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Report on Standards review

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NATURALHY Report on

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INTRODUCTION

The NATURALHY-project investigates the conditions under which hydrogen can be added to natural gas with acceptable consequences for safety, durability of the system, gas quality management and performance of the end-user appliances. Membranes will be developed to subtract hydrogen from a hydrogen/natural gas mixture for use by hydrogen powered equipment.

The new conditions and developments will have to be included in the current standards within the industry and or new standards have to be developed. But the impact of any change needed could and will become rather complex due to a mixture of European, National and international standards, company codes and regulations.

Within the project one of the aims is to assess the current situation of standards and regulations regarding hydrogen/natural gas mixtures and to identify necessary modifications and to initiate required changes.

NEN, the Netherlands Standardization Institute, as ISO and CEN secretariats of technical committees involved with natural gas, is the taskleader for the investigation of the standardisation/regulation situation in the EU regarding introduction of hydrogen/natural gas mixtures within the current gas infrastructure.

This study is the basis of further dissemination of the project results, especially when it comes to CEN or ISO standardization. The first step towards international standardization can be initiated.

A questionnaire will first of all be send to the partners in the project and secondly to the relevant CEN Technical Committees like CEN/TC 19 “Petroleum products, lubricants and related products”, CEN/TC 234, CEN/TC 12, to ISO/TC 67, ISO/TC 28 “Petroleum products and lubricants”, ISO/TC 193 'Natural Gas' and to other relevant and interested parties, with the aim to collect information in the areas of:

- Existing standards, for instance on specifications, classification systems and test methods for hydrogen/gas mixtures, safety issues, and related product and system standards for equipment, pipes, materials, e.g.
- Ongoing and planned work on standards for specifications, classification systems, test methods, etc.
- Setting priorities for future work and standards, for instance on specifications, classification systems and or test methods.
- Relevant regulations.

The responses to the enquiry will be processed and summarised. This summary will then discussed within the members board of the NaturalHY project.

NEN did already have contact and will keep close contact with other European research project like HySafe, HarmonHy, HyRoad and FCTEDI to exchange necessary findings on standards needs.

This report is produced to be a basis for the enquiry and is not to be read as a finalised report of a completed study. This report is a guideline to make it easier to identify needs for revisions of standards and or need for development of standards.

Clause one of this report includes some background of the necessity of standardization. Clause two will give an inside in the actions taken and clause three includes the interim results concerning the standards study.

Clause four is highlighting the relation between regulations and standards and summarises a list of relevant regulations. Within the final report possible barriers due to regulations will be reported.

But, before we are able to prepare a final report we need your cooperation!!

Please provide your input and inform us on specific standards and/or regulations which could form a barrier to the introduction of hydrogen into the gas grid.

Thanking you in advance,

Harold Pauwels
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1. Background

1.1 General information

New technology and new markets are not possible without a framework of regulations, codes and standards. The new technology of hydrogen/gas mixtures within the National and European Gas grid is not possible without a consistent European RCS Framework.

Within the NaturalHY project the separate work packages are developing new materials, new and updated system requirements, amended safety measures and new test procedures and methods. These development are to be introduced either in current gas technology standards or new standards (and/or codes) have to be developed.

This report gives a first insight in the existing codes and standards world wide available (focussed on the European situation). Based on the first draft report input will be asked from the work package leaders andor members.

Based on the inventory recommendations will be made to the various SDO's and International committees. This report gives an overview on the situation and future need for standards in relation to NaturalHY.

Need for standards is to be identified (at first for the next 3 to 5 years) and it is to be analysed how the standardization work could be initiated and/or carried out. It is a fact that NEN already at this stage concluded that only national standards would not be sufficient to solve the upcoming challenges that are connected to the standardization of NaturalHY items.

1.2 Standards – baselines for improvement

There are many kinds of standards: ones that apply to a wide variety of products and services, ones that cover a wide range of processes and test methods and even ones that provide guidance or requirements for management systems. Most products have at least some related standards. The following table lists a few of the many types of standards. This document assists you, as a (possible) standards developer, to optimize your input and to convince your superiors of your good work in (inter)national standardization. It gives you an idea of what Standards do and can say. These ideas may also give you tools to present your role in writing standards and participating in standardization meetings.

Table 1 - Types of Standards

Type	General description
Performance specification	Describes performance requirements for a product.
Safety code standard	Provides requirements for ensuring equipment, system or product safety.
Product specification	Describes characteristics for a product.
Test method	Provides instructions to ensure consistent testing of products or materials.
Process specification	Provides instructions for designing, producing or operating a process.
Management system standard	Provides requirements or guidance for systems to manage specific outcomes such as product quality or environmental performance.
Technique standard	Provides guidance on particular supporting techniques such as statistical sampling.
Guidance standard	Provides guidance that may or may not be accepted by the user; uses words such as "should" or "may".
Requirements standard	Provides requirements that must be met for the user to claim compliance with the standard

Once a better way is determined, standards should be changed to include it
Standards abound in business and industry. Some are company standards while others may be developed by national or international standards development organizations (SDOs). In the world of consumer goods and services, standards are most often invisible to us as purchasers. Of course, if our job involves testing in a paper mill or buying computer components, we see references to the applicable standards every day. They form parts of the contracts we have with our suppliers and may govern how we perform processes in our own organization.

But why do we have all these standards? Perhaps it all started with the need for things to fit together physically, but that is another story. Standards are an important and integral part of commercial interactions. At their best, they facilitate trade by establishing level playing fields for all competitors; at their worst, they can be used to restrain international commerce by excluding potential trading partners that cannot meet their rules.

Standards developers need to be constantly vigilant and root out situations that could cause standards to become non-tariff trade barriers. The world's standards systems also need the help of those who actually use their documents.
There are three things users can do. The first is the easiest. Two and three are more difficult.

1. Participate in the standardization process by volunteering to help write, review and edit new and revised documents.
2. Learn to correctly read, interpret and use standards.
3. Develop a broad attitude toward the long-term utility of standards: continual improvement.

Reading and understanding
In reading and understanding a standard, it is useful to identify the role the document plays in the customer-supplier relationship. Your goal should be to make certain your use of the product, process and testing standards aids both organizations in meeting their needs and objectives. While a win-win result is not always possible, it is certainly good to go into a new project with the attitude you will achieve that result.

Notice the product, process and testing standards are key inputs during identification of product requirements. And we all know identification of requirements is a critical element of an effective quality management system. Proper use of these technical standards is needed for the overall quality management system to meet its objectives.

Continual improvement
The purpose of standardization can be viewed as facilitating problem identification and problem solution for improvement in daily trade business. Daily management activities consist of maintenance and improvement. Maintenance involves setting standards and working in accordance with them and improvement involves setting targets above the

present level and working to achieve those targets. To convert a prevailing situation into a more desirable one, existing standards must be altered.

The message is clear: we should be viewing standards as baselines for improvement, and once we have determined a better way, the standards must be changed to include the improvement. If we find better ways and do not change the standard, we almost always slip back into the old ways. There are many things standards users can do to drive continual improvement through the standards process:

- Make comments on the standards they use and be willing to add new ideas they have developed in their use.
- Develop their own version to guide implementation of new and innovative technology they don't want to share outside their organization.
- Share new technology they feel comfortable sharing and use benchmarking studies to define better practices that should be standardized.
- Perhaps most important, identify severely deficient standards and recommend they either be fixed or cancelled.

It's up to all of us Why should standards' users bother? There are two simple answers.

1. Improved standards can make life better for all of us.
2. Users are the key to improving standards because they can see issues never imagined by the writers.

These ideas are true whether we are talking about the standards of an individual organization or standards developed by international SDOs. Because there are lots of standards, probably too many, it is up to users to provide the input needed to eliminate the useless ones, improve the ones that are useful and develop those new standards that are necessary.

The systems of SDOs are not perfect, but they are often more flexible and responsive than users and companies might think. Get involved and help. It is a rewarding thing to do because standardization is really a component of continual improvement.

METHODOLOGY

As with any new endeavour, there are challenges and unresolved issues. Many of the challenges facing the development of hydrogen infrastructure involve materials of construction. Therefore within the NaturalHY project a lot of subjects is to be dealt with. Research and validation within and also outside the NaturalHY project will influence the existing standards framework for numerous subjects like for instances:

- Piping and pipeline materials
- Pipe welding needs to be reviewed for long-term, sustained load cracking
- Composite pipe construction
- Pipeline performance in hydrogen environments
- Valves and joining methods
- Plastic pipe materials for compatibility with high purity hydrogen environments
- Compressor stations
- Gas detection
- Coating/corrosion
- Training certification in hydrogen safety is required in areas where training certification is required for other fuels; for example, pipeline maintenance
- The safety aspects related to the transmission, distribution and end-use of the gas, i.e.:
- The durability of the transmission and distribution pipeline systems and the end user
- infrastructure (hydrogen may diffuse into materials and change the mechanical properties):
- The gas quality management issues related to the gas delivery;
- The performance of end use appliances.
- Warning signs
- Fire (and explosion) prevention and emergency planning
- Safety distances
- Integrity management (safety management)
- Ignition source control
- Maintenance

By desk research, via experts within CEN and ISO and also national standardization (mirror) committees a first list of standards which are involved will be produced.

Via enquiries to the NaturalHY work package (leader)s and to relevant CEN/TC 's the report will be updated and more specific issues will be highlighted.

Based on the study future (standardization) actions will be discussed.

3 RESULTS

3.1 Existing standards and ongoing work

From the tables and information presented in this report it is possible to identify existing international and national standards that might be of help, for example as a starting point, in CEN's future work on standardization of hydrogen/gas mixtures and amendment of existing standards like for gas pipelines and gas distribution pipes.

The NaturalHY-project investigates the conditions under which hydrogen can be added to natural gas with acceptable consequences for safety, durability of the system, gas quality management and performance of the end-user appliances. Membranes will be developed to subtract hydrogen from a hydrogen/natural gas mixture for use by hydrogen powered equipment. On most these (research) aspects National, European and/or international standards or codes do exist.

The need for amendment of current European standards for the gas supply chain also depends on the hydrogen mixture. For lower percentages of hydrogen (up to 10%) less new requirements and specifications (standards) of the infrastructure, appliances and devices are expected than for higher levels (>25%)

At least agreement should be reached (far) in advance, between all stakeholders regarding codes and standards, requirements and specifications. It is recommended that the experts (work package leaders) involved in the NaturalHY project give their advice on the need for revision /amendment of existing standards or the need for development of new standards.

It is important to identify standards revision or development needs in an early state, knowing that due to process of consensus building the traditional standards development takes approximately 3 years for new standards. For development within shorter timeframes pre-standards are adviced by using the so-called CEN Workshop Agreement.

In the next paragraphs the first results are presented by category.

3.2 Pipeline systems

To assure that a natural gas system will be designed, built and operated at the predetermined hazard level, standards are imposed as related to various following safety evaluation categories.
-Routing of the pipeline
- Distances, of human activity centers, from natural gas pipelines as may be determined by the effects caused by a gas leak and the safety limits imposed.
- Pipelines wall thickness.
- Use of other means for pipeline integrity protection.

-Depth of underground pipeline burial.
- Pipelines operation procedures including maximum allowed pressures.

The same systematic approach will be applicable to gas/hydrogen mixtures. The current gas standards should be reviewed to see what revisions are to be made for hydrogen/natural gas mixtures.

Furthermore it is known that especially prevention of possible embrittlement is an issue to be taken care of in future standards. The responsible work package within the NaturalHY project will be asked to advice on the standards impact.

In 3.2.1 and 3.2.2 several main standards for transmission and distribution standards are listed. On the outcome of the enquiries within the relevant TC's the lists will be extended.

3.2.1 Transmission pipeline (system) standards

Reference	Title
ISO 13623	Petroleum and natural gas industries – Pipeline transportation systems (Revision of ISO 13623:2000) (ISO/TC 67/SC 2)
EN 1594	Functional requirements for pipelines for gas supply systems for pressures over 16 Bar (CEN/TC 234)
UK standard BS 8010	Code of practice for pipelines. Part 2. Pipelines on land: Design, Construction and Installation. (Including the reference IGE/TD/1 Edition 3, 1993, communication 1530: "Steel pipelines for high pressure gas transmission)
German code DIN 2470-2	
Dutch standard NEN 3650	Requirements for pipeline transportation systems
American code API 5L	Pipeline transportation systems
American code ASME 31.8-2003	Gas Transmission and Distribution Piping Systems
ASME B31.8S-2003	Managing System Integrity of Gas Pipelines
ASME B31.12	Code for Hydrogen Piping and Pipelines

The American Society of Mechanical Engineers (ASME) through a task group of volunteer experts studied the need for a new design/safety code for hydrogen piping and pipelines. This study resulted in a recommendation to the ASME Board on Pressure Technology Codes and Standards for a new code. This effort is now underway to develop the new code, designated:

ASME B 31.12 will include requirements specific to hydrogen service for power, process, transportation, distribution, commercial and residential applications. The code will include new code requirements, references to relevant code sections and incorporation of parts of the ASME B31.1 (Power Piping), ASME B31.3 (Process Piping) and ASME B31.8 (Gas Transmission and Distribution Piping Systems).

The new B31.12 Code is anticipated to blend prescriptive and performance based elements and will be divided into four parts: A common section containing requirements and data referenced by the relevant code sections below, Part A: Industrial piping systems, Part B: Pipeline and distribution systems and Part C: Commercial and residential systems.

This ASME standard in development could be very useful as input for amending the European standards.

Technical committees involved are CEN/TC 234 Gas supply, ISO/TC 67 Oil and Gas industries, ISO/TC 138, CEN/TC 155 Plastics piping systems, ASTM, ASME, API, SA

3.2.2 Distribution pipeline (system) standards

Within Europe the standards framework for the gas distribution networks is extensively. The gas supply industry took the responsibility by creation these high level standards to secure the gas supply.

Reference	Title
EN 12007 (all parts)	Gas supply systems. Pipelines for maximum operating pressure up to and including 16 bar
EN 12327	Gas supply systems. Pressure testing, commissioning and decommissioning procedures. Functional requirements
EN 12732	Gas supply systems. Welding steel pipework. Functional requirements
EN 12186	Gas supply systems. Gas pressure regulating stations for transmission and distribution. Functional requirements
EN 12279	Gas supply systems. Gas pressure regulating installations on service lines. Functional requirements
EN 1775	Gas supply - Gas pipework for buildings - Maximum operating pressure up to and including 5 bar - Functional recommendation

Next to this set of European "umbrella" standards most EU countries still have national standards which do not conflict to the European standards but do include additions in relation to the local specific situations.

Next to both European and the national standards "gas"codes do still exist from branche organization and next to that a lot of companies do have their own companies standards which include by reference a mix of the above mentioned codes and standards and additional company specific issues.

Technical committees involved are CEN/TC 234 Gas supply, ISO/TC 138 and CEN/TC 155 Plastics piping systems

3.3 Gas quality standards

When hydrogen is added to the gas grid the resulting gas quality in the grid has to meet the (local) quality requirements. The basis for gas quality is agreed upon in several standards.

Reference	Title
ISO 13868	Natural gas - Quality designation
ISO 13443	Natural gas - Standard reference conditions
ISO 15403	Natural gas - Designation of the quality of natural gas for use as a compressed fuel for vehicles
EN 437	Test gases. Test pressures. Appliance categories
DVGW 260	Gasbeschaffenheit

Amendment of these standards is most probably needed. In Europe only two kinds of natural gas are distributed.:L and H gas. European and national standards for L and H gas will have to be amended, changed.

Technical committees: involved ISO/TC 193 Gas quality CEN/TC 19 Petroleum products, lubricants and related products CEN/TC 234 Gas supply

3.4 End user appliances

Gas appliances directive, boiler efficiency directive, buildings directive, e.g. Installation and equipment standards will have to be amended as currently the gas appliances are designed for specific gas qualities. The appliances need a CE marking based on European product standards. Amendment/revision of these standards is probably needed, especially for higher hydrogen/gas mixtures (> 10%).

Especially Work group/package 5 of NaturalHY on End user appliances will be asked to identify any need for revisions or development of standards in relation to their research on membranes.

3.5 Safety standards

Hydrogen safety is one of the core competencies that transcends applications and is crucial to successfully commercializing hydrogen technologies. The EU HySafe network focuses on issues to improve understanding of hydrogen safety and to support the safe and efficient introduction and commercialisation of hydrogen as an energy carrier.

The program includes 25 European partners and is supported with a €7 million budget. The project is coordinated by the research centre of Karlsruhe, Germany and includes the development of a common approach to risk assessment and codes & standards. The workgroup (Work Package Safety) of Geoff Hankinson are also involved in HySafe.

For lower hydrogen mixture (up to about 10%) no substantial difference in hazards are expected compared to natural gas. This means that minor revisions are expected for Safety standards for these mixtures.

Both the work package two on Safety and the European Hysafe network will be asked for their input.

Technical committees: CEN/TC 234 Gas ISO/TC 197 Hydrogen technologies

3.6 Other issues

Revision of gasmeters and calibration standards could be necessary. However, for gasmeters no significant deviation is expected by adding hydrogen.

Leakage testing and detection (NEN-EN 1435) Hydrogen Embrittlement Engines, turbines, compressors, e.g. Lifetimes of materials (integrity of the systems) Kathodic protection (NEN-EN 12954, NEN-EN 10288; NEN-EN 12068)

4 Regulations

It is recognized by several regulators (governments) that the European gastransport and gasdistribution sector due to self-regulation has reach a high level of safety for the society and the environment and a high level of reliability. This is made possible due to a huge framework of standards. On the regulatory side numerous (harmonized) standards are linked to the European directives or are linked by reference in national regulations. By applying such (European) standards conformity to the European or National legislation can be declared. A lot of regulators use the set of standards for supervision, control and inspection.

Next to the influence to standards it is also important to study the possible gaps within the current European directives and to identify the need of amendments or even amendment of the referred European standards.

In relation to gas/hydrogen mixtures applications at least the following EU directives are relevant:

Gas appliances directive Boiler efficiency directive Pressure equipment directive ATEX Gas quality is regulated on European level. Environmetal

Because of a differences in safety level several regulations are worked out on a national level, like: Building codes/regulations Environmental codes/regulations Fire codes/regulations Pipeline transport regulations Safety regulations on hazardous substances (fireworks, ammonia, hydrogen)

5 Preliminary conclusions

The base for all standardization is that there is a demand for standards. The demand for standards on gas/hydrogen mix infrastructure, appliances, e.g. will emerge when the demand of alternative fuels will increase. Such an increase is expected to come in the next 10 years.

When the use of gas/hydrogen mixtures increases substantially, the have to be made available on the consumer market, in addition to the restricted use in captive fleets' tests.

To enable a market introduction of gas/hydrogen mixtures, all technical barriers should be taken away by amending the existing relevant national and European standards and development of new European standards.

The impact of revision of standards should not be under estimated due to the links created. As explained earlier next to both the European and the national standards also branche codes do still exist and next to that a lot of companies do have their own companies standards which include by reference a mix of the above mentioned codes and standards and additional company specific issues. Furthermore a lot of the standards are linked by references to European and national legislation but also to for instance certification schemes and training plans.

ABBREVIATIONS

CA Administrative Board, CEN BSI British Standards Institute BT Technical Board, CEN CEN Comité Européen de Normalisation (European Committee for Standardization) CNG Compressed Natural Gas CONCAWE Conservation of Clean Air and Water in Europe CS Central Secretariat (ISO) CWA CEN Workshop Agreement DIN Deutsches Institut fur Normalisierung DIS Draft International Standard (in ISO) EN European Standard EU European Union Europia European Petroleum Industry Association IEA International Energy Agency IPQ Instituto Portuguése de Qualidade ISO International Standardization Organization LNG Liquefied Natural Gas MC Management Committee, CEN NEN Nederlands Normalisatie-Instituut TC Technical Committee TF Task Force (CEN) TMB Technical Management Board (ISO) TR Technical Report TS Technical Specification WG Working Group