

### Soyuz Landing Anomalies Study Report Description

More serious for [mid-1990's] NASA plans [for a Russian role in the International Space Station] was the Russians' continuing reluctance to provide information about more recent problems with the Soyuz, especially in the official reports concerning its role in the International Space Station. One such incident that occurred in 1988 [Soyuz TM-5] was the subject of an independent study that I was asked to carry out in 1997. This was a special consulting contract for NASA's safety office, and I was being paid by a contractor, not by NASA. This time it wasn't a question of ancient space history. It was a more recent problem with the adequacy of the Russians' candor about potential problems with the Soyuz.

My private "Soyuz Landing Historical Reliability Study" was delivered to NASA on March 19, 1997. My overall task had been to assess the flight history of Soyuz-type space vehicles, as far as it was known from public news releases and private sources, in order "to ascertain the demonstrated reliability of key functions associated with return to Earth from a space station." In particular, I was supposed to watch for flight events that could be relevant to the success of a medical evacuation mission, which was the most likely scenario for the use of a space station "crew rescue vehicle."

I put together a data base that recorded 222 flight sequences from 186 separate Soyuz-type spacecraft, some with cosmonauts and some on autopilot, and all of the known failures during these sequences. As often happens in a highly challenging space engineering program, I found that the failures were heavily front-end loaded in terms of chronology (they mostly happened early in the program). In the 173 undockings, 2 failures occurred, the last in 1976. In the 97 module separations (separation of the Descent Module from other modules of the same spacecraft), 1 failure occurred, in 1969. In the 110 spacecraft landings (including reentry and parachute deployment), 8 failures occurred, all but one of them in the first five years of flight operations (the eighth and last occurred in 1980). In contrast, the rate of deorbit burn failures (8 out of 182 attempts, or 4 percent) was fairly constant across the three decades. This was probably due in large part to operator error as well as the rate of hardware breakdown.

It was a challenge to determine the completeness of the data base, because so many of the incidents that did get reported did so only by accident. For example, Soyuz spacecraft often wind up on their sides after landing, which is a serious concern if it is necessary to evacuate an injured or unconscious crew member. Documentation of how often this happens is inadequate. Accidents are rarely reported in the Russian media, and most information about such events comes either from inspection of video and photo records made at the landing site or from the personal testimony of crew members. I warned NASA that it should presume that a large number of similar incidents that were not photographed and not described orally have also occurred.

I found that the official Russian reports on Soyuz flight events were inadequate as a means of assessing the effectiveness of medevac (the medical evacuation of sick or injured crew members) missions. As an example, I compared the RSC-Energia report NASW-4727 to NASA on the anomalies in the Soyuz TM-2 through Soyuz TM-15 missions with the anomalies registered in my

study. The Russians reported only trivial procedural deviations, while the flight crews involved in the missions confronted serious operational difficulties, sometimes life-threatening, which would have called the success of a medevac mission into doubt.

The incidence of "hard landings" appeared to actually increase with time, over the history of the program. However, I suggested that this was probably an artifact of the data collection process. Although official accounts continued to omit any such information, nongovernment news media representatives have covered the more recent landings more thoroughly.

As for the hard landing in 1980 (caused by the failure of the soft landing engines) Russian files released in the mid-1990s show that they considered it to be one of the four worst problems they had ever had with that generation of Soyuz vehicle (used between 1972 and 1980). Then, after my study was completed, another Soyuz made a similar "crash landing." NASA, as far as I could tell, wasn't alarmed.

My NASA contract monitor presented my results to the ISS Independent Assessment group in April 1997. He told me that the reaction had been very positive, that the report should be presented to ISS program management and probably also to headquarters.

But after several weeks of waiting without any response, he called his contact on the group, Hugh Baker. Baker told him that "it was not necessary to present the results to anyone else." The reasons were that the Soyuz would someday be replaced by the X-38, that other people were studying the problem, and that "our analysis confirmed what [his office] knew about the Soyuz, anyway." Six months later, after I had mentioned the study in my congressional testimony, my monitor received an urgent call from the Phase 1 office, asking for a copy. But neither they nor anyone else ever called back to comment on it.

The Soyuz spacecraft will continue to be crucial to ISS for years to come, until NASA or another international partner develops an alternative means for the station crew to return to Earth when space shuttles aren't present. Soyuz has overcome a variety of problems, and it continues to evolve, with a new generation of vehicles showing up every decade or so. The model used on Mir and the early ISS missions, Soyuz-TM, is to be replaced in 2002 by the Soyuz-TMA design, which has larger seats (for taller passengers) and simpler controls.

With American lives at stake, NASA has every reason to want to know everything about the spacecraft's past, present, and future. Recent experience has shown that they won't succeed without vigorous, even confrontational, interfacing with Russian space officials, who so far have held most of the cards.

Author Queries

1. Change OK?

2. Who does “they” refer to here—Lockheed, Martin Marietta, or the Russians? Or does it refer to NASA? Please clarify.

3. Was Soyuz-4 a type of Soyuz or one particular spaceship? One particular. Volynov was in soyuz-5

4. These two temperatures aren't quite equivalent ( $-40^{\circ}\text{C} = -40^{\circ}\text{F}$ )—please choose the one you want and correct the other.

5. OK to delete cross-reference? This is Chapter 11. Different chapter was intended.

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