PRESERVING A TRINITY

James R.C. Garry, Red Core Consulting, Canada, examines the efficacy of standards governing the LNG industry.

Arguably, the hallmark of a civilisation is the creation of standards. These may be standards of speech such as language, or the standardisation of value through money. With such standards, meaningful dialogues and transactions can be held with your neighbour. This article describes a problem that is common to standardised industrial processes, with particular emphasis on LNG-related fields, and suggests a process for resolving it.

Standardisation: briefly

Almost everyone uses products that in some way have been designed or built to a criterion established by a standardisation body. In today's industrialised world it is expected that when one buys an item, such as a length of pipe, then that item will have been made and qualified in compliance with a standard of some type. Material or devices with higher cost, or greater impact on human and non-human life, tend to be more tightly controlled. Such is the case for tasks associated with LNG projects. The feedstock is of high economic value and its physically challenging properties make its movement and storage a task that demands precision, accuracy, and robust engineering margins. Efficient and safe procedures for handling LNG are most easily achieved by following the best practice in the industry, which means adhering to standards that reflect the hard-earned lessons of countless earlier engineers.

The origins of such standards in the modern era can be traced to the founding of the International Bureau of Weights and Measures (BIPM) in 1875. This marked the first coherent attempt to forge international standards for trade and research. Similarly, in other fields, agencies arose to take on the role of curating and developing sets of standards for electrical and chemical industries. The last century saw the birth of three types of agency: national agencies (JIS, BSI, DIN, etc.) that govern standards for a nation's industries, international corporate entities such as ASTM, and governmental international organisations such as ISO. The upper half of Figure 1 shows the familiar non-governmental standards agencies to which contractors and persons can belong, and in the lower half the more rarefied transnational agencies. These are fundamentally a different class of organisation in that their membership consists of national entities, drawn from each member country.

It should not be thought that these agencies curate a static collection of standards – far from it. Standards are regularly reviewed by an agency's members and it is recommended that the interested reader take some time to investigate how they might join a non-governmental body and witness at first hand the evolution and growth of a standard.

What can be standardised?

The simple answer is that the ingenuity of humanity is the sole constraint. For example, ASTM International (the American Society for Testing and Materials) currently coordinates and maintains around 12 000 standards, ranging from D3751 that describes how furniture polish may be tested, to C0696 which specifies a protocol for testing uranium dioxide pellets used in nuclear reactors. The existence of multiple agencies, each coordinating a myriad of standards, means that a manufacturer is faced with a difficult choice, namely, which standards should they choose? For a given property of any item, such as the tolerances of a bolt, there might be intra-company standards, national standards, and international standards that all address the same matter but in different ways (Figure 2).

The LNG field has been relatively immune to this multiplication of standards, as much of the early commercial technology was developed by a handful of countries. But the designer of, for example, a static LNG storage tank is still presented with over half a dozen standards from an alphabet-soup of organisations, which all ostensibly discuss the same thing, as is shown in Figure 3.

The same problem arises for almost every imaginable link in the LNG chain. While the technology and engineering principles remain the same, countries may adopt different models to suit their own markets and manufacturers. But much of this complexity is superficial. Manufacturers exist in the ebb and flow of the marketplace and the users of an item or a material rapidly discover which standards are the most useful for solving the problems that they encounter. If a standard confers concrete advantages to both the manufacturer and the user then its use is likely to spread, and one might liken this ideal situation to that of a beneficial phenotype in a heterogeneous population.

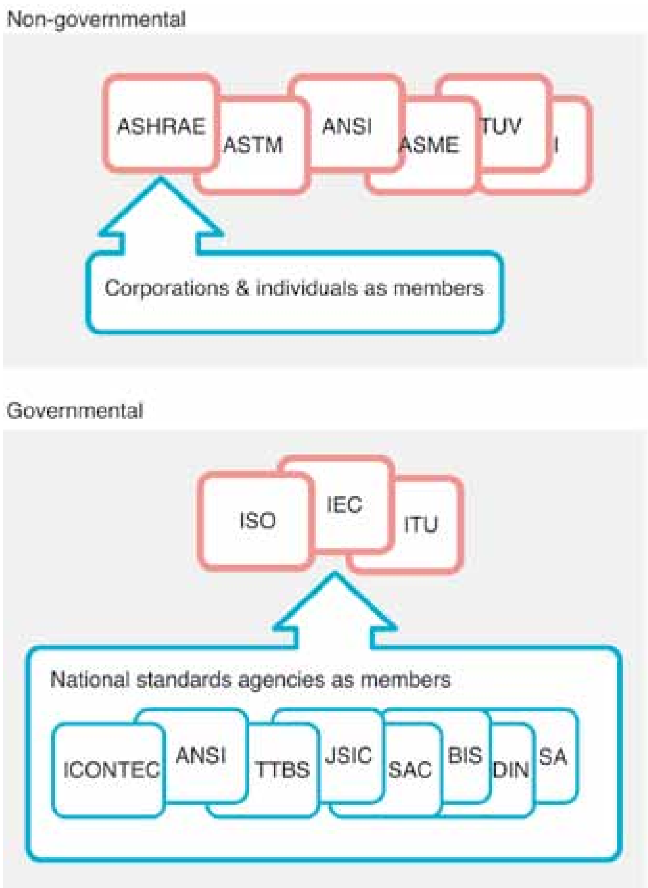

Figure 1. Illustrating the two different classes of standardisation entities.

This idealised scenario relies on several assumptions, namely:

- The standards themselves are pertinent and are in accord with legislation and the industry's best practice.
- The users find that the standards give a real benefit by reducing uncertainty in a design or process and so yield savings of time or money.
- The standards are adhered to by the manufacturers of the item, or the test-laboratories that they employ.

The first point is the responsibility of the agencies that maintain a given standard. If the standard is superseded by developments in materials or methods, then its usage withers and new standards may be created. One can point to relatively few examples of LNG practices displaying such 'evolution of fitter standards', given the comparative youthfulness of the field.

We would hope that meaningful and legal standards would deliver tangible advantages, otherwise what would be their purpose? Before such benefits are realised it is critical to ensure that the third assumption is valid – that the standards are implemented accurately. But how does one prove that a testing agency is both honest and competent? One might appeal to the use of accreditation services that, for a fee, establish whether a given company is compliant with standards such as ISO 9001 or ISO 17025.* But again, that does not resolve the problem of verification. It simply moves the burden of trust again to another entity and the fact that a laboratory is accredited by an agency does not automatically mean that it performs as it ought to in the rough and tumble of the commercial world.

One might argue that the problem of verification is the customer's concern alone. After all, as the standards are readily available from the agencies that coordinate them, surely the user of a tested material could check that the delivered service or item conforms to the necessary standards? If the standard describes a bolt's tensile strength or geometry, this could be quite easy to check. But if the standard described a process involving the handling of cryogens, sensitive electronic monitoring, and finely machined components, then the end-user cannot be expected to verify that the standard was adhered to. And that is the crux of the problem. Entities, including standardisation organisations (ASTM, ISO, etc.), do not and cannot police the implementation of the standards they control. Thus, the user is left with little choice but to either accept what they are given, or take another leap of faith and request that the item be retested by a third-party test house. This, for those with a classical bent, is neatly encapsulated by Agrippa's Trilemma. One either endlessly seeks confirmation of test data by another test house (which is then itself critiqued and tested), or one accepts without reservation possibly flawed data, or one arbitrarily decides at some point to stop asking questions.

This discussion may be thought to be overly wrought. One has to employ trust at some point and surely a commercial entity would be guilty, at most, of unwittingly deviating from a standard? After all, standards are written to be clear and unequivocal and the presumption that a test house is deliberately overlooking parts of a standard is but a short step away from unwarranted and damaging paranoia.

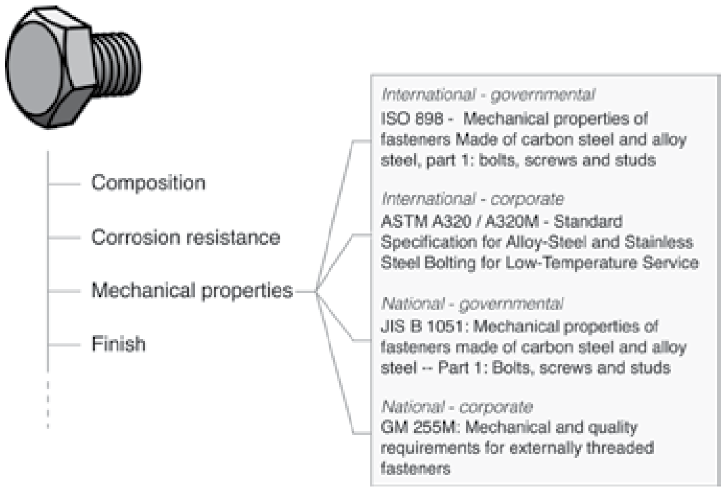

Figure 2. A bolt and a small fraction of the standards that may apply to it.

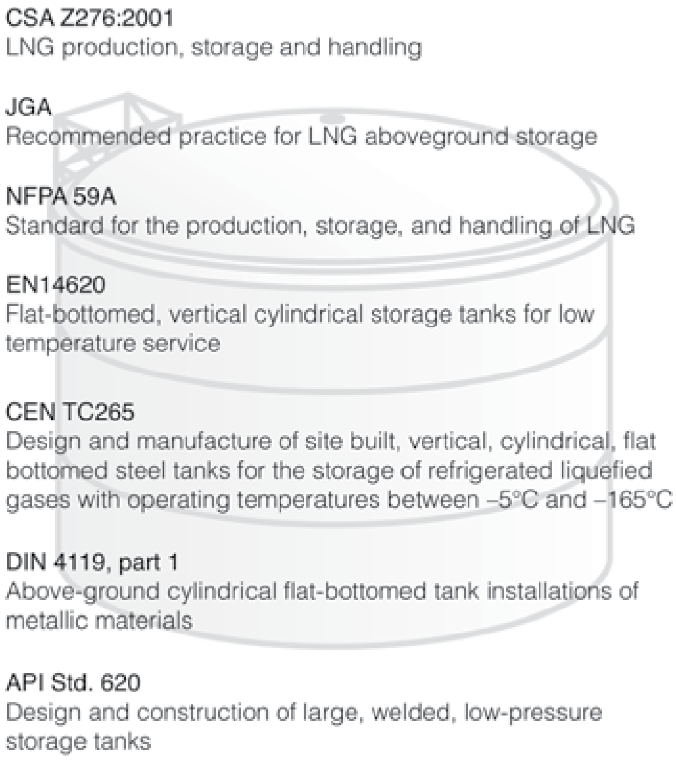

Figure 3. An LNG tank designer's dilemma.

Can standards be trusted?

Some years ago, Red Core Consulting made enquiries about the state of thermal testing in the field of LNG, and as its background is in cryogenics and instrument design it knew what to ask for. There are three main standards for determining the thermal conductivity of insulators for cryogenic applications and with little effort it found certificates from seven laboratories, specifically three companies and four research institutes. All seven certificates purported to adhere to ASTM C177, a standard that describes a fundamental test of an insulator's thermal conductivity. The company purchased a copy of the ASTM C177 standard and found that none of the certificates were fully compliant. Of the seven entities, one firm's certificate failed to comply with 15 mandatory clauses and yet that company promoted itself as being ISO 17025 accredited. The most common failure was the presentation of data without uncertainty figures, giving the client no way of judging how reliable their thermal conductivity data were. This is not a trivial matter. Telling a machinist that you want a length of steel rod cut to be exactly 50 mm long elicits a very different reaction (and cost) than telling them that it can be 50 +/- 5 mm.

A more pertinent example for the LNG field would be a lack of uncertainty data for the thermal conductivity of a storage vessel's wall material. Boil-off-rates (BOR) for mid-size LNG tankers and storage tanks are not insignificant, and can be of the order of 0.1% by volume per day of use. The uncertainty in BOR is directly proportional to the uncertainty in thermal conductivity of the vessel walls, which is dominated by the performance of the insulation. But what client would accept a predicted BOR figure without a sense of how accurate it was? Should one assume perfection in the data? Or perhaps a 1% error?** Maybe 10%? Red Core Consulting knows of at least four laboratories that cannot tell you. With the present softening of gas prices there should be little acceptance of such ambiguity in the performance of a critical component such as cryogenic insulation. The whole LNG economy only works because there is a sufficiently well understood performance margin in the transportation and processing systems for profit to be realised. An unspecified certainty for any item in an error budget should not be acceptable as it exposes the user of those data to a risk of unknown magnitude. However, the utility of uncertainty budgets in forecasting is not universally recognised in large-scale engineering and Red Core Consulting suspects that many firms consider such matters to be needless frippery.

Without a widespread recognition of the need for uncertainty data, duplicitous or incompetent entities can prosper. Standardisation agencies have no protocols for admonishing failing laboratories and customers have no recourse against the purchase of services from a non-compliant laboratory. In serious cases, the non-compliance might be treated as fraud and civil laws might be invoked; such cases are not as rare as might be thought. [1,2,3]

This situation is not desirable, but it can be changed. This article presents a three-part scheme that puts the customer's interests first, and which places only a minimal burden on the test house and the relevant standards agency.

Prevention – a step towards a cure

This scheme is not a panacea, but it offers a path by which end-users can have contractually-supported certainty as to how the work that they are paying for was performed. Firstly, it is proposed that where practicable, committees of standardisation agencies should promote the inclusion in their standards of a clause similar in nature to that found in ASTM C177; "[...]where deviations from the specifics of the test method existed in the tests used to obtain said data, the following statement shall be required to accompany such published information: 'This test did not fully comply with following the provisions of Test Method C177.' This statement shall be followed by a listing of specific deviations from this test method and any special test conditions that were applied."

With such a clause in place a company that performs the test but deviates from the standard must state that fact to the prospective customer.*** By itself, deviation is not a negative criticism of a laboratory's work; the customer may request non-standard processes or there may be other circumstances that make it unavoidable. But at present it appears that one can deviate from a standard without having to report that fact.

Secondly, customers who employ a company to perform a test should be willing to ask the company for evidence as to how they implement a given standard. This gives the customer visibility of the mandatory stages of the test, and provides insight about the chosen laboratory's methods.

Thirdly, to complement the previous point, companies performing standardised tests should prepare and maintain a document that shows how they implement the mandatory features of a standard.

These three points by themselves do not prevent fraudulent transactions, nor do they add value or competence to a test house's activities. But these considerations would force a test house to make clear, documented, and unequivocal statements that can be referred to in a contract. A company that adheres to an international quality standard, such as ISO-9001 or ISO-17025, would have their critical processes documented already. One would hope that the effort needed to build a convincing fake explanation of a test's implementation would be less than that needed to actually perform the task.

Any one of these measures can be independently introduced and would go some way to improving the quality of reporting in the field of industrial testing. **LNG**

References

1. Testwell Laboratories, Inc. vs. New York City Department of Buildings, 7 December 2010.
2. New York City Department of Buildings vs. Stallone Testing Laboratories Inc., 26 August 2009.
3. Schneider, K., "Faking it: The Case Against Bio-Test Laboratories," *The Amicus Journal*, pp. 14 – 26, Spring 1983.

Notes

* The ISO 17025 standard is somewhat like ISO 9001, in that it is designed to help maintain the quality of a test laboratory's work.

** Typically, uncertainties presume Gaussian distributions and are quoted such that 68% of the data fall within that quoted range – the 'one sigma' error range.

*** Surprisingly, clauses of this nature are extremely rare in ASTM and ISO standards. Of the dozen or so standards examined by Red Core Consulting, none but ASTM C177 has such a requirement.