Hydrogen Safety Standards and the HyPER Project

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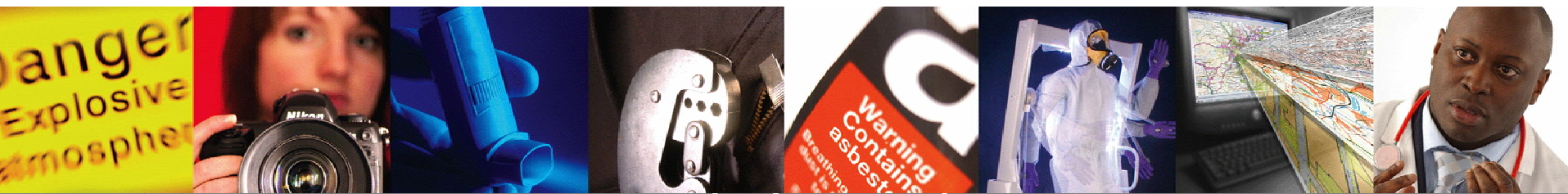
HAZARD REDUCTION GROUP

HEALTH AND SAFETY LABORATORY

BUXTON



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Introduction

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- There is a clear need for hydrogen economy applications to have a suitable safety standards to ensure safe design, installation, operation etc.
- As rate of installations increases standards are essential for safety and to remove potential bottle-necks that could slow development.
- It is important to prevent an incident that could cause irreparable damage to public perception of hydrogen and so slow/stop the development of the hydrogen economy.

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Introduction

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- At present safety standards specifically designed for hydrogen economy applications are few and far between.
- Many of the standards that are available are directly adopted from industrial standards/ practice and so in many ways are not totally suitable.
  - Example is Safety (or Set Back) Distances which are all based on industrial use of gases, and often gases other than hydrogen.

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Existing Guidance & Standards (1)

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- **At present there is limited guidance specifically targeted *to assist* installers of fuel cell and hydrogen systems. Exceptions to this include the**
  - **US Department of Energy (DOE) Module 1 Permitting Stationary Fuel Cell Installations**
  - **Draft UK Installation Guide for Hydrogen Fuel Cells and associated equipment,**

Both clearly focused on fuel cell applications.

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Main Sources

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- International Standards Organisation (ISO) Technical Committee 197 “Hydrogen Technologies”.
- International Electrotechnical Commission (IEC) Technical Committee 105 “Fuel Cell Technologies”.
- European Industrial Gases Association (EIGA), the Compressed Gas Association (CGA).
- National Fire Protection Association (NFPA).

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ISO TC197 “Hydrogen Technologies”

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Group	Documents	Relevance			
		Installation	Fuel Cell	Gas storage	Fuel processing
ISO	ISO/TR 15916 : 2004 - Basic considerations for the safety of hydrogen systems	**X**		**X**	
ISO TC 197 WG8	ISO/CD 22734-2 - H2 generators using water electrolysis process. Part 2: Residential applications				**X**
ISO TC 197 WG9	ISO/CD 16110-1- H2 generators using fuel processing technologies. Part 1 : Safety				**X**
ISO TC 197 WG13	Hydrogen detectors	**X**			

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ISO TC197 “Hydrogen Technologies”

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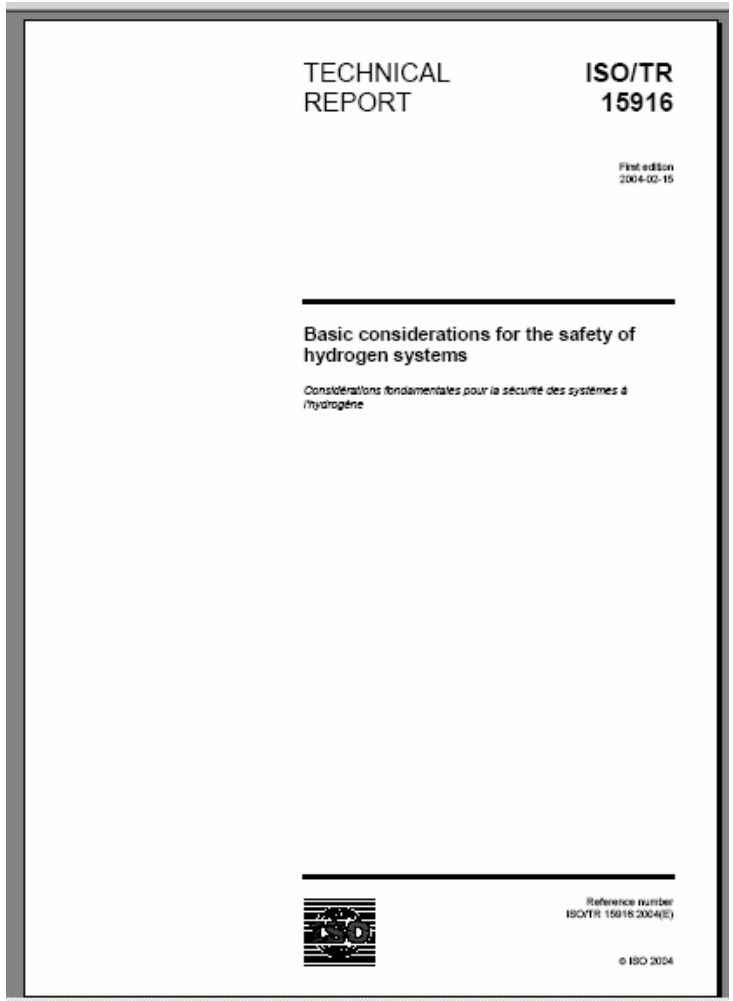
- **Document covering broad range of topics relating to Hydrogen Safety:**
  - **Basic Properties**
  - **Materials/embrittlement**
  - **Combustion**
  - **Cryogenic Issues**



TECHNICAL REPORT

ISO/TR 15916

First edition
2004-02-15

Basic considerations for the safety of hydrogen systems

Considérations fondamentales pour la sécurité des systèmes à l'hydrogène

Reference number
ISO/TR 15916:2004(E)

© ISO 2004

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IEC TC105 “Fuel Cell Technologies”

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Group	Documents	Relevance			
		Installation	Fuel Cell	Gas storage	Fuel processing
IEC	IEC 62282-2 (2005-03) – Fuel cell technologies – Part 1: Terminology	**x**		**x**	
IEC	IEC 62282-2 (2004-07) – Fuel cell technologies – Part 2 : Fuel cell modules		**x**		
IEC WG3	IEC 62282-3-1- Fuel cell technologies – Part 3-1: Stationary fuel cell power plants – Safety		**X**	**X**	
IEC WG5	IEC 62282-3-3 – Fuel cell technologies – Part 3-3: Stationary fuel cell power plants – Installation	**x**			

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IEC “Other”

Group	Documents	Relevance			
		Installation	Fuel Cell	Gas storage	Fuel processing
IEC	IEC 61779-1 – Electrical Apparatus for the Detection and Measurement of Flammable Gases- Part 1. General Requirements & Test Methods (+IEC 60079-29-1 & 2)	**X**			
IEC	EN 60079-10 - Electrical apparatus for explosive gas atmosphere - part 10 classification of hazardous area	**X**			

US DOE / NFPA

Group	Documents	Relevance			
		Installation	Fuel Cell	Gas storage	Fuel processing
US DOE	Regulators' Guide to Permitting Hydrogen Technologies – Overview Including Module 1 – Permitting Stationary Fuel Cell Installations	x			
US / NFPA	NFPA 55 – Storage, Use and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders and Tanks.			x	
US / NFPA	NFPA 50A - Standard for gaseous hydrogen system at consumer sites (1999)			x	
US /NFPA	NFPA 853 – Installation of Stationary Fuel Cell Power Plants	x			

UK & Other

Group	Documents	Relevance			
		Installation	Fuel Cell	Gas storage	Fuel processing
UK	Industry/government working group ” Installation Guide for Hydrogen Fuel Cells and Associated Equipment”	x			
UK / BS	BS EN 50073 – Guide for selection, installation, use and maintenance of apparatus for the detection and measurement of combustible gases or oxygen	X			
EIGA	IGC 75/01/E/rev - Determination of safety distances	X			
EIGA	IGC Doc 15/96 –Gaseous Hydrogen Stations	X		X	
CGA	CGA G 5.5- Hydrogen vent systems	X			
CGA	CGA C 10- Recommended procedures for changes of gas service of compressed gas cylinder			X	
NASA	SAFETY STANDARD FOR HYDROGEN AND HYDROGEN SYSTEMS Guidelines for Hydrogen System Design, Materials Selection, Operations, Storage, and Transportation	X		X	

NASA NSS 1740.16

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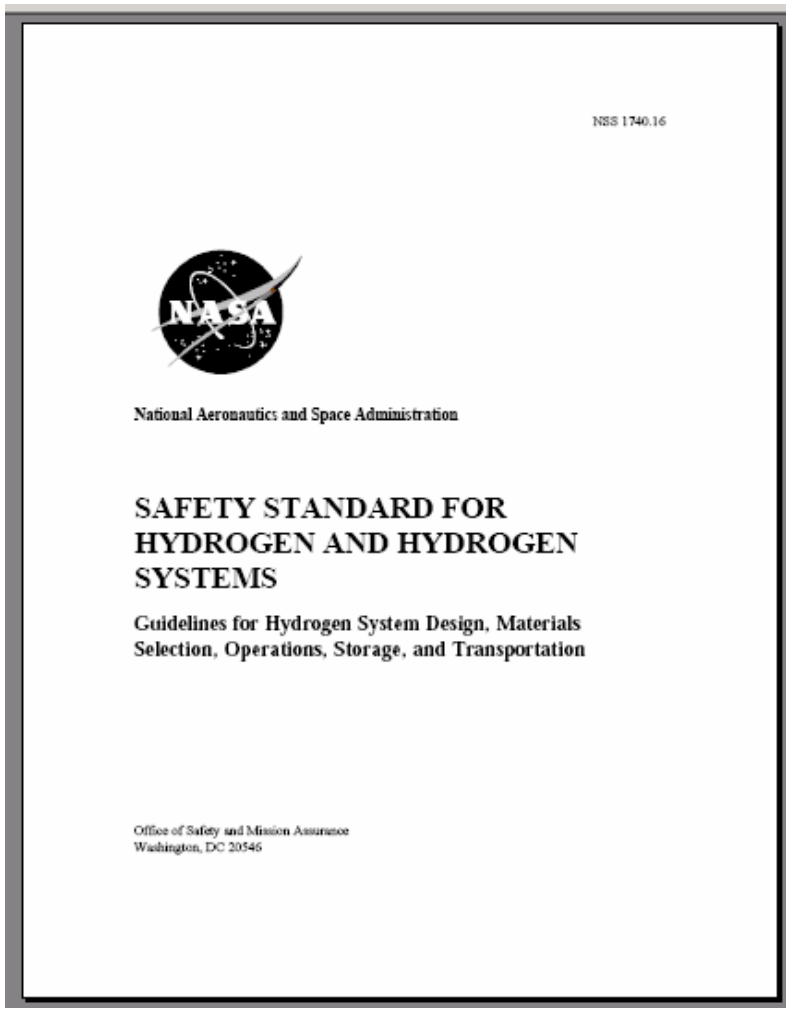
- Freely available on Internet
- Covers full range of hydrogen safety issues
- Also contains large amount of normative data



NSS 1740.16

National Aeronautics and Space Administration

SAFETY STANDARD FOR HYDROGEN AND HYDROGEN SYSTEMS

Guidelines for Hydrogen System Design, Materials Selection, Operations, Storage, and Transportation

Office of Safety and Mission Assurance
Washington, DC 20546

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REGULATIONS

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- There is *currently* no European legislation *covering* the installation of stationary *fuel cell applications* with *power outputs not exceeding* 50kW. However, *installed systems must* be CE marked and therefore compliant with a set of European directives such as:
- Machinery directive ; 98/37/EC,
- Low voltage directive ; 73/23/EEC
- Electromagnetic compatibility directive ; 89/336/EEC,
- Simple pressure vessels directives ; 87/404/EEC , 90/448/EC….
- ATEX….

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HyPer Project

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- **Installation Permitting Guidance for Hydrogen and Fuel Cell Stationary Hydrogen Systems.**

- **Two Year EU funded STREP project**
- **Coordinator is Daniel Spagni (University of Manchester Advanced Research Partnership).**
- **Technical Cooordinators are HSL**

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HyPer Project

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The Focus of the Project is small stationary hydrogen and fuel cell systems (<10kWel) to:

- **Develop an agreed installation permitting process to achieve fast track approval for safety and procedural issues**
- **Incorporate into an Installation Permitting Guide (IPG) for use by developers, engineers, manufacturers, installers and authorities having jurisdiction and promote its acceptance and use across the European Union.**

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Partners

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HYPER H2

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cea

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in der Helmholtz-Gemeinschaft

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INGEGNERIA

Vaillant

Pro-Science

UNIVERSITY of ULSTER

ARCOTRONICS GROUP
ARCOTRONICS FUEL CELLS

Sandia National Laboratories
Combustion Research Facility

plug power
FUEL CELL SYSTEMS

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Applications/Case Studies

A PlugPower natural gas fuelled CHP unit powers a greenhouse in Nancy, France.

A PlugPower GasCore© Fuel System in South Africa provides back-up power for telecommunications.

Stationary applications include systems:

- **Connected to the power grid on stand alone including remote power**
- **Fuel Cell systems fuelled by natural gas, liquid hydrocarbon fuels, biogas, hydrogen**

A Vaillant fuel cell heating appliance, Oldenburg, Germany.

A PlugPower GasCore© Fuel System provides power to a telecommunication mast in Scotland, United Kingdom.

- **Uninterrupted Power Supply (UPS) and backup systems**
- **Combined Heat Power Systems (CHP)**

HYPER Stakeholders Consultative Group (SCG)

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- Ministry of Housing, Spatial Planning and the Environment-VROM-EV (Netherlands)
- Health and Safety Authority (Ireland)
- National Fire Corp (Italy)
- DVGW (Germany)
- KIWA Gastec (Netherlands)
- Ministere de l'Industrie-DGAP (France)
- Office of Technical Inspection- UDT (Poland)
- Regulatory Authority for Energy- RAE (Greece)
- UK Hydrogen Association (UK)
- Association pour la Promotion the l'Hydrogene et de ses Applications- ALPHEA (France)
- Italian Hydrogen and Fuel cell Association (Italy)
- Ducth Hydrogen and Fuel Cell Association- NWV (Netherlands)
- Association Francaise de l'Hydrogene (France)
- Hellenic Hydrogen Association (Greece)
- European Hydrogen association-EHA (Belgium/EU)
- Air Products (UK)
- London Hydrogen Partnership (UK)
- Dr Randy Dey (Canada)
- Professor Toshisuke Hirano (Japan)

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Small H2 and FC Stationary Systems

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- Virtual power plant project (FP5)
- HySafe (already formal link will ensure IPG document legacy)
- EIHP
- Flame SOFC
- FCTESTQA
- FCTEDI
- HyAPPROVAL

- Validity of concept demonstrated
- Key technological components proven
- Costs and reliability need to be improved
- Regulations, codes and standards have to be adapted

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Regulation, Codes, Standards (RCS) issues

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- Need to examine all the existing standards, good practice guides,etc referring to the general use of hydrogen and FC produced by ISO TC197 , IEC TC105 Fuel, EIGAS), CGA, NFPA, NASA.
- No current European legislation covering installation of small stationary hydrogen systems
- Limited relevant RSC available to assist installers of hydrogen stationary systems
- Most RSC have been developed for large industrial hydrogen systems (NFPA 55 or NFPA 853 for stationary fuel cell application) or are based on behaviour of much denser and less buoyant products than hydrogen (usually hydrocarbon fuels)
- A number of existing/proposed codes and standards could be adapted to small industrial & domestic fuel cell markets

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Hydrogen and Fuel Cell Regulations, Codes and Standards

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Key / relevant items to take into account:

- **Fuel cells incl installation, siting- hardware / equipment-type of cell and fuel (natural gas, liquid gas, biogas, hydrogen); fuel storage and dispensing (esp for hydrogen)**
- **Boiler and pressure vessels**
- **Safety systems: fire protection, venting / exhaust, shut off systems, detection / sensors**
- **Interface with building (wiring, grounding, marking, control) and utility interconnection (gas, electricity)**
- **Testing and evaluation procedures (performance test, component acceptance), quality control**
- **Maintenance**
- **Operating instructions**

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Filling Gaps in Pre-normative: Research for Input to RCS

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- **WP4&5 of project will carry out moddelling and experimental program**
- **Purpose of our experimental and modelling is address critical safety issues relating to small H2 and FC installations and provide insight and data to adresses issues for safe installation**

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Hydrogen Jet Flames

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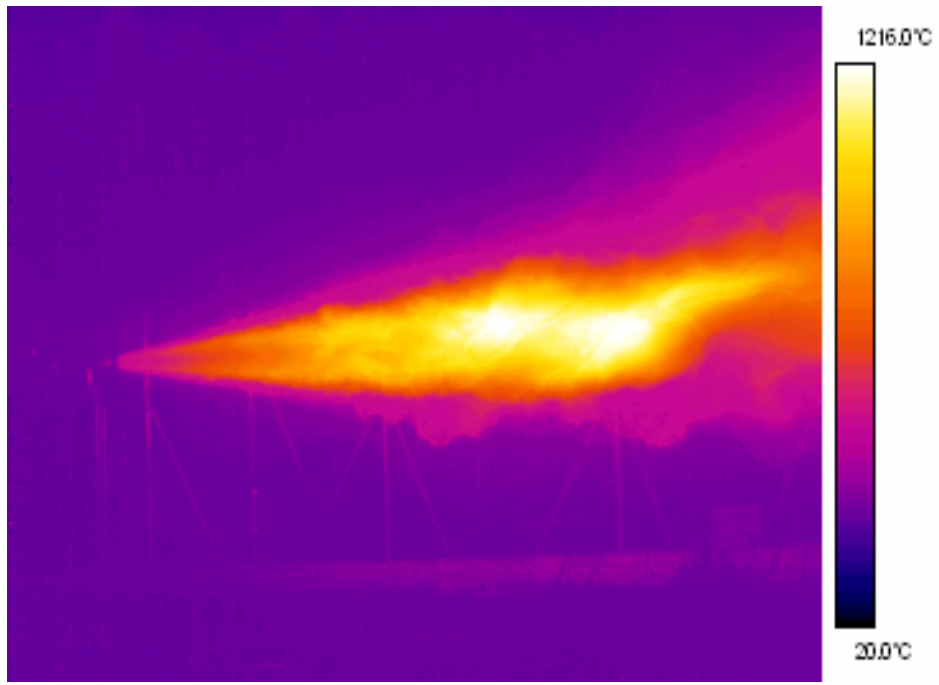
Image from video camera

Image from thermal imaging camera



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Filling Gaps in Pre-normative: Research for Input to RCS

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- **Safety distances – currently based on industry practice and are very large. Aim to reduce these (with sound scientific basis) for hydrogen powered systems. Need experimental data and further modelling to demonstrate this**
- **Hazardous area definition**
- **Ventilation and Senses**
- **Behaviour of Impinging Jets (Sandia, US)**

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Summary

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- Hopefully given you a brief overview of H2 and FC Codes and Standards Development
- Much of the work is still ongoing
- Identified some general documents that anyone working with hydrogen should have.

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Summary

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- A majority of HYPER Participants (Partners and members of the Stakeholders Consultative Group) play an active role in the development of hydrogen and fuel cells related European and International codes and standards
- Initial aim is to develop a European IPG.
- Ultimate aim of the project is to bring the IPG document into IEC as a new work item proposal and then under the IEC umbrella as an International Technical Report or Publicly Available Specification for use worldwide

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Thankyou

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