Donning the Spacesuit

Introduction

In the movies, you'll sometimes see astronauts throw on a spacesuit, step out into space and save the Earth--don't believe everything you see in the movies! What they leave out is the amount of preparation time it takes to get ready for an Extravehicular Activity (EVA) or spacewalk.

Realistically, it really does only take around 15 minutes to get the suit on, but preparations for a spacewalk may actually start one day in advance. The crew-members on board the Shuttle start with routine checks of the equipment that will be used on a mission and they'll also inspect the spacesuits.

The technical name of a spacesuit is an Extravehicular Mobility Unit (EMU). It's like a spacecraft with the only difference being that it can fit only one person! The suit contains the basic necessities of life such as oxygen, water, and protection. It also houses a communications system so the astronaut can stay in touch with Mission Control on Earth.

Just like the cabin of the Shuttle, the suit is pressurized. If you recall, we experience pressure on Earth. If there were no pressure, the air in our lungs would rush out. The gases in our body fluids would expand and boil off. That would be the end of us!

The suit is carefully constructed to ensure an astronaut's survival. The EMU is made up of many parts. The parts must be put on in a particular sequence after a number of preparations are made. We joined the suit designers in the lab and took some pictures so you can get a good idea of what has to happen!

Suiting Up

Typically, two astronauts will suit up at the same time because there are usually two spacewalkers assigned to a mission. They typically dress in the orbiter airlock. This is an airtight chamber in which the pressure can be controlled. It sits between the cabin and the Shuttle's cargo bay.

Here's the step-by-step pro-cedure that all spacewalkers have to follow. Prep time takes about two hours and 20 minutes to get ready for an EVA!

Step 1: Pre-Breathing to Avoid the Bends

"The bends" sounds like a pretty nasty disorder--and it is! People who get "the bends" (also known a Caisson Disease) experience cramping and extreme pain in the joints. Paralysis and death are also possible in the worst case scenarios. People can get "the bends" if they move from an area of high pressure to an area of lower pressure too quickly. People who are likely to get Caisson Disease are underwater divers who rise to the surface too quickly. Astronauts also run the risk of getting "the bends". Here's why:

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On Earth, you breathe in air. Air is a mixture of oxygen, nitrogen and other gases. Your body tissues are filled with nitrogen. The amount of nitrogen that your body can absorb depends on the amount of pressure that's being exerted by the atmosphere. The higher the pressure is, the more nitrogen your body can hold. The lower the pressure is, the less nitrogen your body can hold. If you moved from an area of high pressure to an area of low pressure too quickly or if the difference between pressures was extreme, your tissues would get supersaturated--or overfilled--with nitrogen! Nitrogen would be forced out of your tissues as gas bubbles. Ouch! This causes a lot of pain!

In space, the air within the cabin of the Space Shuttle is at the same pressure as it is here on Earth. It contains the same mixture of nitrogen and oxygen. The spacesuit, on the other hand, operates at about one-third of the Shuttle's cabin pressure. That's because the lack of pressure in space makes the suit act like a rigid balloon. Keeping the pressure as low as possible makes it easier for the astronauts to bend and move in the suit as they perform their tasks. However, if the pressure were kept too low, the astronauts would be at a higher risk of getting "the bends".

To prevent "the bends" the spacewalkers slowly remove nitrogen from their bloodstream and body tissues by breathing pure oxygen. They do this by putting on the helmets from their launch and re-entry suits that are connected by a tube to a tank of 100% oxygen. They breathe in pure oxygen, but the air they exhale is a mixture of oxygen, carbon dioxide and nitrogen. This procedure is called pre-breathing.

About an hour or so after starting their pre-breathe (and at least 12 hours before going stepping into space), the Shuttle's cabin pressure is lowered from 101 kilopascals to 70.3 and the percentage of oxygen in the cabin air is increased.

The combined lower pressure and higher level of oxygen means the astronauts can take off their helmets and breathe the cabin air without the risk of loading any more nitrogen into their bodies. In fact, they slowly continue to lose nitrogen! This procedure usually occurs at the end of the day. The astronauts have a good night's sleep. The next morning, they wake up early to prepare for their spacewalk.

Step 2: The Urine Collector

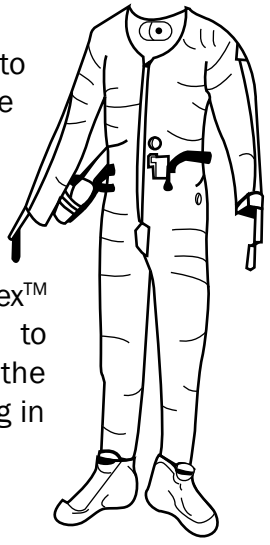
This is the day the spacewalk begins! The astronauts start to get dressed. The first thing on is the urine collector! This does not involve anyone collecting samples from the astronauts!

You can think of urine collectors as materials that absorb or collect urine during the spacewalk.

Male spacewalkers wear a Urine Collection Device while female spacewalkers wear Disposable Absorption and Containment Trunks. The male version is a pouch. The female version is like a pair of multi-layered shorts that contain an absorptive powder. Both can hold almost one whole liter of fluid.

Step 3: Stay Cool!

The astronauts now move into the airlock. They put on the Liquid Cooling-and-Ventilation Garment. This looks like a pair of long underwear with a series of tubes that run throughout it. The Spandex™ garment's tubes are used to circulate cool water to keep the body comfortable while working in the 114-kilogram suit.



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Other tubes are used to whisk away sweat, carbon dioxide and any contaminants into the Primary Life Support System to purify the atmosphere in the suit.

Step 4: Harnessing Electricity

Why would a suit need an electrical supply?

A power connection is necessary to hook up medical instruments that monitor the astronaut's heart rate. It's also necessary run the suit control systems and for radio equipment that serves as the communications link between space and Earth.

To accomplish this, an electrical harness is hooked up to the Hard Upper Torso (HUT) of the suit.

Step 5: Putting the Little Pieces Together

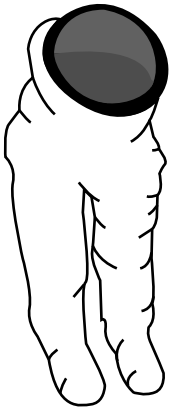
A number of little items need to be prepared. An anti-fog mixture is rubbed into the inside of the helmet. A wrist mirror and checklist are attached to the left arm of the suit.

On the inside of the HUT, a water bag needs to be attached with Velcro™. The In-suit Drink Bag is filled with about two-and-a-half cups of water from the galley. A straw reaches up into the helmet.

Next--the Snoopy Cap! This is a fabric cap that contains earphones and a microphone for communication. It gets connected to the electrical harness and is left floating above the HUT until it's ready to put on.

Step 6: One Leg at a Time

Finally, the rest of the suit goes on. The bottom half of the suit (also known as the Lower Torso) gets pulled on. The Lower Torso consists of the pants, boots, joints for the ankles, knees, and hips, and a metal body-seal closure that connects the Lower Torso to the HUT. It also features a waist bearing which allows the astronauts to twist from side to side if they're locked into foot restraints while working in space.



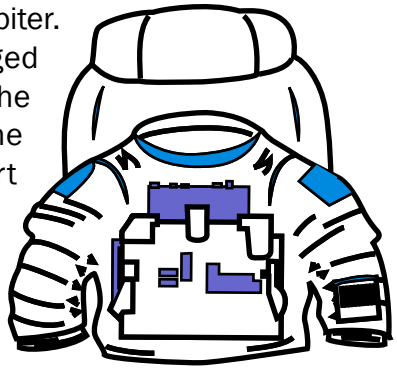
Step 7: Dive In!

Or maybe we should say, "Dive Up!"

The HUT hangs on the wall of the airlock. To get into it, the astronaut has to raise his arms and dive up into the top half and squeeze his head past the neck seal.

Once inside, the Liquid Cooling-and-Ventilation Garment gets hooked up to the Primary Life Support System. The medical instruments are also hooked up to the electrical harness. Finally, the body-seal closure rings are locked together with the help of another crewmember.

The HUT is strong enough to carry the Primary Life Support System which goes on the back and the Displays and Controls Module which attaches to its front. The module remains plugged into the Service and Cooling Umbilical. It provides cool water, oxygen, and power from the orbiter. By remaining plugged into the umbilical, the "consumables" of the Primary Life Support System are conserved until needed.



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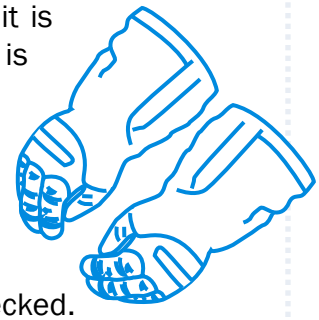
Step 8: The Pressure is On!

The final pieces of the suit are put on--eyeglasses, the Snoopy Cap, comfort gloves, the helmet with lights (and sometimes a TV camera), and gloves.



The helmet is locked on. The suit is now a self-contained unit that is complete with its own oxygen supply, air pressure, power supply and water. The astronaut is no longer in the atmosphere of the airlock.

All the seals get manually checked. The pressure in the suit is increased 29.6 kilopascals above the airlock pressure. The astronauts may feel some discomfort in their ears and sinus cavities. They have to yawn or swallow to relieve the discomfort.

The oxygen supply in the airlock is shut off. The astronaut then reads the chest-mounted digital display which indicates any leakage. A small leak is normal--as long as it isn't more than 1.38 kilopascals per minute.

If leakage is minimal or non-existent, then the suit is depressurized to the airlock's original pressure, and the oxygen is turned back on.

For the next few minutes, the atmosphere from the airlock is forced out of the suit. That way, only pure oxygen is left in the suit. The astronauts continue with the pre-breathing for another 30 to 40 minutes.

Step 9: The Space Walk Begins

Once everything is checked and pre-breathing is completed, the inner door of the airlock is sealed and the airlock is depressurized. Its atmosphere is released into space. Once the airlock pressure drops to 34.48 kilopascals, depressurization is put on pause.

The astronauts check for seal leaks again. If there is a lot of leakage, then the airlock is repressurized and the crew and spacewalkers check all of the seals. If there are no leaks, the final depressurization begins.

Once the airlock is depressurized, the outer airlock hatch is opened and the astronauts are ready to move into the cargo bay. They hook up their tethers to the orbiter so they don't float away, and they move around using handholds.

The astronauts then disconnect their HUTs from the Service and Cooling Umbilical and the Primary Life Support System starts using its own reserves. The astronauts pull themselves through the outer airlock hatch and the spacewalk begins!

For more information about spacesuits, please visit the KidStation for Cosmofans at http://www.space.gc.ca/ks-cosmofans.