National Transportation Safety Board
Office of Research and Engineering
Washington, DC 20594

DCA23FM036

ELECTRONIC DEVICES

Specialist's Factual Report

July 22, 2025

A. ACCIDENT

Location:	900 Nautical Miles east of Cape Cod, Massachusetts
Date:	June 25, 2023
Time:	1740 Eastern Daylight Time (EDT)
Submersible:	OceanGate Titan

B. ELECTRONIC DEVICES SPECIALIST

Specialist	Sean Payne Branch Chief – Vehicle Recorder Division National Transportation Safety Board (NTSB)
Specialist	David Case Recorder Specialist/Computer Engineer NTSB

C. DETAILS OF THE INVESTIGATION

The NTSB Vehicle Recorder Division received the following equipment recovered from the OceanGate Titan wreckage site

Object 1: Large Electronic and Metal Mass

Object 2: Box 1 of Miscellaneous Electronic Equipment

Object 3: Box 2 of Miscellaneous Electronic Equipment

1.0 Device Description

Large Electronic and Metal Mass

The NTSB laboratory received a large electronic and metallic mass from the United States Coast Guard on November 13, 2023. The NTSB was working on behalf of the USCG. The mass was transported in plastic storage container. The mass weighed approximately 100 lbs. The mass is pictured in figure 1. The mass was a compilation of compressed metal, compressed plastic, compressed electronic components and compressed other materials. The mass exhibited signs of thermal damage without typical signatures of having been exposed to open flame. A section of the mass contained polar fleece material. A second small mass consisted mostly of

compressed metal, electronics and fabric was with the larger mass. This is pictured in figure 2. No human remains were externally visible anywhere on the mass.

The mass was suspected of containing a mission computer that would have contained electronic data related to the vessel's performance history, operation as well as acoustic hull monitoring and other diagnostic information. Figure 2 shows the installation of the mission computer in the submersible pre-accident. Specifically, the mission computer was identified as three Nuvo-5000LP series fan-less PCs. An exemplar Nuvo-5000LP PC is pictured in figures 3 and 4.

Figure 1. The large electronic and metallic mass.

Figure 2. A second smaller compressed mass shipped with the large electronic and metallic mass pictured in the above figure.

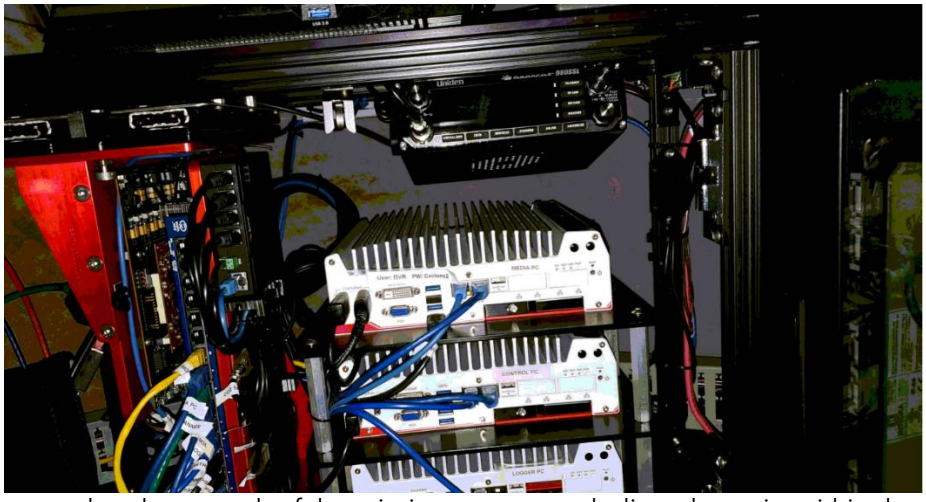

Figure 3. An exemplar photograph of the mission computers believed to exist within the compressed mass.

Figure 4. An exemplar Nuvo-5000LP PC taken from a marketing brochure.

Box 1 and Box 2 - Miscellaneous Electronic Equipment

Box 1 and 2 contained various electronic components that were collected from the seafloor. The boxes are pictured in figure 5 and 6, respectively.

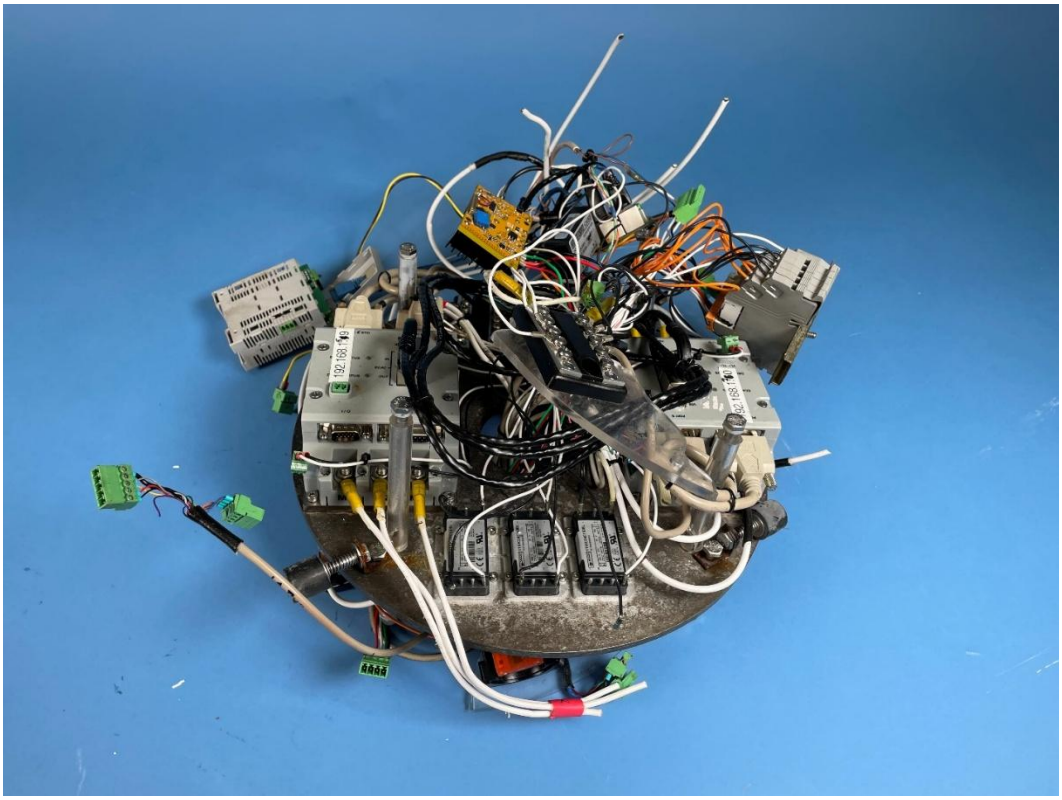

Figure 5. The contents of Box 1.

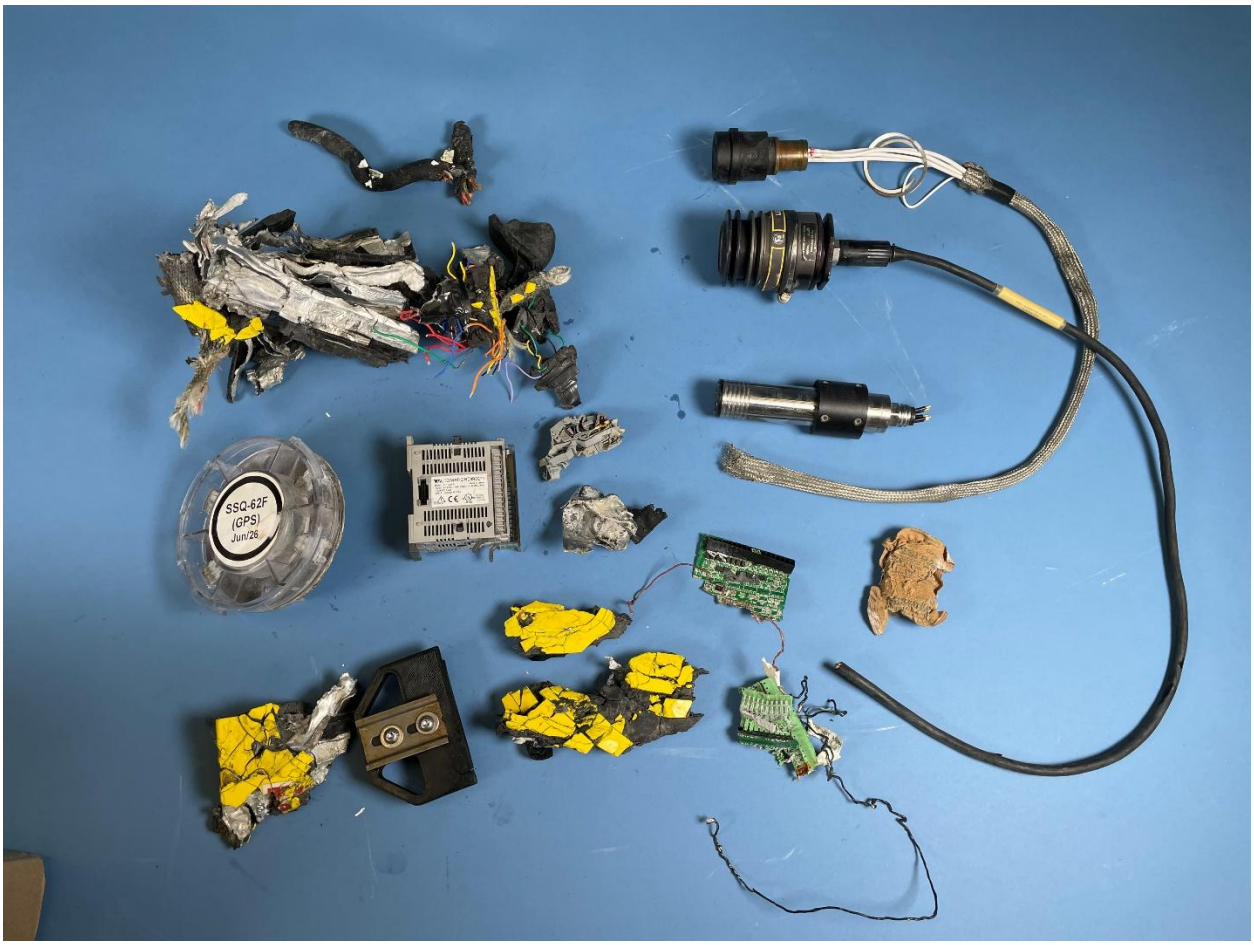

Figure 6. The contents of Box 2.

1.1 Identification and Data Recovery

Large Electronic and Metal Mass

The mass was triaged at the NTSB Vehicle Recorder Laboratory. The mass generally consisted of layers of compressed materials. The layers could not be removed or exposed without using significant force and mechanized tools. As such, there was a concern that examination in this manner could damage any memory components contained within the mass.

To conclude if memory components were survivable, which were presumed to be 2.5-inch solid-state hard drives[1] (SSD), a method of evaluation was constructed. First, a computed tomography (CT) scan of the mass would be conducted which could potentially image compressed memory components. If the compressed memory components could be imaged in the CT scan, then a pathway could be

[1] Records could not be obtained which confirmed the exact specifications of the Nuvo PCs that OceanGate ordered.

established that provided a route for using destructive tools that could reach and extract the memory components.

If the CT scan failed to directly image the memory components, it could still assist in performing a dimensional analysis of the mass. This dimensional analysis would help determine whether any internal space existed that could potentially have preserved a memory device. In this context, "survivable space" was defined as a theoretical minimum three-dimensional void sufficient to contain a 2.5-inch SSD printed circuit board (PCB) without major deformation. However, definition of "survivable space" was complicated by the lack of documentation from OceanGate regarding the specific memory components used. There was also no available information on how the non-volatile memory (NVM) chips within the SSDs were arranged—specifically, whether they were configured in a RAID[2] system. If no RAID configuration was used, full data recovery would require all NVM chips on the board to be functional. If a RAID configuration had been used, fewer functional chips might suffice.

To conduct the CT scans, the large mass was evaluated by a third-party laboratory under NTSB supervision. This facility had a range of scanners with different power and energy levels and could scan large masses using a rotating table, avoiding the need to rotate the mass itself. Ultimately, the third-party laboratory attempted to image the large mass at a power as high as 320 kilovolts (kV). The scans conducted at 320 kV were not powerful enough to penetrate the object, and as a result, no internal structures or voids were visible, and no memory devices could be identified. The NTSB evaluated using another laboratory with higher power and energy CT scan devices, however, there was concern that increased CT scan energy could damage data stored on any surviving NVM chips. Consequently, higher-energy scans were not pursued.

With the CT and subsequent dimensional analysis proven to be unsuccessful, the USCG elected to have the NTSB provide the large mass to the Fire Research Laboratory (FRL) at the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF). The goal of the ATF FRL exam was to utilize tools with the goal of identifying and extracting the 2.5 inch SSD devices associated with the Nuvo-5000 LP PCs, and providing any recovered material for further evaluation.

By the end of May 2024, the ATF FRL had finished the evaluation and successfully extracted and provided two printed circuit boards (PCBs) consistent with having come from a 2.5-inch SSD. The NTSB received these two PCBs via the USCG in June 2024. The two PCBs are pictured in figure 7.

[2] RAID – A data storage virtualization that combines multiple physical data storage components into one or more logical units for the purpose of data redundancy, performance improvement or both.

The two PCBs consisted of at least eight BGA NVM chips each. The PCBs were both deformed in all axes. Three BGA NVM chips were missing from each PCB, and the remaining chips showed visible signs of cracking and distortion. Such damage to the BGA chips is presumed to have compromised the internal silicon dies, rendering the chips inoperable and irreparable. Based on this assessment, the NTSB discontinued its data recovery efforts.

All evidence was returned to the USCG. The USCG elected to continue data recovery efforts on the two PCBs. At the time of publication of this report, the USCG reported that further data recovery efforts were unsuccessful.

No data was recovered from the compressed mass, and the small companion compressed mass.

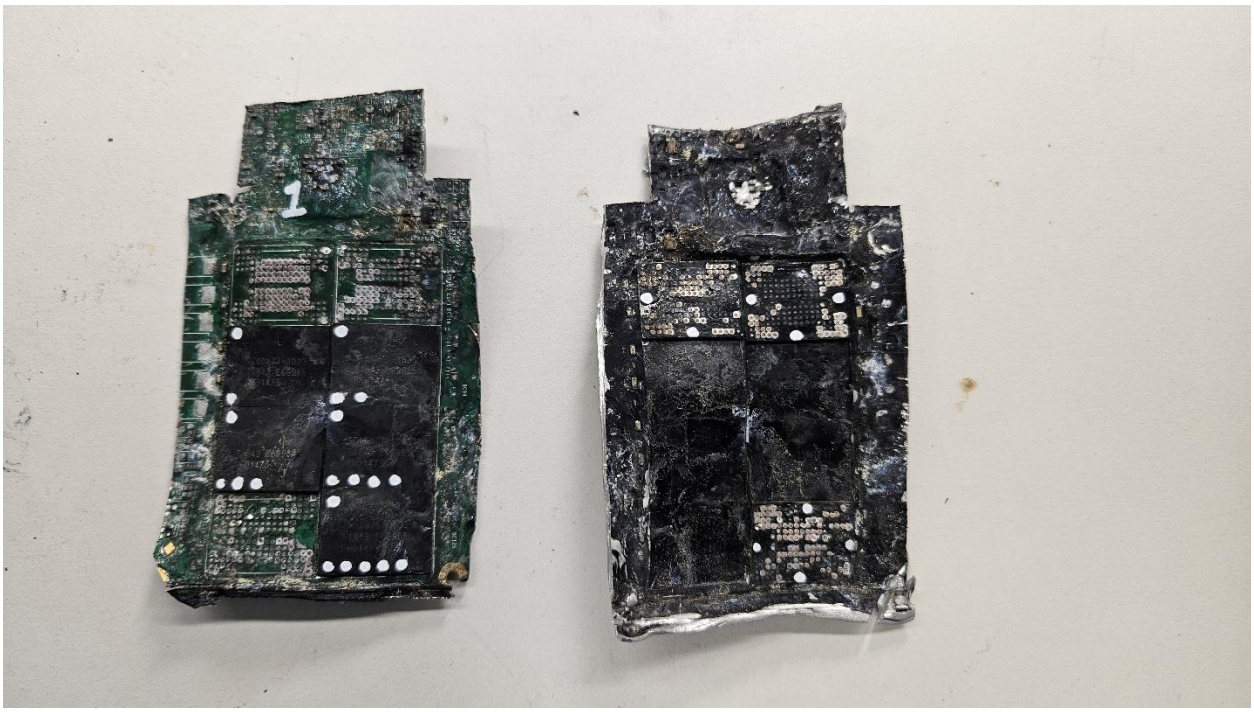

Figure 7. The two recovered PCBs.

Box 1 and Box 2 of Miscellaneous Electronic Equipment

Each component was identified. All components suspected of containing NVM were identified as being of interest. The manufacturers of each component suspected of containing NVM were all contacted and provided a description and additional photographs. All components of interest were determined to either have no NVM, or their contents would have been not important to the investigation. No data was recovered from any of the components in boxes 1 and 2.

Submitted by:

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