

considerations for ventilation, separation, type of construction and location of openings all in the interest of public safety.

The AHC has also addressed and resolved the technical issues identified by the IFGC Committee directly as modified by this and other coordinated public comments to all hydrogen-related proposals (F176, M7, FG2, FG15, FG41 & FG48). The supporting Reason to FG2-02 provides a brief explanation of each solution.

The ICC AHC for Hydrogen Gas requests your Approval as Modified by this Public Comment (AMPC).

F177-02

2210

Proposed Change as Submitted:

Proponent: Guy Tomberlin, County of Fairfax; representing ICC Ad Hoc Committee for Hydrogen Gas

Add new text as follows and re-number remaining section numbers:

SECTION 2210 REPAIR GARAGES

2210.8 Defueling of hydrogen from motor vehicle fuel storage containers. The discharge or defueling of hydrogen from motor vehicle fuel storage tanks for the purpose of maintenance, cylinder certification, calibration of dispensers or other activities shall be in accordance with Section 2210.8.1

2210.8.1 Methods of discharge. The discharge of hydrogen from motor vehicle fuel storage tanks shall be accomplished through a closed transfer system in accordance with Section 2210.8.1.1 or an approved method of atmospheric venting in accordance with Section 2210.8.1.2

2210.8.1.1 Closed transfer system. A documented procedure that explains the logic sequence for discharging the storage tank shall be provided to the code official for review and approval. The procedure shall include what actions the operator will take in the event of a low-pressure or high-pressure hydrogen release during discharging activity. Construction documents shall be provided illustrating the arrangement of piping, regulators and equipment settings. The construction documents shall illustrate the piping and regulator arrangement and shall be shown in spatial relation to the location of the compressor, storage vessels and emergency shutdown devices.

2210.8.1.2 Atmospheric venting of hydrogen from motor vehicle fuel storage containers. The discharge of hydrogen from motor vehicle fuel storage tanks for the purposes of maintenance, cylinder certification, calibration of dispensers or other activities shall be in accordance with Sections 2210.8.1.2.1 through 2210.8.1.2.4.

2210.8.1.2.1 Defueling equipment required at vehicle maintenance and repair facilities. All facilities for repairing hydrogen systems on hydrogen vehicles will have a facility to defuel the vehicle storage tank(s). Vehicle storage tanks for defueling to a vent pipe shall be connected to the vent pipe by way of equipment supplied by the vehicle manufacturer. The rate of flow shall not exceed 1,000 scfm (2.5 kg/min) and shall be controlled via the supplied equipment, at low pressure and without adjustment. The vent pipe for defueling shall not be used for or flow into a vent pipe for any other purpose. The defueling vent pipe shall have a diameter of 1 inch and terminate in accordance with Section 2209.7.1; with a minimum height (H) of at least 8 ft. and a minimum distance (D) to exposures of 15 ft. The minimum design pressure of the vent piping shall be 335 psig.

2210.8.1.2.2 Construction documents. Construction documents shall be provided illustrating the location of the means for vessel support, piping, the method of grounding and bonding, and other requirements specified herein.

2210.8.1.2.3 Tank and cylinder stability. A method of rigidly supporting the vessel during the discharge or defueling of hydrogen shall be provided. The selected method shall provide not less than two points of support and shall prevent the horizontal and lateral movement of the vessel. The system shall be designed to prevent the movement of the vessel based on the highest gas-release velocity through valve orifices at the vessel's rated pressure and volume. The structure or appurtenance shall be constructed of noncombustible materials as set forth in the *International Building Code*®.

2210.8.1.2.4 Grounding and bonding. The structure or appurtenance used for supporting the vessel shall be grounded in accordance with the *ICC Electrical Code*. The valve of the vehicle storage tank shall be bonded prior to the commencement of discharge or defueling operations.

2210.8.2 Repair of hydrogen piping. Piping systems containing hydrogen shall not be opened to the atmosphere for repair without first purging the piping with an inert gas to achieve one percent hydrogen or less by volume. Defueling operations and exiting purge

flow shall be vented in accordance with Section 2210.8.1.2.

2210.8.3 Purging. Each individual manufactured component of a hydrogen generating, compression, storage, or dispensing system shall have a label affixed as well as a description in the installation and owners manuals describing the procedure for purging air from the system during start-up, regular maintenance and for purging hydrogen from the system prior to disassembly (to admit air).

For the interconnecting piping between the individual manufactured components the pressure rating must be at least 20 times the absolute pressure present in the piping when any hydrogen meets any air. [Example: hydrogen meets air in an interconnecting pipe at 3 psig. 3 psig is 17.5 psia. The minimum pressure rating of the pipe would have to be 20 x 17.5 = 350 psia or 335 psig.]

2210.8.3.1 System purge required. After installation, repair or maintenance, the hydrogen piping system shall be purged of air in accordance with the manufacturer's procedure for purging air from the system.

Proponent's Reason: Introduction. Hydrogen energy safety is based on three primary elements: regulatory requirements, capability of safety technology and the systemic application of equipment and procedures to minimize risks. Groups involved in the industrial scale production of hydrogen (producers) currently implement many successful proprietary methodologies for safely generating and handling large amounts of hydrogen. Hydrogen users (e.g., NASA) depend on cryo-hydrogen as a fuel and have effectively proven the safety of large scale ground and vehicle systems which support the Space Shuttle Program.

The efforts of the International Code Council Ad Hoc Committee for Hydrogen Gas (AHC) intend to address how future building codes can safely cover hydrogen applications in fuel cell vehicles and hydrogen gas motor-vehicle fuel dispensing and generation stations. The AHC consists of a balanced membership of user, producer and regulatory interests working together with a diverse group of technical and advisory interests to propose changes as necessary to the ICC International Codes. This, and other, related proposals is a summation of their work.

IFC Section 2210.8. Because of the emerging attraction of alternative fuels and the differences in their properties, repair garages must be designed for the anticipated vehicles and the materials fueling them. This section includes the provisions for many different fuels, including lighter-than-air fuels. Accordingly, if a repair garage makes hydrogen, a lighter-than-air fuel, available for dispensing to motor vehicles, the repair garage must also meet the applicable requirements and compensating hazard mitigation criteria for a repair garage servicing hydrogen-fueled vehicles.

IFC Section 2210.8.1. Under consultation with the Society of Automotive Engineers, the AHC has continued to monitor the progress of the Society's Safety and Interface working groups as affiliated with SAE's Strategic Alliance to Develop Fuel Cell Vehicle Standards. "Best practice" procedures under consideration by SAE and noted by the AHC in their recommendations include both General Vehicle (e.g., crash-worthiness, vehicle immersion, hazards leading to failure, common-mode failures, grounding locations, visual recognition of vehicles, etc.) and General Safety (e.g., design for leakage, detection of leakage, protection from debris, design of vents, short- vs. long-term parking scenarios, and underground/enclosed parking) criteria.

The SAE's Safety Working Group intends to standardize the defueling connections on vehicles as well as the means to limit the defueling flow to 1,000 scfm at 5,000 psig storage pressure.

Provisions for limiting the use of the defueling vent pipe result from safety concerns and risk of backflow from any other venting into the defueling area.

The minimum vent pipe heights (H) and separation distances (D) will provide safe radiation levels and unignited hydrogen concentrations without ignition.

IFC Section 2210.8.3 places the burden of purging requirement on the equipment manufacturer. Commensurately, these requirements can be verified by the code official before, during and after installation. Requirements for rating the interconnecting piping at 20 times the initial pressure assures that a detonation will not rupture the vent piping.

In Summary. The AHC has developed these changes through the consultation of a diverse group of technical and advisory parties from a variety of interests representing the hydrogen community, inclusive of industry, professional associations, testing laboratories, agencies of government, academic and research institutions and believes it important to provide a template for thorough coverage in the International Codes of equipment, appliances and vehicles that will utilize hydrogen as a fuel. The effort affords regulators a sound technical basis on which to verify installation and to uphold the standard of health and safety for the citizens of their jurisdictions.

Industry is ready to commercialize systems fueled predominantly using hydrogen energy. The AHC urges your APPROVAL of this proposal "as submitted".

Committee Action: **Approved as Modified**

Modify proposal as follows:

**SECTION 2210
REPAIR GARAGES**

2210.8 Defueling of hydrogen from motor vehicle fuel storage containers. The discharge or defueling of hydrogen from motor vehicle fuel storage tanks for the purpose of maintenance, cylinder certification, calibration of dispensers or other activities shall be in accordance with Section 2210.8.1

2210.8.1 Methods of discharge. The discharge of hydrogen from motor vehicle fuel storage tanks shall be accomplished through a closed transfer system in accordance with Section 2210.8.1.1 or an approved method of atmospheric venting in accordance with Section 2210.8.1.2

2210.8.1.1 Closed transfer system. A documented procedure describing the logical sequence for discharging the storage tank shall be provided to the code official for review and approval. The procedure shall include the actions the operator will take in the event of a low-pressure or high-pressure hydrogen release during discharging activity. Construction documents shall be provided illustrating the arrangement of piping, regulators and equipment settings. The construction documents shall illustrate the piping and regulator arrangement and shall be shown in spatial relation to the location of the compressor, storage vessels and emergency shutdown devices.

2210.8.1.2 Atmospheric venting of hydrogen from motor vehicle fuel storage containers. The discharge of hydrogen from motor vehicle fuel storage tanks for the purposes of maintenance, cylinder certification, calibration of dispensers or other activities shall be in accordance with Sections 2210.8.1.2.1 through 2210.8.1.2.4.

2210.8.1.2.1 Defueling equipment required at vehicle maintenance and repair facilities. All facilities for repairing hydrogen systems on hydrogen vehicles will have a facility to defuel the vehicle storage tank(s). Vehicle storage tanks for defueling to a vent pipe shall be connected to the vent pipe by way of equipment supplied by the vehicle manufacturer. The rate of flow shall not exceed 1,000 scfm (2.5 kg/min) and shall be controlled via the supplied equipment, at low pressure and without adjustment. The vent pipe for defueling shall not be

used for or flow into a vent pipe for any other purpose. The defueling vent pipe shall have a diameter of 1 inch and terminate in accordance with Section 2209.7.1; with a minimum height (H) of at least 8 ft. and a minimum distance (D) to exposures of 15 ft. The minimum design pressure of the vent piping shall be 335 psig.

2210.8.1.2.2 Construction documents. Construction documents shall be provided illustrating the location of the means for vessel support, piping, the method of grounding and bonding, and other requirements specified herein.

2210.8.1.2.3 Tank and cylinder stability. A method of rigidly supporting the vessel during the discharge or defueling of hydrogen shall be provided. The selected method shall provide not less than two points of support and shall prevent the horizontal and lateral movement of the vessel. The system shall be designed to prevent the movement of the vessel based on the highest gas-release velocity through valve orifices at the vessel's rated pressure and volume. The structure or appurtenance shall be constructed of noncombustible materials as set forth in the *International Building Code*[®].

2210.8.1.2.4 Grounding and bonding. The structure or appurtenance used for supporting the vessel shall be grounded in accordance with the *ICC Electrical Code*. The valve of the vehicle storage tank shall be bonded prior to the commencement of discharge or defueling operations.

2210.8.2 Repair of hydrogen piping. Piping systems containing hydrogen shall not be opened to the atmosphere for repair without first purging the piping with an inert gas to achieve one percent hydrogen or less by volume. Defueling operations and exiting purge flow shall be vented in accordance with Section 2210.8.1.2.

2210.8.3 Purging. Each individual manufactured component of a hydrogen generating, compression, storage, or dispensing system shall have a label affixed as well as a description in the installation and owners manuals describing the procedure for purging air from the system during start-up, regular maintenance and for purging hydrogen from the system prior to disassembly (to admit air).

For the interconnecting piping between the individual manufactured components the pressure rating must be at least 20 times the absolute pressure present in the piping when any hydrogen meets any air. [Example: hydrogen meets air in an interconnecting pipe at 3 psig. 3 psig is 17.5 psia. The minimum pressure rating of the pipe would have to be $20 \times 17.5 = 350$ psia or 335 psig.]

2210.8.3.1 System purge required. After installation, repair or maintenance, the hydrogen piping system shall be purged of air in accordance with the manufacturer's procedure for purging air from the system.

Committee Reason: The code change is needed to address new technology that is already being used.

Assembly Action: No Motion

Individual Consideration Agenda:

This item is on the agenda for individual consideration because a public comment was submitted.

Public Comment:

Larry Fluer and Kevin Scott, Fluer, Inc. and Kern County California Fire Department, respectively,

representing Compressed Gas Association and Kern County Fire Department, respectively, request Approved as Modified by this Public Comment.

Modify proposal as follows:

SECTION 2210 REPAIR GARAGES

2210.8 Defueling of hydrogen from motor vehicle fuel storage containers. The discharge or defueling of hydrogen from motor vehicle fuel storage tanks for the purpose of maintenance, cylinder certification, calibration of dispensers or other activities shall be in accordance with Section 2210.8.1

2210.8.1 Methods of discharge. The discharge of hydrogen from motor vehicle fuel storage tanks shall be accomplished through a closed transfer system in accordance with Section 2210.8.1.1 or an approved method of atmospheric venting in accordance with Section 2210.8.1.2

2210.8.1.1 Closed transfer system. A documented procedures describing the logical sequence for discharging the storage tank shall be provided to the code official for review and approval. The procedures shall include the actions the operator will be required to take in the event of a low-pressure or high pressure hydrogen release during discharging activity. Construction Schematic design documents shall be provided illustrating the arrangement of piping, regulators and equipment settings. The construction documents shall illustrate the piping and regulator arrangement and shall be shown in spatial relation to the location of the compressor, storage vessels and emergency shutdown devices.

2210.8.1.2 Atmospheric venting of hydrogen from motor vehicle fuel storage containers. When atmospheric venting is used for the discharge of hydrogen from motor vehicle fuel storage tanks for the purposes of maintenance, cylinder certification, calibration of dispensers or other activities such venting shall be in accordance with Sections 2210.8.1.2.1 through 2210.8.1.2.4.

2210.8.1.2.1 Defueling equipment required at vehicle maintenance and repair facilities. All facilities for repairing hydrogen systems on hydrogen fueled vehicles will have a facility shall have equipment to defuel the vehicle storage tank(s). Equipment used for defueling shall be listed and labeled for the intended use.

2210.8.1.2.1.1 Manufacturer's equipment required. Equipment supplied by the vehicle manufacturer shall be used to connect the vehicle storage tanks for to be defueled to a the vent pipe by way of equipment supplied by the vehicle manufacturer system.

2210.8.1.2.1.2 Vent pipe maximum diameter. Defueling vent pipes shall have a maximum inside diameter of 1 inch (25.4 mm) and be installed in accordance with Section 2209.7.

2210.8.1.2.1.3 Maximum flow rate. The maximum rate of hydrogen flow through the vent pipe system shall not exceed 1,000 scfm (2.5 kg/min) and shall be controlled via by means of the supplied manufacturer's equipment, at low pressure and without adjustment.

2210.8.1.2.1.4 Isolated use. The vent pipe used for defueling shall not be used for or flow into connected to another venting system pipe used for any other purpose. The defueling vent pipe shall have a diameter of 1 inch and terminate in accordance with Section 2209.7.1; with a minimum height (H) of at least 8 ft. and a minimum distance (D) to exposures of 15 ft. The minimum design pressure of the vent piping shall be 335 psig.

2210.8.1.2.2 Construction documents. Construction documents shall be provided illustrating the defueling system to be utilized. Plan details shall be of sufficient detail and clarity to allow for evaluation of the location of the means for vessel support, piping and control systems to be utilized to include the method of support for cylinders, containers or tanks to be used as part of a closed transfer system, the method of grounding and bonding, and other requirements specified herein.

2210.8.1.2.3 Tanks and Stability of cylinders, containers and tanks stability. A method of rigidly supporting the vessel cylinders, containers or tanks used during the closed transfer system discharge or defueling of hydrogen shall be provided. The ~~selected~~ method shall provide not less than two points of support and shall ~~prevent~~ be designed to resist the horizontal and lateral movement of the receiving cylinder, container or tank vessel. The system shall be designed to ~~prevent~~ resist the movement of the vessel receiver based on the highest gas release velocity through valve orifices at the vessel's receiver's rated service pressure and volume. ~~The Supporting~~ structures or appurtenances used to support receivers shall be constructed of noncombustible materials ~~as set forth in~~ in accordance with the International Building Code®.

2210.8.1.2.4 Grounding and bonding. Cylinders, containers or tanks and piping systems used for defueling shall be bonded and grounded. ~~The s~~Structures or appurtenance used for supporting the vessel cylinders, containers or tanks shall be grounded in accordance with the ICC Electrical Code. The valve of the vehicle storage tank shall be bonded with the defueling system prior to the commencement of discharge or defueling operations.

2210.8.2 Repair of hydrogen piping. Piping systems containing hydrogen shall not be opened to the atmosphere for repair without first purging the piping with an inert gas to achieve one percent hydrogen or less by volume. Defueling operations and exiting purge flow shall be vented in accordance with Section 2210.8.1.2.

2210.8.3 Purging. Each individual manufactured component of a hydrogen generating, compression, storage, or dispensing system shall have a label affixed as well as a description in the installation and owners manuals describing the procedure for purging air from the system during start-up, regular maintenance and for purging hydrogen from the system prior to disassembly.

For the interconnecting piping between the individual manufactured components the pressure rating must be at least 20 times the absolute pressure present in the piping when any hydrogen meets any air.

2210.8.3.1 System purge required. After installation, repair or maintenance, the hydrogen piping system shall be purged of air in accordance with the manufacturer's procedure for purging air from the system.

Commenter's Reasons: 2210.8.1.1 Clarification in part and to require the design documents to be schematic in nature. Schematic plans are simplified plans that clearly illustrate the arrangement of piping, valving and controls.

2210.8.1.2 The existing language is redundant to Section 2210.8. Section 2210.8.1.2 provides requirements for atmospheric venting systems. The charging language should be focused on the intent of the requirements. The installation of the venting system is to be installed in accordance with the requirements of Section 2209.7. Requirements for installation and termination should be consistent with those used for venting systems employed for fueling systems.

2210.8.1.2.1 Revised to require facilities to have defueling equipment rather than to predict such equipment will be there.

Modifications to require listed and labeled equipment are in harmony with Section 2209.2.2.

2210.8.1.2.1.1 through 2210.8.1.2.1.4 revised primarily for reformatting and clarification of requirements to clarify intent.

2210.8.1.2.2 Clarification.

2210.8.1.2.3 Clarification as to what containers are to be secured to resist movement. In general systems cannot be designed to "prevent" movement. They can, however, resist movement. Horizontal and lateral movement are equivalent. Deleting the term horizontal from the section eliminates the redundancy.

2210.8.1.2.4 To clarify those elements that are required to be bonded, and those elements that are required to be grounded.

F180-02 2306.9

Proposed Change as Submitted:

Proponent: Elly Klausbruckner, Klausbruckner & Associates

Revise as follows:

2306.9 Aisles. Aisles providing access to exits and fire department access doors shall be provided in high-piled storage areas exceeding 500 square feet (46 m²), in accordance with Section 2306.9.1 through Section 2306.9.3. Aisles separating storage piles or racks shall also comply with NFPA 23413, NFPA 234C and Aisles shall also comply with Chapter 10.

Exception: Where aisles are precluded by rack storage systems, alternate methods of access and protection are allowed when approved.

2306.9.1 Width. Aisle width shall be in accordance with Figure 2306.9.1.1 and Figure 2306.9.1.2.

EXCEPTIONS:

- ~~1. Cross aisles used only for employee access between aisles shall be a minimum of 24 inches (610 mm) wide.~~
- ~~2. Aisles separating shelves classified as shelf storage shall be a minimum of 30 inches (762 mm) wide.~~

2306.9.1.1 Sprinklered buildings. Aisles in sprinklered buildings shall be a minimum of 44 inches (1118 mm) wide. Aisles shall be a minimum of 96 inches (2438 mm) wide in high piled storage areas exceeding 2,500 square feet (232 m²) in area, that are public accessible and designated to contain high hazard commodities.

Exception: Aisles in high pile storage areas exceeding 2500 (232 m²) square feet in area, that are public accessible and designated to contain high hazard commodity that are protected by a sprinkler system designed to protect multiple-row racks of high hazard commodity shall be a minimum of 44 inches