Safety, Comfort and Health Key to Taikonauts Well-being

China's Shenzhou-12 manned spacecraft, with three taikonauts on board, was successfully launched on June 17, 2021 — an epoch-making event for the country's aerospace industry as a gift for the 100th anniversary of the Communist Party of China.

As this mission played a pivotal role in the construction of China's space station and showcased China's breakthrough in technology, it has not only excited people in the space industry, but also ignited heated discussions among people from all walks of life throughout China.

State-of-the-art Spacesuits Big on Safety

By BI Weizi

Three Chinese astronauts, arrived at China's space station aboard the Shenzhou-12 mission in mid-June. During the three-month stay, they will perform two extravehicular tasks (EVAs) involving assembly and installation. The two taikonauts' extravehicular activities are supported by China's new-generation spacesuit named Feitian.

Literally, Feitian means "flying to space." It is a reference to the apsara or "flying deva" in Chinese, and most famously depicted in Chinese art in the grottoes of Dunhuang. Spacesuits for EVAs, composed of garments, equipment and systems, are designed to defend taikonauts against the threats from the outer space, such as extreme low temperatures, radioactive rays and lack of oxygen, therefore ensuring absolutely safe working conditions in space and allowing them to carry out stipulated tasks.

One of the most significant advances in the new generation of Feitian extravehicular spacesuits is the extension of function time in outer space.

The spacewalk on July 4, 2021, conducted by the taikonauts also verified the long-duration life support system of the spacesuit, which has seen a great leap forward from the old generation of suits employed in the Shenzhou-7 mission. The new-generation suit can withstand temperature differences of more than 200 degrees Celsius, space radiation and other harsh environmental conditions and can allow the taikonauts to work a maximum of eight hours outside the spacecraft, up from four hours previously.

What's more, Feitian is a one-size-fits-all spacesuit, with smaller and more flexible limb joints, able to fit a taikonaut with a height range between 160-180 centimeters. "It's more comfortable than before," said Shenzhou-12 taikonaut Liu Boming, who also participated in the Shenzhou-7 mission in 2008. As they have better mobility, the spacesuits can better protect the taikonauts and are easier to maintain, making it more convenient for them to perform space tasks.

Another point worth mentioning is that it only takes a taikonaut about five minutes to put on and take off the spacesuit as it weighs 130kgs, which is a big progress compared with the old one. When putting on "Feitian" spacesuit, the astronaut has to sit on the edge of the backbag called the primary life support, which contains the oxygen that astronauts breathe during a space walk. According to the deputy chief designer of the mission, Zhang Wanxin, all of the metal parts have been hollowed out through the method of typology, so as to reduce the weight, as a very small weight is significant in outer space. This development has paved the way for future space plans.

"There's some electronic equipment, such as cameras added to the suits, which are helpful for us to complete tasks," said Nie Haisheng. Indeed, by contrast to previous generation spacesuits, the new one features control consoles, video cameras and an audio system. The Feitian's helmets are equipped with cameras, broadcasting a first-person view similar to NASA's extravehicular activity unit (EMU) spacesuit.

The helmet's bubble is composed of four layers: two are pressure resistant windows, the middle one is injected with nitrogen, which serves as an anti-fogging agent and has the function of heat insulation, the outer-most is the space window in case of clashes and scratches while conducting scheduled tasks.

When exiting the cabin and entering outer space, taikonauts will be confronted with harsh environmental conditions, but with the Chinese developed "Feitian" spacesuits and its multi-function ability almost making it a mini manned spacecraft, the safety and comfort outside the space station are ensured.

A Chinese Space uniform was displayed to the public during the National Science and Technology Week in May in Beijing. (PHOTO:VCG)

An astronaut is walking in the outer space. (PHOTO: VCG)

Taikonauts' Live-streamed Life Goes Viral

By BI Weizi

The live-streaming by the three taikonauts, Tang Hongbo, Nie Haisheng and Liu Boming, received more than 20 million views, showing how curious people are about their daily life in outer space, such as what they eat, how they do exercises, what they wear and where they sleep, among which food is a matter of deep concern: as an old Chinese saying goes "Food is the paramount necessity of people."

Aerospace food has developed dramatically since the first manned flight of the Shenzhou-5, when the taikonaut Yang Liwei mainly lived on about 20 types of energy bars. On Shenzhou-7, which blasted off in 2012, there were about 70 types of food. The first breakfast for crew members was assorted fried rice, pickled cabbage and pork, pickled mustard, Char Siu sauce and milk tea.

The menu for Shenzhou-10 expanded to more than 80 types of food, with moon cakes and ice cream on the list. As this trip coincided with the Dragon Boat Festival, female astronaut Wang Yaping ate bean paste rice dumplings to celebrate the festival. Shenzhou-11 carried more than 100 types of food and beverages, including spiced beef and shredded pork in garlic sauce, a popular dish in almost every Sichuan cuisine restaurant, and desserts.

China's Shenzhou-12 taikonauts may select their meals from more than 120 dishes during their three-month stay in orbit. Among the 6.8 tons of supplies delivered by Tianzhou-2 are a range of staple foods and beverages, including a variety of teas, juices and soups. The spacecraft also transported coolers to store fresh fruits and vegetables.

The foods are usually solid, boneless, in small pieces and selected to meet the astronauts' personal tastes, Huang Weifen, China's chief astronaut trainer said. Meals include shredded pork in garlic sauce, kung pao chicken, black pepper beef, pickled cabbage and shredded pork.

Recipes were designed and arranged in accordance with nutritional requirements in different phases of the mission. It was developed based on the special environment in which the astronauts live, combined with the astronaut's taste and digestion and absorption capacity in space. In other words, aerospace food is a special kind of food developed for a specific environment and a specific group of people. It is made according to aerospace recipes that meet required dietary standards. It must contain sufficient and complete scientific nutrition, which is protein, carbohydrate, fat, vitamins, minerals, dietary fiber, and water that the human body needs each day.

Space food is not only a product of outer space exploration, but also is closely relevant to people's daily life. The dehydrated vegetables found in instant noodles actually originated in dehydrated space food. The food provided in Shenzhou-12 proves the value of China's strong food culture.

Taikonauts now enjoy a variety of more than 120 kinds of space food, with a long shelf life, ensuring they are well-fed with three hot meals everyday.（PHOTO: VCG）

Shenzhou-12's Living and Work Space Gets Major Upgrades

By YU Haoyuan

The cabins of China's manned space station, the Shenzhou series of manned spacecraft, the Tianzhou series of cargo spacecraft, and the Long March launch series of carrier rockets were developed by China Aerospace Science and Technology Corporation (CASTC), as was Shenzhou-12.

Compared with previous flight missions, the Tianhe core module provides three times more space for astronauts in the Tiangong-2 Space Laboratory. According to the data collected from the full-sized model of the core module, Tianhe, the taikonauts' living area has a diameter of 3.35 meters. It is equipped with three separate bedrooms and one bathroom to facilitate their daily life routine. The three separate bedrooms mean an improvement in the taikonaut sleeping patterns as they no longer have to sleep standing up and can enjoy undisturbed deep rest.

In the field of aero-communication, through the set up of the space-to-earth communication link and video call equipment, a two-way video call between the space station and ground base can be achieved, sending and receiving emails.

Regarding manned environment control, compared with previous manned missions, the core cabin of the space station is equipped with a regenerative life support system, which includes subsystems such as electrolytic oxygen production, condensed water collection and treatment, urine treatment, carbon dioxide removal, and harmful gas removal. It can also recycle water and other consumable resources to ensure the long-term stay of taikonauts in orbit.

According to CASTC, the daily living space in the early Shenzhou-7 was only seven square meters. Tiangong-1 was upgraded to 15 square meters, which could accommodate the work and living space of three astronauts in orbit. In the current situations, the activity space in the core cabin of Tianhe has increased to 110 square meters.

The current space station has a living area and a working area. The living area has separate sleeping, ablution, exercise, kitchen, and dining sections. The design ensures that maximum consideration has been given to the privacy and convenience of taikonauts, as demonstrated by each having a handheld terminal, allowing them to adjust the cabin's lighting, sleep, work, and sports modes through the APP.

As for health issues after being upgraded, the taikonauts have a wrap around shower facility where the shower nozzle can be hand held for optimum personal hygiene.

Another major factor of wellbeing in modern life, whether on solid ground or in space, is access to a reliable WiFi network. The China Space Station has adopted brand-new technology in this regard and is equipped with mobile WiFi.

The taikonauts on Tianhe core module no longer have to sleep standing up and can enjoy undisturbed deep rest in three seperate bedrooms. (PHOTO: VCG)

Spacewalking and Working Out in a Futuristic Gym

By YU Haoyuan

Liu Boming was the first taikonaut to begin extravehicular activity (EVA) at 8:11 am (Beijing Time) on July 4. Three hours later, his fellow crew member Tang Hongbo stepped outside the Tianhe core module, and took part in a spacewalk before the two of them adjusted a panoramic camera.

However, the third taikonaut Nie Haisheng, also the mission commander, did not follow them out. He stayed inside the cabin and worked with systems onboard Shenzhou-12, operating the smart robotic arm to ensure the two spacewalking taikonauts can complete their mission. According to China Aerospace Science and Technology Corporation (CASC), the robotic arm is 10.2 meters long and capable of carrying 25 tons of weight. Many people will have seen a similar example on the American TV series Space Force.

Wearing upgraded Chinese Feitian spacesuits, Liu and Tang completed the first Shenzhou-12 out-of-cabin mission successfully and stored tools needed for future tasks in the space station.

During their time in space, among other tasks Liu installed the upper arm bracket for the robotic arm, after which he started to move with the robotic arm's assistance. Meanwhile, Tang used the handrails installed on the bulkhead to crawl to the operating point for auxiliary work, during which an emergency return verification was required in time.

Liu and Tang took about seven hours to complete their spacewalk tasks. A second spacewalk is planned in the near future.

Apart from the spacewalk, taikonauts also carried out a variety of fitness exercises inside the space station.

If you watch CCTV (Chinese Central Television) footage released on June 28, you could see taikonaut Nie install the space treadmill and then spend 15 minutes running on it.

The space gym was set up with the help of the China Aerospace Science and Technology Corporation(CASC). Its purpose is to help taikonauts maintain their fitness in real-time in the space environment. According to fitness experts, the gym capacity can ensure that a maximum of six taikonauts can meet their daily physical training requirements. Unlike the traditional gyms back home, the space gym in the Tianhe core module is equipped with different "black technologies," such as a space bicycle, space treadmill and other machines.

Life in space is obviously different from ordinary life. Taikonauts must keep up their fitness levels to prevent possible physical damage caused by weightlessness during their long-term stay. When living in a low gravity condition, the blood circulation will flow more to the upper body and brain. Without enough exercise, human bones will lose density quickly. The bone cells regenerate and grow slowly, which will cause the bones to become fragile. As time in space increases, the situation will become more and more serious. As a result, astronauts need to workout for at least two hours every day, which will help astronauts reduce muscle atrophy and bone loss.

It can be seen from the China Central Television (CCTV) footage that when Tang is doing running exercises, his leg motion aims to stimulate and strengthen his cardiovascular system.

Tang also did a pedaling exercise on the Space-bicycle with a special respirator on his mouth, which can strengthen the cardiopulmonary function. Moreover, a special device for upper-limb exercise was also installed to increase the overall exercise effect of the taikonauts in the gym.

Netizens who watched the taikonauts exercising on TV were envious of the state of the art equipment, eager to get space gym membership.

The picture shows that Nie Haisheng is working inside the Tianhe core module. (PHOTO: VCG)