Technical Specification

ISO/TS 15916

First edition
2026-01

Hydrogen technologies — Basic considerations for the safety of hydrogen systems

Technologies de l'hydrogène — Considérations fondamentales pour la sécurité des systèmes à l'hydrogène

Reference number
ISO/TS 15916:2026(en)

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Published in Switzerland

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 197, *Hydrogen technologies,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/CLC/JTC 6, *Hydrogen in energy systems*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This first edition of ISO/TS 15916 cancels and replaces ISO/TR 15916:2015, which has been technically revised.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The focus of this document is on relatively new hydrogen 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. Given the promise that hydrogen brings as an efficient energy carrier and a fuel with minimal environmental impact, systems are being developed that produce hydrogen using variety of energy sources and feedstocks such as sunlight, wind, biomass, hydropower 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 goal to facilitate the rapid emergence of these hydrogen technologies. A key element in the safe use of hydrogen is to understand its unique safety-related properties and related phenomena, and that there are acceptable engineering approaches to controlling the hazards and risks associated with the use of hydrogen. This document 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 document is to promote the acceptance of hydrogen technologies by providing key information to regulators and by educating people involved with 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 implementation for rapidly emerging technologies was among the needs identified by the ISO/TC 197. This document is one of many that have been developed, or are in the process of being developed. Detailed safety requirements associated with specific hydrogen applications are treated in separate International Standards. This document provides an informative reference for those separate standards as a common, consistent source of safety-related hydrogen information. This is expected to result in a reduction in duplication and possible inconsistencies in these separate standards.

The considerations presented in this document are broad, general, and attempt to address most 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. 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 document can lead to a continuation of the safe and sustainable use of hydrogen.

Hydrogen technologies — Basic considerations for the safety of hydrogen systems

1 Scope

This document provides guidelines for the use of hydrogen in its gaseous and liquid forms as well as its storage in either of these or other forms (hydrides). This document identifies the basic safety concerns, hazards 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.

"Hydrogen" in this document means protium (the most common isotope of hydrogen) (^{1}H), not deuterium (^{2}H) or tritium (^{3}H).

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
ambient conditions
local surrounding conditions characterized by the temperature and pressure at a particular location, such as a city or facility

Note 1 to entry: See *normal temperature and pressure* (3.69).

3.2
annealing
heat treatment process used to soften hard steel so that it can be machined or cold-worked

3.3
arrested flame
combustion process that is stopped or flame that is put out

3.4
auto-ignition
ignition that does not require external ignition energy because the thermal energy of the molecules alone is enough to overcome the activation threshold for combustion initiation

3.5
auto-ignition temperature
lowest temperature at which *auto-ignition* (3.4) occurs

3.6
backfill
process by which a desired gas is used to replace an undesired gas in a system volume