
Basic considerations for the safety of hydrogen systems

*Considérations fondamentales pour la sécurité des systèmes à
l'hydrogène*



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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TR 15916 was prepared by Technical Committee ISO/TC 197, *Hydrogen technologies*.

Introduction

Generally the public is not familiar with industrial hydrogen systems, nor does it have any experience with the new hydrogen systems under development today. The focus of this Technical Report is on the new energy applications. The intent is to provide, those unfamiliar with the technology, a basis upon which to understand the safety issues. This document concerns itself with applications that derive their utility from the chemical reactions of hydrogen and does not apply to applications based on nuclear processes.

Traditionally, hydrogen has been used extensively in the petrochemical and chemical industries and in smaller quantities in the electronics, steel-producing, glass-making, and food hydrogenation industries. In energy applications, the only significant use of hydrogen has appeared in space programmes. This is about to change, given the promise that hydrogen brings as an efficient energy carrier and an energetic fuel with minimal environmental impact. Systems are being developed that produce hydrogen from primary energy sources such as sunlight, wind power, biomass, hydro and fossil fuels, for use in energy applications for home and office heating, generation of electricity, and transportation.

The safe use of hydrogen as a fuel is a primary ISO goal as it seeks to facilitate the rapid emergence of these hydrogen technologies. A key element in the safe use of hydrogen is understanding its unique safety-related properties and that there are acceptable engineering approaches to controlling the risks associated with the use of hydrogen. This Technical Report describes the hazards associated with the use and presence of hydrogen, discusses the properties of hydrogen relevant to safety, and provides a general discussion of approaches taken to mitigate hydrogen hazards. The aim of this Technical Report is to promote the acceptance of hydrogen technologies by providing key information to regulators and by educating the general public on hydrogen safety issues.

The development of International Standards to eliminate barriers to international trade and to simplify the arduous regulatory process by providing hydrogen-specific standards to allow early implementation for rapidly emerging technologies was among the needs identified in the ISO/TC 197 Business Plan. This Technical Report is one of many documents that have been developed, or are in the process of being developed, by ISO as a response to the needs described in the ISO/TC 197 Business Plan. Detailed safety requirements associated with specific hydrogen applications are treated in separate International Standards. This Technical Report provides an informative reference for those separate standards as a common, consistent source of safety-related hydrogen information. This should result in a reduction in duplication and possible inconsistencies in these separate standards.

The considerations presented in this Technical Report are broad, general, and attempt to cover all aspects of hydrogen safety. The degree to which these guidelines are applied will vary according to the specifics of the application (such as the conditions and quantity of hydrogen involved, and the way in which the hydrogen is used). Industrial users may find large portions of the guidelines, presented herein, applicable for their operations. It is not expected that the general public will be required to apply this degree of knowledge to safely operate a hydrogen appliance. It is anticipated that good appliance design, coupled with appropriate care in installation, will reduce the degree of safety considerations to levels that are deemed acceptable by the public for common appliances in use today. The manufacturers of hydrogen appliances will need to consider these guidelines to tailor sufficient specific information for the operation of their appliances, in the environment in which they are to be used, and for the audience that will use them. Readers are encouraged to keep these points in mind as they consider the information presented in this document. Hydrogen has been safely used in many different applications over many years. Adherence to the principles presented in this Technical Report can lead to a continuation of the successful use of hydrogen.

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Basic considerations for the safety of hydrogen systems

1 Scope

This Technical Report provides guidelines for the use of hydrogen in its gaseous and liquid forms. It identifies the basic safety concerns and risks, and describes the properties of hydrogen that are relevant to safety. Detailed safety requirements associated with specific hydrogen applications are treated in separate International Standards.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 11114-4:—¹⁾, *Transportable gas cylinders — Compatibility of cylinder and valve materials with gas contents — Part 4: Test methods for selecting metallic materials resistant to hydrogen embrittlement*

ISO 14687:1999/Cor 1:2001, *Hydrogen fuel — Product specification*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in Annex E apply.

4 Overview of hydrogen applications

4.1 Basic hydrogen infrastructure

4.1.1 Categories of infrastructure

Conceptually, the purpose of hydrogen applications can be categorized as the

- a) production,
- b) storage and transport, and
- c) use of hydrogen.

Some applications may involve all three categories.

4.1.2 Production

The primary means of bulk production of hydrogen today involves chemical processes such as steam reforming of natural gas, displacement of hydrogen from acids by metals, and electrolysis of water. In the

1) To be published.