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

The National Aeronautics and Space Administration (NASA) Kennedy Space Center needs gas mixtures containing argon, helium, hydrogen, and oxygen to calibrate mass spectrometer sensors in and around the space shuttle launch area. NIST obtained gravimetrically prepared gas mixtures at three different concentration ranges from a specialty gas company, certified these gas mixtures, and returned them to NASA. They are now being used to calibrate the monitors during shuttle launches.

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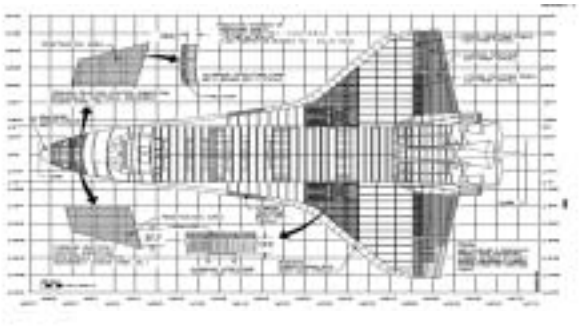
Hydrogen or oxygen leaks can cause a space shuttle mission to be scrubbed, or worse. Mass spectrometers are used to "sniff" connections within the shuttle and the launch platform to detect gas leaking out. They are also used to sniff nitrogen-filled areas for argon to see whether air is leaking in. This leak detection goes on prior to a launch, up until the shuttle leaves the launch pad.

In 1990 NIST developed 20 primary standards for NASA and used them to analyze 20 cylinders containing two similar four-component blends in a balance of nitrogen. NIST successfully assigned concentration values for each component in all 20 mixtures with an expanded uncertainty of 0.8 % to 2.0 % relative. NASA used these standards until 2005 in a quality assurance program to verify vendor-supplied gas standards that they use to calibrate their sensor system.

In 2005 the Kennedy Space Center in Florida needed three new five-component gas standards to calibrate the mass spectrometers that they use for leak detection. A specialty gas vendor gravimetrically blended 15 cylinders of each of three gas mixtures (Mixtures 1, 2, and 3) containing varying levels of argon, helium, hydrogen, and oxygen in nitrogen. Mixture 3 represents a new concentration level that was lower than the materials that NIST provided in 1990. Mixture 3 also had a NASA uncertainty requirement of ± 3 %. NASA asked NIST to analyze and certify the concentration of each component in all 45 cylinders and meet new measurement uncertainty targets at the 95 % confidence level.



Schematic of Space Shuttle
Source: NASA

Using high-capacity, high-sensitivity cylinder balances, NIST prepared 22 new gravimetric primary standards to uncertainties of ± ≤ 0.2 % relative. A total of five gravimetrically prepared high-concentration binary gravimetric mixtures were blended and verified. These binary mixtures were then combined to produce five-component blends that spanned the requested concentrations specified by NASA for Mixtures 1, 2, and 3. Each of the new primary standards was analytically verified using gas chromatography. Existing primary standards from NIST's 1990 NASA standards effort combined with the 22 new primary standards allowed concentrations to be assigned to the 45 mixtures.

In 2006 NIST successfully certified each component in the three different gas mixture sets. Mixtures 1 and 2, with concentrations in the percent and high µmol/mol concentration levels, were certified with expanded uncertainties (95 % confidence interval) of 0.5 % to 1.0 % relative. Mixture 3 represented a much lower concentration level, 25 µmol/mol, than had previously been supplied to NASA by NIST. Expanded uncertainties of 1.0 % to 2.2 % relative were assigned to the concentration values, uncertainties which surpassed NASA's specifications. These certified gas mixtures were placed into service by NASA for the July 4, 2006 space shuttle launch of Discovery STS-121. NASA now has a sufficient supply of NIST-certified gas standards for use through the remaining lifetime of the shuttle fleet.

Future Plans: New gas mixtures may be requested by the NASA Stennis Space Center. They have discussed the need for standards to monitor and study effects of certain gases on shuttle engines during the burn stages of the launch.