Gas Standards in Support of NASA's Space Shuttle Monitoring Program

NASA Kennedy Space Center needs accurate gas mixtures containing argon, helium, hydrogen, and oxygen in a balance to calibrate mass spectrometer sensors in and around the launch area for the space shuttle. NASA orders these mixtures from a specialty gas company, which gravimetrically blends 15 identical mixtures of each NASA-specified blend. Currently, NASA has specified three five-component blends. In the past, NASA had problems with gas standards obtained from specialty gas companies. There were inconsistencies between gas mixtures, and the uncertainties were larger than those that NIST can provide. Therefore, NASA's intent is to use NIST certified cylinder gas standards for their monitoring program in the launch platform area.

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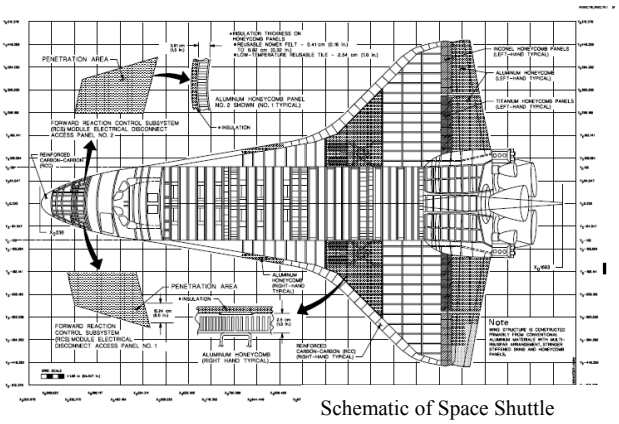
NIST developed 20 new primary standards for NASA in 1991 and used them to analyze twenty cylinders containing two similar four-component blends in a balance of nitrogen. NIST successfully assigned concentration values for each component in all 20 mixtures to an expanded uncertainty of 0.8 % to 2.0 % relative. NASA used these standards in a quality assurance program to verify vendor gas standards that they use to calibrate their sensor system.

In 2005, NIST has again agreed to help NASA by independently performing analyses on 45 cylinders – 15 cylinders each containing one of three different five-component blends. NIST will certify each component to an expanded uncertainty of 0.5 % to 1.0 % relative. New cylinders of research grade argon, helium, hydrogen, oxygen, and nitrogen were purchased as starting materials so that NIST could produce a new set of gravimetric primary standards. Fifteen new gravimetric primary standards with an estimated component weighing uncertainty of < 0.1% have been prepared, and a comparison of these standards with the 1991 set is underway. Research was performed to determine optimum operating conditions needed to separate the four species using two different analytical methods. NIST received Mixture 1 and Mixture 2 (30 cylinders) from NASA's specialty gas contractor in late September 2005.

A total of five gravimetrically prepared high-concentration binary gravimetric premixtures were blended and verified. These binary mixtures were then combined to produce five-component blends at concentrations 10% higher, on target, and 10% lower than nominal concentrations specified by NASA for Mixtures 1, 2, and 3. The smallest mass used in any of the new gas standards is 20 g measured with a weighing accuracy of ± 0.015 g or 0.08% relative to 20 g. Gas chromatographic (GC) analytical methods have been developed for the analysis of the wide range of concentrations in the NASA mixture groups

The NASA space shuttle cabin environment is critical to crews' safety as well as that of the shuttle. The monitoring of cabin air and the fuel joints will allow NASA to determine if there are any potentially catastrophic leaks or other problems with the space shuttle before and during missions. The tight NIST certified values will assure that sensor readings are accurate.



Schematic of Space Shuttle
Source: NASA

Future Plans: NIST is in the process of verifying the new suite of primary gravimetric mixtures developed at concentrations near the nominal values for NASA Mixtures 1, 2, and 3. The research-grade gases will be critically evaluated for impurities. NASA mixtures 1 and 2 will be analyzed against the newly developed standards using optimized GC separations. The more difficult low-concentration Mixture 3 will be evaluated when the cylinders are received from NASA. NIST looks forward to working with NASA on the future launch vehicle.