**Crew Health and Safety**

Main article: Effect of spaceflight on the human body

**Radiation**

The ISS is partially protected from the space environment by the Earth's magnetic field. From an average distance of about 70,000 km, depending on Solar activity, the magnetosphere begins to deflect solar wind around the Earth and ISS. However, solar flares are still a hazard to the crew, who may receive only a few minutes warning. The crew of Expedition 10 took shelter as a precaution in 2005 in a more heavily shielded part of the ROS designed for this purpose during the initial 'proton storm' of an X-3 class solar flare,[241][242] but without the limited protection of the Earth's magnetosphere, interplanetary manned missions are especially vulnerable.



Aurora Australis taken by the crew of Expedition 28 on an ascending pass from south of Madagascar to just north of Australia over the Indian Ocean.

Subatomic charged particles, primarily protons from cosmic rays and solar wind, are normally absorbed by the earth's atmosphere, when they interact in sufficient quantity their effect becomes visible to the naked eye in a phenomenon called an Aurora. Without the protection of the Earth's atmosphere, which absorbs this radiation, crews are exposed to about 1 millisievert each day, which is about the same as someone would get in a year on Earth, from natural sources. This results in a higher risk of astronauts' developing cancer. Radiation can penetrate living tissue, damage DNA, and cause damage to the chromosomes of lymphocytes. These cells are central to the immune system and so any damage to them could contribute to the lowered immunity experienced by astronauts. Radiation has also been linked to a higher incidence of cataracts in astronauts. Protective shielding and protective drugs may lower the risks to an acceptable level.

The radiation levels experienced on ISS are about five times greater than those experienced by airline passengers and crew. The Earth's electromagnetic field provides almost the same level of protection against solar and other radiation in low Earth orbit as in the stratosphere. Airline passengers, however, experience this level of radiation for no more than 15 hours for the longest intercontinental flights. For example, on a 12 hour flight an airline passenger would experience 0.1 millisievert of radiation, or a rate of 0.2 millisieverts per day; only 1/5 the rate experienced by an astronaut in LEO.

**Stress**

There has been considerable evidence that psychosocial stressors are among the most important impediments to optimal crew morale and performance. Cosmonaut Valery Ryumin, twice Hero of the Soviet Union, wrote in his journal during a particularly difficult period onboard the Salyut 6 space station: “All the conditions necessary for murder are met if you shut two men in a cabin measuring 18 feet by 20 and leave them together for two months.”

NASA's interest in psychological stress caused by space travel, initially studied when their manned missions began, was rekindled when astronauts joined cosmonauts on the Russian space station Mir. Common sources of stress in early American missions included maintaining high performance while under public scrutiny, as well as isolation from peers and family. The latter is still often a cause of stress on the ISS, such as when NASA Astronaut Daniel Tani's mother died in a car accident, and when Michael Fincke was forced to miss the birth of his second child.

A study of the longest spaceflight concluded that the first three weeks represent a critical period where attention is adversely affected because of the demand to adjust to the extreme change of environment. While Skylab's 3 crews remained one, two, and three months respectively, long term crews on Salyut 6, Salyut 7, and the ISS last about five to six months while MIR's expeditions often lasted longer. The ISS working environment includes further stress caused by living and working in cramped conditions with people from very different cultures who speak a different language. First generation space stations had crews who spoke a single language, while second and third-generation stations have crew from many cultures who speak many languages. The ISS is unique because visitors are not classed automatically into 'host' or 'guest' categories as with previous stations and spacecraft, and may not suffer from feelings of isolation in the same way. Crew members with a military pilot background and those with an academic science background or teachers and politicians may have problems understanding each other’s jargon and worldview.

**Medical**



Astronaut Frank De Winne is attached to the TVIS treadmill with bungee cords aboard the International Space Station

Medical effects of long-term weightlessness include muscle atrophy, deterioration of the skeleton (osteopenia), fluid redistribution, a slowing of the cardiovascular system, decreased production of red blood cells, balance disorders, and a weakening of the immune system. Lesser symptoms include loss of body mass, and puffiness of the face.

Sleep is disturbed on the ISS regularly due to mission demands, such as incoming or departing ships. Sound levels in the station are unavoidably high; because the atmosphere is unable to thermosyphon, fans are required at all times to allow processing of the atmosphere which would stagnate in the freefall (zero-g) environment.

To prevent some of these adverse physiological effects, the station is equipped with two treadmills (including the COLBERT), and the aRED (advanced Resistive Exercise Device) which enables various weightlifting exercises which add muscle but do nothing for bone density, and a stationary bicycle; each astronaut spends at least two hours per day exercising on the equipment. Astronauts use bungee cords to strap themselves to the treadmill.

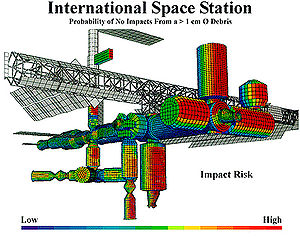
**Orbital debris**

Main article: Space debris

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|  |  | Radar-trackable objects including debris, note distinct ring of Geostationary satellites |

At the low altitudes at which the ISS orbits there is a variety of space debris, consisting of many different objects including entire spent rocket stages, dead satellites, explosion fragments—including materials from anti-satellite weapon tests, paint flakes, slag from solid rocket motors, coolant released by RORSAT nuclear powered satellites and some of the 750,000,000 small needles from the American military Project West Ford. These objects, in addition to natural micrometeoroids, are a significant threat. Large objects could destroy the station, but are less of a threat as their orbits can be predicted. Objects too small to be detected by optical and radar instruments, from approximately 1 cm down to microscopic size, number in the trillions. Despite their small size, some of these objects are still a threat because of their kinetic energy and direction in relation to the station. Spacesuits of spacewalking crew could puncture, causing exposure to vacuum.

The station's shields and structure are divided between the ROS and the USOS, with completely different designs. On the USOS, a thin aluminum sheet is held apart from the hull, the sheet causes objects to shatter into a cloud before hitting the hull thereby spreading the energy of the impact. On the ROS, a carbon plastic honeycomb screen is spaced from the hull, an aluminum honeycomb screen is spaced from that, with a screen-vacuum thermal insulation covering, and glass cloth over the top. It's about 50% less likely to be punctured, and crew move to the ROS when the station is under threat. Punctures on the ROS would be contained within the panels which are 70 cm square.



Example of risk management: A NASA model showing areas at high risk from impact for the International Space Station.

Space debris objects are tracked remotely from the ground, and the station crew can be notified. This allows for a Debris Avoidance Maneuver (DAM) to be conducted, which uses thrusters on the Russian Orbital Segment to alter the station's orbital altitude, avoiding the debris. DAMs are not uncommon, taking place if computational models show the debris will approach within a certain threat distance. Eight DAMs had been performed prior to March 2009, the first seven between October 1999 and May 2003. Usually the orbit is raised by one or two kilometers by means of an increase in orbital velocity of the order of 1 m/s. Unusually there was a lowering of 1.7 km on 27 August 2008, the first such lowering for 8 years. There were two DAMs in 2009, on 22 March and 17 July. If a threat from orbital debris is identified too late for a DAM to be safely conducted, the station crew close all the hatches aboard the station and retreat into their Soyuz spacecraft, so that they would be able to evacuate in the event it was damaged by the debris. This partial station evacuation has occurred on 13 March 2009, 28 June 2011 and 24 March 2012. Ballistic panels, also called micrometeorite shielding, are incorporated into the station to protect pressurized sections and critical systems. The type and thickness of these panels varies depending upon their predicted exposure to damage.