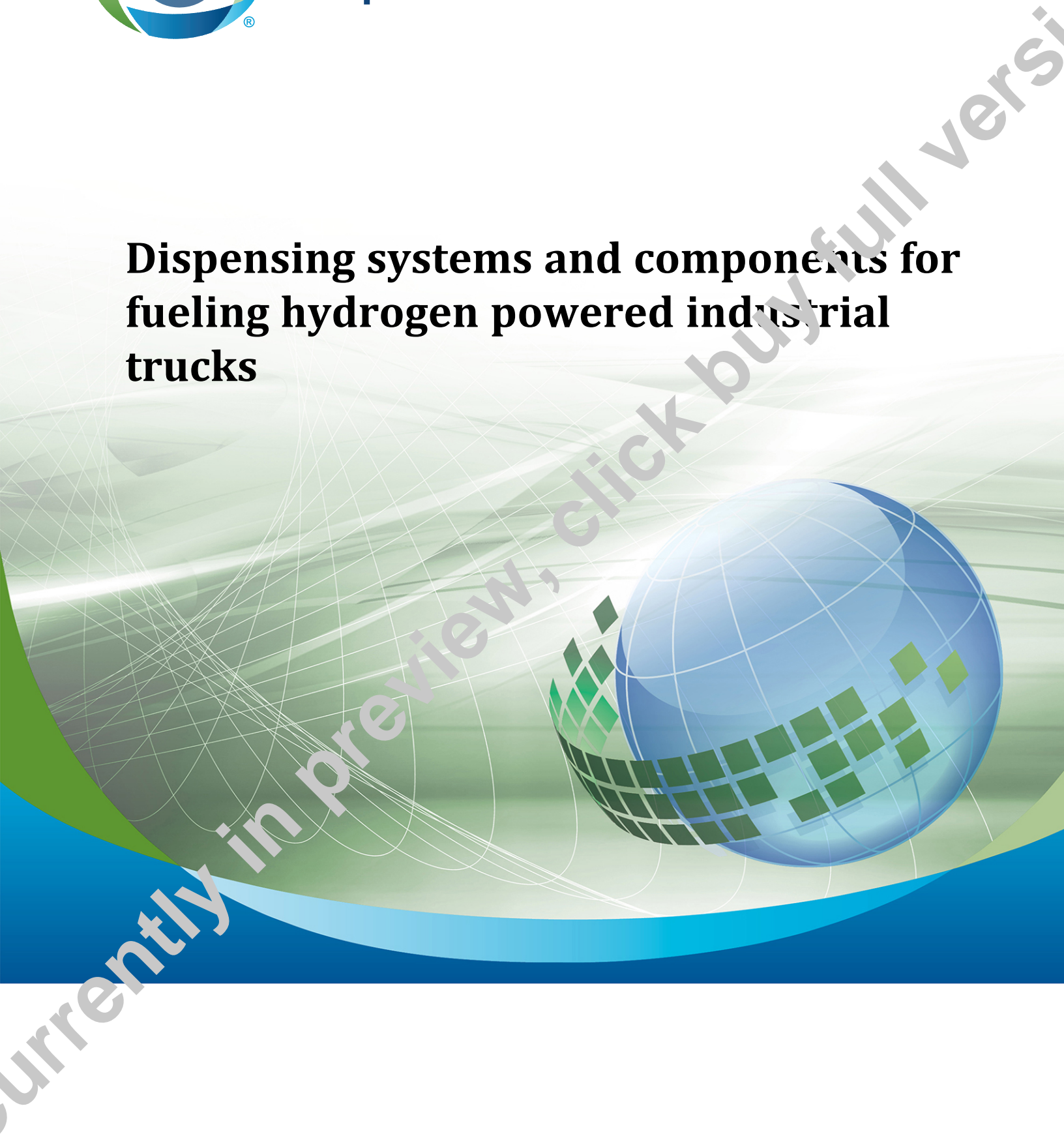




**CSA
Group**

CSA HPIT 2-2017

Dispensing systems and components for fueling hydrogen powered industrial trucks



Legal Notice for Standards

Canadian Standards Association (operating as “CSA Group”) develops standards through a consensus standards development process approved by the Standards Council of Canada. This process brings together volunteers representing varied viewpoints and interests to achieve consensus and develop a standard. Although CSA Group administers the process and establishes rules to promote fairness in achieving consensus, it does not independently test, evaluate, or verify the content of standards.

Disclaimer and exclusion of liability

This document is provided without any representations, warranties, or conditions of any kind, express or implied, including, without limitation, implied warranties or conditions concerning this document’s fitness for a particular purpose or use, its merchantability, or its non-infringement of any third party’s intellectual property rights. CSA Group does not warrant the accuracy, completeness, or currency of any of the information published in this document. CSA Group makes no representations or warranties regarding this document’s compliance with any applicable statute, rule, or regulation.

IN NO EVENT SHALL CSA GROUP, ITS VOLUNTEERS, MEMBERS, SUBSIDIARIES, OR AFFILIATED COMPANIES, OR THEIR EMPLOYEES, DIRECTORS, OR OFFICERS, BE LIABLE FOR ANY DIRECT, INDIRECT, OR INCIDENTAL DAMAGES, INJURY, LOSS, COSTS, OR EXPENSES, HOWSOEVER CAUSED, INCLUDING BUT NOT LIMITED TO SPECIAL OR CONSEQUENTIAL DAMAGES, LOST REVENUE, BUSINESS INTERRUPTION, LOST OR DAMAGED DATA, OR ANY OTHER COMMERCIAL OR ECONOMIC LOSS, WHETHER BASED IN CONTRACT, TORT (INCLUDING NEGLIGENCE), OR ANY OTHER THEORY OF LIABILITY, ARISING OUT OF OR RESULTING FROM ACCESS TO OR POSSESSION OR USE OF THIS DOCUMENT, EVEN IF CSA GROUP HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES, INJURY, LOSS, COSTS, OR EXPENSES.

In publishing and making this document available, CSA Group is not undertaking to render professional or other services for or on behalf of any person or entity or to perform any duty owed by any person or entity to another person or entity. The information in this document is directed to those who have the appropriate degree of experience to use and apply its contents, and CSA Group accepts no responsibility whatsoever arising in any way from any and all use of or reliance on the information contained in this document.

CSA Group is a private not-for-profit company that publishes voluntary standards and related documents. CSA Group has no power, nor does it undertake, to enforce compliance with the contents of the standards or other documents it publishes.

Intellectual property rights and ownership

As between CSA Group and the users of this document (whether it be in printed or electronic form), CSA Group is the owner, or the authorized licensee, of all works contained herein that are protected by copyright, all trade-marks (except as otherwise noted to the contrary), and all inventions and trade secrets that may be contained in this document, whether or not such inventions and trade secrets are protected by patents and applications for patents. Without limitation, the unauthorized use, modification, copying, or disclosure of this document may violate laws that protect CSA Group’s and/or others’ intellectual property and may give rise to a right in CSA Group and/or others to seek legal redress for such use, modification, copying, or disclosure. To the extent permitted by treaty or by law, CSA Group reserves all intellectual property rights in this document.

Patent rights

Attention is drawn to the possibility that some of the elements of this standard may be the subject of patent rights. CSA Group shall not be held responsible for identifying any or all such patent rights. Users of this standard are expressly advised that determination of the validity of any such patent rights is entirely their own responsibility.

Authorized use of this document

This document is being provided by CSA Group for informational and non-commercial use only. The user of this document is authorized to do only the following:

If this document is in electronic form:

- load this document onto a computer for the sole purpose of reviewing it;
- search and browse this document; and
- print this document if it is in PDF form.

Limited copies of this document in print or paper form may be distributed only to persons who are authorized by CSA Group to have such copies, and only if this Legal Notice appears on each such copy.

In addition, users may not and may not permit others to

- alter this document in any way, or remove this Legal Notice from the attached standard;
- sell this document without authorization from CSA Group; or
- make an electronic copy of this document.

If you do not agree with any of the terms and conditions contained in this Legal Notice, you may not load or use this document or make any copies of the contents hereof, and if you do make such copies, you are required to destroy them immediately. Use of this document constitutes your acceptance of the terms and conditions of this Legal Notice.



Standards Update Service

CSA HPIT 2-2017 January 2017

Title: *Dispensing systems and components for fueling hydrogen powered industrial trucks*

To register for e-mail notification about any updates to this publication

- go to shop.csa.ca
- click on **CSA Update Service**

The **List ID** that you will need to register for updates to this publication is **24241-0**

If you require assistance, please e-mail techsupport@csagroup.org or call 416-747-2233.

Visit CSA Group's policy on privacy at www.csagroup.org/legal to find out how we protect your personal information.

CSA HPIT 2-2017
***Dispensing systems and components
for fueling hydrogen powered
industrial trucks***



®A trademark of the Canadian Standards Association, operating as "CSA Group"

*Published in January 2017 by CSA Group
A not-for-profit private sector organization
178 Rexdale Boulevard, Toronto, Ontario, Canada M9W 1R3*

*To purchase standards and related publications, visit our Online Store at shop.csa.ca
or call toll-free 1-800-463-6727 or 416-747-4044.*

ISBN 978-1-4883-0224-4

© 2017 CSA Group

*All rights reserved. No part of this publication may be reproduced in any form whatsoever
without the prior permission of the publisher.*

Contents

Joint Automotive Technical Committee 6

HPIT 2 Technical Subcommittee on Compressed Hydrogen Station and Components for Fueling Powered
Industrial Trucks 9

Preface 11

1 Scope 12

2 Reference publications 13

3 Definitions 17

4 Safety requirements and protective measures 21

4.1 General safety strategy 21

4.2 Safety and hazard analysis 21

4.3 Safety devices identified in risk assessment 22

4.4 Noise 22

4.5 Selection of materials 22

4.5.1 General 22

4.5.2 Suitability of materials 22

4.5.3 Dissimilar metals 22

4.5.4 Prohibited piping and fitting materials 22

4.5.5 Use of hazardous materials 22

4.5.6 Corrosion, abrasion, and erosion 23

4.5.7 Thermal insulating materials 23

5 Design and construction of HPIT dispensing systems 24

5.1 General requirements 24

5.2 Physical environment and operating conditions 24

5.2.1 General 24

5.2.2 Physical environment and operating conditions 24

5.2.3 Operating temperature 24

5.3 Construction requirements 25

5.3.1 General 25

5.3.2 Sharp edges and corners 25

5.3.3 Surface temperature 25

5.3.4 Inadvertent releases of process fluids 25

5.3.5 Anchoring 26

5.3.6 Breakaway devices 26

5.3.7 Shock mounts 26

5.3.8 Unauthorized access 27

5.3.9 Accessibility 27

5.3.10 Maintenance accessibility 27

5.3.11 Protection against distortion, warping, or other damage 27

5.3.12 Access for service 27

5.3.13 Protection against weather 27

5.3.14	Dispenser hose maximum length	27
5.3.15	Dispenser hoses	28
5.3.16	Dispenser nozzles	28
5.3.17	Drive-off protection	28
5.3.18	Hose retracting mechanisms	28
5.3.19	Mounting	28
5.3.20	Securing refueling nozzle	28
5.4	Housing and enclosures	28
5.4.1	General requirements	28
5.4.2	Indoor cabinets	29
5.4.3	Outdoor cabinets	29
5.4.4	Ventilation openings	29
5.4.5	Enclosure ventilation	29
5.4.6	Recess or depressions in enclosures	29
5.4.7	Accommodations for field connections	29
5.4.8	Plastic parts used in dispensing systems	29
5.4.9	Access panels	29
5.5	Pressure equipment and piping	30
5.5.1	Pressure equipment and vessels	30
5.5.2	Pressure piping systems	30
5.5.3	Pressure relief devices	30
5.5.4	Valves	31
5.5.5	Manual isolation valves	31
5.5.6	Isolation valves with lock-out capabilities	31
5.5.7	Hydrogen isolation valves	31
5.5.8	Valves for use with non-flammable fluids	31
5.5.9	Filters and separators	31
5.5.10	Pressure indicating devices	32
5.5.11	Pressure regulators	32
5.6	Hydrogen vent systems	32
5.6.1	Vent selection	32
5.6.2	Design	33
5.6.3	Vent systems	33
5.6.4	Hazard analysis	33
5.6.5	Vent system discharge height	33
5.6.6	Area classification of vent systems	34
5.6.7	Hydrogen vent system documentation	34
5.7	Control systems	34
5.7.1	General	34
5.7.2	Safety circuits	35
5.7.3	Control system signal inputs	35
5.7.4	Manual controls	35
5.7.5	Idle conditions	35
5.7.6	Fill complete	35
5.7.7	Shutdown	35
5.7.8	Remote monitoring and control	37
5.8	Electrical systems	37
5.8.1	General requirements	37
5.8.2	Electrical power supply	37

5.8.3	Electrical enclosures	37
5.8.4	Protection against electrical shock hazards	37
5.8.5	Prevention of miswiring	39
5.8.6	Current rating and over current protection	39
5.8.7	Protection against mechanical damage	39
5.8.8	Securing of internal wiring	39
5.8.9	Conduit and wire ways	39
5.8.10	Termination of conductors	39
5.8.11	Power loss	40
5.8.12	Lock-out devices	40
5.8.13	Electrical disconnects	40
5.8.14	Parts which remain energized	40
5.8.15	Classified areas	40
5.8.16	Component bonding	40
5.8.17	Static discharge	40
5.8.18	Equalizing electrical potential	41
5.8.19	Grounds	41
5.8.20	Protection against lightning strikes	41
5.9	Hydrogen fuel supply	41
5.9.1	Hydrogen fuel quality	41
5.9.2	Hydrogen quality sampling and analysis	41
5.10	Dispensing design and performance requirements	41
5.10.1	Dispenser refueling protocol	41
5.10.2	Pressure class limits	41
5.10.3	Integrity check (hose leak check) system	42
5.10.4	Ambient temperature fault	42
5.10.5	Fueling limits	42
5.10.6	Fueling rates	43
5.10.7	Ability to achieve complete fills	43
5.10.8	Initial vehicle pressure	43
5.10.9	Soak conditions	43
5.10.10	Vehicle depressurizing	44
5.10.11	Maximum fueling rate	44
5.10.12	Communication and non-communication fills	44
5.10.13	Pressure measurement location	44
5.10.14	Temperature measurement location	44
5.11	Markings	44
5.11.1	Marking material	44
5.11.2	Lockout	44
5.11.3	Name plate requirements	46
5.11.4	Self-service visual instructions	46
6	Manuals	46
6.1	General requirements	46
6.2	Vehicle container types and sizes	47
6.3	Installation manual	47
6.3.1	General	47
6.3.2	Drive-off protection	48
6.3.3	Foliage, debris, and other materials	48

6.4	Complex installations	48
6.4.1	General	48
6.4.2	NEMA compliance	48
6.4.3	Safety signage	48
6.4.4	Confined spaces	48
6.5	Operating manual	48
6.5.1	General	48
6.5.2	Signage	48
6.5.3	NEMA signage	48
6.5.4	Usage	48
6.5.5	Water removal	48
6.5.6	Instrumentation gas	49
6.6	Maintenance manual	49
6.7	Installation testing	51
7	Maintenance requirements	51
7.1	General requirements	51
8	Type tests	51
8.1	General	51
8.2	Pressure testing	51
8.2.1	General	51
8.2.2	Pneumatic leakage test	52
8.2.3	Hydrostatic leakage test	52
8.3	Hose retractor breakaway test	53
8.4	Dispensing system test	54
8.4.1	Dispenser emergency stop	54
8.4.3	Dispenser and vehicle ground	54
8.5	Hose integrity test	55
8.6	Dispenser fill performance test	55
8.6.1	Fueling process limits testing	57
8.6.2	Communication check testing	57
8.6.3	Ambient temperature fault testing	57
8.6.4	Excessive flow	57
8.6.5	Cold soak test	57
8.6.6	Hot soak test	57
8.7	Purge system failure	61
8.8	Dielectric requirements	62
8.8.1	General	62
8.8.2	Ground continuity	62
8.8.3	Earth leakage	62
8.8.4	Dielectric strength	62
8.9	Protection parameters	62
8.10	Marking material adhesion and legibility	62
8.11	Surface and component temperatures	63
8.12	Motors	64
8.12.1	Electric motor design	64
8.12.2	Electric motor winding temperatures	64
8.13	Rain test	65

8.14 Access to energized parts (test finger) 65

9 Quality assurance 69

9.1 Quality assurance plan 69

9.2 Routine tests 69

10 Design by rule for HPIT dispensers 70

10.1 General 70

10.2 Clauses to be exempt 70

10.3 Tank type 70

10.4 Fixed orifice 70

10.4.1 General 70

10.4.2 Orifice diameter 71

10.5 Fill control 71

10.5.1 General 71

10.5.2 Filling to service pressure 71

10.6 Vehicle communication 72

10.6.1 General 72

10.6.2 Temperature 72

10.6.3 Loss of communication 72

10.7 Markings 72

10.7.1 Name plate markings 72

10.7.2 Tank warning label 72

10.7.3 Orifice marking 73

10.8 Manuals 73

Annex A — Material compatibility and hydrogen embrittlement (Informative) 74

Annex B — Design by Rule (Informative) 76

Joint Automotive Technical Committee

J.F. Jordan	Agility Fuel Systems, Cook, Minnesota, USA <i>Category: User Interest</i>	<i>Acting Chair</i>
J. Birdsall	Toyota Motor Engineering & Manufacturing North America, Gardena, California, USA <i>Category: User Interest</i>	
D. Bowerson	NGVAmerica, Washington, District of Columbia, USA <i>Category: General Interest</i>	
R. Boyd	Boyd Hydrogen LLC, Oakland, California, USA <i>Category: General Interest</i>	
R.A. Cameron	General Motors of Canada, Oshawa, Ontario, Canada <i>Category: User Interest</i>	
G. Chirdon	CSA Group, Charlotte, North Carolina, USA	<i>Technical Advisor</i>
J.P. Cohen	Air Products and Chemicals Inc., Allentown, Pennsylvania, USA <i>Category: Gas Supplier</i>	
J.B. Dimmick	JB Dimmick, LLC, Wausha, Wisconsin, USA <i>Category: General Interest</i>	
J. Eihusen	Hexagon Lincoln Inc., Lincoln, Nebraska, USA	<i>Alternate</i>
E. Girouard	Emcara Gas Development Inc., Guelph, Ontario, Canada <i>Category: Producer Interest</i>	
L.P. Grote	Swagelok Company, Solon, Ohio, USA <i>Category: Producer Interest</i>	

A. Harris	Air Liquide, Houston, Texas, USA <i>Category: Gas Supplier</i>	
P. Horacek	Powertech Labs Inc., Surrey, British Columbia, Canada <i>Category: General Interest</i>	
S. Johnston	Ann Arbor, Michigan, USA	<i>Non-Voting</i>
S. Katz	S. Katz and Associates Inc., North Vancouver, British Columbia, Canada <i>Category: General Interest</i>	
M. Leavitt	Quantum Fuel Systems LLC, Lake Forest, California, USA <i>Category: Producer Interest</i>	
N.L. Newhouse	Hexagon Lincoln Inc., Lincoln, Nebraska, USA <i>Category: Producer Interest</i>	
S. Quong	Quong & Associates, Inc, San Francisco, California, USA <i>Category: General Interest</i>	
A. Ryan	Toyota Motor Engineering & Manufacturing North America, Gardena, California, USA	<i>Alternate</i>
M. Spears	AFV LLC, Twinsburg, Ohio, USA <i>Category: Producer Interest</i>	
R. Stephenson	Motor Vehicle Fire Research Institute, La Canada, California, USA	<i>Non-Voting</i>
M. Ursan	Burnaby, British Columbia, Canada	<i>Non-Voting</i>
M. Veenstra	Ford Motor Company, Dearborn, Michigan, USA <i>Category: User Interest</i>	
T.A. Williams	American Gas Association Inc., Washington, District of Columbia, USA <i>Category: Gas Supplier</i>	

L.B. Willmore

Southern California Gas Company,
Los Angeles, California, USA
Category: Gas Supplier

J. Cairns

CSA Group,
Cleveland, Ohio, USA

Project Manager

HPIT 2 Technical Subcommittee on Compressed Hydrogen Station and Components for Fueling Powered Industrial Trucks

B.R. Gordon	Nuvera Fuel Cells, Inc., Billerica, Massachusetts, USA	<i>Chair</i>
K. Quackenbush	Fuel Cell & Hydrogen Energy Association, Washington, District of Columbia, USA	<i>Vice-Chair</i>
R. Boyd	Boyd Hydrogen LLC, Oakland, California, USA	
G. Chirdon	CSA Group, Charlotte, North Carolina, USA	<i>Technical Advisor</i>
J.P. Cohen	Air Products and Chemicals Inc., Allentown, Pennsylvania, USA	
A. Harris	Air Liquide, Houston, Texas, USA	
J.L. Hutton	Millennium Reign Energy LLC, Dayton, Ohio, USA	<i>Alternate</i>
F. Lomax	Headwaters Solutions LLC, Hector, New York, USA	
C. McWhinney	Millennium Reign Energy LLC, Dayton, Ohio, USA	
C. Minas	Plug Power LLC, Latham, New York, USA	
M. Moran	Isotherm Energy LLC, North Ridgeville, Ohio, USA	<i>Non-voting</i>
E. Nupoort	H2 Logic A/S, Herning, Denmark	

I. Patterson

NGV Technologies Inc.,
Calgary, Alberta, Canada

S. Marxen

CSA Group,
Cleveland, Ohio, USA

Project Manager

Preface

This is the first edition of CSA HPIT 2, *Dispensing systems and components for fueling hydrogen powered industrial trucks*.

Notes:

- 1) *Use of the singular does not exclude the plural (and vice versa) when the sense allows.*
- 2) *Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.*
- 3) *This Standard was developed by consensus, which is defined by CSA Policy governing standardization — Code of good practice for standardization as “substantial agreement. Consensus implies much more than a simple majority, but not necessarily unanimity.” It is consistent with this definition that a member may be included in the Technical Committee list and yet not be in full agreement with all clauses of this Standard.*
- 4) *This Standard is subject to review at least every five years; suggestions for its improvement will be referred to the appropriate committee. To submit a proposal for change, please send the following information to inquiries@csagroup.org and include “Proposal for change” in the subject line:*
 - a) *Standard designation (number)*
 - b) *relevant clause, table, and/or figure number;*
 - c) *wording of the proposed change; and*
 - d) *rationale for the change.*
- 5) *To submit a request for interpretation of this Standard, please send the following information to inquiries@csagroup.org and include “Request for interpretation” in the subject line:*
 - a) *define the problem, making reference to the specific clause, and, where appropriate, include an illustrative sketch;*
 - b) *provide an explanation of circumstances surrounding the actual field condition; and*
 - c) *where possible, phrase the request in such a way that a specific “yes” or “no” answer will address the issue.*

Committee interpretations are processed in accordance with the CSA Directives and guidelines governing standardization and are available on the Current Standards Activities page at standardsactivities.csa.ca.

CSA HPIT 2-2017

Dispensing systems and components for fueling hydrogen powered industrial trucks

1 Scope

1.1

This Standard applies to:

- a) the mechanical and electrical features of dispensers, which includes the control system and any ancillary equipment, used to dispense compressed hydrogen gas for hydrogen powered industrial trucks (HPITs) used for mobility/propulsion in a non-public application;
- b) systems that refuel hydrogen powered industrial vehicles to a service pressure of 25 and 35 MPa at a refueling rate of no more than 33 g/second.

1.2

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 are to be evaluated as to their ability to yield levels of safety and performance equivalent to or better than those prescribed by this Standard.

1.3

A hydrogen powered industrial truck (HPIT) is an electric industrial truck that is powered by a fuel cell system. These vehicles include the following:

- a) electric fork lift trucks;
- b) airport tuggers;
- c) yard trucks;
- d) refrigerated trucks (reefer units); and
- e) auxiliary power units (APUs)

1.4

This Standard does not apply to dispensers intended for the refueling of automotive vehicles or heavy duty surface vehicles.

Note: *HPIT dispenser should not be used to refuel vehicles requiring SAE J2601-1 or SAE J2601-2 fueling protocols.*

1.5

This Standard does not apply to residential fueling appliances.

1.6

In the case of conflict between this Standard and Federal, Provincial, State, or Local requirements, the governmental requirements take precedence.

1.7

This Standard contains SI (Metric) units with corresponding yard/pound quantities, the purpose being to allow the standard to be used in SI (Metric) units. If a value for a measurement and a corresponding value in other units are stated, the first stated value is to be regarded as the requirement. The given corresponding value may be approximate. If a value for a measurement and a corresponding value in other units are both specified as a quoted marking requirement, the first stated unit, or both are to be provided.

Note: *IEEE/ASTM SI 10 or ISO 80000-1 was used as a guide in making metric conversions to yard/pound quantities.*

1.8

All references to pressure throughout this Standard are to be considered gauge pressure unless otherwise specified.

1.9

In this Standard, “shall” is used to express a requirement, i.e., a provision that the user is obliged to satisfy in order to comply with the standard; “should” is used to express a recommendation or that which is advised but not required; “may” is used to express an option or that which is permissible within the limits of the standard; and “can” is used to express possibility or capability.

Notes accompanying clauses do not include requirements or alternative requirements; the purpose of a note accompanying a clause is to separate from the text explanatory or informative material.

Notes to tables and figures are considered part of the table or figure and may be written as requirements.

Annexes are designated normative (mandatory) or informative (non-mandatory) to define their application.

2 Reference publications

This Standard refers to the following publications, and where such reference is made, it shall be to the edition listed below, including all amendments published thereto.

CSA Group

ANSI/CSA CHMC 1-2014

Test methods for evaluating material compatibility in compressed hydrogen applications - Metals

ANSI/CSA HGV 3.1-2015

Fuel system components for compressed hydrogen gas powered vehicles

ANSI/CSA HGV 4.2-2013

Hoses for compressed hydrogen fuel stations, dispensers, and vehicle fuel systems

ANSI/CSA HGV 4.4-2013

Breakaway devices for compressed hydrogen dispensing hoses and systems

ANSI/CSA HGV 4.6-2013

Manually operated valves for use in gaseous hydrogen vehicle fueling stations