

## **Demise of “Tiangong-1” : The UNCONTROLLABLE FALL!**

"It did exactly what it was expected to do; the predictions, at least the past 24 hours' ones, were spot on; and as expected it fell somewhere empty and did no damage," said Jonathan McDowell, an astrophysicist at the Harvard-Smithsonian Center for Astrophysics<sup>1</sup>.

China's first space station, the bus-size Tiangong-1, was falling hysterically on the way towards Earth, with a blazing plunge through our atmosphere expected sometime between March 30 and April 2, 2018. And the dive was predicted, in fact, be a blazing one: Scientists expected that as the station burns up, it will generate huge fireballs visible from the ground. It was a blistering conclusion to what was once one of China's highest-profile space projects.

It landed about 8:15 a.m. Beijing time (2 April), China's Manned Space Agency said<sup>2</sup>.

David Barnhart, a satellite designer who is the director of the University of Southern California's space technology and systems group, said. "To date, almost everything we put into space, at some point, is going to die. But something that large, we now have the technology to go up to it and prolong its life."<sup>3</sup>

Chinese space officials lost contact with the station in 2016 after five successful years of operations, which included two visits by Chinese crews of astronauts. China kept in confidentiality if they cut off connection with the station purposely, or if they lost telemetry due to a technical issue. Whatever the cause, the result was the same: Tiangong-1 began an inevitable descent into Earth's atmosphere.

Tiangong-1's orbital inclination carried it over most of Earth's populated areas, between 43 degrees north and 43 degrees south latitudes. The zone includes the United States, Central America, South America, Australia and much of Europe and Asia.

With so many people below Tiangong-1's path, its descent caused worldwide speculation about the dangers of space debris from the module. Several entities closely monitored its fall and issued updates, including the China Manned Space Engineering (CMSE) Office, the European Space Agency's Space Debris Office in Germany, and Aerospace Corp.

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<sup>1</sup>*Tiangong-1: Defunct China space lab comes down over South Pacific BBC News*

<sup>2</sup>*China's out-of-control Tiangong 1 crashed to earth news.com.au*

<sup>3</sup>*Chinese Space Station Tiangong-1 falling to Earth now, but where? Space.com*

## **Heaven down to earth!**

The China National Space Administration (CNSA) designed Tiangong- 1 as an 8.5-tonne (19,000 lb) "space-laboratory module", capable of supporting the docking of manned and autonomous spacecraft. <sup>4</sup>

It was a 9.4-ton (8.5 metric tons) about 34 feet long by 11 feet wide (10.4 by 3.4 meters) and features 530 cubic feet (15 cubic m) of habitable internal volume. <sup>5</sup>It settled into an orbit about 217 miles (350 kilometers) above Earth — a little lower than the International Space Station, whose average altitude is 250 miles (400 km).

Tiangong-1 had a pressurized habitable volume of approximately 15 cubic meters (530 cu ft), and used passive APAS-type docking connectors. Structurally, Tiangong-1 was divided into two primary sections: a resource module, which mounted its solar panels and propulsion systems, and a larger, habitable experimental module. <sup>6</sup>

Tiangong-1's experimental module contained exercise gear and two sleep stations. High-resolution interior cameras allowed manned missions to be closely monitored from the ground, and the two sleep stations had individual lighting controls. Toilet facilities and cooking equipment for the manned missions were provided by the docked latter Shenzhou spacecraft.

The launch occurred at 13:16 UTC on 29 September, successfully placing Tiangong-1 into low Earth orbit. On 2 October 2011, Tiangong-1 completed the second of two orbital transfer maneuvers, reaching an apogee altitude of 362 kilometers (225 mi). The unmanned Shenzhou 8 mission successfully docked with Tiangong-1 on 2 November 2011 GMT, marking China's first orbital docking. In December 2011, the Tiangong-1 module began automated internal checks for toxic gas, to ensure that its interior would be safe for astronauts to enter. Shenzhou 9 launched successfully on 16 June 2012, carrying with it China's first female astronaut, Liu Yang. On 15 June 2013, the Shenzhou 10 crew completed China's first orbital maintenance operation, replacing Tiangong-1's interior cladding. <sup>7</sup> Additional maintenance work was conducted on the space station's seal rings. After a series of successful docking tests, Shenzhou 10 undocked and returned safely to Earth on 26 June 2013. With duration of 15 days, Shenzhou 10 was China's longest manned space mission, until Shenzhou 11's 30 day mission to Tiangong-2 in 2016. <sup>8</sup>

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<sup>4</sup> 天宫一号"空间站已进入初样研制阶段(图) (in Chinese). CCTV. 25 January 2009. Retrieved 26 July 2013.

<sup>5</sup> "China Accelerates Manned Space Program with Tiangong Docking Module and Advanced Shenzhou". AmericaSpace. 23 September 2011. Retrieved 3 November 2011.

<sup>6</sup> "China Launches Tiangong-1 Space Lab". InterSpace News. 29 September 2011. Retrieved 3 November 2011.

<sup>7</sup> "China successfully completes space docking". China Daily. 19 June 2012. Retrieved 4 November 2013.

<sup>8</sup> "Astronauts complete first maintenance on Tiangong-1". China Daily. 15 June 2013. Retrieved 19 June 2013.

## What lead to the Demise?

Tiangong-1 was designed to endure for two years, and the Shenzhou-10 visit marked the end of the space lab's operational life; China put it into "sleep mode" shortly thereafter. It was intended that it would remain in orbit for some time, allowing China to collect data on the longevity of key components before being commanded to gradually re-enter the atmosphere. Chinese officials had said they planned to de-orbit Tiangong-1 in a controlled fashion, using the craft's thrusters to guide it into Earth's atmosphere. But in March 2016, China announced that Tiangong-1 had stopped sending data back to its handlers. So a controlled re-entry was no longer in the cards; the space lab would fall back to Earth on its own, pulled down by atmospheric drag. The orbit of Tiangong-1 was decaying gradually, and the space laboratory was predicted to be destroyed upon re-entry into Earth's atmosphere.

The IADC<sup>9</sup> predicted that Tiangong-1 would break up during re-entry, but that parts of the station would survive and fall to the Earth's surface, potentially falling across an area thousands of kilometers long and tens of kilometers wide. However, because most of the re-entry area was ocean or uninhabited land, the IADC calculated the odds of a person being hit by falling debris to be infinitesimal ("the personal probability of being hit by a piece of debris from the Tiangong-1 is 10 million times smaller than the yearly chance of being hit by lightning"). The IADC's final prediction before re-entry was that Tiangong-1 would re-enter at around 01:00 UTC on 2 April 2018, plus or minus 2 hours, falling somewhere on Earth between 42.8° North and 42.8° South latitudes, with the most likely re-entry points being at the north and south extremes of that range.<sup>10</sup>

Tiangong-1 reentered the Earth's atmosphere at 00:16 UTC on 2 April 2018 over the South Pacific Ocean at 24.5°S 151.1°W. According to Chinese state news agency Xinhua, the station mostly burnt up upon re-entry.

The demise of Tiangong-1 raised questions about the end of the International Space Station, which planned to host crews until at least 2024. It's unclear what will happen to the ISS after that. While the nominal plan is to deorbit it, Barnhart advised engineers to plan how to re-use ISS as soon as possible, to avoid throwing it away into the Earth's atmosphere.<sup>11</sup>

Tiangong-1 won't be the biggest spacecraft ever to fall uncontrolled from the sky. In July 1979, for example, NASA's 85-ton Skylab space station burned up over the Indian Ocean and Western Australia. Some big chunks survived the fall, and the Australian town of Esperance famously

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<sup>9</sup> ["Note verbale dated 4 May 2017 from the Permanent Mission of China to the United Nations \(Vienna\) addressed to the Secretary-General"](#)(PDF). UN Office for Outer Space Affairs. 4 May 2017.

<sup>10</sup> David, Leonard (10 June 2016). "When Will China's 'Heavenly Palace' Space Lab Fall Back to Earth?" *Space.com*. Retrieved 15 July 2016.

<sup>11</sup> A private Space Station Might Be born from ISS *Space.com*

sued NASA \$400 for littering. And in February 1991, the Soviet Union's 22-ton Salyut 7 orbital outpost came tumbling down while it was connected to another 22-ton spacecraft called Cosmos 1686. Nobody was aboard Skylab or the Salyut-Cosmos 1686 complex when they hit Earth's atmosphere. (The Soviet-Russian space station Mir was even larger, at about 140 tons. But its March 2001 destruction was a controlled re-entry.)

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