PRHYDE-Protocol for heavy-duty hydrogen refuelling

Call Identifier FCH-04-2-2019:
Refuelling Protocols for Medium and Heavy-Duty Vehicles

PRHYDE
Protocol for heavy-duty Hydrogen refuelling

01 JAN 2020 - 31 DEC 2021

Horizon 2020
European Union Funding
for Research & Innovation

FCH
FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

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Acknowledgement

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Heavy Duty Fueling Protocol Strategic Approach

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Background

- You can have several different approaches to fueling protocols
- Each of these approaches will fundamentally change how fueling is done
  - Impact on performance, cost, and reliability
- Example SAE J2601
  - Decision: Fueling without communications mandatory
  - Impact: Could not optimize protocol using vehicle parameters (CHSS Temp, etc.)
  - Result: Conservative assumptions lead to longer fueling times

PRHYDE Strategic Approach

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- PRHYDE partners and industry need to agree on approaches to heavy duty fueling protocols.
- These decisions will have significant impact to how the protocol is structured
- This presentation tries to show the impact of each approach through yes/no questions
- Your feedback is welcome. Please visit the link for a poll
  https://bit.ly/3mpjL39

Station/Vehicle Pressure

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- Is fueling of lower NWP dispenser into higher NWP vehicle allowed? (e.g., H35 dispenser into H70 vehicle)

- Is fueling of higher NWP dispenser into lower NWP vehicle allowed? (e.g., H70 dispenser into H35 vehicle)

Lower station, higher vehicle

- Provides additional fueling options
- Currently allowed for light duty vehicles
- Would require harmonization of nozzles
- No concern about over-pressurization
- May result in slower fueling or lower SOC for higher pressure vehicle

Higher station, lower vehicle

- Provides additional fueling options
- Currently not allowed for light duty vehicles
- One nozzle could be used for H35 & H70
- Would require additional controls to prevent over-pressurization

Station/Vehicle Flow Rate

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- Is fueling of a higher flow rate station into a lower flow rate limited vehicle acceptable?

Yes—High flow rate station into low flow rate vehicle

- Would require the fueling protocol to modify fueling based upon flow rate
  - More complexity

No—High flow rate station into low flow rate vehicle

- Vehicles would need to be designed for higher flow rates or would not be allowed to fuel

Communications

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- Does the fueling protocol have a combined comm and non-comm approach?
  - If yes, then does the fueling protocol have a conservative non-comm approach?

Comm and non-comm
-Combined protocol (similar to SAE J2601)

-Reduced performance because no vehicle info

Communications
- Standard protocol

Non-communications
No fueling or reduced fueling

Communications [NEW]

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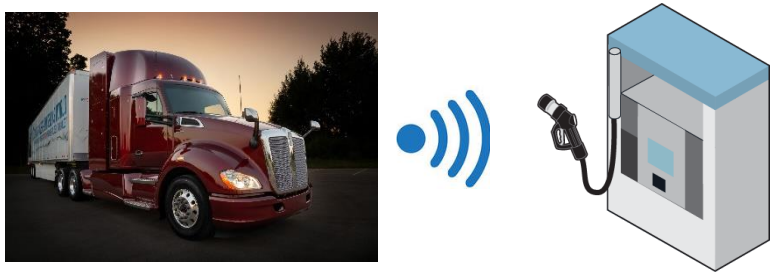
- Does the fueling protocol incorporate two-way communications? (i.e., vehicle to station and station to vehicle communications)

Two Way
- Better optimization of fueling protocol
- Would be required if vehicle controls fueling
- Higher vehicle and station cost



Vehicle to station only
- Limited optimization of fueling protocol
- Lower vehicle and station cost

Communications

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- Will the communication signals from the vehicle be designed with a reliability level sufficient to be used for critical fueling decisions?

Sufficient Reliability

- Better optimization of fueling protocol
- Vehicle comm will like need to have ASIL rating
- Higher vehicle cost

Insufficient reliability

- Limited optimization of fueling protocol
- Static may still require vehicle ASIL
- Lower vehicle cost

This question tries to capture if the communications signals from the vehicle can be used by the station for critical fueling protocol decisions. For example, some stations currently using SAE J2601 will not use the tank volume signal to determine the fueling rate without the signals from the vehicle meeting a certain reliability level.

Vehicle/Station Responsibility [new]

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- Does the vehicle have any responsibility in determining fueling rate?

1)Vehicle—No Responsibility

- Station will need to perform fueling rate calculation
  → Higher cost, complexity
- Protocol may be limited by range of vehicle assumptions
- Would work with non-comm
- Station assumes all "liability"
- Same as J2601

2)Combined Station/Vehicle Responsibility

- Vehicle provides some reliable data and would require reliable vehicle comm (ASIL)
- Station will need to perform fueling rate calculation
  → Higher cost, complexity
- Would increase range of vehicle assumptions
- May work with non-comm
- "Liability" shared

3) Vehicle —Final Decision

- Vehicle will need to perform fueling rate calculation
  → Higher cost, complexity
- Station only needs to provide station status data
  →Reduced cost, complexity
- Would not work with non-comm
- Station to vehicle comm needed
- Would allow for new vehicle technology
- Vehicle assumes all "liability"

Station/Vehicle Capacity

- Is fueling of a small capacity station into a larger vehicle acceptable?

Small station, larger vehicle

- Provides additional fueling options
- Would deplete station and result in slower fueling or lower SOC
- May need to over-design station

Station status

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- Does the protocol take into account current status of the station?
  - If no, then stations may need to be over-designed to ensure full capacity or cooling and will not be able to fuel when below full
  - If yes, then lower performing fueling may be allowed

I can always give a fueling rate of 5 for six fills, then will need to pause for 30 minutes to fill again

OR

I can give 3 fills at a fueling rate of 5, then the next fills will be a fueling rate of 2 until I can pause for 30 minutes

Station Performance

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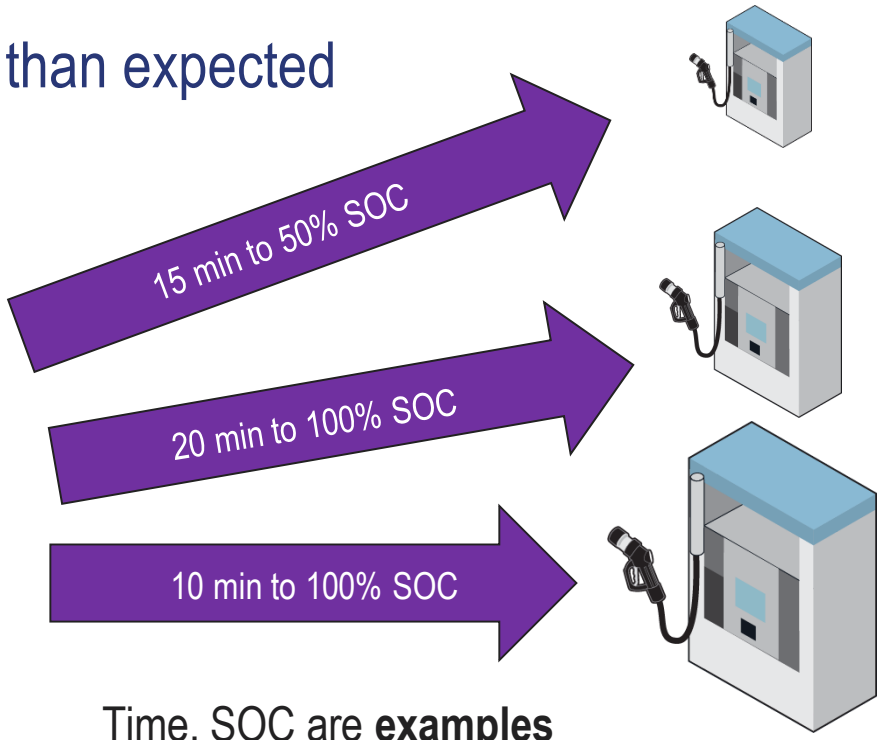
Does the protocol have minimum performance standards based upon vehicle and station size?

- If yes, then performance can be predicted
- If no, then may result in lower performance than expected

Long Haul Truck
H70 C kg
X1, Y1, Z1 parameters



Time, SOC are **examples**

Small Station
H35 Tamb
A1, B1, C1 parameters

Medium Station
H70 T20
A2, B2, C2 parameters

Large Station
H70 T40
A3, B3, C3 parameters

Backwards Compatibility

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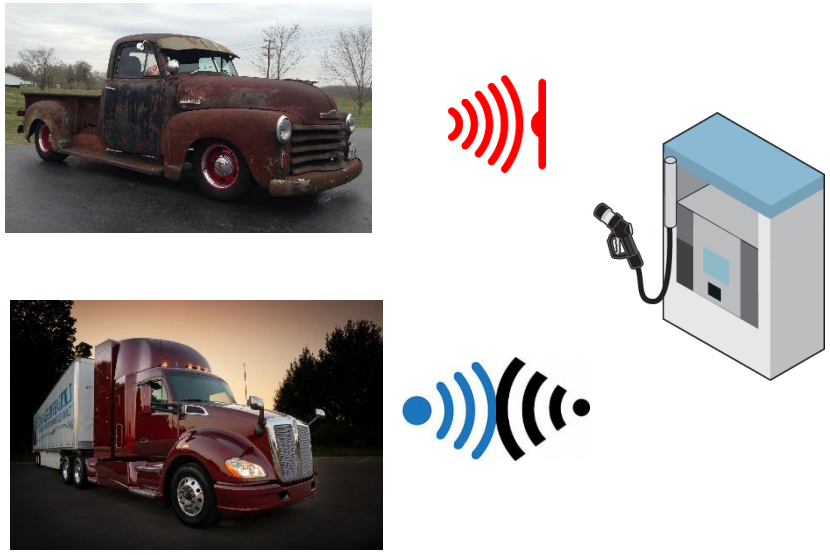
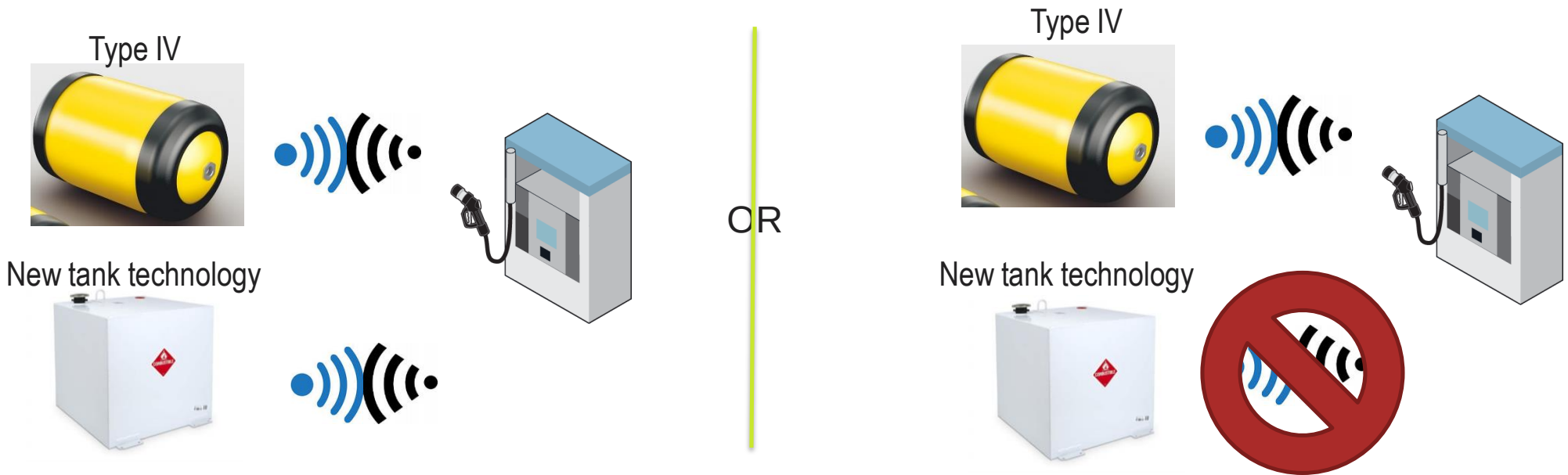
- Does the fueling protocol need to be compatible with existing LDV hardware?
  - Nozzle?
  - IRdA communications?
  - Vehicle tanks?



OR

Future Technology

- Does the protocol allow for adoption of future technology (e.g., tank types/shapes, different Kv, CHSS Temperature)
  - If yes, then protocol may require additional parameters, modeling
  - If no, then protocol will be limited to defined technology



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