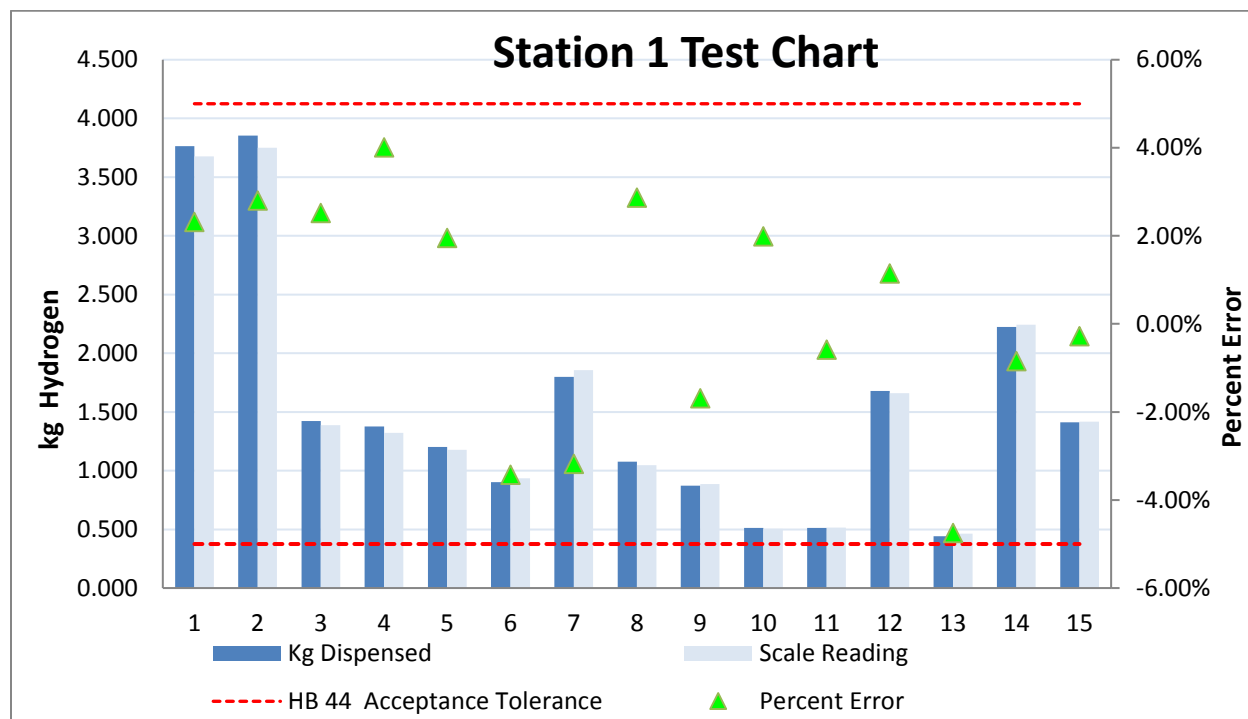
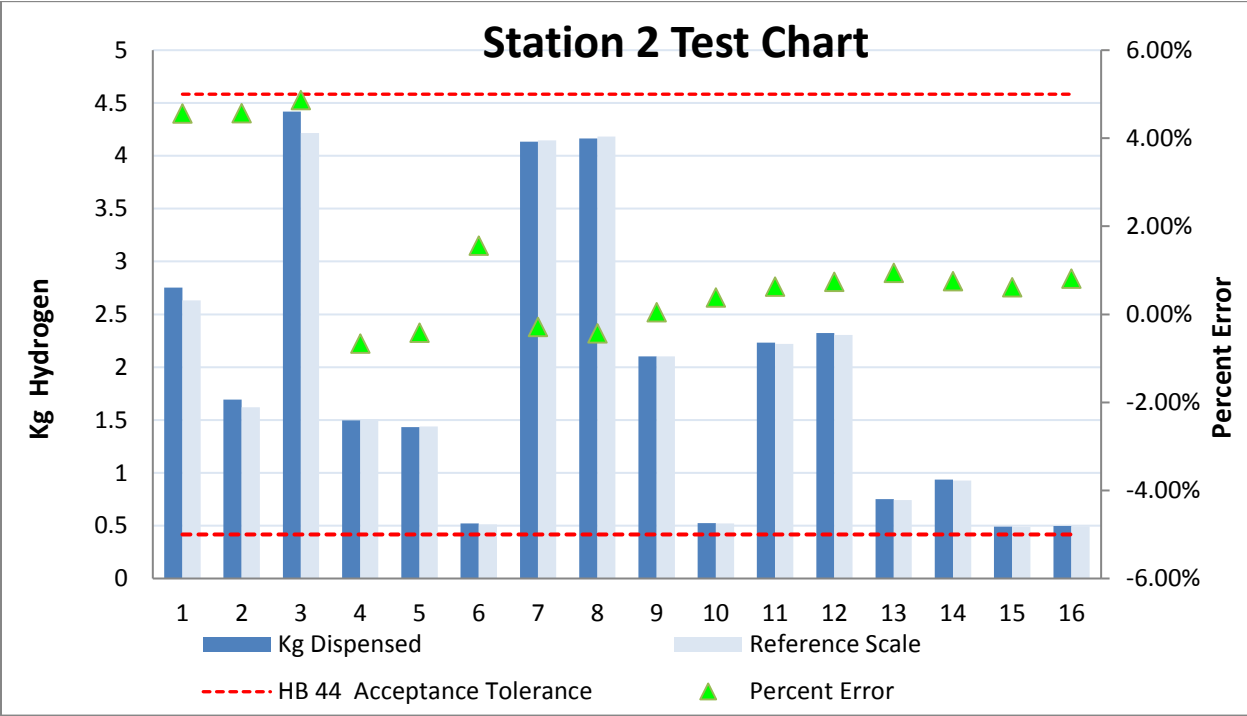


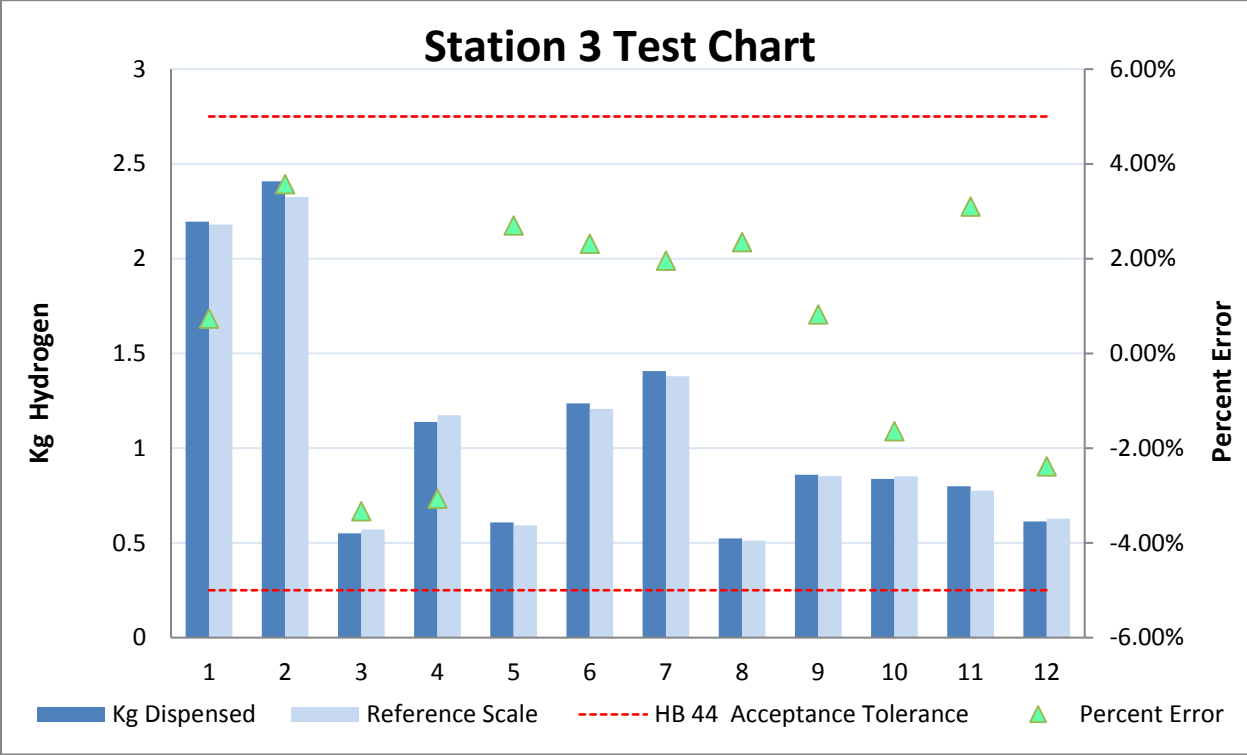
California Division of Measurement Standards  
 Hydrogen Gas-Measuring Device Test Data  
 Supporting Documentation to Form 15  
 NIST Handbook 44 Section 3.39 Hydrogen Gas-Measuring Devices  
 September 2018

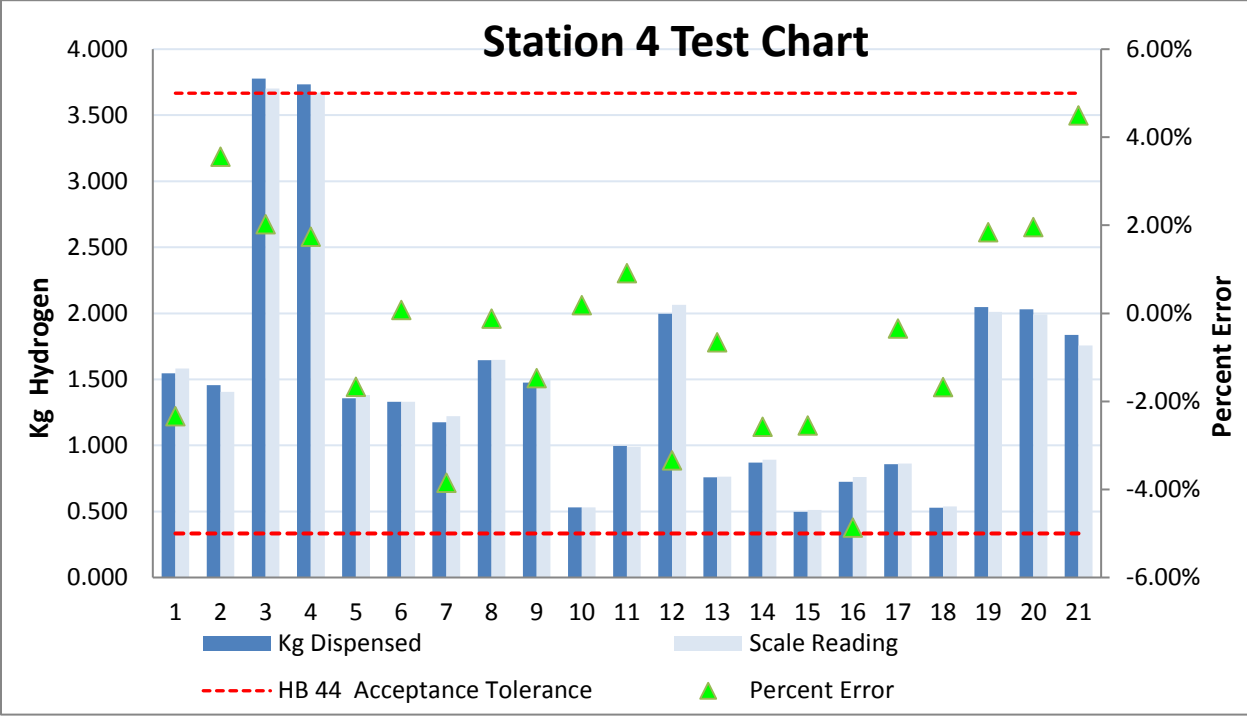
To date, the California Division of Measurement Standards has issued California Type Evaluation Program Certificates of Approval to five manufacturers of hydrogen dispensing systems. The following five charts illustrates test data from these type evaluations.

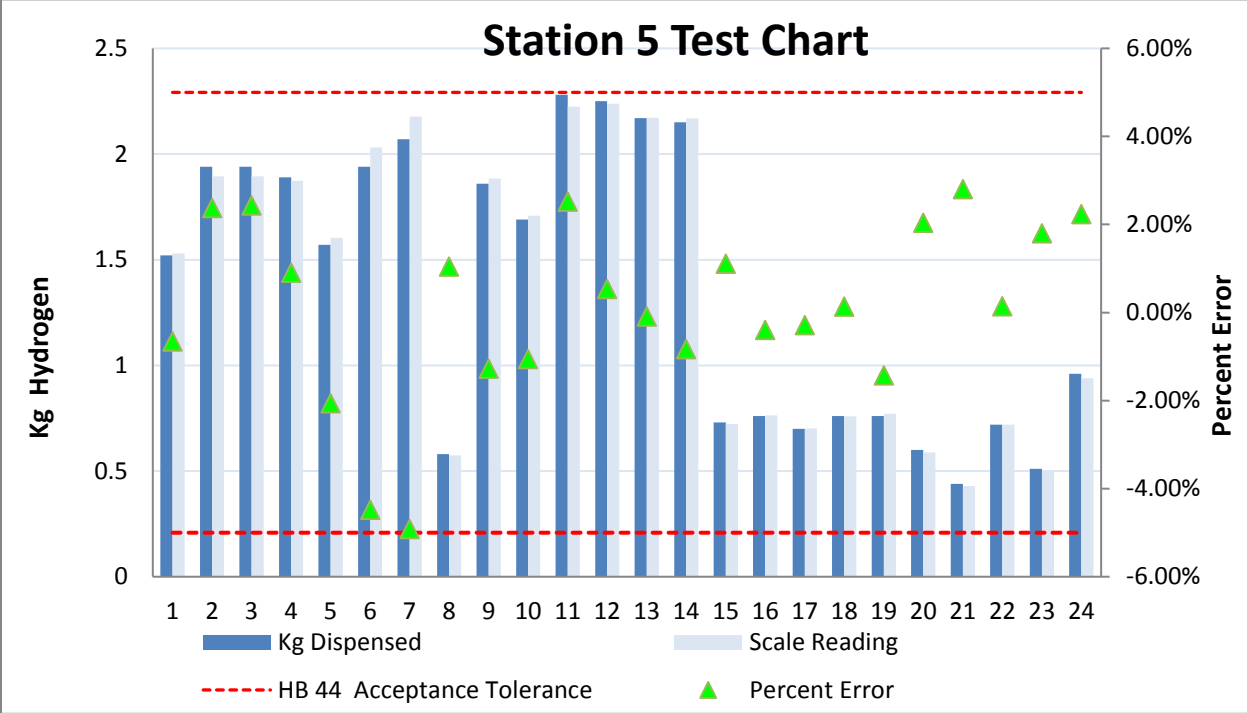
In the charts, the legend on the left side indicate draft size (kg). Dark blue bars represent the dispenser indication and light blue bars represent the scale indication. The legend on the right side indicates the percent error between dispenser and scale indications and is illustrated with green triangles. The dashed red lines represent NIST Handbook 44 Section 3.39 acceptance tolerance range of  $\pm 5\%$ . Note that all dispensers can meet the established tolerance.



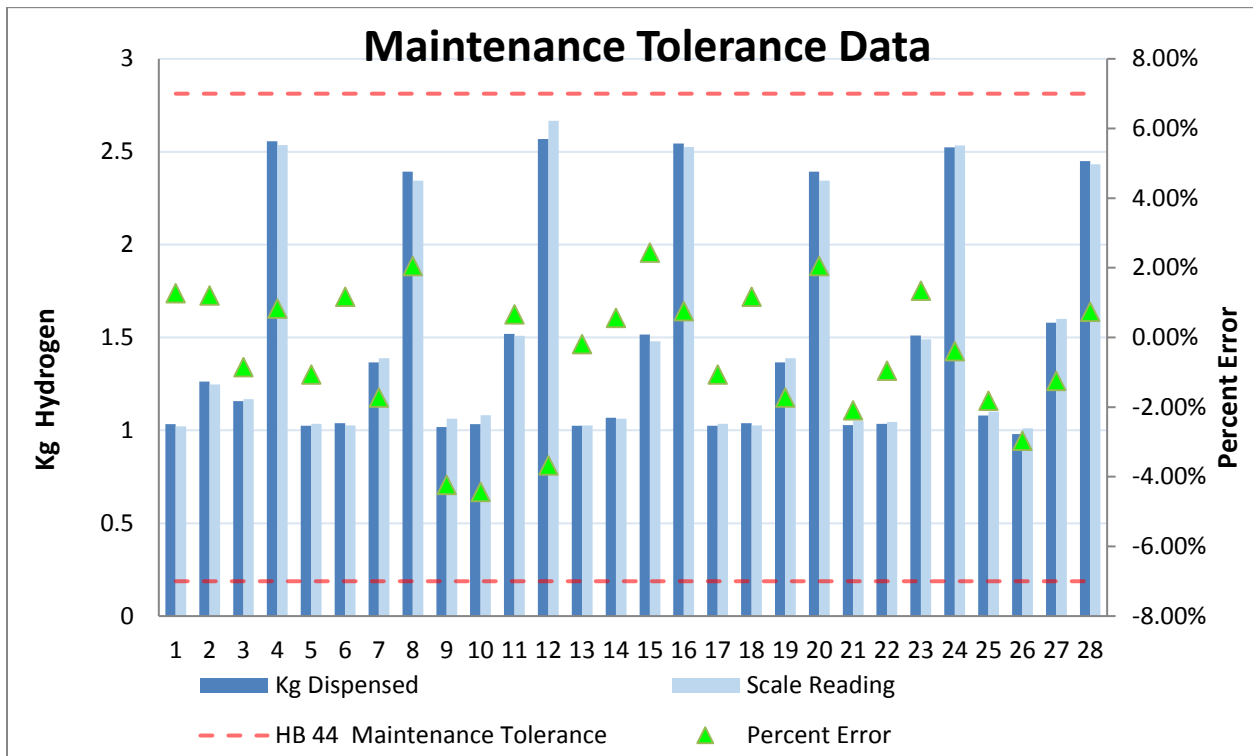






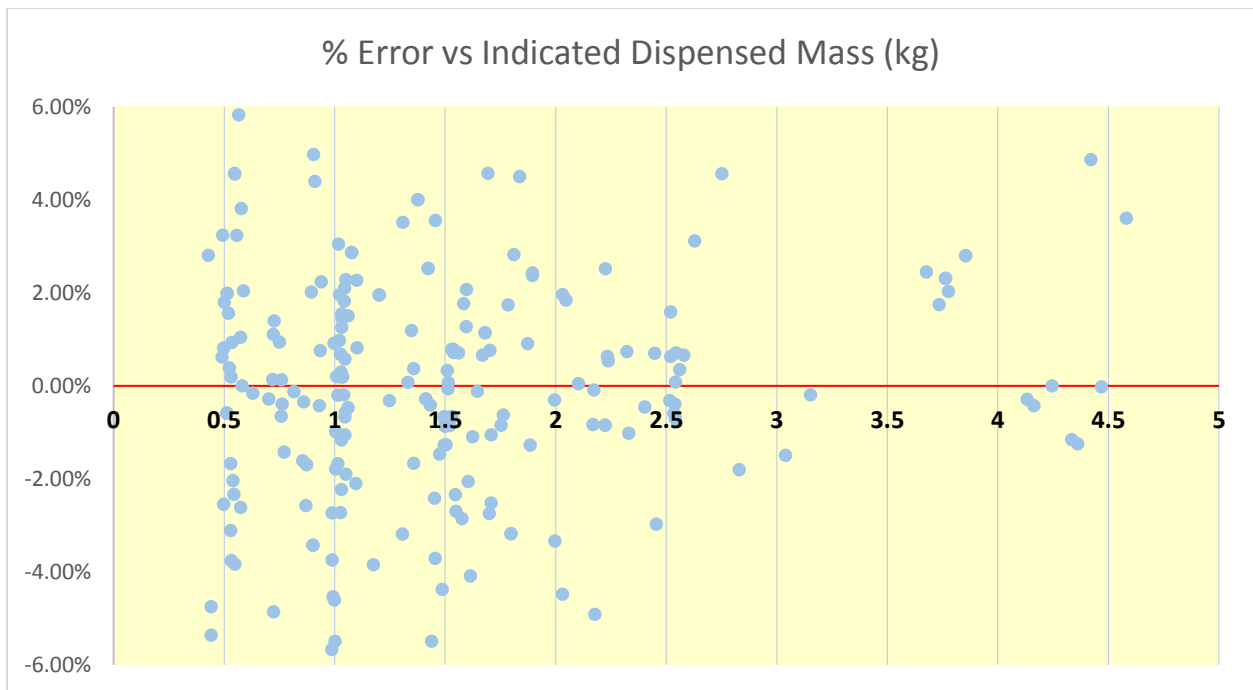


Hydrogen dispensers are still relatively new in California, so maintenance tolerance data is limited. The following chart contains test data from seven dispensers in operation for more than one year. The dashed red lines represent NIST Handbook 44 Section 3.39 maintenance tolerance range of  $\pm 7\%$ . Note that all dispensers can meet the established tolerance.



The following scatter chart represents over 200 drafts from 5 different California type approved hydrogen dispenser designs installed in 35 locations throughout the state. Data is from dispensers with service pressures of 350 and/or 700 bar (MPa 35 and/or 70).

Note: Data obtained by California during type evaluation and initial verification testing are non-communication fills, meaning the test equipment does not communicate with the dispenser. Today's fuel cell vehicles are all designed to communicate with dispensing equipment via the infra-red data interface on the fueling nozzle. California's test equipment does not have the capability of collecting communication fill data. Preliminary research data from NREL indicates that communication fills may be more accurate, particularly at draft sizes greater than 2.5 kg.



Data is concentrated with smaller draft sizes of 1.5 kg or less; however, this chart shows no correlation between % error and draft size. Over-registrations and under-registrations appear equally distributed and no bias can be discerned from the data.