

By Tereza Pultarova

# Soyuz TMA-11 Ballistic Reentry

**W**hen Soyuz TMA-11 undocked from the International Space Station at 5 AM (GMT) on April 19 2008, not one of the three people aboard had the slightest idea that just a few hours later their lives would be in imminent danger. Yuri Malenchenko and Peggy Whitson were members of ISS Expedition 16 and they were about to leave the station after 192 days. Together with them in the capsule was the first South Korean spaceflight participant, scientist So-Yeon Yi. She had arrived at the station 11 days before with members of Expedition 17.

When the capsule reached the upper layers of the Earth's atmosphere after a smooth departure at 7:40 AM (GMT), the braking engine started firing, but then something went wrong. The crew later reported experiencing extreme shaking and buffeting. Less than a minute later the capsule switched to ballistic reentry. "We were spinning up to 8 Gs and coming in on a steeper descent," Peggy Whitson recalled later, "I saw 8.2 Gs on the meter."

Under the normal circumstances, the flight control system takes advantage of the aerodynamic properties of the landing capsule. The spacecraft generates a small amount of lift which keeps it at a higher altitude while slowly approaching Earth. In contrast to that, ballistic reentry is uncontrollable, steeper, and much shorter.

## Rescued by Kazakh Peasants

**L**ess than an hour later the crew landed, 420 kilometers away from the nominal landing site, in the town of Arkalyk in Kazakhstan. As the communication links were cut during the reentry, the ground support crew only learned about the actual touch down site thanks to an aircraft that was assigned to cover the possibility of a ballistic reentry. However, the support crew arrived late only to see the crew climbing out of the damaged capsule still in their landing suits and the local residents gathering around.



The ritual blessing of a Soyuz (TMA-04M pictured) has been a tradition since the early '90s.  
Credits: Bill Ingalls/NASA

**“The apparatus was so hot that the ground started burning,”**

Assisting the exhausted crew were members of the local agricultural community who were disturbed by the landing when planting seeds. Their leader, Zhalgaskan Shurenov, later gave his account of the event to a Kazakh newspaper: "On the ground there was a black apparatus, which looked like a pot. The moment we approached there was a boom. We jumped back. Immediately, a cover, which looked like a fry pan flew off and an antenna jumped out. The apparatus was so hot that the ground started burning. We were waiting what would happen next. Then a man fell out of the pot. 'We are cosmonauts,' he told us, neither his hands nor feet were mov-

ing. He was pale and sweaty. We put him on the ground, gave a pillow under his head, while he asked to get others out," Shurenov said.

## Too Many Women Aboard

**S**oon after, experts worldwide started speculating about the causes of the incident. The Chief of the Russian Federal Space Agency at that time, Anatoly Perminov, speaking at a press conference after the landing gave a rather surprising explanation: "You know in Russia, there are certain bad omens about this sort of things. Of course in the future, we will work somehow to ensure that the number of women will not surpass the number of men. When a majority of the crew is female, sometimes certain kinds of unsanctioned behavior or something else occurs," he said.

However, this was not the first time that Soyuz suffered similar problems. Just seven months before an unmanned Soyuz landed in a comparable un- ▶▶



A Russian ground crew member examines the over turned soil near the Soyuz TMA-11 spacecraft after it landed. - Credits: NASA/Reuters/Pool

controlled ballistic way. Also the return to the Earth of the Soyuz 5 with 3 male cosmonauts aboard in 1969 underwent the steep descent. Are women really to blame?

Soon, the improper separation of the propulsion and service module was identified as the most probable culprit. Yuri Malenchenko reported signs of smoke during the reentry inside the capsule, and an examination revealed more extensive heat damage. According to the investigation the service module was still loosely connected to the spacecraft during entry in the upper atmosphere. As a consequence the correct orientation of the capsule was impossible. Instead of flying with the heat shield first, the capsule with the module still attached was hurtling with the entry hatch forward exposing it to extreme heat loads.

## Crew Was in Danger, Insider Said

Insiders familiar with the investigations told the Russian press agency Interfax that the heat damage could have led to the loss of pressure inside the capsule. Also damaged was an external portion of the valve which balances the pressure between interior and exterior and so was the communication antenna.

Had the front section melted just a little bit more, the nearby parachute containers could have been damaged. In

that case, the crew would not have had a chance to survive.

During the investigation, the assembly of the next Soyuz vehicle was stopped. There were concerns about the safety of Soyuz TMA-12 that was docking with ISS at the time. The possibility of an unmanned landing of the capsule was seriously considered which would have left the crew waiting to be brought back to Earth on a subsequent Space Shuttle mission.

## Degraded Wire in a Pyrotechnic Bolt

The most likely cause for the late separation of the service module was a failure of a special pyrotechnic device that breaks the connection between the capsule and the module before the reentry. The scientists and engineers performing the investigation concluded that the wire leading electric current to the pyrotechnical bolt may have been degraded because of the exposure to cosmic plasma around the space station.

Almost three months after the ballistic descent of Soyuz TMA-11 it was decided, for the sake of the crew's safety, to remove the critical bolt in Soyuz TMA 12. On July 10 2008 the ISS crew commander Sergei Volkov and Flight Engineer Oleg Kononenko conducted a 6 hour 18 minute spacewalk, where they inspected the Soyuz TMA-12 capsule

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and removed the pyro bolt by disconnecting one of the locks holding the capsule and the service module together. Three months later, on October 24 2008, Soyuz TMA-12 performed a nominal landing safely.

Several improvements were designed for the following Soyuz TMA-13 and 14. Additional wiring for the separation system was added as well as cabling providing a backup source of electrical current for the pyrotechnic devices.

Safety of Soyuz spacecraft is of strategic importance as, with the retirement of the Space Shuttle in 2011, the Russian vehicle provides the only way to transport human crew to and from the International Space Station.

And despite the proven reliability demonstrated after long years of service, even a system so thoroughly tested as the venerable Soyuz can present a conditional probability of a failure that requires a design revision, a failure that can happen despite the number of women in the crew.



NASA astronaut Peggy Whitson, Expedition 16 commander, receives assistance at a helicopter after landing in the Soyuz TMA-11 spacecraft.

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