# AT on Buried LPG Tanks Over 13 $m^3$: An Innovative and Practical Solution

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**Abstract.** In Italy, since 2005, techniques based on Acoustic Emission have been introduced for testing of underground LPG tanks up to 13 $m^3$, according to the European standard EN 12818:2004.

The testing procedure for these tanks, plans to install one or more pairs of sensors inside the "dome" suited for the access to the valves and fittings of the tank , directly on the accessible metal shell.

This methodology is not applicable for the underground LPG buried tanks, where it is necessary to install a larger number of AE sensors, in order to cover at 100% the whole tank shell, even at very deep positions.

Already in 2004, the European standard EN 12820 (Appendix C - Informative) gives the possibility to use Acoustic Emission testing of LPG underground or buried tanks having a capacity exceeding 13 $m^3$, but no technique was specified for the application.

In 2008, Blu Solutions srl - Italian company of TÜV AUSTRIA Group - has developed a technique to get access to the tank shell, where tank capacity is greater than 13 $m^3$ and its diameter greater than 3,5 m.

This methodology was fully in comply with the provisions of the European Standard EN 12819:2010, becoming an innovative solution widely appreciated and used in Italy since this time.

Currently, large companies and petrochemical plants, at the occurrence of the tank's requalification, have engaged Blu Solutions to install such permanent predispositions, which allow access to the tank shell - test object – with diameters from 4 to 8 m. Through this access, you can install the AE sensors needed to cover at 100% the tank surface and then perform the AE test.

In an economic crisis period, this technique is proving to be a valid and practically applicable answer, in order to reduce inspection costs and downtime by offering a technically advanced solution (AT), increasing the safety of the involved operators, protecting natural resources and the environment.

## 1. Introduction

Since 1980, the LPG tanks test has been one of the first technical applications based on Acoustic Emission. Since then, inspection procedures have been developed and published on all European territory.

European and International Technical Committees (TC) have developed, on the basis of observed practical evidences, general and product technical regulations, applicable to the LPG sector [1, 2].

These regulations differentiate the methods of application of the techniques depending on the capacity of the LPG tanks involved, less or greater than 13 $m^3$, specifying, in the concerning annexes, the typologies of testing procedures based on Acoustic Emission.

In Italy, since 2004, the European standard EN 12818 has been introduced through a ministerial decree. It allows, starting from 2005, to perform the integrity tests based on Acoustic Emission only for underground LPG tanks up to 13 $m^3$ [3]. For all other typologies of tanks, especially those greater than 13 $m^3$, the D.M. 329/04 decree and the inspection plan provided for by art. 12 [4] must be applied.

The so-called traditional inspections, as stated in art. 12 of the D.M. 329/04, consist in:

- Internal and external visual inspection
- Thickness inspection of the tank shell
- Further controls needed in case of evident damages
- In case no internal/external visual inspection is possible, implementation of the above-mentioned inspection plan with an hydraulic pressure test - 1.125 times the design pressure - or pneumatic pressure test - 1.10 times the design pressure - (upon implementation of necessary security measures)

Currently, no alternative inspections, other than the ones listed above, are envisaged by the decree.

It is evident that, especially for big vessels, this inspection plan is technically limited as well as tremendously invasive. As a consequence of its application, the user/owner of the equipment to be tested, has to bear the enormous costs and a loss of storage capacity for several weeks/months.

Fortunately, the D.M. 329/04 decree, allows the user/owner of the equipment to ask the Ministry of Economic Development for an inspection different from what foreseen by art.12, provided that it ensures an equivalent protection level.

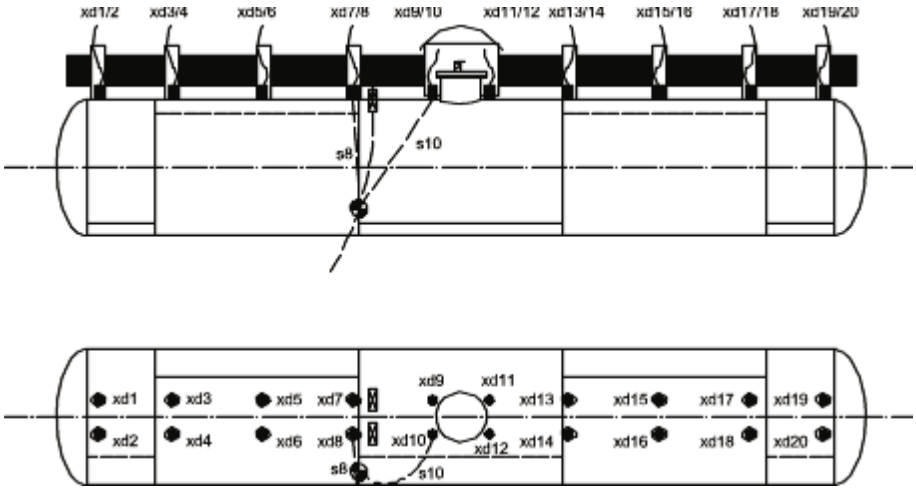
Concerning this, since 2008, thanks to the acknowledgement of the Ministry of Economic Development and the INAIL (ex ISPESL), new techniques based on Acoustic Emission have been applied also on these typologies of tanks, taking advantage of the experience and reliability of the testing procedure developed by TÜV AUSTRIA.

## 2 Background scenario

In Italy, probably due to the geographical shape of the country that makes the peninsula a natural dock for raw materials and an energy entry point of Europe, are present many storage facilities, petrochemical plants and refineries. Unlike the rest of Europe, starting from 2000, many buried or underground tanks have been installed.

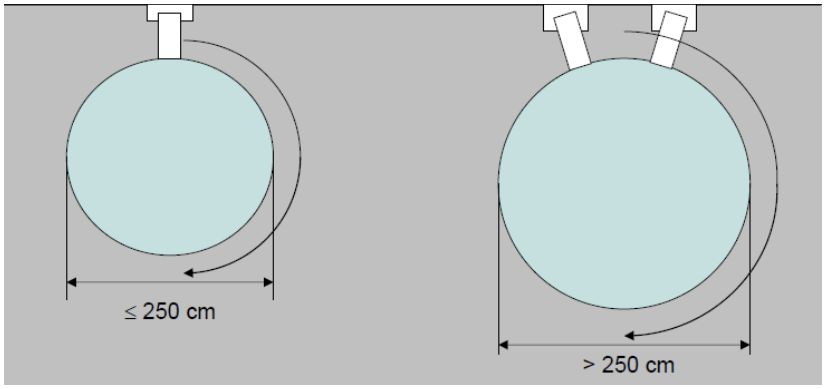
Usually, the capacity of these tanks does not exceed 50 $m^3$ when installed in industries, local pipeline networks and petrol stations; for the storages aimed to the national distribution it can reach 450 $m^3$; for the petrochemical plants and refineries it reaches a capacity up to 3000 $m^3$.

This being stated, even if the European standards are rather clear concerning the testing procedures based on Acoustic Emission, practical difficulties can arise as for the applicability in case of underground or buried tanks having a diameter greater than 2,5 m [2].



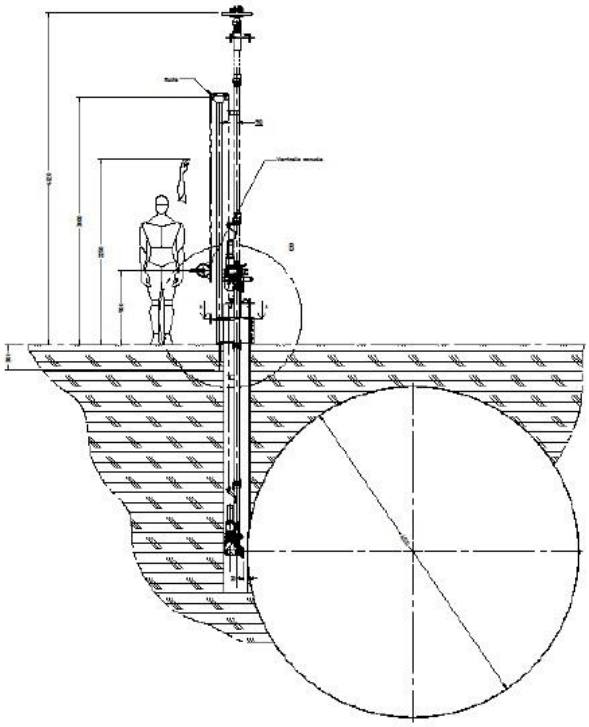

**Picture 1** Example of sensor locations on a large underground LPG tank, two rows of sensors [2]

According to EN 12819 and with respect to EN 14584, the installation of AE sensors in one or more rows must be set so as to cover the whole tank surface, in relation to the attenuation profile developed.

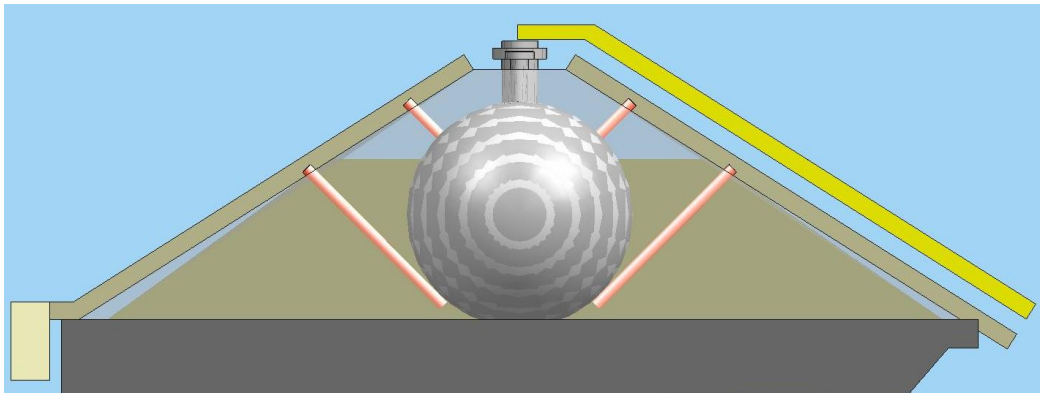



**Picture 2** Rows and sensor locations respect the tank diameter

Thanks to the experience gained, these rows can be two (with the addition of a third one for additional information on top) when the tank diameter is less or equal to 4 m, with the installation of sensors down to the equatorial line of the tank; as the diameter grows, it is necessary to add further sensor rows, installing the latter deeper than the equatorial line of underground tank.



**Picture 3** Equatorial predisposition (two rows**)**



**Picture 4** Four rows predisposition

Therefore, the need to develop a solution arises, as less invasive as possible for the user/owner of the tank, in order to make the testing procedure using Acoustic Emission applicable.

## 3. An innovative AT tank predisposition

Since 2008, Blu Solutions Srl – namely the Italian business unit of TÜV AUSTRIA GROUP – has developed an innovative solution for AE predisposition of underground or buried LPG tanks, improving a technique yet employed by TÜV AUSTRIA.

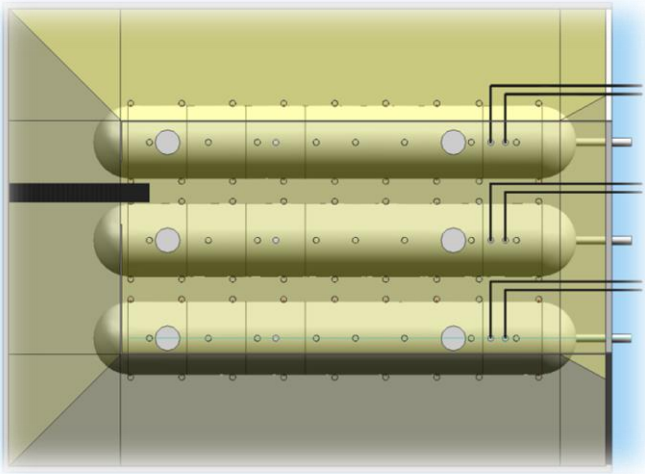
This technique envisages the use of pipe for the access to the shell of the underground or buried tanks, also at greater depths.

The application of this technique is different depending on the diameter of the tank, herefore:

- **"predisposition through vertical micro drilling"** in case of two rows of sensors installed on the equatorial line of the tank
- **"predisposition through suck extractor"** in case the installation of more rows of sensors at greater depths than the equatorial line of the tank is needed.

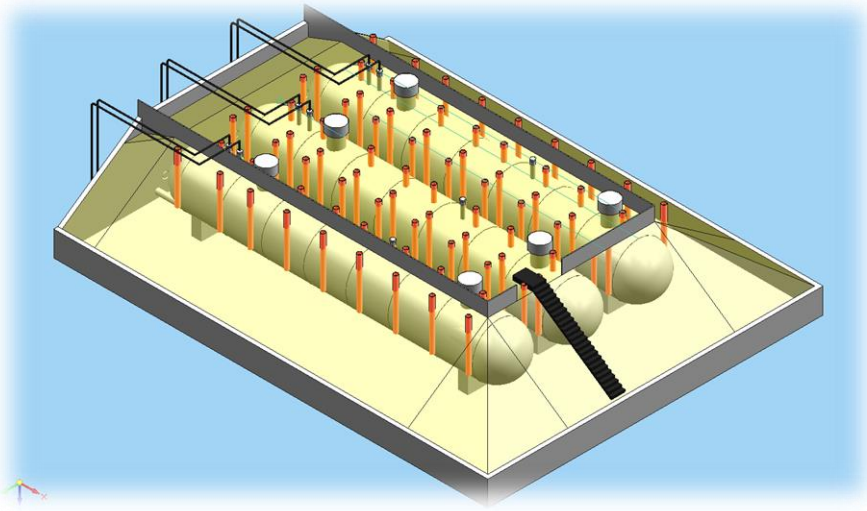
*3.1 Predisposition through vertical micro drilling*

It is a micro-invasive predisposition consisting in the making of holes tangential to the equator of each tank (east and west side as opposed to the circumference of the cross section of the tank) and in the installation of PVC pipe conveniently shaped and connected manually to the surface of the tank.



**Picture 5** Vertical predisposition - aerial view

Each hole has a diameter of around 320 cm, variable length depending on the depth (from 1 to 5 m), inclusive of 315 mm diameter covering PVC pipe, and E.V.A. closing caps (closed-cell polymer having specific physic-mechanical properties, fireproof, atmospheric-agent resistant, UV-resistant, deterioration resistant).



**Picture 6** Vertical predisposition – side view

**Picture 7** Tanks predisposition overview

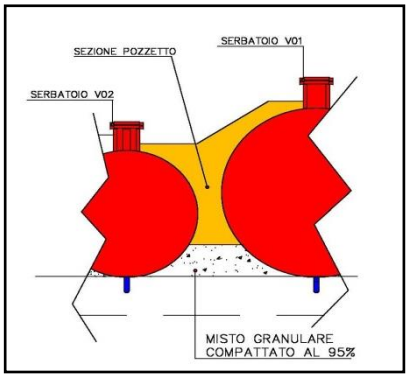
Once the permanent pipe are installed, the protective coating of the tanks is removed (bitumen, epoxy resin, epoxy-bituminous paint, etc.) with the help of a pneumatic robot –remote video guided -, especially designed for this task.

**Picture 8** Pneumatic Robot

The surface being ready, the sensors are installed through specific positioning and coupling tools. From here on, an AE test can be performed according to reference standards.

*3.2 Predisposition through suck extractor*

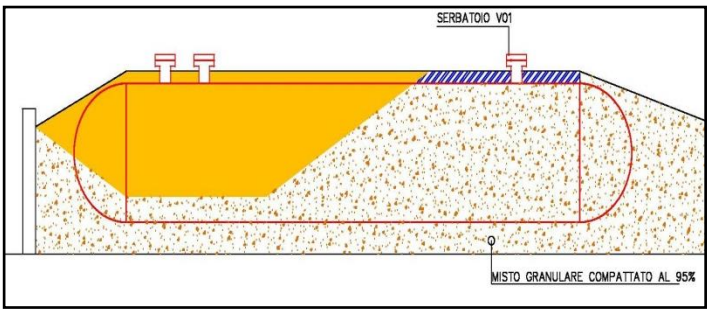
If the tank diameter needs the installation of many rows of sensors, it is necessary to perform a predisposition of the mound or the tanks by digging trenches and removing the material covering the tank until the necessary depth for the installation of the AE sensors is reached.




**Picture 9** Digging section of the tanks mound

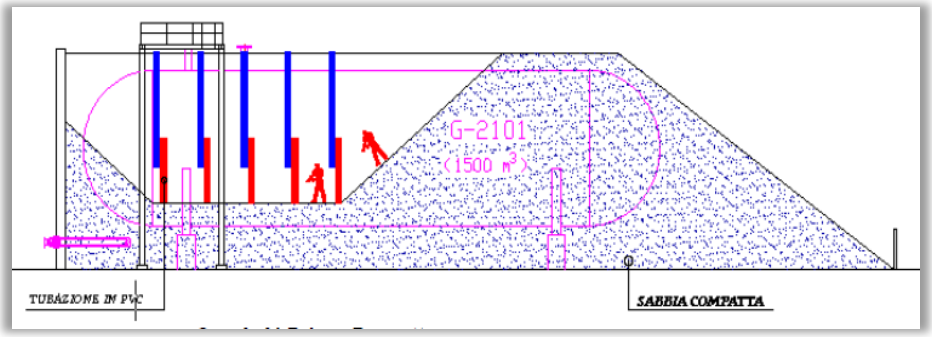
The covering material is removed through latest generation devices – namely suck extractors – safely ensuring the removal of sand and/or soil and with no risk of damaging the tank and the equipment installed.

The material extracted, depending on the characterization of the mound, will be stored and then re-used.




**Picture 10** Side view of the digging area

The trenches being dug, some PVC pipe are installed thanks to the use of a crane. The pipe, conveniently shaped, are connected to the surface of the tank by means of a specific glue. Inside the pipe, an AE sensor will be installed in the opening made in the protective cover of the tank, in order to perform the integrity test.




**Picture 11** Example of installation procedure

Once all pipes are installed, the mound is buried again and restored.

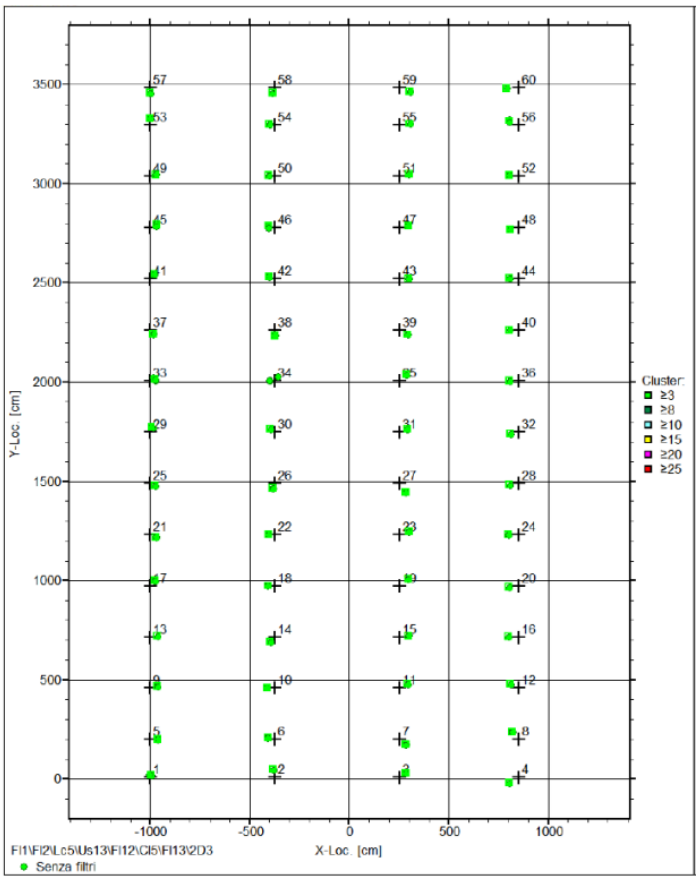
**Picture 12** Stepwise pipe installation and sand restore

The predisposition stage being ended, each and every tank is ready to be tested according to the reference standards.

**Picture 13** Overview of a full equipped storage facility

At this stage, nothing is left than to install through each pipe and by means of specific tools, the AE sensors which are necessary to perform the integrity test.

**Picture 14** AE Sensors installation through the pipes




**Picture 15** Planar source location (automatic channel pulsing) using four rows

## 4. Conclusions

European standards provide excellent reference points and guidelines concerning integrity tests on underground or buried tanks. Despite this, the applicability of the Acoustic Emission techniques depends on the accessibility of the tank shell involved.

The innovative solution proposed is a practical and valid answer for carrying out the integrity test based on Acoustic Emission.

This being stated, the inspection based on Acoustic Emission proves to be a technologically advanced and reliable technique that reduces downtime and inspection costs of the tank, increases the safety of the operators involved in the test and protects natural resources and the environment (no disposal of residuals necessary, no cleaning and no draining of contaminated water).

## References

1. EN 12817: 2010 - LPG Equipment and accessories - Inspection and requalification of LPG tanks up to and including 13 m³
2. EN 12819:2010 - LPG Equipment and accessories - Inspection and requalification of LPG tanks greater than 13 m3.
3. D.M. 17 Gennaio 2005 “Procedura operativa per la verifica decennale dei serbatoi interrati per GPL con la tecnica basata sul metodo delle emissioni acustiche”,
4. Decreto Ministeriale n° 329 del 01/12/2004 - Regolamento recante norme per la messa in servizio ed utilizzazione delle attrezzature a pressione e degli insiemi di cui all'articolo 19 del decreto legislativo 25 febbraio 2000, n. 93.