June 14, 2024

To:
National Highway Traffic Safety Administration (NHTSA), Department of Transportation (DOT)

Subject:
Notice of proposed rulemaking for Federal Motor Vehicle Safety Standards (FMVSS) 307 and 308; Docket number NHTSA-2024-0006

Dear reader,

Verne Inc., a San Francisco based company, is developing innovative cryo-compressed hydrogen (CcH_2) technologies intended for safe commercial use in heavy-duty trucking and other applications.

CcH_2 is cryogenic and pressurized single phase gaseous hydrogen. CcH_2 storage systems are designed to store hydrogen at a nominal working pressure (NWP) of 35 MPa and at gas temperatures down to and below -200ºC. CcH_2 storage systems consist of well insulated fuel containers of Types 1, 2, or 3, and can achieve best in class hydrogen storage densities, even higher than liquid hydrogen. Given this value proposition to the trucking industry, CcH_2 storage and refueling commercialization efforts are well under way in the United States and Europe.

Today, CcH_2 technology is not adequately addressed in global or local regulations, codes, and standards (RCS), except for ISO TC/197 WG36, which intends to standardize the CcH_2 fueling connector and the CcH_2 fueling protocol. As the standardization landscape for CcH_2 develops, Verne will be adopting the intent, best practices, and methodology of the existing RCS for hydrogen powered vehicles such as and including the UN GTR No. 13. Additionally, Verne is and will continue taking a leading role in CcH_2 standardization development.

After reviewing the new proposed rulemaking of FMVSS 307 and 308, Verne kindly requests clarification from NHTSA on whether CcH_2 storage systems, and hydrogen powered vehicles using CcH_2 storage systems are in-scope of the first versions of FMVSS 307 and 308 as a Compressed Hydrogen Storage System (CHSS), or not.

Verne's internal assessment, provided here in good faith to aid NHTSA's assessment and decision is as follows:

- Given the broad and encompassing scope of the UN GTR No. 13 and FMVSS 307 and 308, a CcH_2 storage system is not explicitly nor implicitly out of scope as a CHSS except for an informative note in the UN GTR No. 13 Part I Section C.3.
- A CcH_2 storage system complies with the definition of a CHSS, including its required components: a container, a thermally activated pressure relief device (TPRD), a shut-off valve (SOV), a check valve (CV).

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- Primarily, a CcH_2 storage system differs from a conventional gaseous CHSS as considered in the UN GTR No. 13 in the following ways:
    - Design: A CcH_2 storage system has additional devices and container attachments to enable safe and sustained storage of CcH_2. These devices and container attachments may include more than one pressure relief device (PRD), insulation, and an all-metal vacuum jacket.
    - Pressures: A CcH_2 storage system is mostly aligned with the H35 (NWP of 35 MPa) pressure levels. However, given the need to provide dormancy margin to the PRDs and considering after fueling pressure increases, the target and/or maximum fueling pressure must be set to a value lower than 43.75 MPa with sufficient margin. Although not yet standardized, Verne expects a target and/or maximum fueling pressure of 35 MPa, operational pressure relief at 40 MPa, redundant safety pressure relief at a value greater than 40 MPa, but less than or equal to 43.75 MPa, and component pressure ratings of 43.75 MPa.
    - Temperatures: A CcH_2 storage system will seldom if ever be operated at, or fueled to, an internal gas temperature of +85°C. Additionally, it is designed to normally receive and then store hydrogen at gas temperatures much lower than -40°C. Although not yet standardized, Verne expects an operational gas temperature range of -253°C to +85°C.
- Verne considers many of the UN GTR No. 13 and FMVSS 307 and 308 specified performance requirements as relevant and adequate for assuring safety of certain aspects of CcH_2 storage systems. This includes crash, fire, external vehicular hazards such as surface damage, and elements of the performance durability and expected on-road performance tests.
- However, the UN GTR No. 13 and FMVSS 307 and 308 does not adequately consider the CcH_2 storage system design, components, and service conditions as listed above. Verne acknowledges that performance requirements will need to be modified and/or added for CcH_2 storage systems in future revisions of the UN GTR No. 13 and FMVSS 307 and 308 with proper industry expert consideration of CcH_2 technology.

Independent of this clarification, Verne suggests the following modification to FMVSS 308 "Compressed hydrogen storage system integrity":

- For the surface damage test, section S5.1.2.3, Verne recommends exempting all-metal container attachments from the flaw cuts using the same rationale applied to all-metal containers; metal is scratch/cut resistant, and the flaw cut depth may be greater than the all-metal container attachment wall thickness.

If deemed to be in scope as a CHSS, Verne suggests the following modification to FMVSS 308 "Compressed hydrogen storage system integrity":

- Exemption from the CHSS expected on-road performance test in section S5.1.3, for CHSS's with a label identifying intended service for CcH_2 or for cryogenic operating gas temperatures. Rationale for this exemption is as follows:
    - The expected on-road performance test is primarily a test of the potentially sensitive non-metallic liner of Type 4 containers, and non-metallic sealing interfaces of all container types, and their ability to resist the combination of extreme pressures and

temperatures in the presence of hydrogen. The CcH_2 storage system design necessitates the use of metal to metal or other sealing designs for performance at cryogenic temperatures, and therefore doesn't have the inherent sensitivities of non-metallics.

- The rapid temperature swings and the temperature levels used in the on-road expected performance test are not representative of normal or even extreme CcH_2 storage systems operation or fueling.
- Test execution by NHTSA and by CcH_2 storage system manufacturers will be impossible with the requirements as written, due to the presence of PRDs with set-points lower than the pressure threshold requirements as noted above.
- As such, for CcH_2 storage systems, the expected on-road performance test as currently written is a long and expensive test that provides little value for assuring safety. This test needs to be overhauled and better tailored for CcH_2 storage systems if it were to provide a similar value to expense ratio as it does for conventional CHSS's.

Verne thanks NHTSA for its consideration and feedback, and for its role in assuring a safe and prosperous American mobility industry.

Sincerely,

David E. Jaramillo
Chief Technology Officer & Co-Founder
Verne Inc.