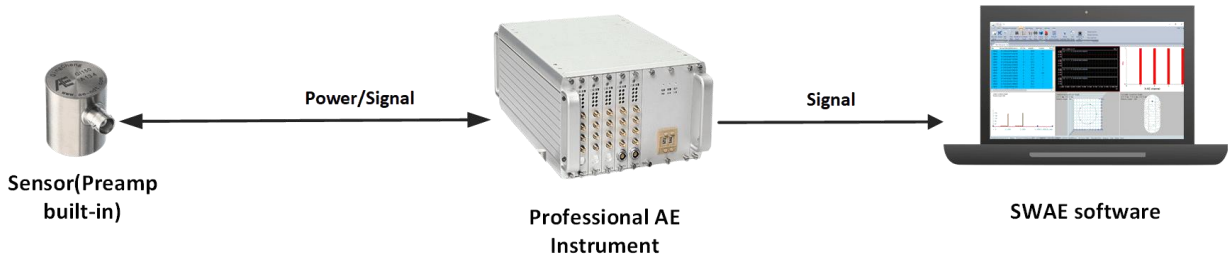
https://aendt.com/acoustic/products/Accessories/2022/1123/147.html

3.5. Acoustic Emission Instrument (DAQ)

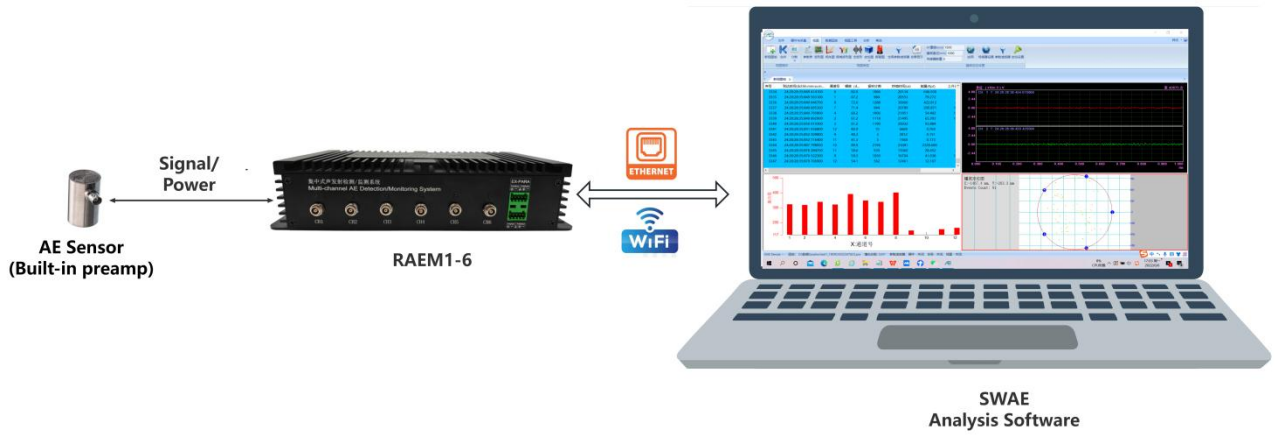
The acoustic emission instrument should have enough AE channels. The sensors after preamplifier are all connected to the AE instrument for signal recording, processing, analysis and transmission.

There are two types of AE instruments that can be used for AE detection of storage tanks, the **SAEU3H** multi-channel AE system, and the **RAEM1-6** acoustic emission system respectively. Choose one type as your AE processor system. **Our recommended system is RAEM1-6 because of its cost-effectiveness and system flexibility**.

- The SAEU3H is a conventional AE acquisition instrument based on the Windows system. It requires connecting to a computer for controlling, storage, display and analysis. SAEU3H only has multiple of 4 channels (because each AE board has fixed 4 channels on), like 4, 8, 12 channels. https://aendt.com/products/multichannel-systems/254.html



- The RAEM1-6 is based on the Linux system which makes it standalone, stable and reliable even in the remote unattended monitoring applications. RAEM1-6 can work with the windows PC as the benchtop instrument and send data to SWAE software for the display and analysis, just as the SAEU3H. But it can also work as a standalone remote long term monitoring system which sends the data to PC/cloud/servers etc via wirelessly transmission (WiFi/4G). RAEM1-6 has flexible channel numbers, minimum of 2 channels and maximum of 6 channels per case. Two or more cases of RAEM1-6 can cascade together to a bigger system.
  https://aendt.com/products/ae-detection-system/190.html



Specifications

	SAEU3H	RAEM1-6
		
Channel	4 channels per AE board. There are chassis for 4/20/48 channels. Cascade chassis for 128 channels.	Flexible to order any number of channels. Each chassis can install up to 6 channels. Cascade chassis for unlimited channels
Sample Mode	Threshold	Threshold/time/continuous
Sample Rate	Max 10MS/s per channel, 16-bit	Max 2MS/s per channel, 16-bit

System Noise	<15dB (no load)	< 30dB
Dynamic Range	85dB	70dB
Input Frequency	1kHz to 2.5MHz (-3dB bandwidth)	10kHz to 800kHz (-3dB, pass-through)
Analog Filter	High-pass filter: 20kHz, 100kHz, 400kHz; Low-pass filter: 100kHz, 400kHz, 1200kHz; any combination of the two filters to be set in the software; each channel is independent	Software selectable (kHz): 20-100kHz/ 20-400kHz/ 70-100kHz/ 70-400kHz/ Pass-through/ Bypassed
Digital Filter	From 1KHz-2.5MHz frequency range, any value can be set as the pass-through, high-pass, low-pass, band-pass filter	Set any value in between 0 to 1000 kHz frequency range as pass-through/ high-pass/ low-pass/ band-pass filter
Phantom Power Output to Preamp	28V or 5V or 0V phantom power through coaxial cables to the preamplifier in software	Hardware fixed only one type of phantom power to preamp: 28V or 12V or 5V
Data Output	Waveform, parameters	Waveform, parameters
AE Featured Parameters	Arrival time, amplitude, counts, duration, energy, rise counts, rise time, RMS, ASL, 12 external parametric, center frequency, peak frequency, 5 partial powers	Arrival time, amplitude, counts, duration, energy, rise counts, rise time, RMS, ASL, 12 external parametric, center frequency, peak frequency, 5 partial powers
Internal Capacity	1GB per AE board	/
Transmission	USB3.0	Ethernet, additional WiFi/4G
External Input	Each AE board supports 4 external inputs; Up 12 external inputs in a system. Input range from ±10V. Maximum sample rate of 1MHz; able to external input trigger	Up to 4 external inputs; input range from ±10V. Maximum sample rate of 1MHz; able to external input trigger
Alarm Output	Switches or lights can be used to output alarm signals	2 channels
Temperature	-10℃~45℃	-20~60℃
Input Power	100~240VAC, 50-60Hz (4-channel chassis: 12VDC)	12VDC
Dimension (L x W x H, mm)	4-channel chassis: 320 x 125 x 50 20-channel chassis: 363 x 225 x 150 48-channel chassis: 368 x 363 x 150	232 × 125 × 52
Weight (kg)	1.3 / 3.7 / 5.16	1.25

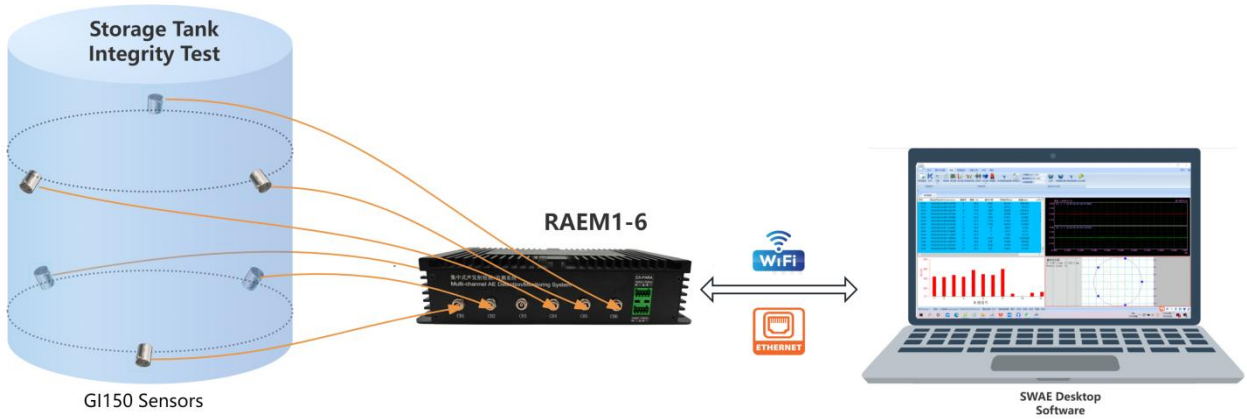
3.6. Product List

The channel number is based on the size of the pressure vessels diameter and height.

	Model	Quantity	Note
AE Sensor	GI150		Resonant at 150kHz, frequency range 60-400kHz, with 40dB built-in preamp.
DAQ	RAEM1-6		Max 6 channels per case, but can cascade to bigger system
Signal cable	AE cable		From integral sensor to DAQ, customer choose length
Sensor holder	Magnetic holder		To hold the sensors in place
Software	SWAE & Configuration software	1	Included in the package, no extra fee, no limitation

4. Sensor Installation

4.1. Storage tank Wall Integrity Detection System Layout



The GI150 (60kHz to 400kHz) series of sensors should be placed on all over the tank wall.

We recommend the sensor spacing doesn't exceed 6m.

Thick layers of sediment affect the sensitivity of AET.

It is highly suggested to do the attenuation test on site to confirm the attenuation distance and then to decide the final sensor spacing.

Care shall be taken that the sensitivity of the sensors is similar.

If the tank is made of metal, the magnetic sensor holder can be used to hold the sensor fixed and tight on the tank wall.

4.2. Before Installation

For storage tanks with insulation layers, a hole can be drilled in the insulation layer where the acoustic emission sensor is installed, so that the acoustic emission sensor can directly contact the surface of the storage tank wall.

The tank wall surface in contact with the sensor should be clean and free of impurities to ensure good coupling. Paint or coatings, geometric discontinuities, or surface roughness on the tank wall surface can cause acoustic emission signal loss and should be removed before installation.

5. Testing Procedures

Installation and system connection -> sensitivity test -> background noise test -> attenuation test -> velocity test -> simulation/source calibration test -> official testing -> possible second sensitivity test for verification.

For details, please read the ISO 24367 and BG/T 18182 standards carefully.

6. Analysis Software

We provide SWAE, the Windows software for data display and analysis. The SWAE uses TDOA to locate the and display the sources on the software.