

U.S. DOE HTAC Meeting April 6, 2016

Commercial Hydrogen Measurement and Fuel Quality Requirements

Presented by:

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Division of Measurement Standards

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Hydrogen Dispensers in California

- The required specifications and accuracy tolerances for hydrogen dispensers are found in the National Institute of Standards and Technology (NIST) Handbook 44 Section 3.39. Hydrogen Gas-Measuring Devices -Tentative Code.
- Existing hydrogen dispensing technology cannot routinely meet the accuracy tolerances published in NIST HB 44.
- California consulted with government, academia, and industry to determine an acceptable range of tolerances that could facilitate rapid deployment of commercially viable hydrogen fueling equipment.
- California modified, amended, and made specific sections of NIST HB 44 through rulemaking in 2014 to establish attainable California specifications and accuracy tolerances for hydrogen gas measuring devices.

Expanded Accuracy Classes for Hydrogen Dispensers in California - Adopted June 16, 2014

Accuracy Class	Acceptance Tolerance	Maintenance Tolerance
2.0	1.5 %	2.0 %
3.0 *	2.00%	3.00%
5.0 *	4.00%	5.00%
10.0 **	5.00%	10.00%

* Due to expire 12/31/2019

** Due to expire 12/31/2017

Hydrogen Dispenser Requirements

- The California Business and Professions Code (BPC) Section 12500.5 requires that CDFA/DMS pre-certify hydrogen fuel dispensers prior to use through the California Type Certification Program (CTEP).
- Conformance to accuracy classes specified in CCR Title 4, Division 9 Section 3.39 Hydrogen Gas Measuring Devices is determined along with adopted portions of NIST Handbook 44.
- Type approved devices must meet Acceptance Tolerance prior to being placed into commercial service. Registered Service Agents can perform this work with a local County Official witnessing the testing.
- Re-tested annually thereafter, Maintenance Tolerances are applied.

Hydrogen Dispenser Requirements

- Type Evaluation of retail hydrogen fuel dispensers is conducted using the Hydrogen Field Standard (HFS) designed and constructed by NREL.
- To evaluate hydrogen dispensers, field tests are designed to determine:
 - Conformance to one of the adopted accuracy classes specified in regulation.
 - Fill-to-fill repeatability, accuracy, and precision.
 - Dispenser performance during interrupt and emergency stop simulations.
 - Conformance to advertising, labeling, and method of sale requirements.

Field Testing with the HFS

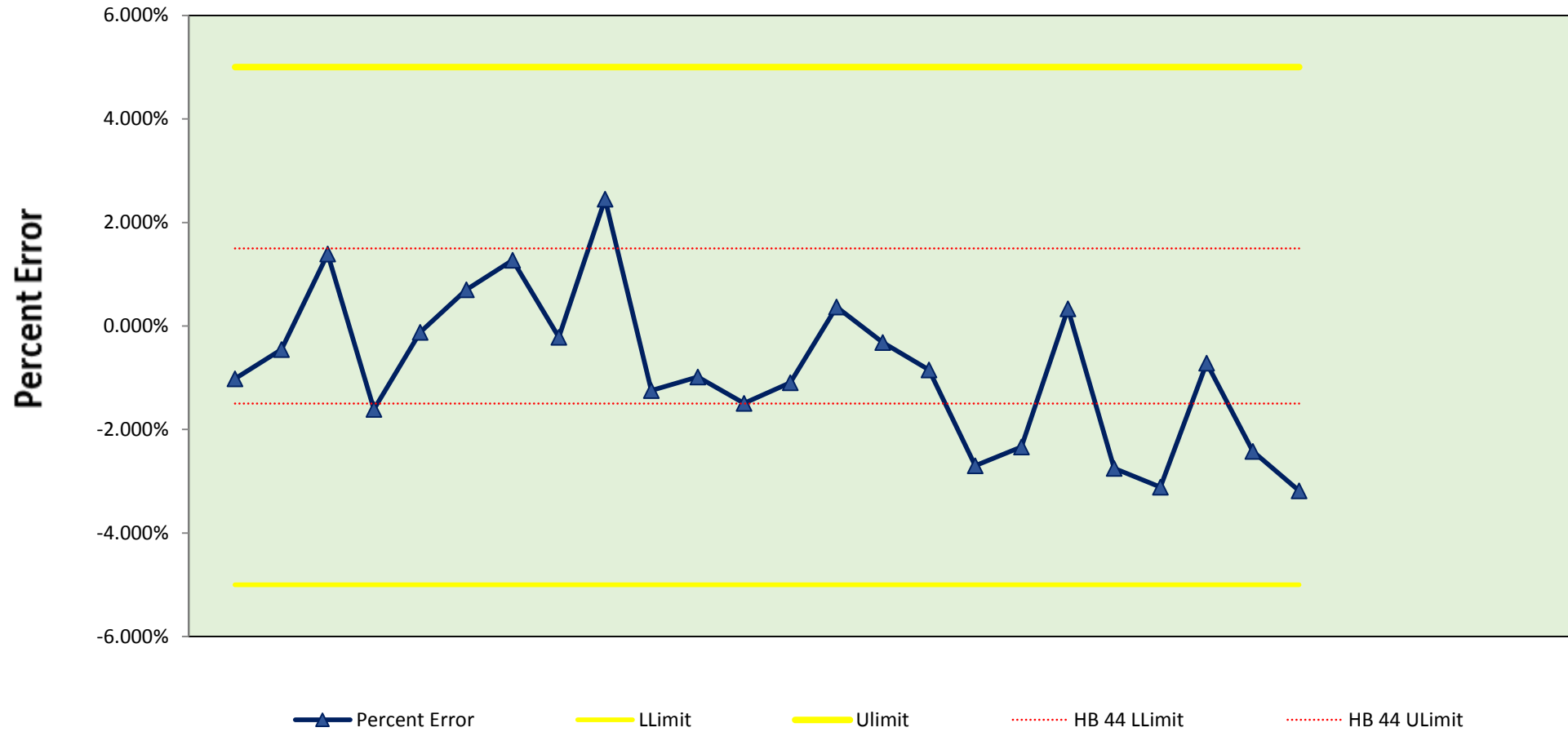
- Hydrogen Field Standard (HFS) is driven to hydrogen station.
 - HFS is set up and operating systems validated.
 - CDFA works with on-site operators and engineers to insure operational safety.
 - Fueling protocols and sample drafts are conducted to simulate “live-fill” scenarios.
 - Data is collected in real time.
 - Accuracy Assessment is completed at the end of test cycle.
 - Conformance to CCR Title 4, Division 9 Section 3.39 Hydrogen Gas Measuring Devices is determined.
- Test data is compiled and a Compliance or Deficiency Letter is mailed to manufacturer.
- Time for type evaluation: 3 months from initial through subsequent testing.
- Time for routine testing - accuracy class verification and maintenance tolerance: 1 day.

Field Station Testing



Device Testing Data Samples

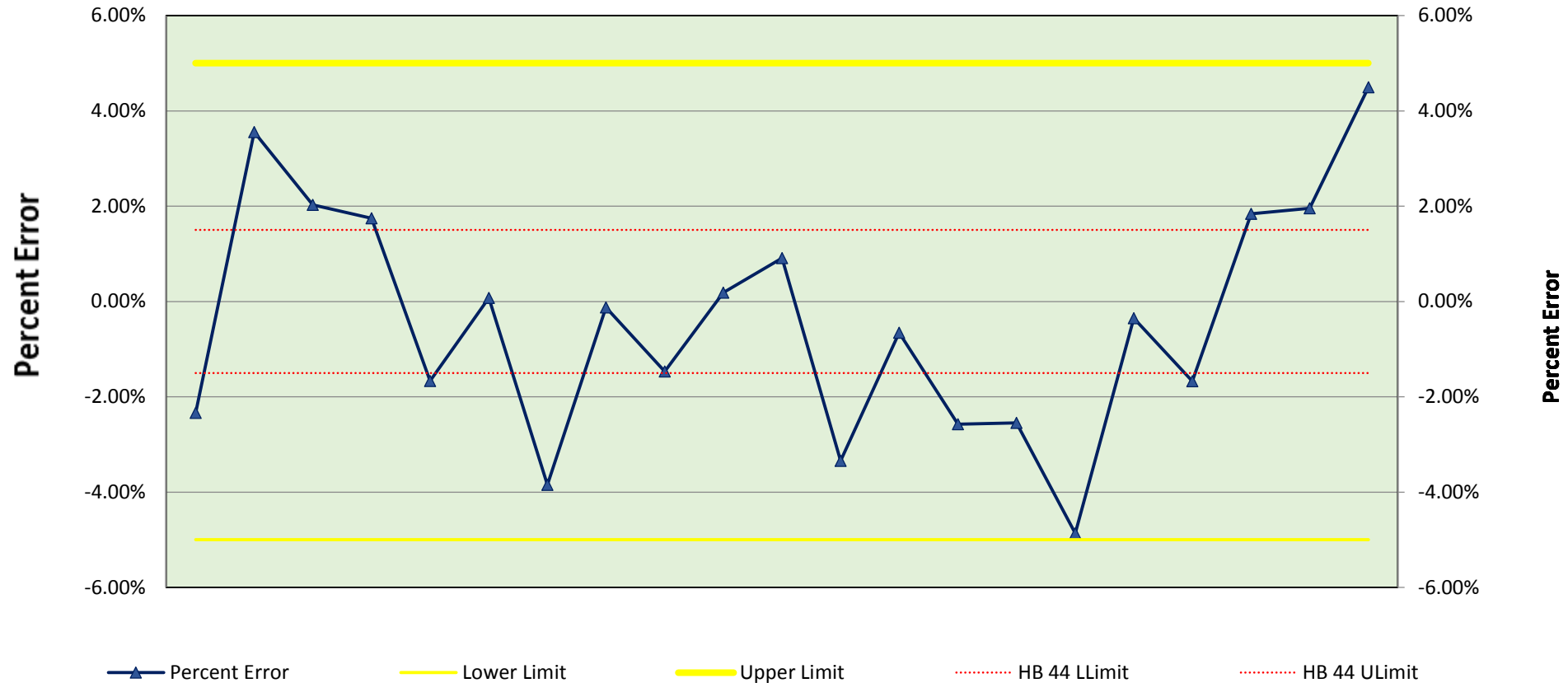
Station BB Test Chart



Percent Error

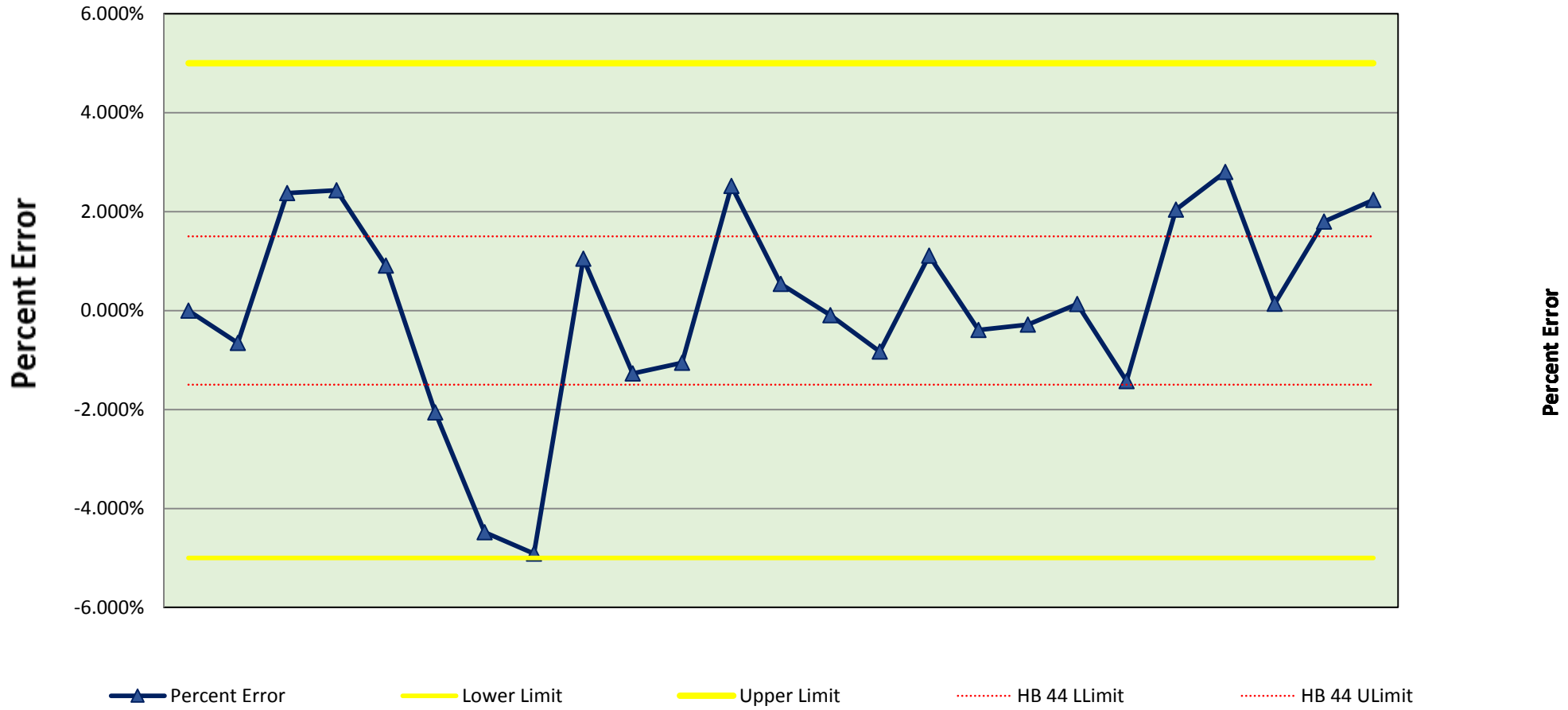
Device Testing Data Samples

Station GG Test Chart



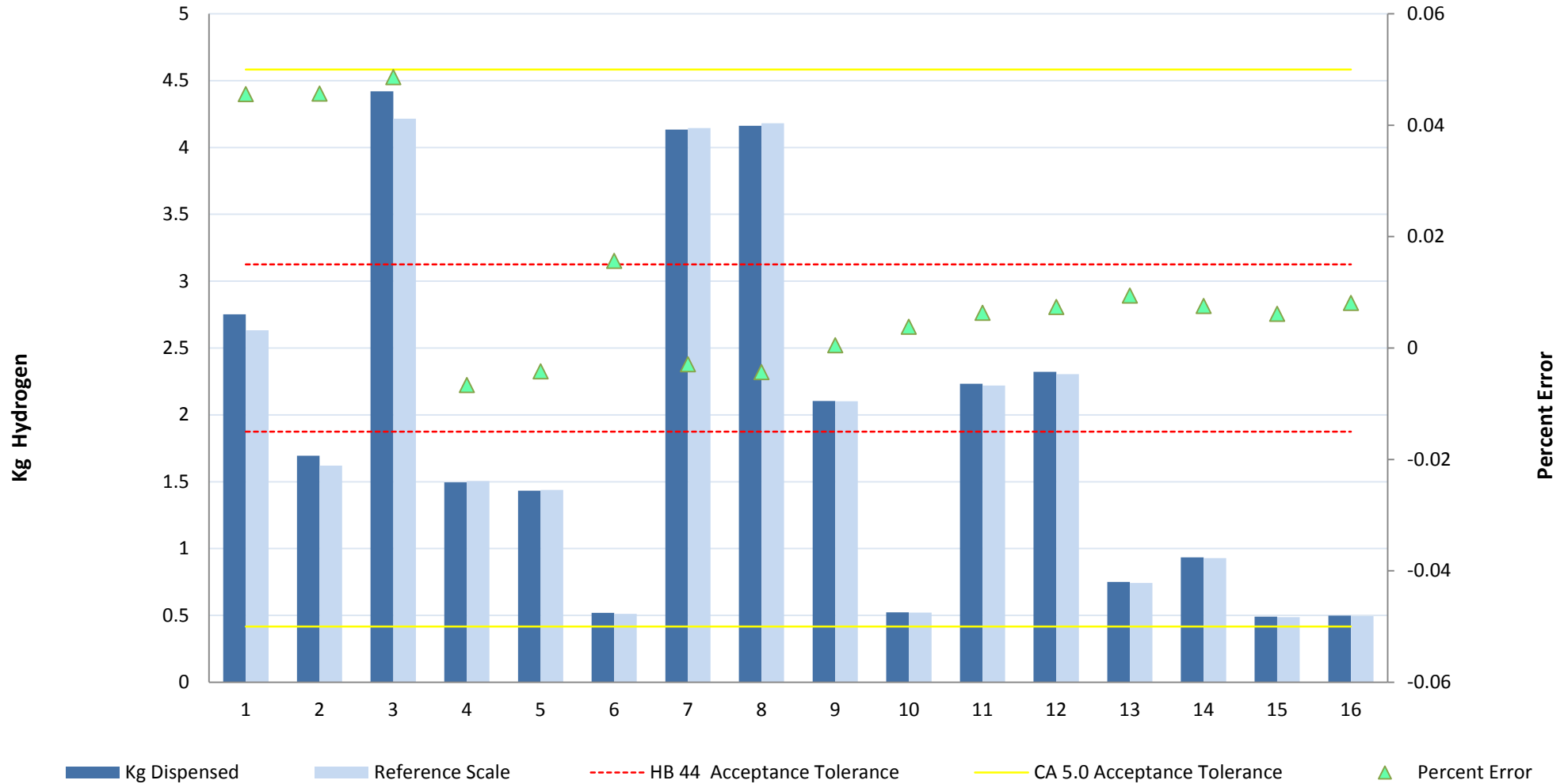
Device Testing Data Samples

Sation X Test Chart

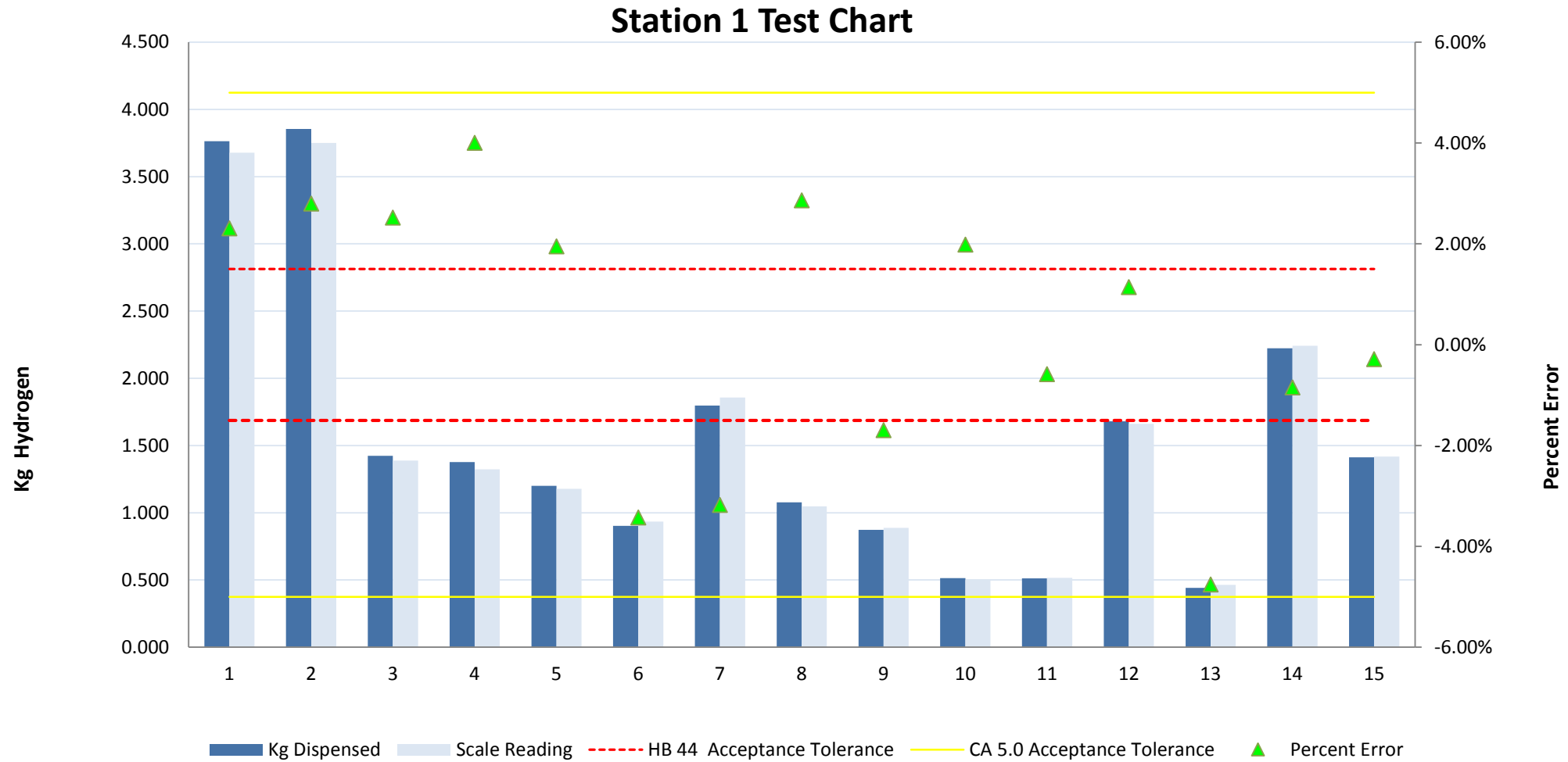


Device Testing Data Samples

Station 5 Test Chart



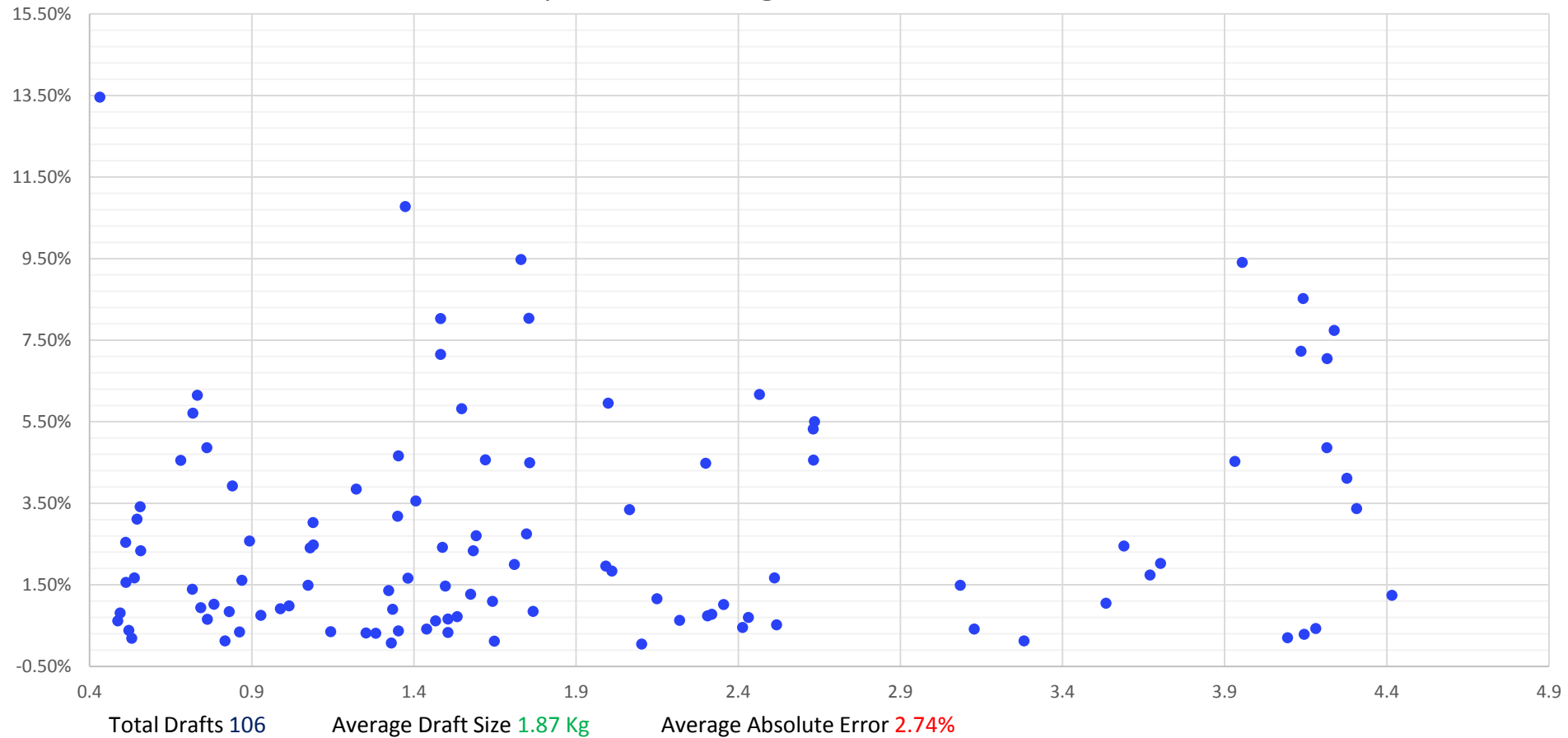
Device Testing Data Samples



Device Testing Data Samples

Correlation Analysis of Draft Size to Measurement Error

Representative Station Data
Dispensed Mass in Kg vs % Error Absolute Value



Status of Field Evaluations

- 12 stations tested using gravimetric method as of February 29, 2016
- 3 original test stations upgraded and re-tested
- Initial testing has issued five (5) temporary use permits with permanence testing resulting in four (4) type approval certificates.
- Fourth type approval certificate issued January 2016.
- Four Completed Initial Verifications of Placed in Service Dispensers
- Two Applications for new type evaluations received and in process.

Status of Field Evaluations

- To date — No dispenser tested meets the 1.5% acceptance and 2% maintenance tolerances listed in NIST Handbook 44.
- The expanded accuracy classes appear warranted.
- Several current dispenser designs meet one of the expanded classes.
- Some stations require second initial tests after adjustments are made and deficiencies are corrected, some will not require nor request permanence testing (non-retail stations).
- Acquisition of maintenance tolerance test data has just begun.

Efforts for National Uniformity

- CDFA-DMS submitted a proposal to the National Conference on Weights and Measures (NCWM) Specifications and Tolerances Committee to adopt CA expanded accuracy classes for hydrogen gas measuring devices.
- CDFA –DMS Staff presented testimony during the NCWM interim meeting January 2016 and provided rebuttal to arguments against expanded accuracy classes.
- Specifications and Tolerances committee agreed to elevate the proposal to voting status for the 2016 annual meeting held in Denver, CO July 24-28.
- The Committee elected to propose the addition of only one new accuracy class (10.0) for consideration by NCWM voting membership.

Method of Sale, Advertising, and Labeling Requirements

- AB 808 Enacted January 1 , 2016. CDFA shall adopt by reference NIST HB 130 Method of Sale for hydrogen and codifies legal requirements.
- Document for Retail Sale Advertising Requirements of Hydrogen Fuel is available at: <http://www.cdfa.ca.gov/dms/hydrogenfuel/hydrogenfuel.html>
- All provisions specified in CCR Title 4, Division 9, Chapter 1, Article 1, Section 3.39 Hydrogen Gas Measuring Devices apply.
- Conformance to requirements is evaluated during type evaluation process, during initial accuracy assessment of newly installed type-certified dispensers, and any routine or complaint testing.

Hydrogen Fuel Quality

- Chapter 14 of the Business and Professions Code requires the Division of Measurement Standards to establish and enforce quality specifications for transportation fuels in California.
- Quality standards for hydrogen fuel were published in 2011 as SAE International's Surface Vehicle Standard J2719 - Hydrogen Fuel Quality for Fuel Cell Vehicles.
- SAE J2719 has been adopted by reference by the Department of Food and Agriculture in California Code of Regulations Title 4, Division 9, Chapter 6, Article 8, Section 4181.
- California operates the only regulatory hydrogen fuel quality lab in the United States.

Hydrogen Fuel Quality Enforcement

- By law, compliance to all specifications for hydrogen fuel quality identified in SAE J2719 is mandatory in California.
- CDFA-DMS conducts random, routine, and complaint based sampling and testing of all retail motor fuels throughout the state.
- CDFA-DMS assures minimum quality standards for most automotive products (gasoline, oxygenated blends, diesel fuel, motor oil, brake fluid, automatic transmission fluid, antifreeze/coolants and hydrogen fuel) sold in California.
- Retailers dispensing, selling, or offering to sell hydrogen fuel that is out of conformance with specifications will have the nonconforming product immediately taken off-sale.

Hydrogen Fuel Quality Enforcement

Hydrogen Quality Sampling Apparatus (HQSA)

- Engineered and Constructed by Gas Technology Institute (GTI) with full HAZOPS.
- Fuel sample is collected from the nozzle – sample is approximately 68 liters at 1000 psi.
- On-site technician required to override system leak detection auto shot-off.
- Total sampling time is approximately 0.5 hrs.
- Full spectrum of tests takes approximately 2 days in our Sacramento laboratory.



Hydrogen Fuel Quality Enforcement

Hydrogen Fuel Quality Laboratory



Test Results by Sample ID

Sampled by: DMS

Sample Test Results Report (Partial)

15N0001-HY01**Fixed Gases by GC/PDD**Test performed by: *John Mough*

<u>Contaminant</u>	<u>Result</u>	<u>Units</u>	<u>Run #</u>	<u>Pass/Fail</u>
Argon	< 11	ppm	2,738	Pass
Nitrogen	952	ppm	2,738	Fail

Formaldehyde by CRDSTest performed by: *John Mough*

<u>Contaminant</u>	<u>Result</u>	<u>Units</u>	<u>Run #</u>	<u>Pass/Fail</u>
Formaldehyde	< 0.002	ppm	2,704	Pass

Helium by GC/TCDTest performed by: *John Mough*

<u>Contaminant</u>	<u>Result</u>	<u>Units</u>	<u>Run #</u>	<u>Pass/Fail</u>
Helium	< 40	ppm	2,737	Pass

Hydrocarbons and other gasTest performed by: *John Mough*

<u>Contaminant</u>	<u>Result</u>	<u>Units</u>	<u>Run #</u>	<u>Pass/Fail</u>
Carbon Dioxide	< 0.5	ppm	2,740	Pass
Carbon Monoxide	< 1000	ppm	2,740	Pass
Methane	< 0.25	ppm	2,740	Pass
Total Hydrocarbons	< 0.25	ppm	2,740	Pass

Total Halogenates by GC/MTest performed by: *John Mough*

<u>Contaminant</u>	<u>Result</u>	<u>Units</u>	<u>Run #</u>	<u>Pass/Fail</u>
Total Halogenated Compound	0.0021	ppm	2,739	Pass

Contact Information:

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