The Implementation of SAE J2601: Hydrogen Fuelling Protocol Guideline for Demonstration Projects

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The Implementation of SAE J2601: Hydrogen Fuelling Protocol Guideline for Demonstration Projects

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1 Scope

The goal of this presentation is to describe the Technical Information Report SAE J2601, how it was developed and its intended implementation in hydrogen vehicle demonstration projects.

The international SAE Fuel Cell Standardization and Interface team, who created this document, consisted of cross-industry representation of most of the major automakers, energy companies, laboratories and government hydrogen and fuel cell system suppliers.

The implementation of hydrogen vehicles in the market necessitates having a universal fuelling protocol for all vehicles. The goal is to achieve a 'customer acceptable' fuelling, which means a full tank of hydrogen within a reasonable amount of time without exceeding the temperature, pressure and density (SOC) limits. However, fuelling performance may be limited by the pre-cooling capacity of the station dispenser.

2 Industry-wide Fuelling Protocol

SAE TIR J2601 establishes industry-wide fuelling protocol guidelines for the fuelling of gaseous hydrogen into on-road passenger vehicles operating with nominal working pressures (NWPs) of 35MPa and 70MPa. Fuelling stations should employ fuelling algorithms and equipment to conduct the fuelling process within these guidelines. Vehicles filled at stations using these protocols should be designed appropriately for fuelling according to these guidelines. SAE TIR J2579 provides guidance for qualifying the vehicle hydrogen storage system (HSS) for operation at specific nominal working pressures.

This document establishes safety limits and performance requirements for gaseous hydrogen fuel dispensers. The criteria include maximum fuel temperature at the dispenser nozzle, the maximum fuel flow rate, the maximum rate of pressure increase and other performance criteria based on the cooling capability of the station's dispenser.

J2601 establishes fuelling guidelines for "non-communication fuelling" in the absence of vehicle communication and guidelines for "communication fuelling" when specified information is transmitted from the vehicle and verified at the dispenser. The process by which fuelling is optimized using vehicle-transmitted information is specified. SAE TIR J2799 (fig. 2) provides details of the communication data transmission protocol.

This document applies to light duty vehicle fuelling for vehicles with storage capacity from 1kg to 10kg for 70MPa and 1kg to 7.5 kg for 35MPa. It is intended to be revised in the next two years to include separate requirements for fuelling heavy duty vehicles and motorcycles,

and also for residential hydrogen fuelling appliances. Since there is a significant difference between the onboard storage capacity of heavy-duty and light-duty vehicles, the performance specifications could be different.

Standard Designation		H35			H70		
Storage Capacity Classification		Small (motorcycle)	Light Duty (light duty 1 ~ 7.5 kg)	Heavy Duty (bus, commercial truck)	Small (motorcycle)	Light Duty (light duty 1 ~ 10 kg)	Heavy Duty (bus, commercial truck)
Fueling Connection Device		J2600 Recommended Practice			J2799 TIR (to J2600 in future)		
Vehicle-to-Station Communication		J2799 TIR (to J2601 in future)			J2799 TIR (to J2601 in future)		
Fueling Protocols	A ➔ -40C	2601 in future	J2601 TIR in 2009	2601 in future	2601 in future	J2601 TIR in 2009	2601 in future
	B ➔ -20C	2601 in future	J2601 TIR in 2009	2601 in future	2601 in future	J2601 TIR in 2009	2601 in future
Dispenser Type ➔ Cooling	C ➔ 0C	2601 in future	J2601 TIR in 2009	2601 in future	2601 in future	2601 in future	2601 in future
	D ➔ None	2601 in future	J2601 TIR in 2009	2601 in future	2601 in future	2601 in future	2601 in future
	Residential	2601 in future	2601 in future	2601 in future	2601 in future	2601 in future	2601 in future

Figure 1: Summary of fuelling interface standards and scope of current TIR J2601.

The tables based approach in this document has been simulated by vehicle auto manufacturers and validated by independent laboratory and some preliminary field results. The tables give targets for pressure levels with a given ambient temperature, for non-communications fuelling and start pressure to arrive at a high desired state of charge.

SAE J2799 Optional Communications: IrDA Wireless Communications

- IrDA Available Technology
- Transparent to customer
- Vehicle tank info for Temp. Comp.
- Real Time H2 Storage Information

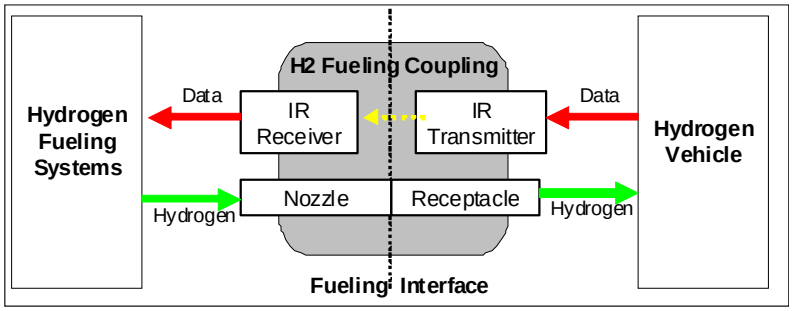

Figure 2: Overview of SAE J2799.

This document applies to fuelling using an average pressure ramp rate methodology which is to be verified with a hydrogen dispenser test apparatus as defined CSA HGV 4.3. This document includes provisions for optional alternative communications fuelling protocols and is planned to be revised in the future to include specifications for additional fuelling processes to allow more freedom than the present document. New dispenser protocol proposals would need to be verified with data and experience demonstrating the fuelling

algorithm's capability to operate within the constraints of the General Requirements for Fuel System (SAE J2579) and Interface (SAE J2600, J2799).

3 Implementation of the Hydrogen Fuelling Guideline

It is expected that this document will be used in conjunction with the CSA HGV 4.3 Hydrogen Dispenser Temperature Compensation Confirmation Report, which will to provide a test method and equipment specification for confirming that the performance of a fuel dispenser is consistent with the requirements of SAE TIR J2601.

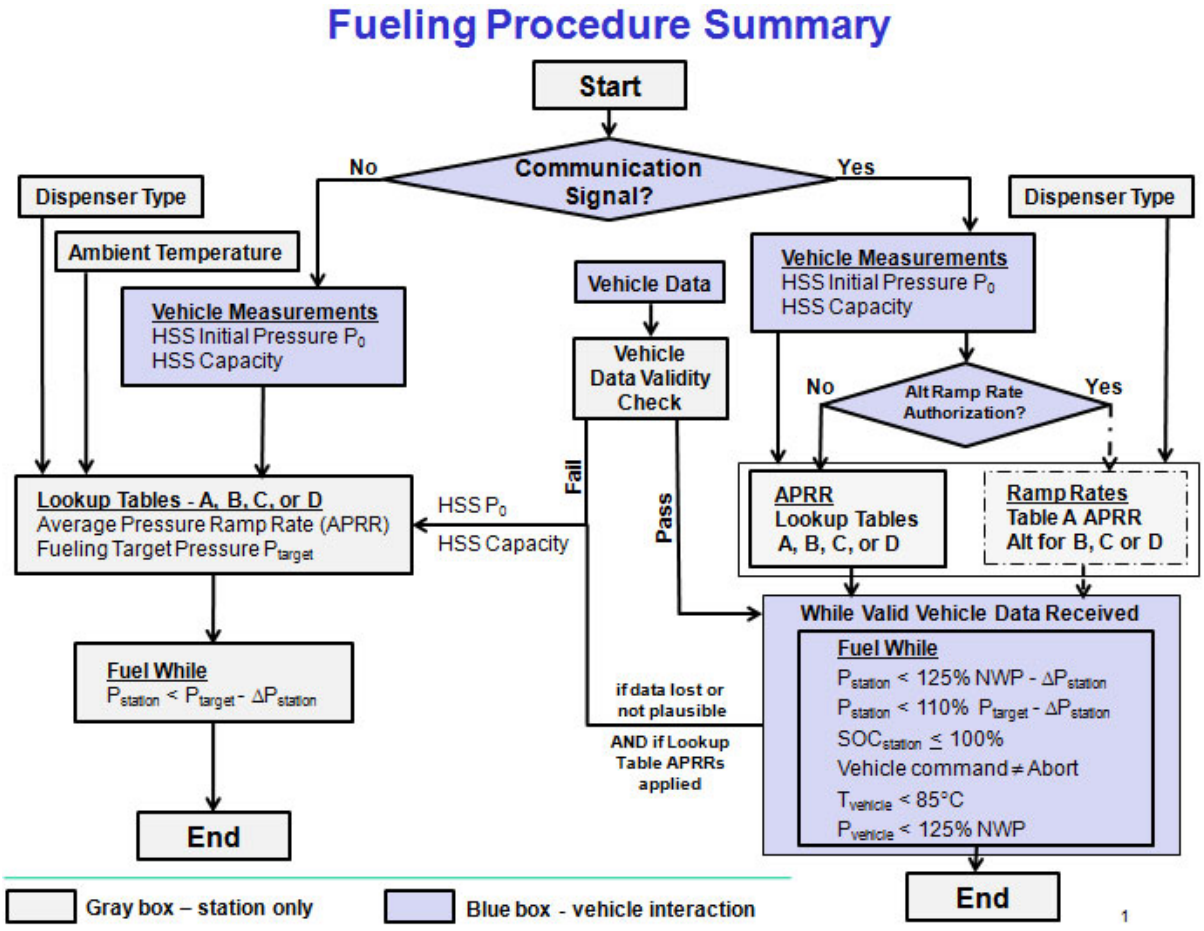

Figure 3: Flow sheet of decision tree for each fuelling procedure.

This document establishes a formal industry-wide fuelling guideline that supersedes all temporary guidelines informally established by non-ANSI-certified organizations, such as the vehicle manufacturer (OEM) document Fuelling Specification for 70 MPa Compressed Hydrogen Vehicles, Version A posted on the NextEnergy website and all CaFCP Fueling Protocols. It is understood, however, that other fuelling protocols that differ from the look-up table-based protocol specified in this document may be used when the station provider has a.) an agreement from a vehicle manufacturer that the protocol is appropriate for a particular vehicle system, and b.) a method of identifying the particular vehicle and limiting the protocol to that vehicle is utilized in the station design and operation. The intent is that developments

be brought to the SAE TIR J2601 team to enable modification of the document to allow for a more performance based approach for future revisions. The current document is table-based, providing concise performance targets and dispenser performance specifications for both communicated and non communicated fills as shown in figure 3.

This TIR is intended to evolve over time before it is standardized. The goal is to establish a protocol guideline in the initial publication and request industry to give feedback and improvement suggestions before standardizing in the 2011 timeframe.

Depending on which dispenser type is chosen (classified by pre-cooling temperature capability), a relatively quick fuelling time and SOC can be achieved. In fact, the Department of Energy fuelling goals for the year 2015 were achieved with an ‚A-Type' Dispenser.

Recommendations will be made in the presentation as to which dispenser type would give a "customer acceptable" fuelling.

References

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