The Russian Soyuz spacecraft, slated to serve as an emergency vehicle for the International Space Station crew, is touted as reliable by both Russian and U.S. officials. But only recently have some hair-raising tales about the vehicle come to light.

Secrets of Soyuz

by James Oberg — Dickinson, TX

When NASA was drawing up its plans for a space station about 10 years ago, there was a problem with leaving a crew aboard the station after the visiting space shuttle had returned home. They had no way to reach Earth in case of an emergency.

Although NASA had no manned space capsule available (the last Apollo capsule had flown in space in 1975), the Russians did. It was the Soyuz. After the collapse of the Soviet Union in 1991, the United States began to explore the possibility of expanded cooperation with the Russian space program. Using a modified "Soyuz" on the American station — it was called the ACRV, or assured crew return vehicle — was one promising idea.

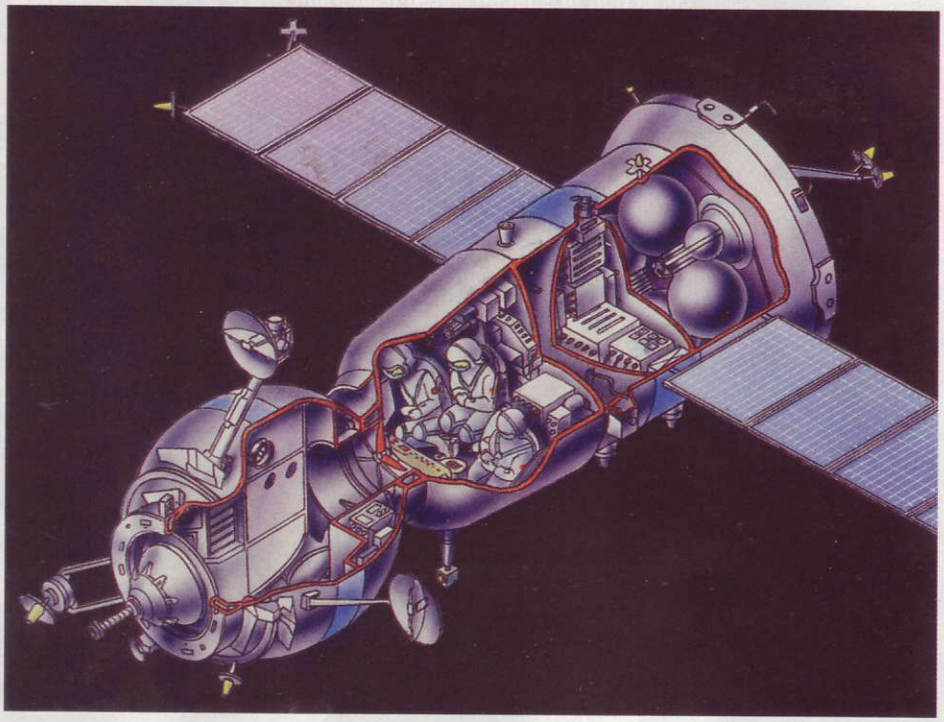
The basic Soyuz spacecraft design contains three connected modules. In the center is the "descent module," where the crew rides during launch and landing. Attached at its back end is the "equipment module," containing the rocket engines and power supplies for the space vehicle. Attached at the front end is the "orbital module" containing additional living space, radios and docking equipment for linking up with other space vehicles.

The Russians liked the idea of using Soyuz for the American space station, since the Americans would be paying cash. But to qualify, the Russians had to turn over to NASA a lot of details about the safety and reliability of the Soyuz. This went against generations of Soviet-era habits and Russian cultural standards.

Early in its history, the Soyuz had suffered two fatal accidents, in 1967 and 1971. But since that time, despite many known malfunctions, on every flight the crew had always returned safely to Earth. Russian officials told NASA this proved the safety and reliability of the Soyuz, so please send the money.

Eventually, as Russia became a full-fledged partner in the redesigned International Space Station, it agreed to provide a Soyuz to remain docked to the station as an emergency escape vehicle for the crew. The first Soyuz flights to the station are now expected in mid-1999.

Officials in both countries assert that the Soyuz is safe, despite small malfunctions from time to time, based on official Russian reports. However, it wasn't until 1996 that the worst "almost fatal" Soyuz landing incident became known, and then only through a Russian newspaper article, not through the official space agency cooperative programs.



Soyuz spacecraft showing three sections: *in the middle is the "command module" where Volynov sat. The forward module was jettisoned after retroburn, but the aft "service module" failed to separate, forcing the spacecraft to enter nose forward and threatening total destruction from entry heating.*

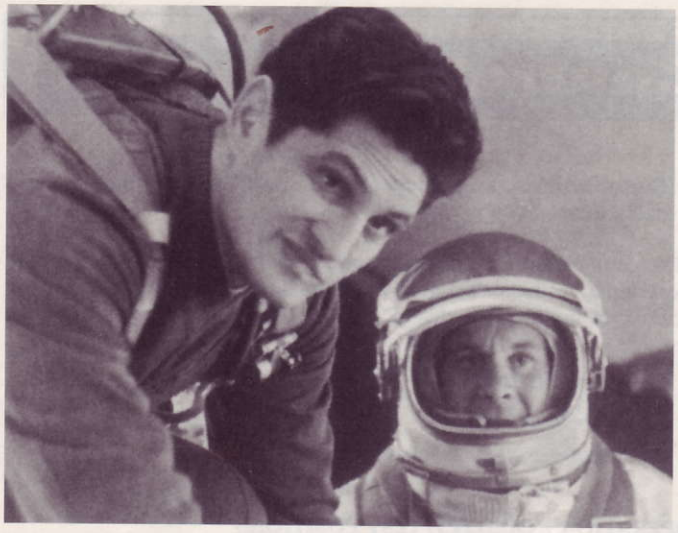
It had happened in January 1969, at the end of the flight of Soyuz-5. Cosmonaut Boris Volynov was returning to Earth alone, after his ship had docked in space with Soyuz-4 and transferred two of his crew to the other vehicle. The "moon race" was in full swing, and the Soyuz double flight had tested spacewalking techniques to be used by Russian cosmonauts during their planned landing on the moon — hopefully, ahead of the Americans.

The 34-year-old rookie space pilot had completed the course change back to Earth, and the Soyuz spaceship then was supposed to jettison its extra modules so the cone-shaped descent module could enter the atmosphere safely. Flying over the South Atlantic, headed northeast, Volynov expected to be on the ground within half an hour.

But then something went very wrong. The spaceship's equipment module failed to fully separate. The explosive separation bolts had fired, but it was still loosely attached, as Volynov could tell from the feel of the ship as he tried to turn it by manual control.

He radioed his situation to a tracking ship below him, who passed the terrifying news to mission control in Russia. It only took a few moments for them to realize nothing more could be done. The ship's heat shield was at the base of the descent module, now blocked by the balky equipment module. Unshielded portions of the vehicle would now be exposed to the 5,000° C heat of atmospheric entry, which would destroy the entire capsule and its pilot.

For Volynov, doing nothing was the hardest task in his life, so he continued making reports into his voice recorder and writing notes in his flight log. His spaceship was falling back into the atmosphere, and he began to hear grinding noises as the deceleration stresses built up. The ship was slowly tumbling end over end, exposing all of its surface to the growing fireball of flames. Finally, it stabilized nose forward — exactly the wrong orientation since that part of his capsule was the thinnest. Radio contact was lost with the ground. He heard and felt the explosions of the equipment module's fuel tanks, and from his seat he



Volynov *trains with spacesuited crewmember Khrunov.*

Cosmonaut Boris Volynov, *in flight clothing, aboard Soyuz 5 in January 1969.*

watched the overhead exit hatch bulge inwards under the unplanned forces.

As his cabin walls began searing, Volynov watched smoke from singed insulation fill his descent module. He could feel the heat against his unprotected skin (he had no spacesuit to wear). Concluding he only had seconds to live, he grabbed his logbook, tore out the most recent pages and stuffed them deeply inside his jacket. Perhaps, he thought, they might not be fully destroyed.

Then with a crash, his module spun even more violently. It then settled itself into the proper orientation, its shielded bottom pointed against the super-heated plasma shockwave in front. Whatever mechanical failure had prevented the separation had itself been overcome by the severe stresses.

His next worries concerned the landing and recovery. Had the flimsy parachutes in their outer containers been damaged by the flames? Where was he going to land, and would his recovery beacon work to guide the searchers to him?

Two thousand km short of his aim point (and the waiting rescuers), Volynov rode the Soyuz down onto the snowy steppes near Orenburg, Russia. The parachute worked partially, although the impact force tore him from his seat and threw him across the cabin, knocking out several of his upper front teeth. But in the silence after landing, he could hear the hissing of his overheated capsule lying in snow, and he knew he had survived. Then he felt the bitter cold seeping into the ship.

Ground searchers did not know he was alive, although radar did give some indication he was far off course. Many hours later, helicopters spotted the capsule's parachute and landed nearby. The men were unsure if they were on a rescue mission or simply a recovery of a dead body. Then they found the capsule's hatch open, with nobody inside, and no trace of the cosmonaut.

Volynov had quickly decided he would die in the mid-winter cold if he waited for rescue, so he had set out on foot toward a distant line of smoke in the sky. He found a peasant hut only a few kilometers away, and they took him in and kept him warm until searchers followed his footprints in the snow.

Naturally, no news of this was ever printed in the Soviet press. This kind of information was kept secret. But even years later, the post-Soviet Russian space program kept the information to itself until 1997, when an official new history book briefly mentioned the incident. But the incident was long ago and the cause had long since been repaired.

More serious to current NASA plans was the continuing Russian reluctance to provide information about more recent Soyuz problems, especially in official reports to NASA related to using the Soyuz for the International Space Station. One such incident in 1988 was the subject of a special independent study the author was asked to perform privately for a NASA contractor in their safety office.

A formal portrait of Volynov *in the mid-1980s, after his second space flight in 1976.*

In September 1988, the Soyuz TM-5 was headed back to Earth. It was commanded by a veteran cosmonaut, Vladimir Lyakhov, but the co-pilot was an Afghan pilot. He had been given six months of hurried space training and then sent up as a publicity stunt to encourage the pro-Soviet puppet regime in Kabul. The entire space mission, which had docked for a few days to the Mir space station, had been thrown together quickly, without thorough planning or training. The Russians knew the Afghan was along only for propaganda and they expected him to do nothing and say nothing that might disturb the real cosmonaut.

Just after starting the rocket burn to head back to Earth, the spaceship's computer detected a malfunction in a navigation instrument. It shut off the engine, halted the automatic sequence and sounded an alarm.

Lyakhov quickly determined that the spaceship's orientation was proper, and that it was simply a problem with the navigation device. He ordered the computer to resume the program for descent. The rocket engine fired. But then, only a few moments later, the computer again detected an error and again shut off the rocket engine.

At this point, Lyakhov responded with what he had been trained to do: sit still and wait for mission control to assess the situation. They would provide new instructions in an hour or two, and the landing could resume.

But the Afghan pilot, Abdul-Ahad Mohmand, had a different idea. He knew from his own flying experience that the first thing a pilot in a troubled vehicle must do is assess the status of his vehicle. While Lyakhov relaxed and waited for radio contact with Moscow, Mohmand ran his eyes over the control panel and its gauges and timers. And then he nearly shouted with alarm.

Although the computer had shut off the rocket burn the second time, it was still following Lyakhov's command to ignore its first automatic shutoff. Thus it was continuing with the normal descent sequence of other commands. It had already concluded that the ship was descending towards Earth, and after it had received the expected cue of "rocket shutdown" it knew that the next step was to fire the explosive bolts to separate the Soyuz descent module from its equipment module. But the ship was still in orbit, and the rocket engine in the equipment module was the only way to get home. Mohmand saw that the clock showed less than a minute to the firing of the explosive separation bolts!

Shocked into action, Lyakhov was able to shut down the sequence with another command. If he had waited for advice from Moscow (and if the Afghan had obeyed his instructions to sit quietly and trust the Russian commander), the Soyuz modules would have separated while they were still in orbit. They had battery power and air for only a few hours, and then both men would have died.

Yet the official Russian safety report to NASA mentioned only the delay in landing (the crew was able to complete the descent the following day). No mention was made of the confused computer that had brought the men to within seconds of death. The story was only vaguely hinted at in public, but was common knowledge among cosmonauts, who told their European colleagues the whole story. Mohmand, too, described it in detail to interviewers in Germany, where he now lives in exile following the collapse of the Soviet-backed regime he served. But the Russians never told NASA.

Launchspace

James Oberg is a widely-published author on space operations, and a leading specialist on Russian aerospace topics, with 22 years of experience as a space engineer in Houston. While there, he specialized in shuttle operations for orbital rendezvous. He has worked at the Johnson Space Center since 1975.