STS-1 40th Anniversary…. "The Glass Spaceship"

For scheduling in late March early April

Panel Discussion: *Five Space Shuttle Engineers will remember and discuss the story of the TPS (Thermal Protection System for the Columbia Shuttle Orbiter. The first Space Shuttle Mission and the whole program almost never happened. Design and production issues delayed the launch of STS-1 by almost 2 years. Special engineering teams from Rockwell were able to save the program and the Columbia Orbiter. This is that story told by those who were there.*

Moderated by: *G. A. Blackburn, Manager M&P Engineering*

Panelists:

Peter Hogenson – Manager, Materials & Processes Engineering

Edward Zadorozny – Design Engineering

Jack Holt – Design Engineering

Gordon Toombs – TPS Engineer

Special Guests (Dave Thomann) – Mike Ehret*

- *Video Clip Inserts*

FIGURE 1

TPS Tile installation on Columbia OV-102 in the Orbiter Processing Facility, at the Kennedy Space Center, Florida, circa 1980.

THE GLASS SPACESHIP

THE COLUMBIA SPACE SHUTTLE ORBITER WAS THE FIRST REUSABLE SPACESHIP TO FLY INTO SPACE.

On April 12, 1981, Columbia launched from the Kennedy Space Center on its first mission, STS-1. Thus began a new era of spaceflight with a machine that could provide continuous flight service into earth orbit. There is a backstory to this mission's success. The engineering challenges of building a safe and reliable spacecraft. Here is that story.

THE GLASS SPACESHIP

SPACE SHUTTLE FIRST FLIGHT

THE ENGINEERING CHALLENGE

In the late 1970's the Space Division of Rockwell International was under contract to the NASA Johnson Space Center, JSC to deliver a fleet of spacecraft, Shuttle Orbiters. By 1979 the first space rated flight vehicle designated OV-102, Columbia was scheduled to be on station at the Kennedy Space Center in Florida. Columbia was scheduled to launch in late 1979. It was delivered there on March 25, 1979. There was a problem though, the vehicle was not complete. It had been "shipped short". There were 7800 tiles missing from the 31,000 that should have been installed, in addition to this hardware shortage of the installed tiles there was a question of their strength and ability to stay in-place.

The TPS (Thermal Protection System) is a very complex system of materials and designs to protect the Orbiter spacecraft from the dangerous re-entry heating the spacecraft experiences on its return to earth. There are seven different types of insulation configurations and five of them are based on the use of silica. The HRSI (Black Tiles) are the most predominate insulation covering almost 80% of the surfaces of the spacecraft. The material, invented by Lockheed Corp.is essentially glass. That gives it great high temperature resistance but also makes it very fragile. The tiles were attached to the surface of the vehicle with a silicone adhesive creating a soft bond, and a potential failure point. The problems we faced in the summer of 1979 was to test all the tiles installed and finish the installations.

Under the pressures of schedule and resources we had to develop a solution to these problems and get Columbia on the launch pad.

THE TIGER TEAMS

Those summer days of 1979 could get very hot in the upstairs lab in building 1. I was working as an engineer on the Space Shuttle Program for Rockwell International in Downey, California. We were discussing some trivial matter when the door opened and in walked the Boss, Jorge Diaz and he did not look Happy.

"Downey we have a Problem! "

"DOWNEY WE HAVE A PROBLEM!"

The first Shuttle Orbiter was scheduled to be shipped to KSC from California in the summer of 1979. Problems with the Thermal Insulation would delay that schedule and eventually the launch for two years. The Shuttle Program was at risk and would require a monumental effort to save America's Space Program. This is the story of the Team who like Apollo 13 saved STS-1

He shared with us an incident that had occurred the previous day in Palmdale, the final assembly area for the Columbia Shuttle Orbiter. It was due to be shipped to the KSC within the next two weeks. Jorge described the recent walk through inspection by the JSC NASA engineering team. The Rockwell production teams were working 24/7 installing the TPS tiles and had completed over 20,000. Just a little more time and we could complete the job and send the vehicle on its way.

The way Jorge described it, from a ground stand one of the NASA managers curious about the tile installation progress reached up to touch one of them at random, it was loose! “Downey we have a problem!”. Something had gone wrong in our design considerations. Now every tile installed was suspect and installation procedures screeched to a halt.

Our assignment from Jorge was simple and direct, we had 72 hours to develop a non-destructive test for every tiled installed. We would then train the personnel necessary to conduct these tests.

When a spaceship enters Earth’s atmosphere, it is traveling very, very fast — at the minimum, it’s traveling about 28,000 kilometers per hour (about 17,400 miles per hour). It’s moving so fast that air molecules simply cannot get out of its way fast enough. As a result, air molecules get piled up in front of the re-entering spaceship and squeezed together. This condition is called adiabatic compression and can raise temperatures to over 3,000 degrees well above the melting point of the aluminum structure.

THE PROBLEMS

Materials were needed to protect the spacecraft metal surfaces from intense re-entry heating. Special refractory silica based materials were the most suitable but had to be engineered into forms that could easily be produced and installed on the vehicles with minimum return to flight maintenance. Most of these challenges were met but several problems became apparent during the preparation of the Columbia Orbiter. The silicone adhesive bond was weak and time consuming. Because of the porous nature of the insulation water intrusion was a problem. Evidence in flight test indicated damage would occur in local instance therefore, patches needed to be developed.

In the summer of 1979 these issues resulted in schedule and program impacts that delayed the launch schedule. A program decision was made to ship the vehicle to the Kennedy Space Center in spite of its incomplete condition. The remaining work would be completed there. The greatest problem we faced was the work would be done 3000 miles away in Florida without our California support teams and resources at hand. Over 400 engineers, technicians and specialists began an adventure for the next 670 days to get Columbia ready for mission STS-1.

THE RESULTS

Team efforts resolved each of the problems and insured the success of future missions and Space Shuttles. Over 7,000 insulation tiles were installed and those already installed were tested. Every tile was certified for flight. Local teams were hired and trained for handling and servicing the TPS.

The technical problems were resolved and the greatest challenges were the logistical issue of establishing, and managing the bi-costal teams.

On January 14, 1980 The Columbia OV-102 was ready for its final test series. One year later a Flight Readiness Firing was performed and on April 12, 1981 Bob Crippen and John Young launched from KSC on a million-mile test drive.

Space Exploration is a challenging venture. The expertise and skills of the Shuttle Orbiter engineering team saved the program from what could have been an end to the U.S. Space Transportation System.

EPILOG

Columbia – STS-107, February 1, 2003

The last mission for Columbia ended at 13:59:32 UTC over Texas when the spacecraft disintegrated on re-entry due to damage to the vehicles TPS. The vehicle and all seven crew members were lost.

During the launch of Columbia STS-107 on July 16, 2003, a portion of foam insulation broke loose from the external tank and impacted the left wing leading edge RCC damaging it. This would result 15 days later during the Columbia's re-entry in a thermal breech of the space craft and the destruction and loss of the spacecraft and crew.

2021

From 1962 to 2000, There was a Spaceship Factory in Downey California that served as America's Cradle for the Cosmic Age. This was our "Cosmic Camelot". People from all over this nation came together to explore beyond our world, not to make weapons of war but the tools of learning and discovery, Spacecraft, to take us to new worlds and new possibilities. A great team was formed that rallied around our nation's leader and his vision of what we could do with our resolve. We met that goal and went beyond with even greater dreams. Dreams that have been forgotten and replaced with visions of new priorities. The stories remain with those who know the tale and made that history not so long ago. But for one brief shining moment we were a global nation of one sharing in that magnificent accomplishment that came from the "Spaceship Factory".

Gerald Blackburn

Spaceship Factory Engineer

1962 – 2003