

By Merrill Azriel

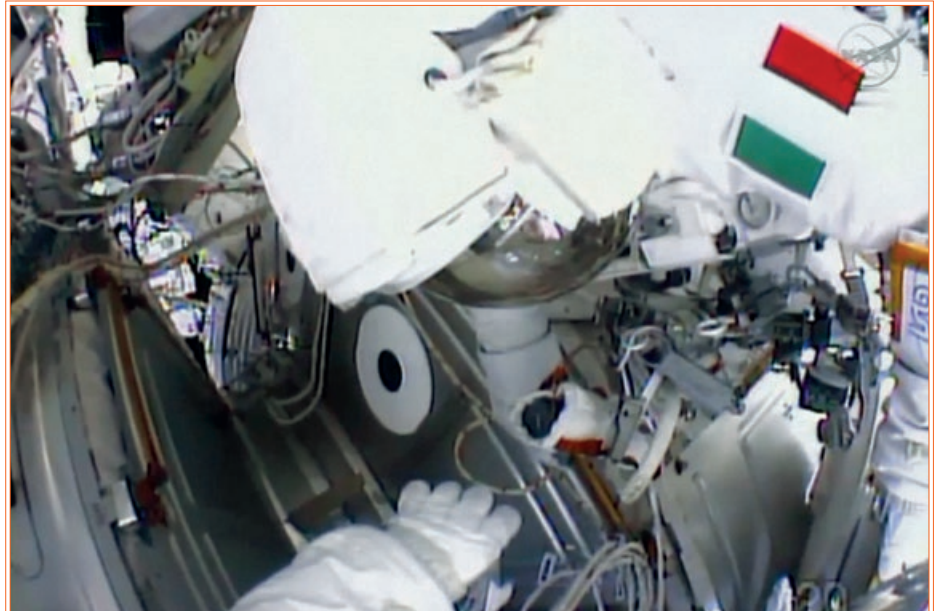
# Water-filled Helmet Ends EVA: The Close Call of Luca Parmitano

Those watching the live feed of EVA-23 from outside the International Space Station (ISS) on July 16 may be forgiven for not realizing that they were watching the worst Extravehicular Activity (EVA) accident in ISS history. The calm, professional response of both those on orbit and in Mission Control belied the gravity of the situation as astronaut Luca Parmitano, on just his second spacewalk, faced mortal danger when a substantial leak filled his helmet with water. In the unforgiving vacuum of space, removal of his helmet would have meant an even quicker death than drowning or choking on the inexorably building water climbing over his face.

## Progression of the Incident

EVA-23 began at 11:57 AM UTC, 13 minutes ahead of schedule, with astronauts Chris Cassidy and Luca Parmitano heading out of the Quest airlock. They split up, with each astronaut's first two tasks going well. At 12:47 PM UTC, Parmitano reported feeling wet on the back of his head. He continued his work, aware that this wasn't the first time an astronaut encountered this issue. One particular suit used on three EVAs during STS-129 and STS-130 manifested reduced audio quality when the wearer felt dampness around the ear cups; yet, post-EVA analysis in those cases found no water in the affected area and the issue was attributed to condensation. But by 12:54 PM it became clear that Parmitano's issue went well beyond condensation. After visual assessment, Cassidy reported seeing approximately 500 ml of water centered at the back of Parmitano's head, but creeping forward. Suspecting the drink bag may be to blame, Parmitano eliminated that source by the simple expedient of drinking the bag dry. He also drank water that had accumulated on the visor - it tasted a bit off, but that was to be expected due to the visor's anti-fog coating.

Alas, the water buildup continued - clearly the drink bag was not the source.



"How much can I sweat, though?" Parmitano asks when considering possible sources of the fluid in his helmet just before the EVA was terminated. - Credits: NASA

Mission Control didn't think the cooling system was likely; the astronauts considered bodily fluids. By 1:05 PM, it didn't matter what it was: Mission Control made the call to terminate the EVA. "There is some [water] in my eyes, and some in my nose," Parmitano said before losing the ability to communicate entirely. "It feels like a lot of water." With Cassidy's help, Parmitano made his way back to the airlock. At 1:17 PM Parmitano's eyes, ears, and nose were covered in water and his mouth was only free because he kept drinking. Unable to speak, Parmitano let Cassidy know he was ok by squeezing his hand - and waited as Cassidy cleaned up the equipment.

After a slightly expedited repressurization procedure, the internal hatch opened at 1:37 PM. The rest of the ISS crew waited just inside to help with Parmitano's expedited doffing procedure. At 1:38 PM astronaut Karen Nyberg got Parmitano's helmet off and cosmonauts Pavel Vinogradov

and Fyodor Yurchikhin converged on him with towels. There was water everywhere. Parmitano emerged looking very shaken, as well he might. In a press conference a few hours later, lead spacewalk officer Karina Eversley reported that if the situation had warranted they could have expedited reentry even further; but there is no question that this was a close call.

## Investigation and Repercussions

After taking some deep breaths, the ISS crew got to work examining Parmitano's Extravehicular Mobility Unity (EMU), designated 3011, for the most likely culprits. They were able to quickly rule out some suspects, but the leak, probably located somewhere in the primary life support system (PLSS) backpack, proved difficult to find. Soon enough, the crew had to go back to their day jobs, the mystery still undiscovered. But they've been running a few tests in between times and NASA has two teams working on the ground: an Anomaly Resolution Team (ART) to help trace

“It feels like a lot of water,”

L. Parmitano during EVA-23

“I don’t ever remember seeing a problem like this,”

J. Ross

the physical failure and a Mishap Investigation Board to derive lessons learned and prevent future recurrence. Neither team has announced any findings yet, although NASASpaceflight.com reported that the ART fingered the T2 port that vents into the helmet as the most likely source of the leak. The T2 is the juncture just before the water line is routed through the helmet, where it is designed to cool the air that is blown into the top rear of the helmet to keep the astronaut cool and ventilated; that incoming air vent was the entry point for the water that plagued Parmitano. When tested on orbit, the T2 line showed external accumulation of droplets, although not the high volume stream that might have been expected.

While the investigation remains underway, any routine EVA activity involving the EMUs is on hold out of concern that EMU 3011 may not be the only suit with this problem. This is considered to be unlikely given the history of the suit, and in a real emergency the astronauts would probably be permitted to don the other suits.



Chris Cassidy explains where the leak occurred in Parmitano’s helmet. – Credits: NASA

EVA-23 was intended to be the final US EVA until 2015. However, with several tasks remaining, including preparation for the new Russian module scheduled to be installed at the end of 2013, sooner or later EVA-23 tasks will have to be completed.

## The Path Forward

I don’t ever remember seeing a problem like this in the past and I don’t know that anyone else will remember one either,” seven-time astronaut and EVA specialist (now retired) Jerry Ross told Space Safety Magazine. The incident resulted in the shortest EVA since astronaut

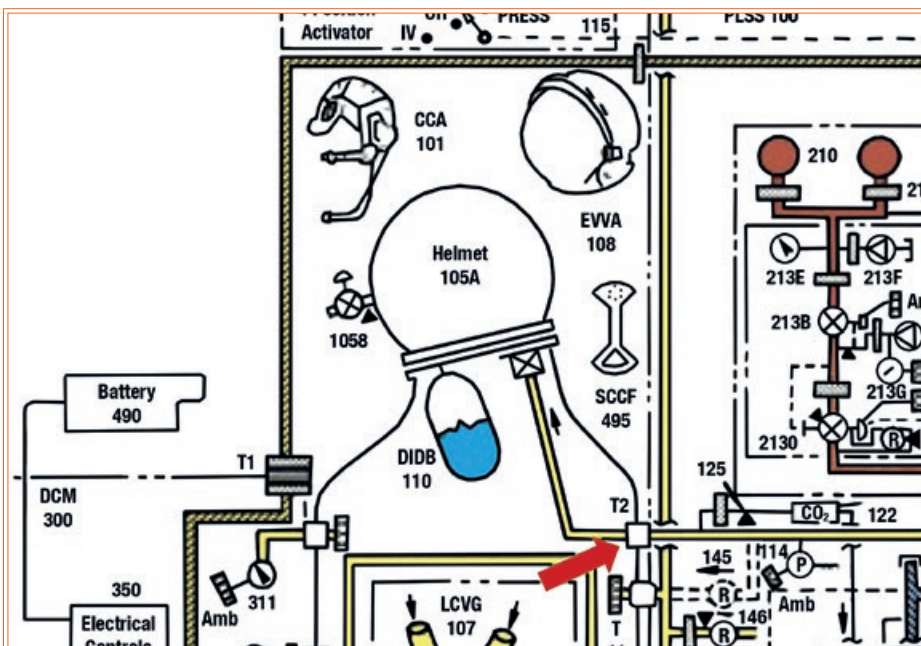
Mike Fincke’s 14 minute abort when he lost pressurization in his primary oxygen tank during ISS Expedition 9 in 2004. One must look to the earliest days of EVA to identify another incident close to the severity of Parmitano’s July 16 mishap.

Although initially reluctant to do so, NASA finally decided that EMU 3011 is going to need some specialized work and they booked its passage back to Earth on the upcoming SpaceX Dragon flight in January 2014. Dragon is the only substantive downmass capability available to ISS, so it is not possible to take measures any sooner. According to NASASpaceflight.com, a special rack is being constructed to hold the suit on its return journey.

Removal of the suit will have the unfortunate effect of leaving ISS without a medium-sized Hard Upper Torso (HUT) unit. While other elements of the suit may be adjusted to individual astronauts’ sizes, the HUT only comes in three sizes and mismatches with HUT size preclude an astronaut from qualifying to perform EVAs.

Longer term responses to this incident have yet to be defined. The Mishap Investigation Board is certain to develop a response procedure to be enacted if such an incident should occur again. They might also reexamine the shelf life of the EMU – currently set at 25 EVAs or six years – and consider training procedures for such an occurrence. It might even be prudent to make more extensive use of the PLSS in EVA testing and training on Earth. Currently, the PLSS is used only in vacuum chamber tests.

It seems unlikely that there will be any fault found to be associated with this occurrence; it is simply another reminder that however routine space activities might appear to have become, space remains an unforgiving habitat requiring preparation and constant vigilance to survive.



Pneumo-Hydraulic schematic of the PLSS. The arrow indicates the port most likely to be at fault for the EVA-23 leak. – Credits: NASA