

Simultaneous Fueling Investigation Performance and Challenges

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Project ID #H2021

Overview

Timeline and Budget

- Project start date: 10/1/2017
- FY17 DOE funding: \$ 342k
- FY18 planned DOE funding: \$0
- Total DOE funds received to date: \$ 342K

Barriers

Technology Validation Barriers

D. Lack of Hydrogen Refueling Infrastructure Performance and Availability Data

Systems Analysis Barriers

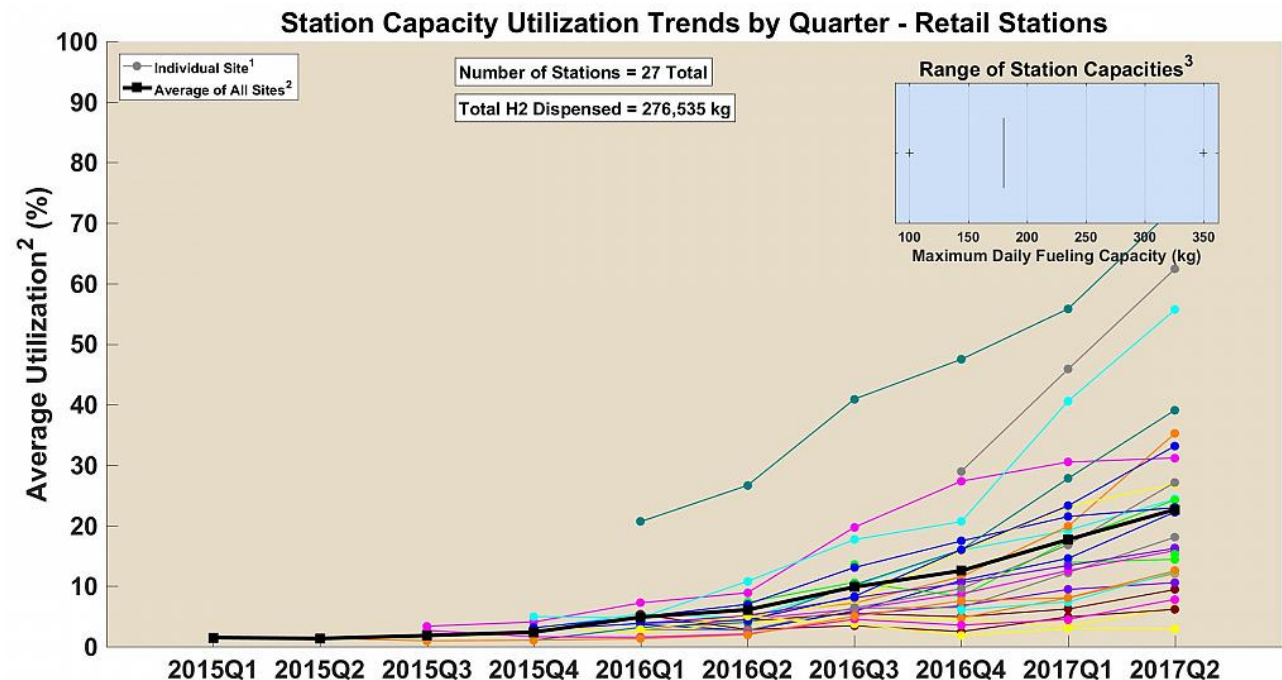
C. Inconsistent Data, Assumptions and Guidelines

Partners

Key partnerships are being explored and will be leveraged where possible on this project

Relevance

- Most existing LD stations are single dispenser
- Increasing FCEV market penetration requires increased station capacity, requiring multiple dispensers
- Publicly available station operational limitations, component upgrade requirements, and performance for simultaneous fueling capability is not available



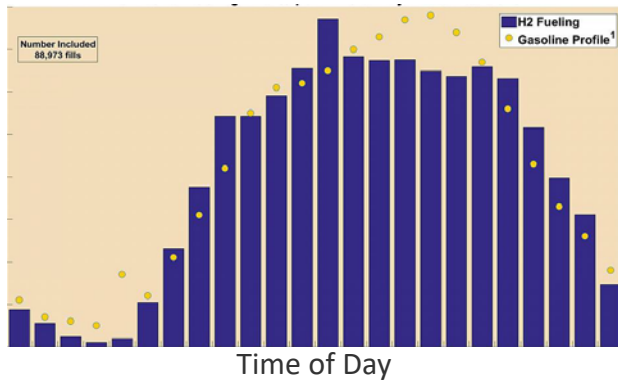
Relevance

Project Goal: Address the technical challenges associated with simultaneous fueling with multiple dispensers

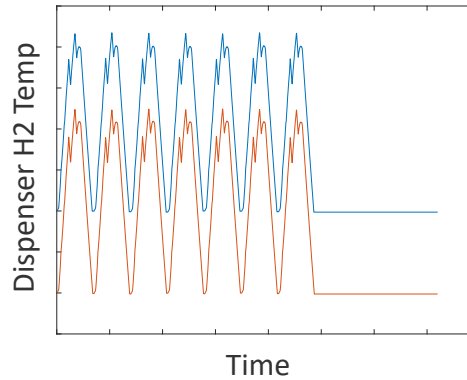
- Identify fueling demand profiles and perform an analysis of dispenser precooling requirements for simultaneous fueling
- Determine station thermal precooling systems that will be used at NREL's Hydrogen Infrastructure Testing and Research Facility (HITRF) for experimental evaluation
- Determine station operational strategy that maximizes system performance
- Compare simultaneous fills using two dispensers for gas temperature, final state-of-charge, fueling rate, and station control impact.
- Develop a reference station design concept for a light duty vehicle station with a capacity of at least 1,000 kg/day.

Approach

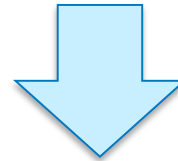
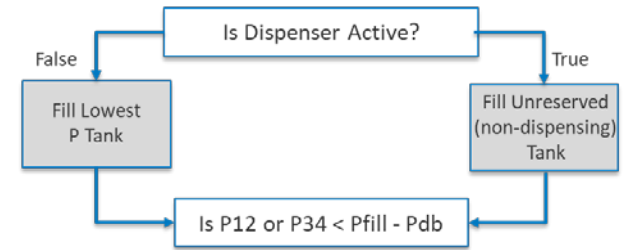
Representative Station Demand Profile



Dispenser Thermal System Requirements

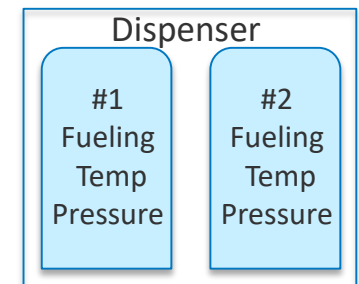
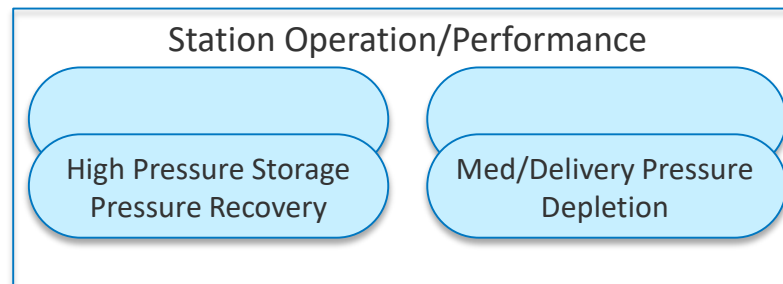
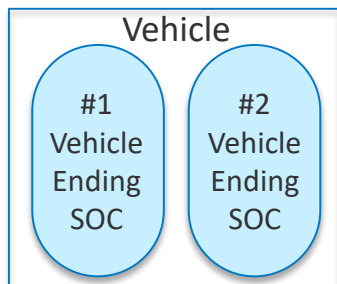


Station Operational Strategy Definition

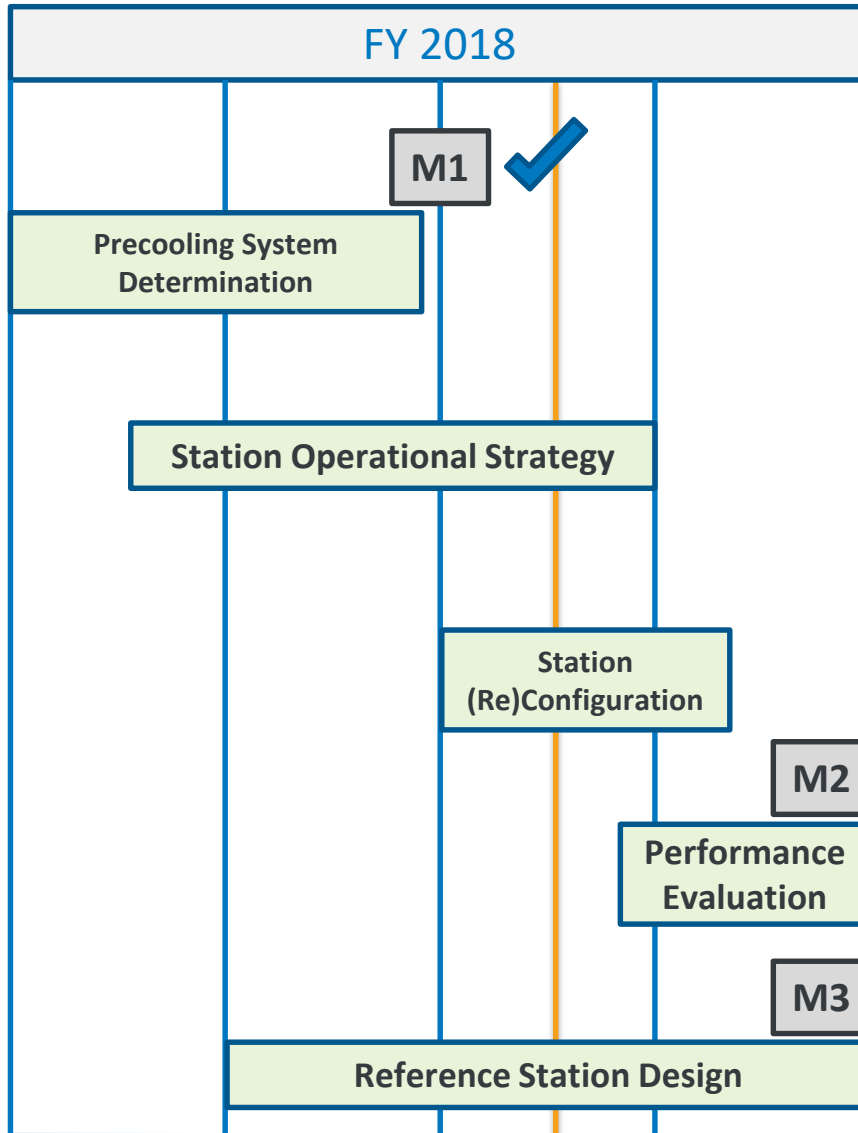


HITRF Station Configuration

System Performance Evaluation and Results Generation



Approach: Project Milestones



M1: Complete analysis of precooling system performance and identify the system used for hardware demonstration.

M2: Compare simultaneous fills using two dispensers for gas temperature, final state-of-charge, rate, final pressure, and station control impact.

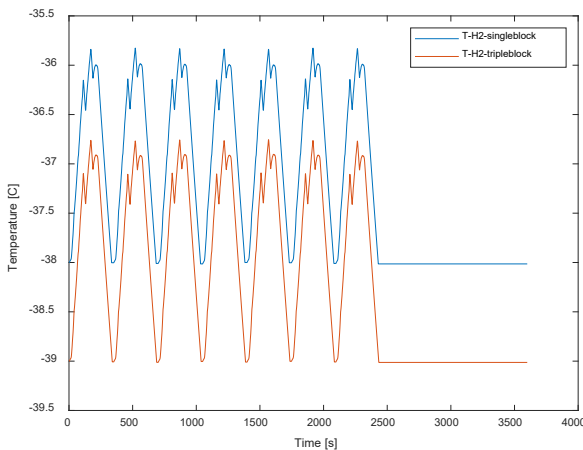
M3: Complete a 1,000+ kg/day reference station design that includes capacity, storage, capital cost, fueling position count, and footprint estimates.

Accomplishments and Progress: Dispenser Precooling System Analysis

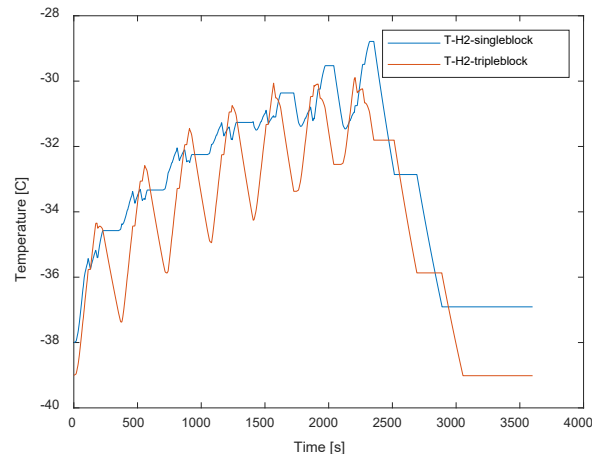
- 7 back-to-back LD fills (~3.8 min each, ~3.7 kg each) in one hour, with 120s recovery. Ambient T = 13.8°C
- Initial thermal mass temperature of -45°C
- Plots are of hydrogen dispense temperature after pre-cooler

Hydrogen Dispense Temperature Analysis Results For Different Precooling Configurations

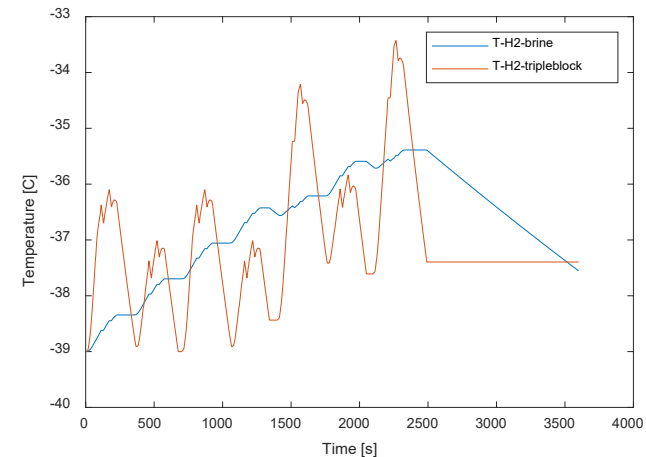
D1: 16 HP chiller w/ single block HX
D2: 16 HP chiller w/ triple block HX



16 HP chiller shared D1 and D2
D1: single block, D2: triple block HX

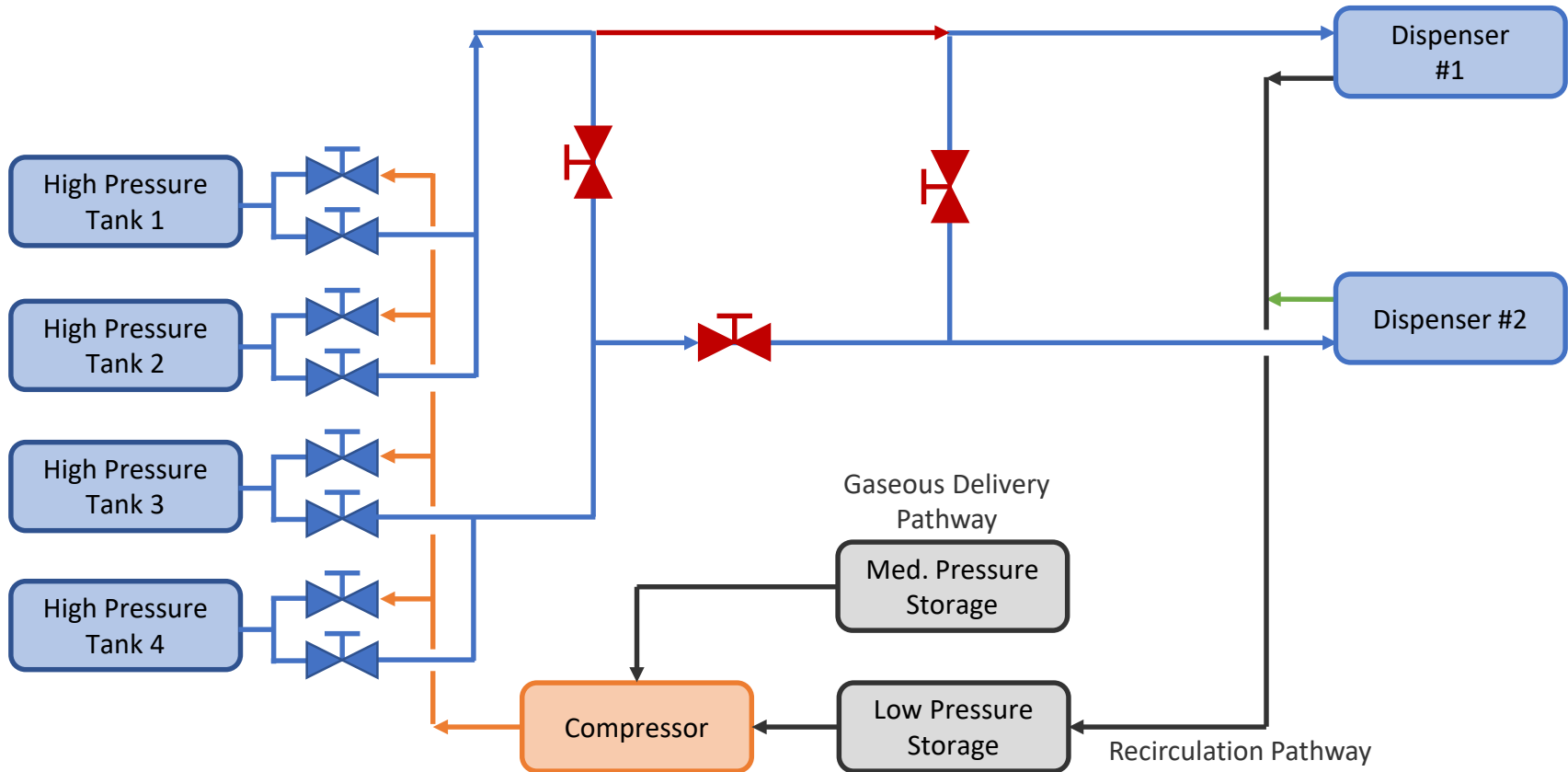


16 HP chiller shared D1 and D2
D1: triple block, D2: Brine system



Conclusion: Two independent chillers are necessary for adequate system function

Accomplishments and Progress: Station Reconfiguration and Hardware Upgrades



New 15,000 psi installation (valves and pipe)
New 5,000 psi installation (pipe)

Existing 15,000 psi installation
Existing 15,000 psi installation
Existing 5,000 psi installation

Accomplishments and Progress: Simplified Station Control Strategy

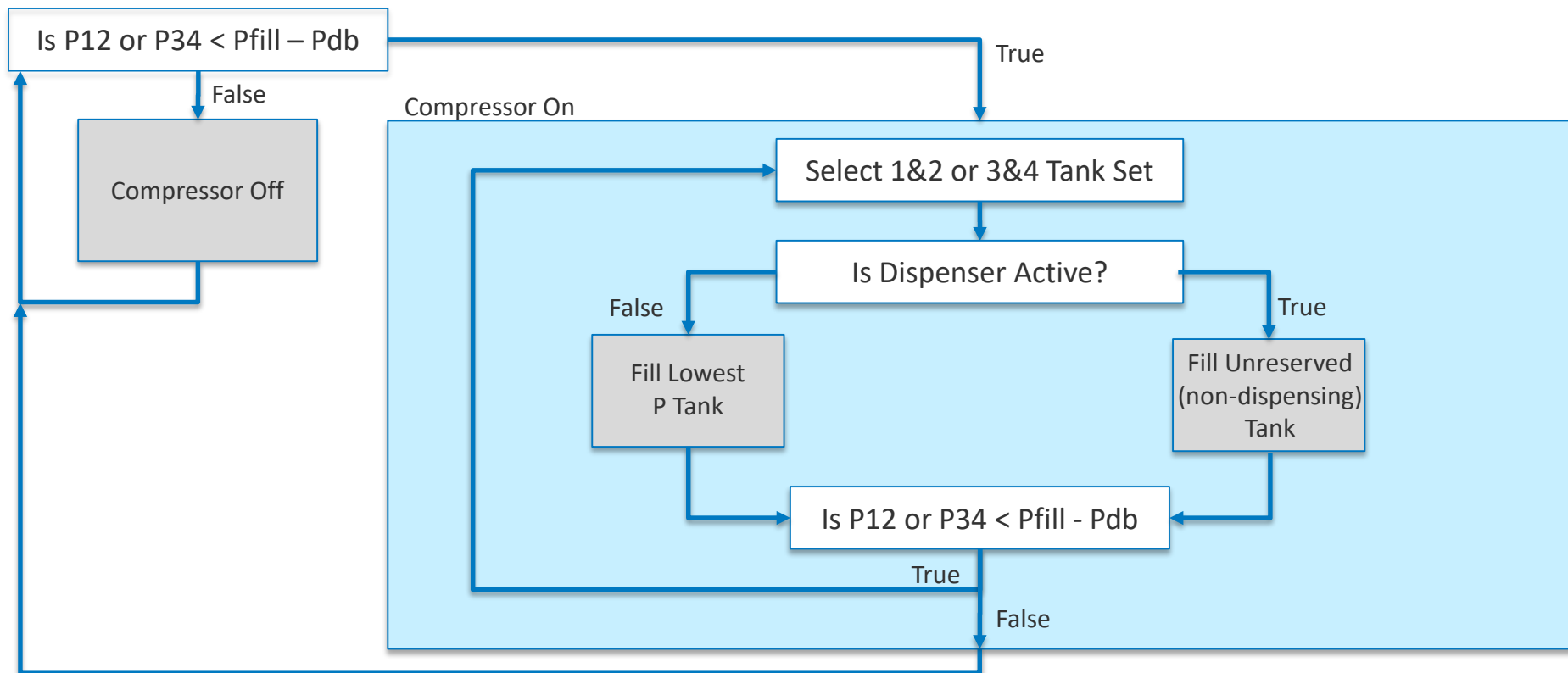
Assumptions:

HP tanks 1 & 2 dedicated to dispenser 1. P12 = average pressure in HP tanks 1 and 2

HP tanks 2 & 3 dedicated to dispenser 2. P32 = average pressure in HP tanks 3 and 4

Pressure deadband (Pdb) is needed for control purposes to avoid rapid state change

HP tanks have a target fill pressure, labeled Pfill



Accomplishments and Progress: Responses to Previous Year Reviewers' Comments

- This project was not reviewed in the prior year

Collaboration and Coordination

- Key partnerships are being explored and will be leveraged where possible on this project
- Specific partnerships being explored
 - Hydrogen infrastructure compressor manufacturers
 - Provide compression operational control strategy recommendations
 - Station Owners/operators
 - Recommendations and verification of simultaneous fueling station configuration
 - Dispenser suppliers
 - Verification of requirements for thermal precooling for back-to-back fueling operation

Proposed Future Work

- Complete HITRF station hardware reconfiguration
 - Safety review
 - Plumbing and process valve changes
 - Recirculation system implementation for dispenser(s)
- Complete experimental evaluation
 - Finalize test matrix
 - Shakedown HITRF system operation
 - Perform simultaneous fueling experiments
- Complete 1,000+ kg/day reference station design
- Deliver publication opportunities resulting from the project
- Follow-up work on MD/HD dispensing performance evaluation, and additional high throughput LD evaluations (subject to future funding levels)

Summary

- Analysis of dispenser precooling thermal requirements for station operation is complete
 - Each dispenser will require individual chillers (~16 HP) and heat exchangers to complete back-to-back fueling requirements
- HITRF hardware upgrades for simultaneous fueling have been identified and implementation is in-progress
 - High pressure storage pairs dedicated to each dispenser
 - Plumbing upgrades for expected fueling rates
- Station operational control strategy has been identified
- Remaining tasks include operational shakedown, experimental evaluations, and completion of reference station design

Thank You

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