A Fully Redundant On-Line Mass Spectrometer System
For The Space Shuttle Used to Monitor Cryogenic Fuel Leaks

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The Space Shuttle uses liquid hydrogen and oxygen for the fuel and oxidizer for the main engines, respectively. Because of the hazards associated with these commodities it is important to ensure that the main engines do not leak. From the beginning of the Space Shuttle program mass spectrometers have been used to monitor for cryogenic fuel leaks. Mass spectrometers are the only technology that has been shown to monitor all of the gas constituents necessary at the limits-of-detection required; namely, hydrogen, helium, nitrogen, oxygen, and argon all in low parts-per-million. There are currently four on-line mass spectrometer based systems in use for each launch: Prime Hazardous Gas Detection System (HGDS), Backup HGDS, Portable Aft Mass Spectrometer (PAMS), and Hydrogen Umbilical Mass Spectrometer (HUMS). The Prime and Backup HGDS were developed during the first stages of the Space Shuttle program. The HUMS was developed in the early 1990's in response to the 1990 leaks on two Orbiters. The PAMS was developed in the middle 1990's to meet the need for a dedicated system to monitor parts-per-million (ppm) levels of helium in the Aft compartment of the Orbiter. An on-line gas monitoring system was developed to replace the Prime HGDS and Backup HGDS. The system uses a mass spectrometer to monitor multiple locations in the process, which allows the system to monitor all gas constituents of interest in a nearly simultaneous manner. The system is fully redundant and meets all requirements for Ground Support Equipment (GSE). This includes ruggedness to withstand launch on the Mobil Launch Platform (MLP), ease of operation, and minimal operator intervention. The system can be fully automated so that an operator is notified when an unusual situation or fault is detected. User inputs are through Personal Computer using mouse and keyboard commands. The interface is very intuitive and easy to operate. The system has supported four launches to date. This presentation will cover the design and operation of the system including limits-of-detection, response/recovery times, and stability.