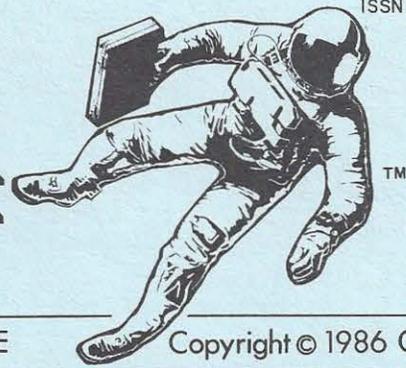


THE COMMERCIAL SPACE REPORT

ISSN 0735-9314



A MONTHLY NEWSLETTER ON FREE ENTERPRISE IN SPACE

Copyright © 1986 C.S.R.

Volume 10, No. 11

November, 1986

NASA Works To Get Shuttle Back Into Space

The National Aeronautics and Space Administration (NASA) is striving to recover from the explosion which ended Space Shuttle Mission 51-L and destroyed the Shuttle Orbiter Challenger and its crew of seven.

The space agency is walking a difficult and narrow tightrope between getting the Shuttle back into space as soon as possible (to begin reducing the rapidly-building backlog of Shuttle payloads) and falling into the same trap of rushed schedules and unrealistic expectations that were a major cause of the disaster that put NASA into this predicament in the first place.

New Shuttle Launch Schedule:

The Space Shuttle's proposed flight manifest is drastically reduced compared to the once-hoped-for 24 flights per year. The current manifest, describing NASA's flight plans through 1994, calls for five Shuttle flights in 1988, working up to 16 flights per year by 1994.

The first Shuttle flight since Mission 51-L is currently scheduled for February 18, 1988, with the launch of a Tracking and Data Relay Satellite (TDRS-C) identical to one that was being carried aboard the Challenger on its last flight. The other four flights planned for 1988 consist of two classified military missions in May and July, another TDRS in September, and the Hubble Space Telescope in November.

The proposed Shuttle manifest lists dates and payloads for 10 missions in 1989 and 11 missions in 1990. Although payloads are listed for missions from 1991 through 1994, specific launch dates have not yet been assigned for these (the fourth orbiter is currently scheduled to enter service in 1991).

A majority of all these missions are military and government payloads.

Only 20 commercial payloads are included, since the Shuttle is no longer in the commercial launch business (C.S.R., Aug. 1986, pp. 1-2). The first of these paying customers, a British Skynet-4 military payload, is not due to be launched until July of 1990. Most of the rest of the 20 will not see orbit until 1992 or later.

Only 19 major space science missions are left, out of the 50 or so that were originally planned. 11 scientific Spacelab flights have either been cancelled or left without funds (these are mostly missions involving a Spacelab pallet which is sharing payload bay space with one or more satellites--pressurized Spacelab module missions fared somewhat better).

Beginning in 1993, Space Station construction flights occupy most of the Shuttle's time, with five such flights scheduled for 1993 and seven in 1994.

As mentioned, NASA hopes to raise the flight rate to 16 per year by 1994. Many people feel that the new Shuttle schedule is still unrealistic. An 11-member panel of experts at the National Research Council (NRC) stated in an October 9th report that NASA would not be able to handle a launch rate of more than 8 to 10 missions per year with three orbiters, or 11 to 13 missions per year with the addition of a fourth orbiter. Some astronauts also feel that 16 flights per year may be too high for safe operations (NASA Administrator James Fletcher started making some noises about 20 flights per year but one assumes that he has been given his medication and has since settled down).

In addition to concern about NASA's flight rate, doubts are also being expressed about NASA's chances of being ready for their first Shuttle launch by February of 1988. A more realistic date for first launch would probably be sometime closer to the end of 1988 or early in 1989.

NASA, faced with these doubts, is proceeding as best as it can. Some of the major areas of concern which must be addressed before the Shuttle can resume normal operations include: management reform, redesign of the Shuttle's Solid Rocket Boosters (SRBs), additional testing and certification of the Space Shuttle Main Engines (SSMEs), and examination of the controversial issue of escape systems for Shuttle crew members. Following are short discussions of these subjects.

Shuttle Management:

NASA is attempting to reorganize the convoluted management structure of the Shuttle program. Management and communication problems have been held to be partially responsible for the Challenger disaster, and may also account for at least some of the current problems NASA is having getting the Shuttle back into space.

NASA's goal is to develop a management structure based on that of the successful Apollo program. A key feature of this is to centralize more responsibility for major program decisions at NASA Headquarters in Washington, D.C. (up to now, most Shuttle decisions have been made at the Johnson Space Center in Houston, as well as at other NASA centers). As part of this reorganization, NASA will attempt to clarify the chain of command and improve communications between NASA Headquarters and the various centers.

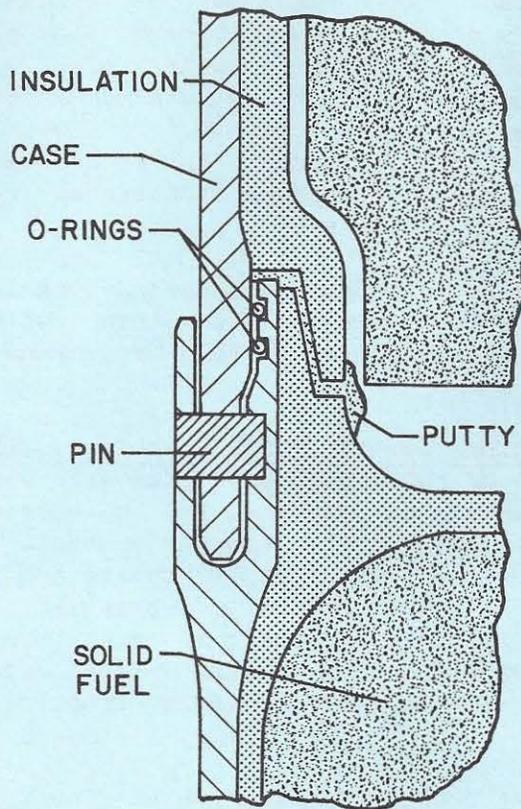
What makes this reorganization a touchy problem is dealing with the various NASA centers' strong sense of their own "turf." Marshall, Johnson, and others are naturally inclined to want to hold on to as much authority and power as possible, and NASA Headquarters will have to tread lightly and with much stroking of egos to get the job done (NASA is having to handle similar turf battles with the Space Station project--but that's another story).

Solid Rocket Booster Redesign:

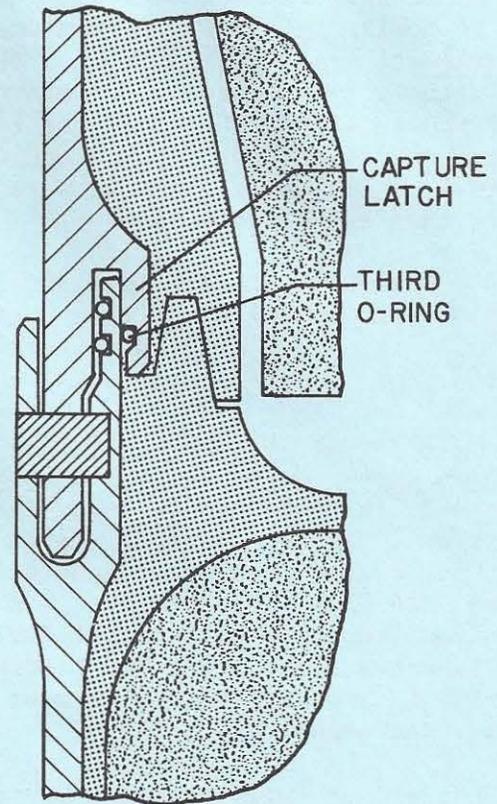
NASA is endeavoring to correct the design flaws in the Shuttle's Solid Rocket Boosters that were the cause of the destruction of the Shuttle Challenger.

NASA has proposed a new design for the SRB field joints, which would, to a large extent, be able to utilize existing hardware. The new joint is similar to the old joint, with the major change being the addition of a "capture latch," with a third O-ring (see illustration on page 3). This latch is designed to reduce the joint rotation that kept the O-rings from properly seating themselves during Mission 51-L.

Additional changes in the joint design have also been proposed. The old O-rings relied on the gas pressure at ignition to seat them, but the new rings will be seated as part of the assembly. The material used to make the current O-rings, an



OLD JOINT



NEW JOINT

elastomer called Viton, will probably be replaced by a material less likely to stiffen up in cold conditions (candidate materials include nitrile and silicon rubbers, among others). The unreliable putty used to seal the original joint will be replaced by a room-temperature-vulcanizing (RTV) adhesive material. Heaters, in the form of thin tapes one inch wide, may be mounted on the outside of the booster casing near each set of O-rings to further reduce potential problems with the cold.

Redesign of the SRBs is not limited to the joints. Other areas, which have been identified as potential problem-causers, are also due for design changes.

The SRB nozzle area has long been under scrutiny by NASA. Like the field joints, the joints around the nozzle area are due for a number of changes. These include the addition of reinforcing bolts and more O-rings, the replacement of sealing materials, and improved manufacturing methods.

The new SRB designs will be subjected to a test program which will be as rigorous as NASA can manage, while still keeping to the schedule for the next Shuttle launch.

NASA determined at the beginning of October that full-scale tests of the re-designed booster could be successfully performed horizontally. This decision will help alleviate NASA's scheduling crunch, since a new vertical test stand will not have to be built.

The President's Commission investigating the Challenger accident, along with a committee at the Marshall Space Flight Center, has recommended vertical testing. However, NASA claims that the horizontal test stand can best simulate the conditions on the field joint that caused the failure of 51-L.

Another panel at the National Research Council has been charged with overseeing the Shuttle's Solid Rocket Booster redesign process. This panel agreed with NASA that horizontal testing would work. At the panel's recommendation, though, NASA has agreed to construct a second, full-scale horizontal test stand (estimated cost: \$19 million). There are two major reasons for constructing this new test stand. First, at present, NASA has only one facility for testing the full-sized SRB, and a second stand would provide a necessary backup in case of problems. Second, the second test stand would be designed to more closely simulate launch and ascent stresses on the SRB than the existing stand.

The NRC panel, in light of the new designs for the field joints and nozzle, also recommended that NASA expand its planned SRB test program, something which would certainly stretch the schedule. NASA has not yet acted on this recommendation.

Although NASA appears to have workable solutions for the SRB's problems, the space agency does not wish to appear to be closing off its options. Contracts were issued in September to study new SRB design concepts, unrestricted by the current fixes. The contractors will be required to come up with the design concept, a proposed test program, and detailed cost and scheduling estimates. Contracts are to run 120 days, and are not to exceed \$500,000 each. The contracts were issued to United Technologies Chemical System Division, San Jose, CA; Atlantic Research Corp., Alexandria, VA; Hercules Aerospace Co., Salt Lake City, Utah; Morton Thiokol Inc., Brigham City, Utah (the current SRB contractor); and Aerojet Strategic Propulsion Co., Sacramento, CA.

Aerojet will probably propose its single-cast booster design, which involves casting the propellant into a pre-assembled booster casing rather than into individual segments which are later assembled at the launch site. This idea, which eliminates field joints altogether, has been proposed by Aerojet in the past (C.S.R., Feb. 1986, p. 3, May 1986, p. 5) and deals handily with the transport problems that arise when the booster has to be shipped in one piece. This idea is eminently sensible (there is some evidence that United Technologies may also propose a single-cast booster) and as such is likely to be completely ignored by NASA. Bets are that Thiokol will keep its SRB business.

Space Shuttle Main Engines:

NASA intends to proceed with a thorough test program to iron any potential problems out of the Space Shuttle Main Engines (SSMEs). The agency would like to carry out 8 tests per month, twice as many as were being carried out before the Challenger disaster. To this end the SSME will, like the SRB, be acquiring a new and better test stand.

Although the SSMEs were not responsible for the loss of Mission 51-L, there is a school of thought that views these powerful high-pressure hydrogen-oxygen rocket engines as an accident waiting to happen. Problems have occurred with pumps, welded joints, and a number of other components. While the Shuttle was flying, engines were constantly switched around to make sure the current mission's orbiter had three engines that worked (although not widely publicized, a major blow to the Shuttle program was the three good engines that the Challenger took into the sea with it). Concerns have been raised at NASA about the practice of operating SSMEs routinely at 104% of their rated power, a practice which is likely to continue.

So, intense testing of the SSME will continue before the Shuttle flies again (any problems on the test stand will, of course, create further delays). NASA is also examining major redesign of the engine's powerhead to improve reliability, but this will not take place before the Shuttle is back in operation. It is my opinion that the current SSME technology is still not as reliable or safe as it needs to be,

and I will venture a prediction that the next serious Shuttle problem will arise from these engines. One can only hope that the problem will not be a fatal one--which brings me to the next area of NASA's concern...

Shuttle Crew Escape Systems:

NASA is seeking out ways to improve the astronauts' chances of surviving Shuttle failures during flight. The major scenario currently being addressed is that of a controlled ditching of the Shuttle orbiter into the ocean (a standard emergency procedure). Astronauts have stated, and NASA has agreed, that ditching a Shuttle filled with payload and hypergolic propellants into the water at its normal landing speed of over 200 mph was not "a survivable situation." At present, NASA's escape solutions for this scenario involve requiring the Shuttle crew members to actually bail out of the stricken Shuttle orbiter and then parachute into the sea.

There are many limitations on the usefulness of a bail-out escape system. First, it is impossible to bail out of the orbiter during most of its flight regime. Such an escape is impossible while the Solid Rocket Boosters are firing. After the SRBs burn out and drop off, the crew must still wait for the orbiter to glide down (assuming it is controllable) to a safe speed and altitude before they can leave the ship. Bailing out at high speeds and high altitudes would be fatal to the astronauts, who do not normally wear pressure suits. These restrictions confine the safe bail-out period to a short period of time after SRB burnout when the Shuttle has glided--or fallen--to below 20 or 30,000 feet, and has not yet hit the ocean. With the Shuttle's 22-degree glide slope, and descent rate of over 200 feet per second, this gives the crew of up to seven a grand total of about two and one half minutes in which they can clamber out of the Shuttle and hit the silk.

NASA has proposed several types of new escape systems (standard ejection seats were found to be unworkable for all except the front two seats on the command deck). As yet, these systems are still in the conceptual stages and the space agency has not gone into any great detail on them.

The simplest method of escape has the crew simply jumping out. Astronauts wearing parachutes (and equipped with ocean survival gear) would line up at the orbiter hatch and bail out one by one. The main problem with this is that a crew member simply jumping out would almost certainly be struck by the orbiter's left wing or some other piece of structure.

A second proposal would equip the orbiter with "extractor rockets:" small solid rocket motors with lanyards attached. An astronaut, wearing a special harness, would position himself on a rack by the open hatchway and attach one of these lanyards to the harness. Compressed gas would push the rocket out, where it would ignite, "extracting" the astronaut--at 12 Gs--out from the Shuttle and well clear of any collision with the wing. It should be noted that both of these proposals require the crew to line up by the door--a difficult proposition if the orbiter is out of control, and somewhat tricky in terms of protocol (who goes first? The closest to the door? The women? The oldest? The biggest? The meanest? Think fast, here comes the ocean!)

A third proposal attempts to solve this problem by attaching the extractor rocket lanyard directly to the astronaut while still in his seat. The astronaut could then be sucked neatly out of his chair and through the nearest hatch (more escape hatches could be added if necessary). The image that this brings to mind reminds me of an old cartoon where a character suddenly finds himself attached to a rope which is wound throughout and under a number of interesting obstacles (e.g. through a knothole) and attached by its other end to a huge, lit skyrocket. The following scene is often highly amusing to the audience. It might not be quite so amusing in a real situation where lives were at stake.

All of this nonsense might have been avoided. NASA's official position is that these proposed escape systems are the best solution available, and that no escape system whatsoever would have been able to help the crew of the Challenger to survive under the circumstances which caused that vehicle's destruction. Neither of these statements is true.

The early designs for the Space Shuttle back in the early '70s incorporated abort systems capable of saving the orbiter and its crew under circumstances identical with those of Mission 51-L. In its proposal, described in some detail in the February, 1986 C.S.R., McDonnell Douglas outlined an abort system using a combination of a solid propellant abort rocket on the orbiter, blow-out ports on the SRBs that could neutralize their thrust in mid-burn, and a battery of sensors to detect problems such as O-ring burnthrough long before they became serious. McDonnell Douglas' concept would have allowed the entire orbiter to break free and fly away from danger during any portion of the early flight regime, even while the Shuttle was still sitting on the pad (the abort motors would have provided the orbiter with sufficient altitude to make a landing on the Kennedy Space Center runway). Other contractors bidding for the Shuttle also proposed similar abort rocket systems.

NASA turned down these concepts then, and is still ignoring them now. The obvious reasons: too expensive, too much extra weight, and most of all, it would take too long to equip the existing Shuttles with such a system.

Are NASA's current escape proposals of any value at all? And why is NASA concentrating on systems that are useful in such a narrow portion of the flight regime? The answer to the first question must be yes--any chance is better than no chance. As for the second question: It was revealed during the Challenger investigation (from autopsies and examination of manually-activated cabin emergency equipment) that at least some of the Challenger's crew apparently survived the explosion that tore the pressurized crew cabin nearly intact from the orbiter and sent it spinning down into the Atlantic. And of these survivors, at least some were apparently conscious and aware during the ten-mile fall to the sea where the cabin and its crew were instantly crushed by the impact with the water. An uncomfortable thought for anyone to contemplate, but a particular nightmare for the planners of the American space program.

It cannot be entirely coincidental that the escape methods NASA is currently developing, although inferior to systems that might have been, are precisely those methods that just might save the crew of a stricken orbiter--or an orbiter cabin--plummeting towards the ocean below.

Until next time,

Tom Brosz

The Commercial Space Report (C.S.R.) is published monthly, and endeavors to report and analyze developments in the field of private initiatives in space transportation and exploitation.

Subscription rates are: U.S., Mexico, Canada: 1 year--\$15.00, 2 years--\$28.00, 3 years--\$39.00. Foreign Air Mail: 1 year--\$20.00, 2 years--\$38.00, 3 years--\$54.00. Back issues are available at \$1.50 each from September, 1977. Xerographic copies may be substituted as stocks are depleted.

Address all correspondence to: *Commercial Space Report*, P.O. Box 60547, Sunnyvale, CA 94088. Editor: Tom A. Brosz. Tel: (415) 965-8666. Comments, ideas, or requests for information are welcomed, as are any items which may be of interest to our readers. Unless otherwise noted, contents are ©1986 by *The Commercial Space Report* and may not be reproduced in any form without written permission. The opinions contained in the *Report* are those of the writer or writers, and do not necessarily reflect those of any organization or company.