GUIDED WAVES: STANDARDIZATION AND CERTIFICATION

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Abstract
The Guided Wave Testing (GWT) Method is a new NDT Method, which is typically used for rapid screening of long lengths of pipe-work. One of the main attractions to this method is its ability to screen relatively long length of pipe from a remote location (avoiding the need to directly access the area to be inspected). GWT is now widely recognized and is the preferred NDT method when other approaches are not very effective. This article summarizes the effort that has recently been made to qualify the method, standardize the inspection approach and certify the personnel that carry out the inspection. This work aimed to provide confidence to the industry that appropriate GWT tools can be used by qualified operators to properly assess their assets.

Key words: Guided Waves, Standardization, Certification, GWT, LRUT

1. Introduction
Non-Destructive Testing is rapidly evolving due to increased safety requirements of industrial plants, more challenging environments (e.g. deep water pipelines) and the general requirement to offer more efficient inspection. Evolution has certainly been attained in recent years; however this implies major efforts for the industry as several steps are needed for a genuinely good idea to evolve from its incubation stage to an officially recognized testing method, the last of which is the creation of standardization documents and related recommended practices. With regard to Guided Waves, this process started in the 80s. This article is aiming to offer a view of the current status of the Guided Wave technology and summarizes the effort made in several countries towards standardization of the testing method.

2. Status of Guided Waves Testing Method
Research conducted in the late 1980s in the field on Non-destructive testing using Guided Wave demonstrated the potential of this innovative approach.
By the 1990s the patents [1, 2] that are the basis of the existing technology were filed. By the end of the 1990s the first generation of Guided Wave equipment for the routine inspection of plant piping entered the market and was sold to NDT service providers. Currently the third generation of Guided Wave technology (e.g. Wavemaker G3) is available and its capabilities have greatly improved compared to the first generation equipment. At the same time the knowledge of the capabilities and limitations of Guided Waves has increased and the boundaries have been pushed with more applications being developed every year. Concurrently training schemes have been developed by the equipment manufacturers (e.g. GUL training scheme, [3]) to create a quality system that could ensure a minimum standard to all users. Indeed training of operator is critically important in the Guided Wave field due to the novelty of the interpretation approach compared to other existing NDT methods and the level required that is above the industry average. Where this is a potential weakness of Guided Waves, the method offers great potential to the industry when appropriately applied (using best available technology, appropriate training and skilled personnel).

Guided Wave Testing is now routinely used in a number of countries worldwide and the capabilities and limitations are known by a number of experts in the NDT field. The spreading of this know-how has enabled open discussion amongst users of the technology and consequently the creation of industrial standards and recommended practices.

3. Guided Wave Testing is a new method

Guided Wave Testing is now accepted as a new method rather than a technique of other existing methods (namely UT or AT which with it has some similarities). As reported in previous publications by the same authors [4] the interpretation rules of a Guided Wave test result are unique. Although the software tools of advanced equipments (e.g Wavemaker G3) were developed in a way to minimize operator effort in learning a new inspection system, the GWT inspection approach is unique. While UT is a detection and sizing method that uses bulk waves and propagates along short lengths, GWT is a screening method that uses Guided Waves and has long propagation range. Mode conversion, effect of geometric features along the length of the pipe and sensitivity to stiffness changes are also aspects that make GWT different from UT. Similarly to electromagnetic waves, the properties of waves having different wavelengths induce differences in behaviour that lead to our perception of them being completely different. For example this is the case of Microwaves and Infrared as it is fully accepted the fact that both are electromagnetic waves and that they are so different that they should be treated separately. This concept also applies to UT and Guided Waves. AT uses Guided Waves however the way the information is gathered (passive
system in AT, send-receive system in GWT) and the type of information gathered (number of events or energy in AT and echoes in GWT) makes the two methods radically different in their practical use.

In agreement with the above, a number of GWT committees (e.g. BINDT, UNI, RINA working groups) have completed their work in the field of standardization and certification and have reached the conclusion that GWT is a new NDT method.

4. Guided Wave Testing standards

**UNI/TS 11317**

The first standardization document on GWT was published by UNI (Italy) in February 2009. The technical specification UNI/TS 11317 gives some basic recommendations on how to screen above ground pipelines and plant piping using long range guided waves. This product standard defined the testing approach and set minimum requirements for the equipment, preparation of the inspection job, follow-up inspection and reporting [4]. UNI/TS 11317 was referenced in another UNI standard UNI/TS 11315 that defines the inspection approach to be followed in Italy to comply with Italian decree D.M. 329. This standard is in Italian, however an English version has recently been made available.

**JIS – NDIS 2427**

This Japanese standard was published in 2010 and addresses the general principles of Guided Wave inspection as the title suggests “General principles of Guided Wave inspection for piping by pulse echo technique”. This standard is available in Japanese only.

**Active working groups**

There are several working groups in the process of defining new standards and/or recommended practices on Guided Waves.

ASTM committee on emerging NDT methods is working on the definition of a “Standard practice for Guided Wave Testing of Aboveground Steel Pipework using Piezoelectric Effect Transduction”. This document is well underway and is aiming to provide a practical guide on how to carry out Guided Wave inspection.

BSI committee WEE/46 is working on the definition of both a general principles document and a related document that sets the basic requirements for guided wave testing of pipes, pipelines and structural tubulars.
NACE TG 410 aims to develop a standard that establishes performance specifications for the capabilities, limitations and minimum detection and identification capabilities of Guided Wave Testing.

IIW commission V is currently drafting a document that could provide guidance on inspection of aboveground pipes using Guided Waves.

Integration of national and international standards

One of the potential threats of such a prolific activity in the creation of standards is the possibility that they are not harmonized. The authors and other individuals involved in many of the committees listed above are attempting to keep a common basis amongst the standards developed to avoid compatibility issues that could generate performance issues and/or increased costs.

Another point is the integration of the standard within a specific industrial and legal environment. In Italy the standardization process started for the need to officially authorize the use of Guided Waves as this approach could help comply with existing regulations. The path was traced by the responsible Italian authorities (Italian HSE) and the Guided Wave standard was readily integrated with an inspection standard (UNI/TS 11315) and a set of HSE guidelines on Guided Waves that was designed to help the final users (petrochemical or power generation inspection managers) to identify if Guided Waves could be a good solution for their inspection issue. In other countries the GW T standard may precede a specific regulation on pipe inspection and the integration at national level shall be carefully considered.

5. Personnel certification

Guided Ultrasonics Ltd (GUL) have designed a training scheme for GW operators which has been in use since 2000, and has been continually updated to keep up with new applications and developments. GUL has also created a certification system that enables operator qualification and experience to be monitored. Each operator has a personal ID key which stores the information about the number of days experience, number of tests performed and revalidation date together with other useful information to monitor operator quality. Each testing day the operator must logon to the Wavemaker G3 instrument and the information on the key will be updated with the tests performed by the operator. This method for monitoring operator experience and quality is unique and very effective.

Compliance with existing international standards on personnel certification has been also addressed in recent years and EN473/ISO 9712 compliant schemes have been put in place for example by RINA (an Italian certification
body) that included in its quality system a Guided Wave syllabus and issued the first EN473 compliant certificates for the Guided Wave method in 2008. More recently PCN has organized a working group on Guided Wave certification where a major point is that under the same scheme 3 different certifications are allowed that are for the 3 different GW technologies commercially in use. The PCN scheme is due to start by end of 2011. ASNT Guided Wave committee is also discussing the topic of certification and some updates may be issued before the end of 2011.

Fig. 1. Certificate confirming qualification of Guided Ultrasonics GWT procedure according to EN 14748/2004.
6. Qualification under EN14748

The European standard EN14748/2004 sets out basic principles and provides recommendations and general guidelines for carrying out qualification of non-destructive tests. Considering the current absence of an EN or ISO standard on GWT, qualification under the EN14748 can be a very useful tool to confirm the capability of the method, using a specific equipment, procedure and training scheme. Recently TUV agreed to verify the qualification process of the Guided Ultrasonics GWT procedure (specifically including use of Wavemaker G3 instrumentation package and an inspector certified under the GUL Training and Certification Scheme). The successful completion of the qualification programme was confirmed with the issue of a TÜV-Süd certificate (see Figure 1).

7. Conclusions

Guided Wave Testing is a new NDT method. Several national and international standards are being developed to support the use of GWT for pipe screening. Company and third party GWT personnel certification schemes are already available and have been reported here.

8. References


