**Repairs**

Main articles: Orbital Replacement Units and International Space Station maintenance

**Orbital Replacement Units** (**ORUs**) are spare parts that can be readily replaced when a unit either passes its design life or fails. Examples of ORUs are pumps, storage tanks, controller boxes, antennas, and battery units. Some units can be replaced using robotic arms. Many are stored outside the station, either on small pallets called ExPRESS Logistics Carriers (ELCs) or share larger platforms called External Stowage Platforms which also hold science experiments.

Both kinds of pallets have electricity as many parts which could be damaged by the cold of space require heating. The larger logistics carriers also have computer local area network connections (LAN) and telemetry to connect experiments. A heavy emphasis on stocking the USOS with ORU's occurred around 2011, before the end of the NASA shuttle program, as its commercial replacements, Cygnus and Dragon, carry one tenth to one quarter the payload.



Spare parts are called ORU's, some are externally stored on pallets called ELC's and ESP's.

Unexpected problems and failures have impacted the station's assembly time-line and work schedules leading to periods of reduced capabilities and, in some cases, could have forced abandonment of the station for safety reasons, had these problems not been resolved. During STS-120 on 2007, following the relocation of the P6 truss and solar arrays, it was noted during the redeployment of the array that it had become torn and was not deploying properly. An EVA was carried out by Scott Parazynski, assisted by Douglas Wheelock, the men took extra precautions to reduce the risk of electric shock, as the repairs were carried out with the solar array exposed to sunlight. The issues with the array were followed in the same year by problems with the starboard Solar Alpha Rotary Joint (SARJ), which rotates the arrays on the starboard side of the station. Excessive vibration and high-current spikes in the array drive motor were noted, resulting in a decision to substantially curtail motion of the starboard SARJ until the cause was understood. Inspections during EVAs on STS-120 and STS-123 showed extensive contamination from metallic shavings and debris in the large drive gear and confirmed damage to the large metallic race ring at the heart of the joint, and so the joint was locked to prevent further damage. Repairs to the joint were carried out during STS-126 with lubrication of both joints and the replacement of 11 out of 12 trundle bearings on the joint.



While anchored on the end of the OBSS, astronaut Scott Parazynski performs makeshift repairs to a US Solar array which damaged itself when unfolding, during STS-120.

2009 saw damage to the S1 radiator, one of the components of the station's cooling system. The problem was first noticed in Soyuz imagery in September 2008, but was not thought to be serious. The imagery showed that the surface of one sub-panel has peeled back from the underlying central structure, possibly due to micro-meteoroid or debris impact. It is also known that a Service Module thruster cover, jettisoned during an EVA in 2008, had struck the S1 radiator, but its effect, if any, has not been determined. On 15 May 2009 the damaged radiator panel's ammonia tubing was mechanically shut off from the rest of the cooling system by the computer-controlled closure of a valve. The same valve was used immediately afterwards to vent the ammonia from the damaged panel, eliminating the possibility of an ammonia leak from the cooling system via the damaged panel.

Early on 1 August 2010, a failure in cooling Loop A (starboard side), one of two external cooling loops, left the station with only half of its normal cooling capacity and zero redundancy in some systems. The problem appeared to be in the ammonia pump module that circulates the ammonia cooling fluid. Several subsystems, including two of the four CMGs, were shut down.

Planned operations on the ISS were interrupted through a series of EVAs to address the cooling system issue. A first EVA on 7 August 2010, to replace the failed pump module, was not fully completed due to an ammonia leak in one of four quick-disconnects. A second EVA on 11 August successfully removed the failed pump module. A third EVA was required to restore Loop A to normal functionality.

The USOS's cooling system is largely built by the American company Boeing, which is also the manufacturer of the failed pump

An air leak from the USOS in 2004, the venting of fumes from an *Elektron* oxygen generator in 2006, and the failure of the computers in the ROS in 2007 during STS-117 which left the station without thruster, *Elektron*, *Vozdukh* and other environmental control system operations, the root cause of which was found to be condensation inside the electrical connectors leading to a short-circuit.

The four Main Bus Switching Units (MBSUs, located in the S0 truss), control the routing of power from the four solar array wings to the rest of the ISS. In late 2011 MBSU-1, while still routing power correctly, ceased responding to commands or sending data confirming its health, and was scheduled to be swapped out at the next available EVA. In each MBSU, two power channels feed 160V DC from the arrays to two DC-to-DC power converters (DDCUs) that supply the 124V power used in the station. A spare MBSU was already on board, but the 30 August 2012 EVA failed to be completed when a bolt being tightened to finish installation of the spare unit jammed before electrical connection was secured. The loss of MBSU-1 limits the station to 75% of its normal power capacity, requiring minor limitations in normal operations until the problem can be addressed.

As of 2 September 2012, a second EVA to tighten the balky bolt, completing the installation of the replacement MBSU-1 in an attempt to restore full power, has been scheduled for Wednesday, Yet in the meanwhile, a third solar array wing has gone off line due to some fault in that array's Direct Current Switching Unit (DCSU) or its associated system, further reducing ISS power to just five of the eight solar array wings for the first time in several years.

On 5 September 2012, in a second, 6 hr., EVA to replace MBSU-1, astronauts Sunita Williams and Akihiko Hoshide successfully restored the ISS to 100% power.