Boeing Changes Delta III Control Software

The Delta III investigation team here completed the cause and corrective action investigation into the Aug. 26 failure of the Boeing Delta III launch vehicle.

"The roll instability which led to the Delta III failure can be corrected by a change to our control software," said Clarence Quan, Boeing [NYSE: BA] Delta III investigation chairman. The Delta III control system consists of an onboard computer system which controls the main engine, two vernier engines and three solid-rocket motors (SRMs) with thrust-vector control (TVC) assemblies.

When designing the roll aspects of the control system, 56 roll modes were identified. A 4 hertz (cycles per second) roll mode caused the roll instability seen in the Delta III launch. A mode is the characteristic pattern of movement or shape an object takes as it vibrates. "Past flight data with Delta II shows the most significant roll mode at liftoff remains the dominant mode throughout the first phase of flight," Quan said. "This data drove the design of the control system; because the 4 hertz roll mode was not significant at liftoff it was not designed into the control system."

The 4 hertz roll mode was caused by the three airlit solid-rocket motors rocking back and forth in unison. As the ground lit SRMs burned and lost weight, the rocking air-lit solids had a greater influence on the vehicle. The mode became significant 40 to 50 seconds into flight. Once the control system recognized the mode, it attempted to correct the roll oscillation. In doing so, the hydraulic fluid used to move the nozzles on the solid-rocket motors with TVCs was depleted.

Without the solid-rocket-motor TVC system, the Delta III was unable to maintain control. Approximately 72 seconds after liftoff, the vehicle flew through a wind shear, yawed 25 - 35 degrees, started to breakup and the rocket's automatic destruct system initiated. At this time the investigation team is focusing on the return-to-flight planning for the next Delta III launch, planned for the first quarter of 1999. Dan Collins is leading the Delta III return-to-flight and revalidation team. Clarence Quan and Walt Wilson will continue to lead the senior investigation board.

Other former and current senior members of the Delta team will join representatives from NASA, U.S. Air Force Space and Missile Center, Aerospace Corporation, Hughes Space and Communications, as well as a retired vice president from General Dynamics on the senior investigation board.

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