

# Estimating the Loss of Crew and Loss of Mission for Crew Spacecraft

Michael G. Lutomski

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**Abstract:** Once the US Space Shuttle retires in 2011, the Russian Soyuz Launcher and Soyuz Spacecraft will comprise the only means for crew transportation to and from the International Space Station (ISS). The U.S. Government and NASA have contracted for crew transportation services to the ISS with Russia. The resulting implications for the US space program including issues such as astronaut safety must be carefully considered. Are the astronauts and cosmonauts safer on the Soyuz than the Space Shuttle system? Is the Soyuz launch system more robust than the Space Shuttle?

The Soyuz launcher has been in operation for over 40 years. There have been only two loss of life incidents and two loss of mission incidents. Given that the most recent incident took place in 1983, how do we determine *current* reliability of the system? Do failures of unmanned Soyuz rockets impact the reliability of the currently operational man-rated launcher? Does the Soyuz exhibit characteristics that demonstrate reliability growth and how would that be reflected in future estimates of success?

NASA's next manned rocket and spacecraft development project will have to meet the Agency Threshold requirements set forth by NASA. The reliability targets are currently several times higher than the Shuttle and possibly even the Soyuz. Can these targets be compared to the reliability of the Soyuz to determine whether they are realistic and achievable?

To help answer these questions this paper will explore how to estimate the reliability of the Soyuz Launcher/Spacecraft system, compare it to the Space Shuttle, and its potential impacts for the future of manned spaceflight. Specifically it will look at estimating the Loss of Crew (LOC) and Loss of Mission (LOM) probability using historical data, reliability growth, and Probabilistic Risk Assessment techniques used to generate these numbers.

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