IEC 62282-3-100

Edition 1.0 2012-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Fuel cell technologies –
Part 3-100: Stationary fuel cell power systems – Safety

Technologies des piles à combustible –
Partie 3-100: Systèmes à piles à combustible stationnaires –
Sécurité

IEC 62282-3-100:2012-02(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 62282-3-100 has been prepared by IEC technical committee 105: Fuel cell technologies.

This bilingual version (2015-01) corresponds to the English version, published in 2012-02.

IEC 62282-3-100 cancels and replaces IEC 62282-3-1 published in 2007. IEC 62282-3-100 constitutes a technical revision.

IEC 62282-3-100 includes the following significant technical changes with respect to IEC 62282-3-1:

a) general reorganization of the safety requirements;
b) major changes for addressing electrical safety requirements for internal components;
c) clarifications for numerous requirements and tests, particularly the pressure leakage and strength tests;

d) expanded wind tests;

e) additional tests for condensate discharge and ventilation leakage.

The text of this standard is based on the following documents:

FDIS	Report on voting
105/371/FDIS	105/384/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

The French version of this standard has not been voted upon.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all the parts of the IEC 62282 series, under the general title *Fuel cell technologies*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

A typical stationary fuel cell power system is shown in Figure 1.

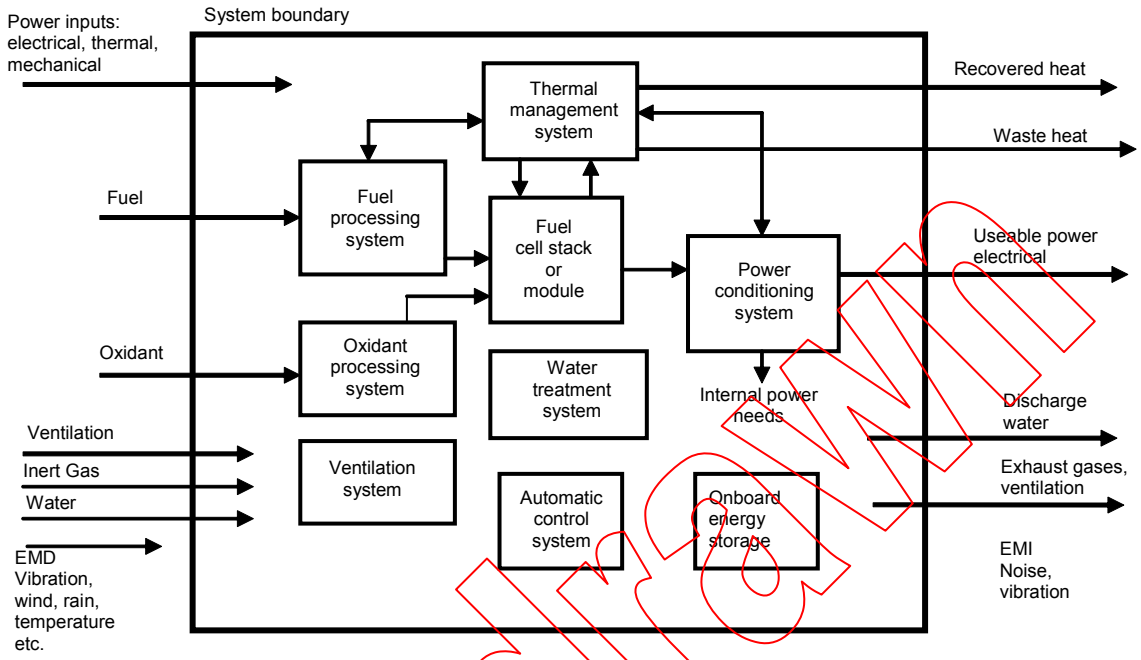

Figure 1 – Stationary fuel cell power systems

The overall design of the power system anticipated by this standard forms an assembly of integrated systems, as necessary, intended to perform designated functions, as follows.

– **Fuel processing system** – System of chemical and/or physical processing equipment plus associated heat exchanges and controls required to prepare, and if necessary, pressurize, the fuel for utilization within a fuel cell power system.

– **Oxidant processing system** – System that meters, conditions, processes and may pressurize the incoming supply for use within the fuel cell power system.

– **Thermal management system –** System that provides heating or cooling and heat rejection to maintain the fuel cell power system in the operating temperature range, and may provide for the recovery of excess heat and assist in heating the power train during start-up.

– **Water treatment system –** System that provides all the necessary purification treatment of the recovered or added water for use within the fuel cell power system.

– **Power conditioning system –** Equipment that is used to adapt the electrical energy produced by the fuel cell stack(s) to application requirements as specified by the manufacturer.

– **Automatic control system –** System(s) that is composed of sensors, actuators, valves, switches and logic components that maintain the fuel cell power system parameters within the manufacturer's specified limits including moving to safe states without manual intervention.

– **Ventilation system –** System that provides air through forced or natural means to the fuel cell power system's enclosure.

– **Fuel cell modules –** Equipment assembly of one or more fuel cell stacks which electrochemically converts chemical energy to electric energy and thermal energy intended to be integrated into a power generation system.

– **Fuel cell stack –** Equipment assembly of cells, separators, cooling plates, manifolds and a support structure that electrochemically converts, typically, hydrogen rich gas and air reactants to DC power, heat and other reactant bi-products.

– **Onboard energy storage –** System of internal electric energy storage devices intended to aid or complement the fuel cell module in providing power to internal or external loads.

FUEL CELL TECHNOLOGIES –

Part 3-100: Stationary fuel cell power systems – Safety

1 Scope

This part of IEC 62282 applies to stationary packaged, self-contained fuel cell power systems or fuel cell power systems comprised of factory matched packages of integrated systems which generate electricity through electrochemical reactions.

This standard applies to systems

– intended for electrical connection to mains direct, or with a transfer switch, or to a stand-alone power distribution system;
– intended to provide AC or DC power;
– with or without the ability to recover useful heat;
– intended for operation on the following input fuels
  a) natural gas and other methane rich gases derived from renewable (biomass) or fossil fuel sources, for example, landfill gas, digester gas, coal mine gas;
  b) fuels derived from oil refining, for example, diesel, gasoline, kerosene, liquefied petroleum gases such as propane and butane;
  c) alcohols, esters, ethers, aldehydes, ketones, Fischer-Tropsch liquids and other suitable hydrogen-rich organic compounds derived from renewable (biomass) or fossil fuel sources, for example, methanol, ethanol, di-methyl ether, biodiesel;
  d) hydrogen, gaseous mixtures containing hydrogen gas, for example, synthesis gas, town gas.

This standard does not cover:

– micro fuel cell power systems;
– portable fuel cell power systems;
– propulsion fuel cell power systems.

NOTE For special application such as “marine auxiliary power”, additional requirements may be given by the relevant marine ship register standard.

This standard is applicable to stationary fuel cell power systems intended for indoor and outdoor commercial, industrial and residential use in non-hazardous (unclassified) areas.

This standard contemplates all significant hazards, hazardous situations and events, with the exception of those associated with environmental compatibility (installation conditions), relevant to fuel cell power systems, when they are used as intended and under the conditions foreseen by the manufacturer.

This standard deals with conditions that can yield hazards on the one hand to persons, and on the other to damage outside the fuel cell system only. Protection against damage to the fuel cell system internals is not addressed in this standard, provided it does not lead to hazards outside the fuel cell system.

The requirements of this standard are not intended to constrain innovation. When considering fuels, materials, designs or constructions not specifically dealt with in this standard, these

alternatives shall be evaluated as to their ability to yield levels of safety and performance equivalent to those prescribed by this standard.

2 Normative references

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

IEC 60079-0, *Explosive atmospheres – Part 0: Equipment – General requirements*

IEC 60079-2, *Explosive atmospheres – Part 2: Equipment protection by pressurized enclosure «p»*

IEC 60079-10 (all parts), *Explosive atmospheres − Part 10: Classification of areas*

IEC 60079-29-1, *Explosive atmospheres – Part 29-1: Gas detectors – Performance requirements of detectors for flammable gases*

IEC 60079-30-1, *Explosive atmospheres – Part 30-1: Electrical resistance trace heating – General and testing requirements*

IEC 60204-1, *Safety of machinery – Electrical equipment of machines – Part 1: General requirements*

IEC 60335-1:2010, *Household and similar electrical appliances – Safety – Part 1: General requirements*

IEC 60335-2-51, *Household and similar electrical appliances – Safety – Part 2-51: Particular requirements for stationary circulation pumps for heating and service water installations*

IEC 60417, *Graphical symbols for use on equipment.* Available from: <http://www.graphical-symbols.info/equipment>

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*

IEC 60730-1, *Automatic electrical controls for household and similar use – Part 1: General requirements*

IEC 60730-2-5, *Automatic electrical controls for household and similar use – Part 2-5: Particular requirements for automatic electrical burner control systems*

IEC 60730-2-6, *Automatic electrical controls for household and similar use – Part 2-6: Particular requirements for automatic electrical pressure sensing controls including mechanical requirements*

IEC 60730-2-9, *Automatic electrical controls for household and similar use – Part 2-9: Particular requirements for temperature sensing controls*

IEC 60950-1, *Information technology equipment – Safety – Part 1: General requirements*

IEC 61000-3-2, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic currents emissions (equipment input current ≤16 A per phase)*

IEC 61000-3-3, *Electromagnetic compatibility (EMC) – Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤16 A per phase and not subject to conditional connection*

IEC 61000-3-4, *Electromagnetic compatibility (EMC) – Part 3-4: Limits – Limitation of emission of harmonic currents in low-voltage power supply systems for equipment with rated current greater than 16 A*

IEC/TS 61000-3-5, *Electromagnetic compatibility (EMC) – Part 3-5: Limits – Limitation of voltage fluctuations and flicker in low-voltage power supply systems for equipment with rated current greater than 75 A*

IEC 61000-3-11, *Electromagnetic Compatibility (EMC) – Part 3-11: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems – Equipment with rated current ≤75 A and subject to conditional connection*

IEC 61000-6-1, *Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity for residential, commercial and light-industrial environments*

IEC 61000-6-2, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments*

IEC 61000-6-3, *Electromagnetic compatibility (EMC) – Part 6-3: Generic standards – Emission standard for residential, commercial and light-industrial environments*

IEC 61000-6-4, *Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments*

IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems*

IEC 62040-1, *Uninterruptible power systems (UPS) – Part 1: General and safety requirements for UPS*

IEC 62061, *Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems*

IEC/TS 62282-1, *Fuel cell technologies – Part 1: Terminology*

IEC 62282-3-200, *Fuel cell technologies – Part 3-200: Stationary fuel cell power systems – Performance test methods*

ISO 3864-2, *Graphical symbols – Safety colours and safety signs – Part 2: Design principles for product safety labels*

ISO 4413, *Hydraulic fluid power – General rules and safety requirements for systems and their components*

ISO 4414, *Pneumatic fluid power – General rules and safety requirements for systems and their components*

ISO 5388, *Stationary air compressors – Safety rules and code of practice*

ISO 7000, *Graphic symbols for use on equipment – Index and synopsis.* Available from: http://www.graphical-symbols.info/equipment.

ISO 10439, *Petroleum, chemical and gas service industries – Centrifugal compressors*

ISO 10440-1, *Petroleum, petrochemical and natural gas industries – Rotary-type positive-displacement compressors – Part 1: Process compressors*

ISO 10440-2, *Petroleum and natural gas industries – Rotary-type positive-displacement compressors – Part 2: Packaged air compressors (oil-free)*

ISO 10442, *Petroleum, chemical and gas service industries – Packaged, integrally geared centrifugal air compressors*

ISO 12499, *Industrial fans – Mechanical safety of fans – Guarding*

ISO 13631, *Petroleum and natural gas industries – Packaged reciprocating gas compressors*

ISO 13707, *Petroleum and natural gas industries – Reciprocating compressors*

ISO 13709, *Centrifugal pumps for petroleum, petrochemical and natural gas industries*

ISO 13849-1, *Safety of machinery – Safety related parts of control systems – Part 1: General principles for design*

ISO 13850, *Safety of machinery – Emergency stop – Principles for design*

ISO 14847, *Rotary positive displacement pumps – Technical requirements*

ISO 15649, *Petroleum and natural gas industries – Piping*

ISO 16111, *Transportable gas storage devices – Hydrogen absorbed in reversible metal hydride*

ISO 23550, *Safety and control devices for gas burners and gas-burning appliances – General requirements*

ISO 23551-1, *Safety and control devices for gas burners and gas-burning appliances – Particular requirements – Part 1: Automatic valves*

ISO 23553-1, *Safety and control devices for oil burners and oil-burning appliances – Particular requirements – Part 1: Shut-off devices for oil burners*

ISO 26142, *Hydrogen detection apparatus – Stationary applications*

3 Terms and definitions

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

3.1
accessible
area to which, under normal operating conditions, one of the following applies:

a) access can be gained without the use of a tool;

b) the means of access is deliberately provided to the end user;

c) the end user is instructed to enter regardless of whether or not a tool is needed to gain access

Note 1 to entry: The terms "access" and "accessible", unless qualified, relate to end user access area as defined above.

Note 2 to entry: Only service technicians are allowed into non-accessible areas. Service personnel that are allowed access into non-accessible areas may need to have proper personal protective equipment as noted in the maintenance manual.

3.2
anode exhaust catalytic reactor
catalyst reactor which oxidizes hydrogen-rich gas used for hydrogen fuel cell power systems

3.3
automatic burner control system
system which monitors the operation of fuel burners. It includes a programming unit, a flame/oxidation detector and may include an ignition source and/or ignition device

3.4
burner port
any opening in a burner head through which gas or gas-air mixture is discharged for ignition

3.5
combustible materials
item capable of combustion

Note 1 to entry: Such materials shall be considered combustible even though flame-proofed, fire-retardant treated, or plastered

Note 2 to entry: When pertaining to materials adjacent to, or in contact with, heat-producing appliances, vent connectors, flue gas vents, steam and hot water pipes, and warm air ducts, those materials made of or surfaced with wood, compressed paper, plant fibres, or other materials that are capable of being ignited and burned.

3.6
design pressure
highest pressure that may occur under any and all operating modes, including steady state and transient

3.7
effluent
products of combustion plus the excess air being discharged from gas utilization equipment

3.8
electromagnetic disturbance
EMD
any electromagnetic phenomenon that may degrade the performance of a device, equipment or system, or adversely affect living or inert matter

3.9
electromagnetic interference
EMI
degradation of the performance of an equipment, transmission channel or system caused by an electromagnetic disturbance

3.10
electrical equipment
general term including material, fittings, devices appliances, fixtures, apparatus and the like used as part of, or in connection with, and electrical installation

3.11
emergency shutdown
safety shutdown
control system actions, based on process parameters, taken to stop the fuel cell power

system and all its reactions immediately to avoid equipment damage and/or personnel hazards

3.12
fuel cell
electrochemical device that converts the chemical energy of a fuel and an oxidant to electrical energy (DC power), heat and other reaction products

3.13
fuel cell power system
generator system that uses a fuel cell module(s) to generate electric power and heat

3.14
fuel compartment
cabinet compartments with internal sources of flammable gas/vapour release

3.15
flue gas vent
passageway, for conveying vent gas from gas utilization equipment or their vent connectors to the outside atmosphere (see also 3.33)

3.16
heat exchanger
vessel in which heat is transferred from one medium to another

3.17
igniter
device which utilizes electrical energy to ignite gas at a pilot burner or main burner

3.18
ignition device
device mounted on or adjacent to a burner for igniting fuel at the burner

EXAMPLE Pilot burners, spark electrodes and hot surface igniters.

3.19
ignition system timings

3.19.1
flame-establishing period
period of time between the signal to energize the fuel flow means and the signal indicating presence of the burner flame

Note 1 to entry: This may be applicable to proof of the ignition source or main burner flame, or both.

3.19.2
ignition activation period
period of time between energizing the main gas valve and deactivation of the ignition means prior to the lock-out time

3.19.3
start-up lock-out time
period of time between the initiation of gas flow and the action to shut off the gas flow in the event of failure to establish proof of the supervised ignition source or the supervised main burner flame. Re-initiating the lighting sequence requires a manual operation

3.19.4
purge time
period of time intended to allow for the dissipation of any unburned gas or residual products of combustion

3.19.4.1
pre-purge time
purge time which occurs at the beginning of a burner operating cycle prior to initiating ignition

3.19.4.2
post-purge time
purge time which occurs at the end of a burner operating cycle

3.19.5
recycle time
period of time between the signal to de-energize the gas supply following loss of the supervised ignition source or the supervised flame and the signal to begin a new start-up procedure

3.20
interlock
control to prove the physical state of a required condition and to furnish that proof to the safety related control device which performs the safety shutdown

3.21
lock-out time
period of time between the signal indicating absence of flame and the action to shut off the fuel supply

3.22
main burner
device or group of devices essentially forming an integral unit for the final conveyance of gas or a mixture of gas and air to the combustion zone, and on which combustion takes place to accomplish the function for which the equipment is designed

3.23
manifold
conduit(s) which supplies fluid to or collects it from the fuel cell or the fuel cell stack

3.24
permissive
condition within a logic sequence that must be satisfied before the sequence is allowed to proceed to the next phase

3.25
pilot
small gas flame used to ignite the gas at the main burner

3.25.1
continuous pilot
pilot that burns without turning off throughout the entire time the burner is in service, whether the main burner is firing or not

3.25.2
intermittent pilot
pilot which is automatically lit each time there is a signal for initialization and burns during the entire period that the main burner is firing

3.25.3
interrupted pilot
pilot which is automatically lit each time there is a signal for initialization. The pilot fuel is cut off automatically at the end of the main burner flame-establishing period

3.25.4
proved pilot
pilot flame supervised by a primary safety control

3.26
purge
Protective operation to remove gases and/or liquids, such as fuel, hydrogen, air or water, from a fuel cell power system

3.27
reformer
reactor to produce a hydrogen rich gas mixture from a raw fuel

3.28
specific gravity
ratio of the weight or mass of a given volume of a substance to that of an equal volume of another substance (air for gases, water for liquids and solids) used as a standard, both measured under the same conditions

3.29
state

3.29.1
cold state
state of a fuel cell power system at ambient temperature with no power input or output

3.29.2
operational state
state of a fuel cell power system with substantial electrical active output power available

3.29.3
passive state
state of the fuel cell power system when the fuel and oxidant systems have been purged with steam, air or nitrogen or per manufacturer's instructions

3.29.4
standby state
state of a fuel cell power system being at sufficient operating temperature and in such an operational mode, with zero electrical output power that the fuel cell power system is capable of being promptly switched to an operational state with substantial electrical active output power

3.29.5
storage state
state of a fuel cell power system being non-operational and possibly requiring, under conditions specified by the manufacturer, the input of thermal and/or electric energy and/or an inert atmosphere in order to prevent deterioration of the components

3.30
thermal equilibrium conditions
stable temperature conditions indicated by temperature changes of no more than 3 K (5 °F) or 1 % of the absolute operating temperature, whichever is higher between three readings 15 min apart

3.31
vent connector
that portion of the venting system which connects the flue outlet of gas utilization equipment to the flue gas vent or single-wall metal pipe

3.32
vent gases
products of combustion from gas utilization equipment plus excess air, plus dilution air in the venting system

3.33
vent terminal
vent cap
fitting at the end of the vent pipe that directs the flue products into the outside atmosphere

3.34
ventilation

3.34.1
mechanical ventilation
movement of air and its replacement with fresh air by mechanical means

3.34.2
natural ventilation
movement of air and its replacement with fresh air due to the effects of wind and/or temperature gradients

3.35
venting system
flue gas vent and vent connector if used, assembled to form a continuous open passageway from the flue collar of gas utilization equipment to the outside atmosphere for the purpose of removing vent gases

4 Safety requirements and protective measures

4.1 General safety strategy

The manufacturer shall perform in written form a risk analysis to ensure that

a) all reasonably foreseeable hazards, hazardous situations and events throughout the anticipated fuel cell power system's lifetime have been identified (see Annex A for a listing of typical hazards);

b) the risk for each of these hazards has been estimated from the combination of probability of occurrence of the hazard and of its foreseeable severity;

c) the two factors which determine each one of the estimated risks (probability and severity) have been eliminated or reduced to a level not exceeding the acceptable risk level as far as practical possible through

   1) inherently safe design of the construction and its methods; or