

**THyGA Workshop:
Standardization and Certification of Gas Appliances**

U. S. Experience and Approach



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AGA Antitrust Policy

AGA and its members are committed to full compliance with all laws and regulations and to maintaining the highest ethical standards in the way we do business. This commitment includes strict compliance with federal and state antitrust laws.

To read AGA's full antitrust policy, please visit our website:

<https://www.aga.org/aga-antitrust-compliance-program-detail/>

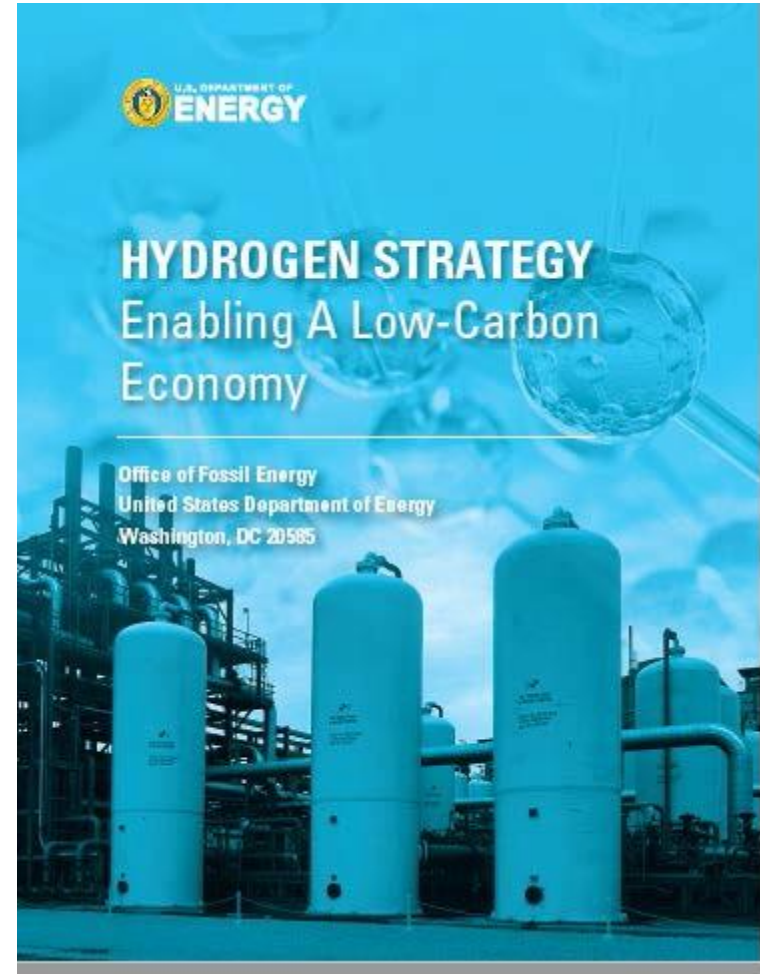
Characteristics of the U. S. Appliance Market

- **Standards Requirements Harmonized in North America (U. S. and Canada) through the CSA Group Standards Secretariat**
- **Appliances Installed In the U. S.:**
 - **Over 70 Million Residential Customers as of 2019**
 - **5.5 Million Commercial Customers**
- **Gas Supplies Serving Residential and Commercial Customers – Increasingly Networked**
- **Experience with Gas Interchangeability Research and Gas Quality Requirements.**

U. S. Hydrogen Efforts in Context

- **DOE Hydrogen Economy Strategy**

(https://www.energy.gov/sites/prod/files/2020/07/f76/US_DOE_FE_Hydrogen_Strategy_July2020.pdf)



Additional Resources



- **National Renewable Energy Laboratory (NREL) “Hydrogen Data, Tools, and Maps”**

(<https://www.nrel.gov/gis/hydrogen.html>)

The screenshot shows the NREL Geospatial Data Science website. The NREL logo is at the top left, with the tagline "Transforming ENERGY". A search bar is at the top right. The main navigation bar includes "Research", "Staff", "Publications", "Data & Tools", and "Work with Us". The "Data & Tools" menu is active, and the breadcrumb trail reads "Geospatial Data Science > Hydrogen Resource Data, Tools, and Maps".

On the left side, there is a vertical menu with the following categories: Biomass, Geothermal, Hydrogen (highlighted), Marine & Hydrokinetic, Solar, Wind, and Crosscutting.

The main content area is titled "Hydrogen Resource Data, Tools, and Maps". It includes the following sections:

- Hydrogen Resource Data, Tools, and Maps**: Explore hydrogen resource data via our online geospatial tools and downloadable U.S. maps and data sets.
- Geospatial Data Tools**:
 - HyDRA**: View, download, and analyze hydrogen data spatially and dynamically. HyDRA contains hydrogen demand, resource, infrastructure, cost, production, and distribution data.
 - Renewable Energy Atlas**: View and explore renewable energy resource data.
 - Tribal Energy Atlas**: Explore techno-economic renewable energy potential on tribal lands.
- U.S. Hydrogen Resource Maps**: This collection of U.S. hydrogen maps provides examples of how geographic information system modeling is used in hydrogen infrastructure, demand, market, and resource analysis. The images below are samples of the maps available in the associated reports. Refer to the reports for further information. If you have difficulty accessing these maps because of a disability, contact the Geospatial Data Science Team.

Two map thumbnails are shown at the bottom:

- U.S. Hydrogen Infrastructure Demand – Consumer Strategy**: GIS was used to analyze demographic, socio-economic, transportation, and policy data that influence hydrogen demand. The demand scenarios were then further used to estimate infrastructure needs and usage throughout the country and predict transition infrastructure costs. *Geographically Based Hydrogen Consumer Demand and Infrastructure Analysis: Final Report*, NREL Technical Report (2006).
- Proposed Hydrogen Refueling Stations along Major Interstates**: This report identified a minimum infrastructure to connect the

Natural Gas Interchangeability – A Key Consideration for “Renewable Gases”

- “Renewable Gases” – “Renewable Natural Gas” (RNG), Biogas, “Synthetic” or “Substitute” Natural Gas
- American Society of Testing and Materials (ASTM) Definition of “RNG:”

“renewable natural gas (RNG), n - a pipeline-quality gas that is all or in part from renewable sources and is fully interchangeable with geological (fossil fuel) natural gas.”
- The Challenge for Natural Gas/Hydrogen Blends: *Are They Interchangeable with Natural Gases Covered by FERC-Approved Tariff Specifications?*

Natural Gas Interchangeability – A Key Consideration for “Renewable Gases” (cont.)

FERC and Technical Interchangeability Criteria:

White Paper on Natural Gas Interchangeability and Non-Combustion End Use

NGC+ Interchangeability Work Group
February 28, 2005*

* Including appendices added to document June 7, 2005. Appendices are the contributions of the listed authors and have not been subjected to the consensus review of the Work Group. As such, the appendices do not necessarily represent the views of the Work Group.

UNITED STATES OF AMERICA FEDERAL ENERGY REGULATORY COMMISSION

Before Commissioners: Joseph T. Kelliher, Chairman;
Nora Mead Brownell, and Sudeen G. Kelly.

Natural Gas Interchangeability

Docket No. PL04-3-000

POLICY STATEMENT ON PROVISIONS GOVERNING NATURAL GAS QUALITY AND INTERCHANGEABILITY IN INTERSTATE NATURAL GAS PIPELINE COMPANY TARIFFS

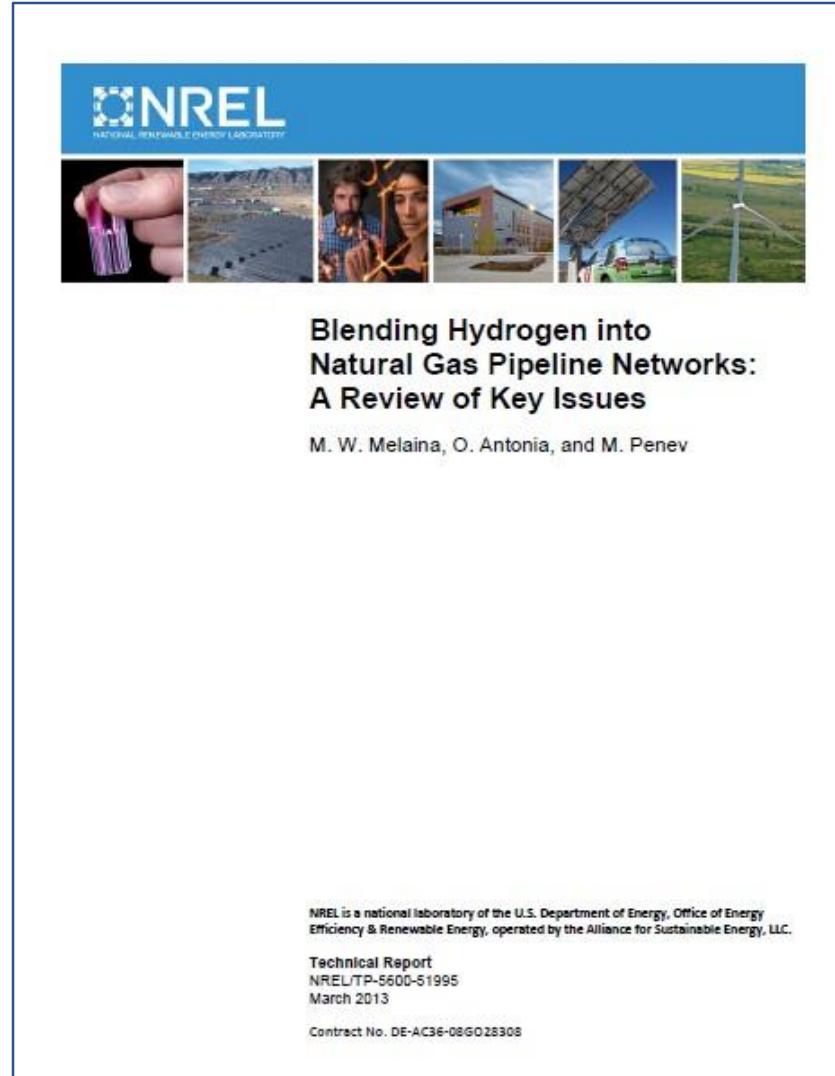
(Issued June 15, 2006)

I. Introduction

1. In this proceeding, the Commission has been exploring natural gas quality and interchangeability issues and the impact of those issues on the natural gas companies subject to the Commission's jurisdiction, as well as on natural gas producers, shippers and end-users. Based upon the information developed during this proceeding, which will be discussed below, the Commission today announces its policy on natural gas quality and interchangeability issues.

2. The Commission's intention in issuing this statement of generic policy is to provide direction for addressing gas quality and interchangeability concerns, as well as to provide guidance to individual companies that have concerns about these issues. The Commission's policy embodies five principles: (1) only natural gas quality and interchangeability specifications contained in a Commission-approved gas tariff can be enforced; (2) pipeline tariff provisions on gas quality and interchangeability need to be flexible to allow pipelines to balance safety and reliability concerns with the importance of maximizing supply, as well as recognizing the evolving nature of the science underlying gas quality and interchangeability specifications; (3) pipelines and their customers should develop gas quality and interchangeability specifications based on technical requirements; (4) in negotiating technically based solutions, pipelines and their customers are strongly encouraged to use the Natural Gas Council Plus (NGC+) interim

Technical Issues and Uncertainties for Natural Gas Pipelines



- **Natural Gas/Hydrogen Blends of 5% to 15% Hydrogen “appears to be viable without significantly increasing risks...”**
- **Blends Using Natural Gas as a Carrier Gas for Delivering Hydrogen.**

(<https://www.nrel.gov/docs/fy13osti/51995.pdf>)

AGA Hydrogen/Natural Gas Testing and Documentation

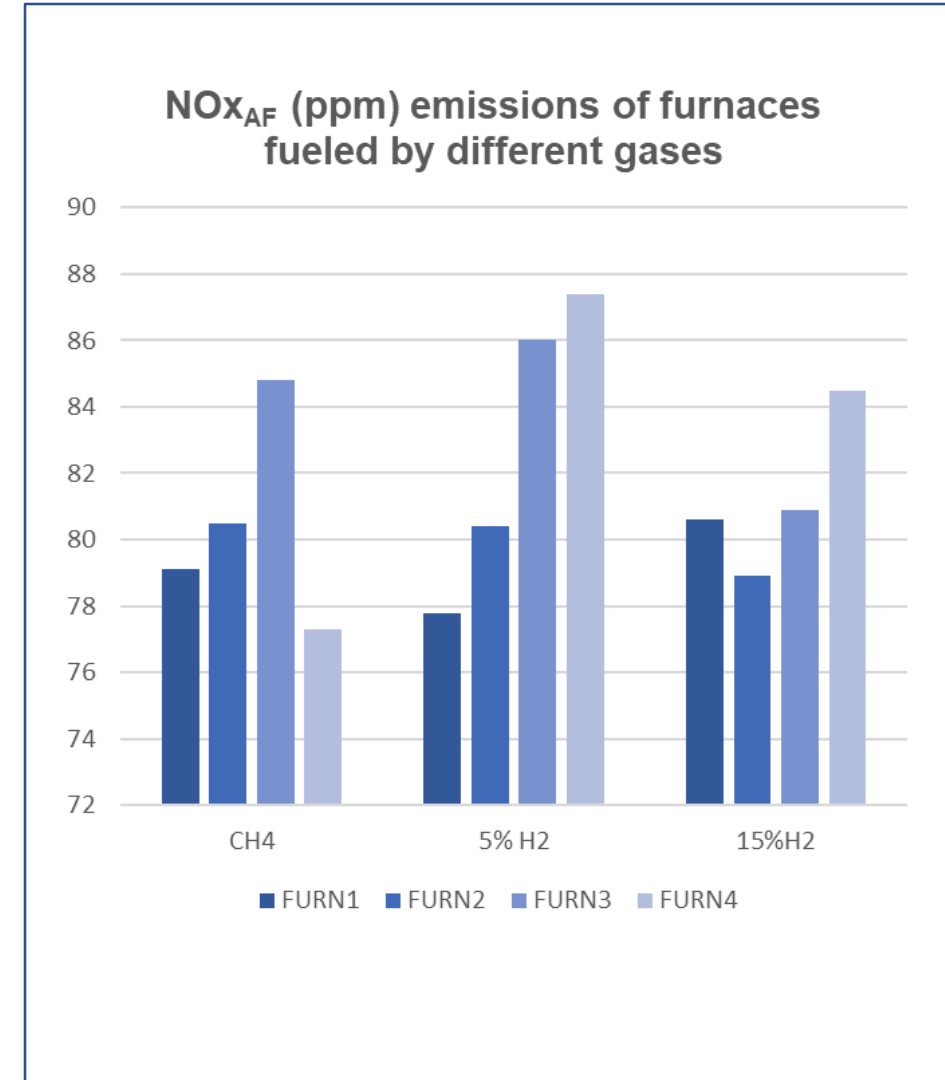
Technical Work:

- **Completed: Exploratory Testing of Residential Natural Gas Appliances Operability on Methane/Hydrogen Mixtures**
 - **Participants: CSA Group, AHRI, AGA**
 - **Operability Testing Completed; Testing Organization Draft Testing Report Delivered; CSA Group Project Report Delivered and Under CSA Review; Separate Distribution of AEI Testing Report to CGA Proposed.**
 - **Additional Testing of Leakage from Connectors Completed and Final Reporting-Revision.**

Exploratory Testing Findings

- **Standards for Safety: Performance on 5% and 15% Hydrogen Blends**

- **No Operability Challenges or Critical Safety Issues Were Identified**
- **No Carbon Monoxide (CO) or Oxides of Nitrogen (NO_x, including NO₂) Excursions from Baseline Performance Were Observed**
- **No Effects on Appliance Controls or Leakage Due to Reduced Density and Other Physical Characteristics Were Observed**
- **Excessive Heat Exchanger Temperatures Were Not Observed**
- **Stability of Pilot Ignition Was Observed in One Space Heater.**

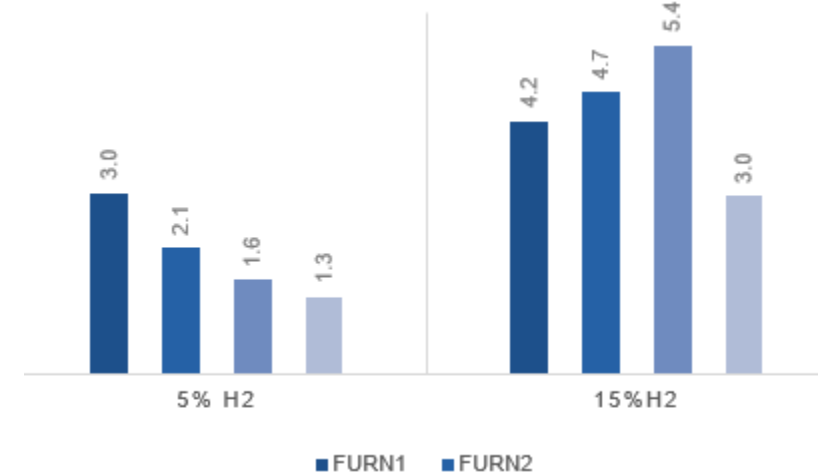


Exploratory Testing Findings (cont.)

- **Appliance Input Effects**

- **Consistent Reduction in Input and Useful Heat Output Was Observed in All Four Appliance Categories with Increasing Hydrogen Fraction**
- **Despite Differences in Input Reduction Within and Across Appliance Categories, Results Were Consistent With Theoretical Predictions**
- **Influence of Staged and Modulated Operation Was Not Tested; All Results Were for Maximum Firing Rate.**

Input rate decrease (%) at normal static pressures of furnaces fueled by hydrogen/methane blends



Issues Raised by Investigations to Date for AGA Consideration

- **Influence of “Real Natural Gas” in Natural Gas/Hydrogen Blends**
 - **Combustion Behavior Correspondence with Methane/Hydrogen Blend Tests**
 - **Consensus on Representative Natural Gases**
 - **Implementation in Appliance Testing and Certification**
- **Focus on Diffusion Flame Burner Appliances**
 - **“Legacy Technology” Considerations versus Installed Appliance Stock Considerations**
 - **AGA Combustion Consultant Advisories**
 - **Certification Testing versus Field Performance (e.g., pilot ignition).**
- **Near-Term Appliance Testing Opportunities**
 - **Sampled “Used Appliances”**
 - **Cooking Appliances**
- **Potential Standards Actions**
 - **Test Gas in Z21/Z83-CSA Standards (combustion performance and tubing).**

Test Gases in Current North American Standards

- A Brief “Limit Gas” History
- Implications for Hydrogen/Natural Gas Blends Treatment
- Example and First Target for Discussion, Z21.47-2016/CSA 2.3-2016, “Gas-Fired Central Furnaces:”



Table 12
Characteristics of Test Gases
(See Clause 5.4.)

	Heating value		Specific gravity
	Btu/ft ³	(Mj/m ³)	(Air=1.0)
Gas A (natural)	1075	(40.1)	0.65
Gas B (manufactured)	535	(19.9)	0.38
Gas C (mixed)	800	(29.8)	0.50
Gas D (n-Butane)	3200	(119.2)	2.00
Gas E (propane HD-5)	2500	(93.1)	1.55
Gas F (propane-air)	700	(26.1)	1.16
Gas G (Butane-air)	1400	(52.2)	1.42
Gas H (propane-air)	1400	(52.2)	1.30

**For Follow-Up
Questions,
Comments,
Support
Inquires, and
Related IAQ
Matters:**



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