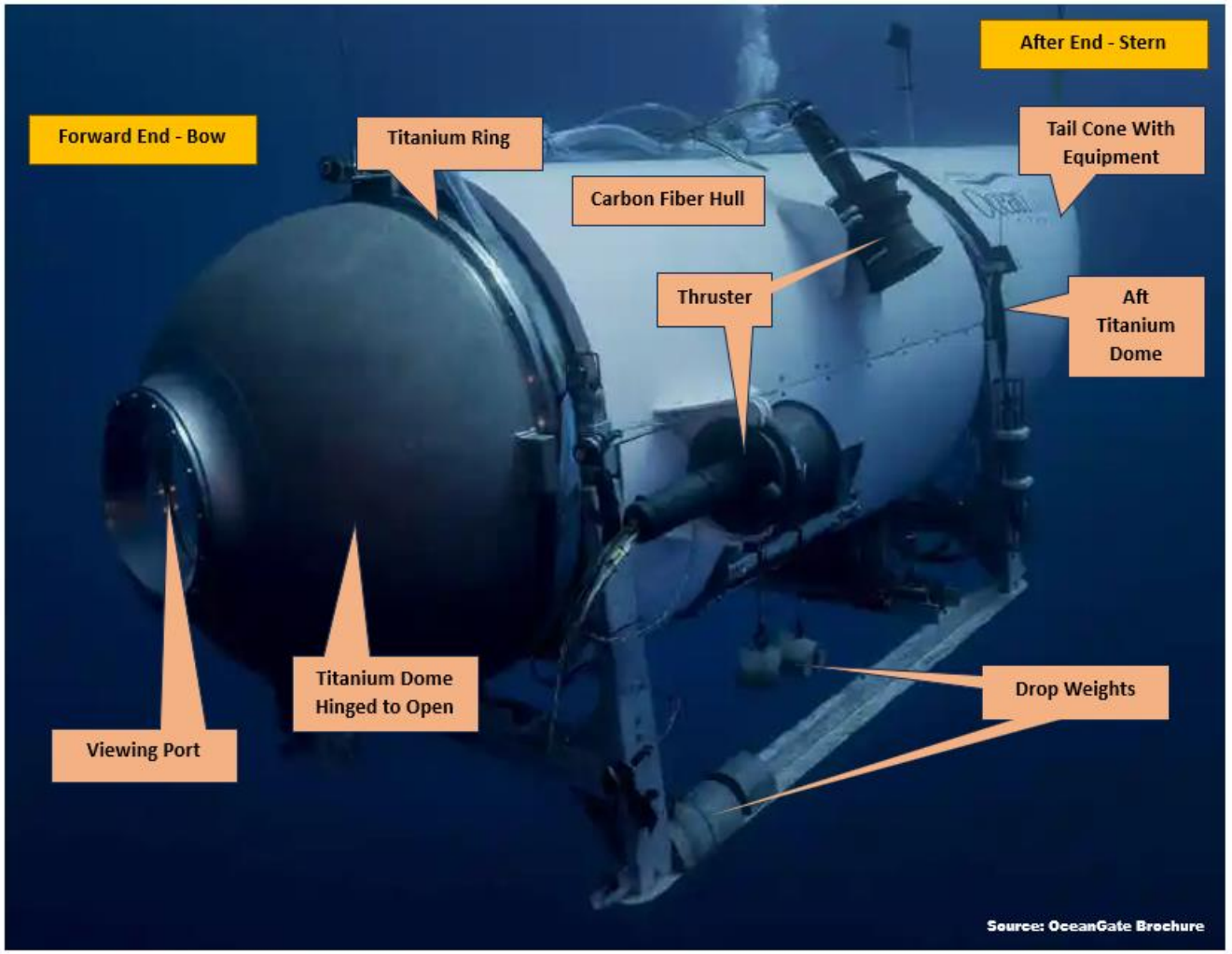
Submersible TITAN
USCG Marine Board Public Hearing
September 16 – 27, 2024

Purpose of the Investigation

Whether there is evidence that any failure of material (either physical or design) was involved or contributed to the casualty, so that proper recommendations for the prevention of the recurrence of similar casualties may be made;

Whether there is evidence that any act of misconduct, inattention to duty, negligence or willful violation of the law on the part of any licensed or certificated person contributed to the casualty, so that appropriate proceedings against the license or certificate of such person may be recommended and taken under 46 U.S.C. 6301; or

Whether there is evidence that any Coast Guard personnel or any representative or employee of any other Government agency or any other person caused or contributed to the casualty.



Principal Components of the Manned Submersible TITAN

Vessel Particulars

Official Name:	**TITAN**
Identification Number:	**None**
Owner/Operator:	**OceanGate, Inc. Everett, WA USA**
Vessel Class/Type/Sub-Type:	**Submersible**
Build Year:	**2020**
Gross Tonnage:	**23,000 pounds**
Length:	**22 feet**
Beam/Width:	**9.2 feet**
Vertical Height:	**8.3 feet high**
Main/Primary Propulsion:	**4 Innerspace 1002 electric thrusters**

Crew

Name	Relationship to Vessel*	Sex	Age	Status
Stockton Rush	Pilot/ Owner	Male	61	Deceased
Paul-Henri Nargeolet	Co-Pilot	Male	77	Deceased
Shahzada Dawood	Crew 1	Male	48	Deceased
Suleman Dawood	Crew 2	Male	19	Deceased
Hamish Harding	Crew 3	Male	68	Deceased

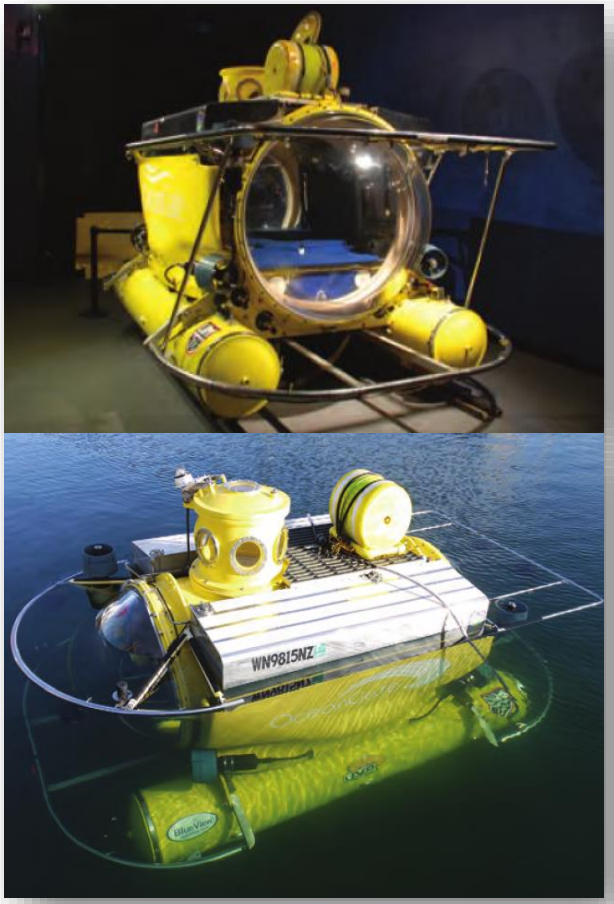
*as per TITAN Dive Plan C2_088

OceanGate History

- **OceanGate, LLC was founded in 2009 by Stockton Rush, Guillermo Sohnlein, and Sarah Schwitters.**

- **OceanGate corporations include:**
  - OceanGate Inc.
  - OceanGate Expeditions
- **Associated with OceanGate:**
  - OceanGate Foundation

- **2009- Purchased ANTIPODES, 13-ft ABS classed A1 submersible (~305 M capability)**
  - Applied for CG Certification, unable to attain due to sub-T regulations
  - Attained oceanographic research vessel (ORV) designation and conducted dive operations (Puget Sound, Miami, San Francisco)

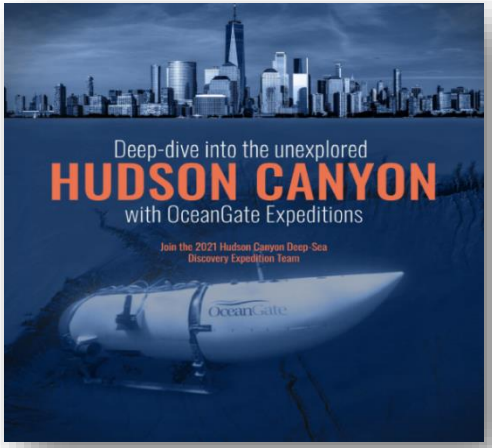


ANTIPODES images from OceanGate specification sheet, Source: OceanGate

OceanGate History

- **2013- Purchased 5-person 22-ft submersible w/ 500-meter capability. CYCLOPS I, was utilized as test platform for software, technology and equipment for TITAN.**
  - Never applied for inspection from USCG; obtained oceanographic research vessel (ORV) designation from Coast Guard Sector Puget Sound in 2018.
  - Conducted domestic operations from 2015,
  - ANDREA DOREA mission (2016) - Departed Boston, towed to dive site off Nantucket Island; charged "mission specialists" $20K for a seat on submersible.
  - Hudson Canyon Mission (2020)- Departed New York, towed by offshore supply vessel (OSV), "mission specialists" paid $35K for dive.
  - Completed 17 major expeditions with ANTIPODES and CYCLOPS I

CYCLOPS 1 image from OceanGate specification sheet., Source: OceanGate



CYCLOPS I brochure 2021, Source: OceanGate

TITAN Prototype History

- 2013: Entered contract with University of Washington- Applied Physics Lab for $5 million for development, construction and testing of manned carbon fiber submersible, estimated time frame for vehicle (TITAN), 30 months.

- 2015/2016:
  - 1/3 scale model testing:
    - December 2015 failed at 2,943M
    - February 2016 failed at 4,121M
    - March 2016 failed at 2,753M
    - July 2016 failed at 4,465M

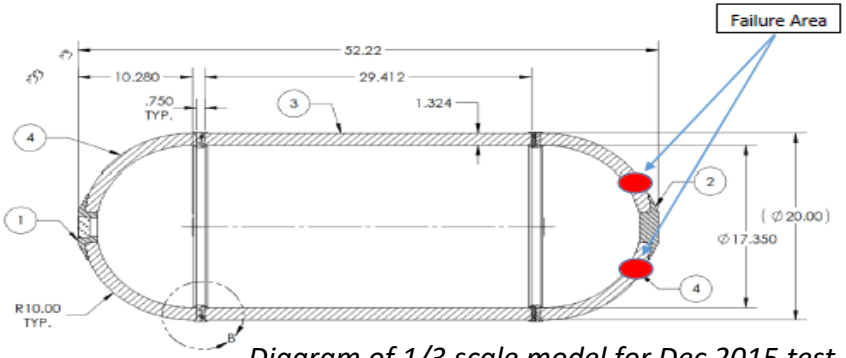


Diagram of 1/3 scale model for Dec 2015 test, Source: OceanGate

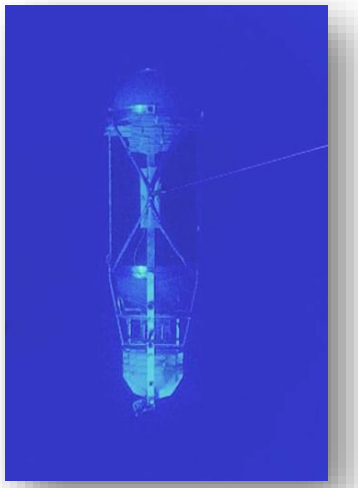
- 2017: Carbon Fiber hull was completed by Spencer Composites with no Coast Guard or classification society oversight. There was no non-destructive testing (NDT) conducted on the hull.

- The original plan was to utilize carbon fiber domes, but due to the failures in the 1/3rd scale models (cited in the above image), they then switched to titanium domes and rings which were manufactured by TIFAB with no Coast Guard or Classification Society oversight.

- **The ABS Underwater Rules do not permit the use of carbon fiber composites for PVHOs.**

2017-2018 TITAN Development

- March 2017: OceanGate announces trips to the TITANIC. The price of an "SME" ticket is $105,129; the inflation-adjusted cost of a first-class ticket of the Titanic on its maiden voyage ($4,350).
- May 2017: OceanGate began conducting engineering work in house.
- July 2017: Carbon fiber hull and titanium rings were bonded together using an adhesive by OceanGate employees.
- December 2017: Final mechanical inspection report for Conical Frustrum Dome window completed by Hydrospace Group.
- January 2018: The TITAN was full assembled
- February 2018: First manned dive in TITAN to 3M.
- April 2018: TITAN arrives in Bahamas, allegedly stuck by lightning, delaying scheduled test dives
- Released statement cancelling 2018 TITANIC Expedition, due to weather, OceanGate unable to achieve 4000M < 45 days before expedition
- June 2018: 3 unmanned dives (1200M, 2500M, 4000M)



Overhead view of the TITAN during testing in 2018, Source: OceanGate

TITAN Prototype History, Late 2018 - 2019

- December 2018: Mr. Rush completed solo dive in TITAN to ~3939M.
- April 2019; completed a dive to 3,760M w/ 4 total crew.
- June 2019: OceanGate pilot visually identified a large crack on the internal surface of the carbon fiber hull.
- June 2019: TITANIC Expedition 2019 cancelled citing complications to do with the status/ flag of the support vessel MV HAVILA HARMONY.
- October 2019: TITAN tested at Deep Ocean Test Facility. Hull showed signs of fatigue, hull derated to 3000M.

TITAN prototype being transported in for testing in the Bahamas.

MBI photo of failed prototype TITAN carbon fiber hull, red circle indicates crack on internal hull surface that occurred in June 2019.

TITAN Final Hull- 2020

- NASA and OceanGate in contract (Space Act Grant) for development, manufacturing and testing of manned submersible. Due to COVID, NASA provided limited services to OceanGate.
- OceanGate contracted local WA company, ElectroImpact, to build 2 1/3 scale models and the new carbon fiber hull utilizing the Automated Fiber Placement (AFP) system.
- The full-size hull was cured after every ~ inch in an autoclave at Janicki Industries.
- Titanium domes and rings were removed from prototype hull and used on final hull.
- 16 strain gauges and 8 acoustic emission sensors were affixed to the inside of the hull to act as a Real Time Monitoring hull assessment.
- The outside of the hull was covered with a polyurethane coating prohibiting any external visual inspection of the carbon fiber hull.

2020: TITAN Hull at ElectroImpact

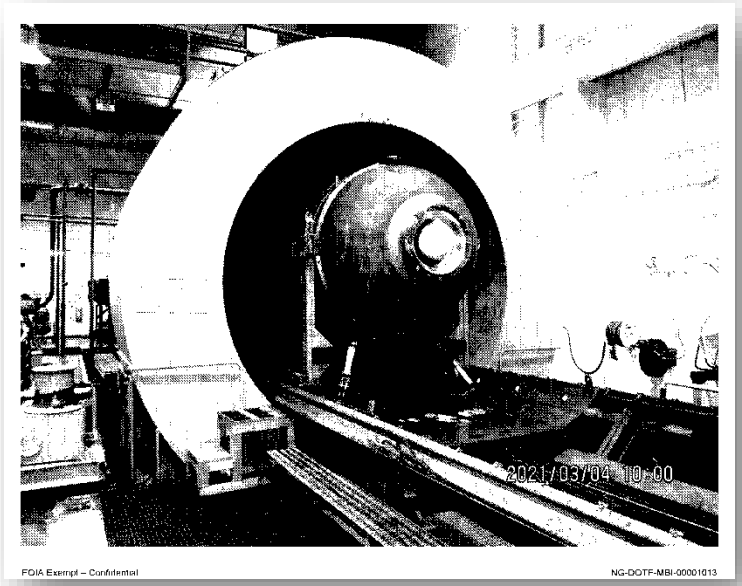
TITAN Final Hull- 2021

- March 2021: Completed TITAN hull was tested at Deep Ocean Test Facility in MD:

Test Cycles

Day 1: max depth of ~4,000M
(5,858psi for two cycles (30 min and 40 min)
Day 2: max depth of ~4,200M
(6,154 psi for one 20-minute cycle)
Day 3: max depth of ~3,840M
(5,627psi for one 240-minute cycle)
Day 4: max depth of ~3,840M
(5,628 psi for one 240-minute cycle)

Operating Depth of TITAN at the RMS TITANIC site was 3,840M; TITAN was tested to 1.09 times its operating pressure. Industry standard is 1.25 times twice every 5 years as per ASME for allowed materials.

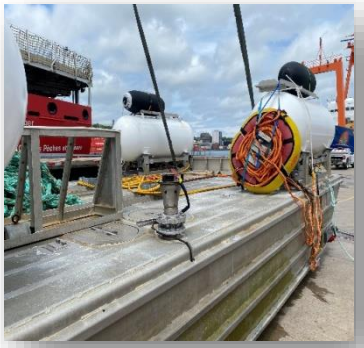


2021: TITAN in test chambers at the Deep Ocean Test Facility, Source: Deep Ocean Test Facility

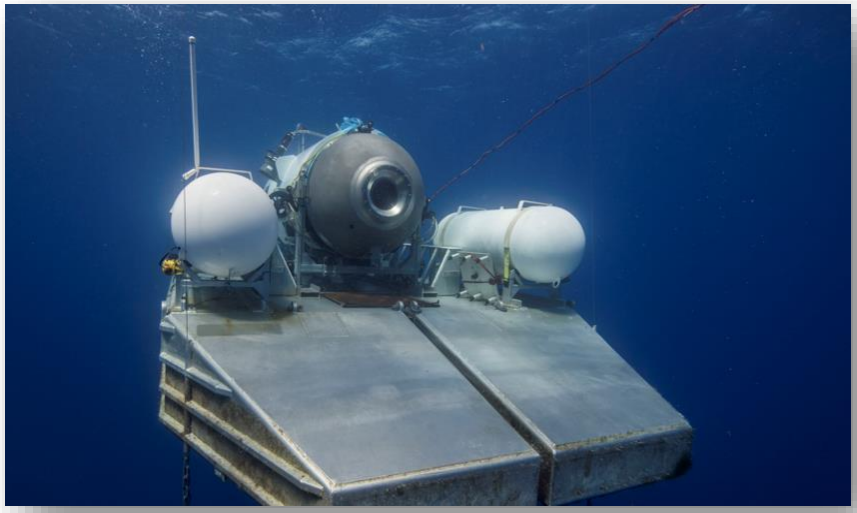
- June 2021 :Mobilized to St. Johns, Newfoundland, Nova Scotia, Canada and began Expedition 2021

Launch and Recovery System (LARS)

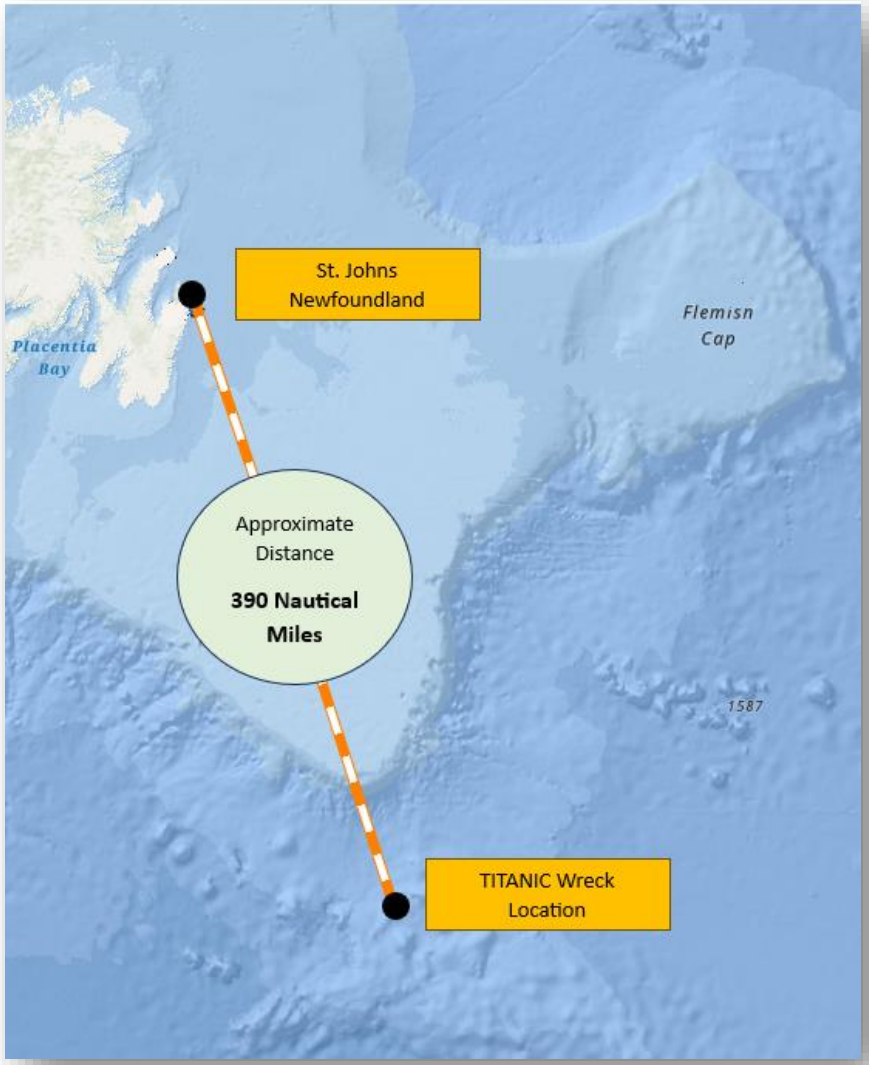
- Built by Everest Marine in 2017, completed in 2018
- 38’ long x 16’ 6” beam x 3’ 8” depth
- 4 separate hull compartments that can be manipulated to flood, which would sink the platform to approximately 10M below the surface to allow for the TITAN to depart and/or arrive under the water surface.
- Those compartments would then be filled with air from the 4 air receivers on the LARS to raise the platform. This action is completed by the platform operator who is stationed above in a small support vessel.



Left: Source: USCG, Right, Source: Dr. Steven Ross



Source: OceanGate Expeditions



Distance and Location of RMS TITANIC wreck site for TITANIC Expeditions

North Atlantic Ocean

Latitude:	41 Deg 43.980’ N
Longitude:	049 Deg 56.900’ W

Approximately 390 nautical miles SSE of St. Johns, Newfoundland

Depth of wreck: 3,355 meters (11,007 Feet)

Source: USCG

TITANIC Expedition 2021

- NOAA notified of operations pursuant to expedition, NOAA determined no Section 113 authorization was required.

- 2021 and 2022: Utilized HORIZON ARCTIC (Canadian Flag OSV), mission departed from St. John's, NF, NB. TITAN and platform were loaded on the stern ramp affixed to the vessel and transported to TITANIC wreck (370-Nautical Miles from Newfoundland). Each mission lasted approx. 8 days: 2 days transit time, 4 days of dives, 2 days return.

<u>2021 Expedition</u>: June 28th to August 6th; 10 dives attempted, 6 successful to TITANIC depth (3,840M)

- Conducted 1 test dive (dive #63) to depth on TITANIC (3,840M) before carrying paying passengers/ "mission specialists"
- 70 equipment issues requiring correction including:
  - forward dome fell off during recovery,
  - multiple drop weight issues to include the tray being jettisoned due to malfunction,
  - drop weight and thruster failure at 3,500M, and
  - platform damaged on recovery.
- Departed Canada via flatbed; conducted 4-month road show to market TITANIC Expeditions (University of Rhode Island; Atlanta, GA; Lake Forest, IL; Los Angeles, CA)

Expedition 2022, TITAN on LARS on stern ramp of the HORIZON ARCTIC, LARS/TITAN could be winched on deck during transits, Source: OceanGate

TITANIC Expedition 2022

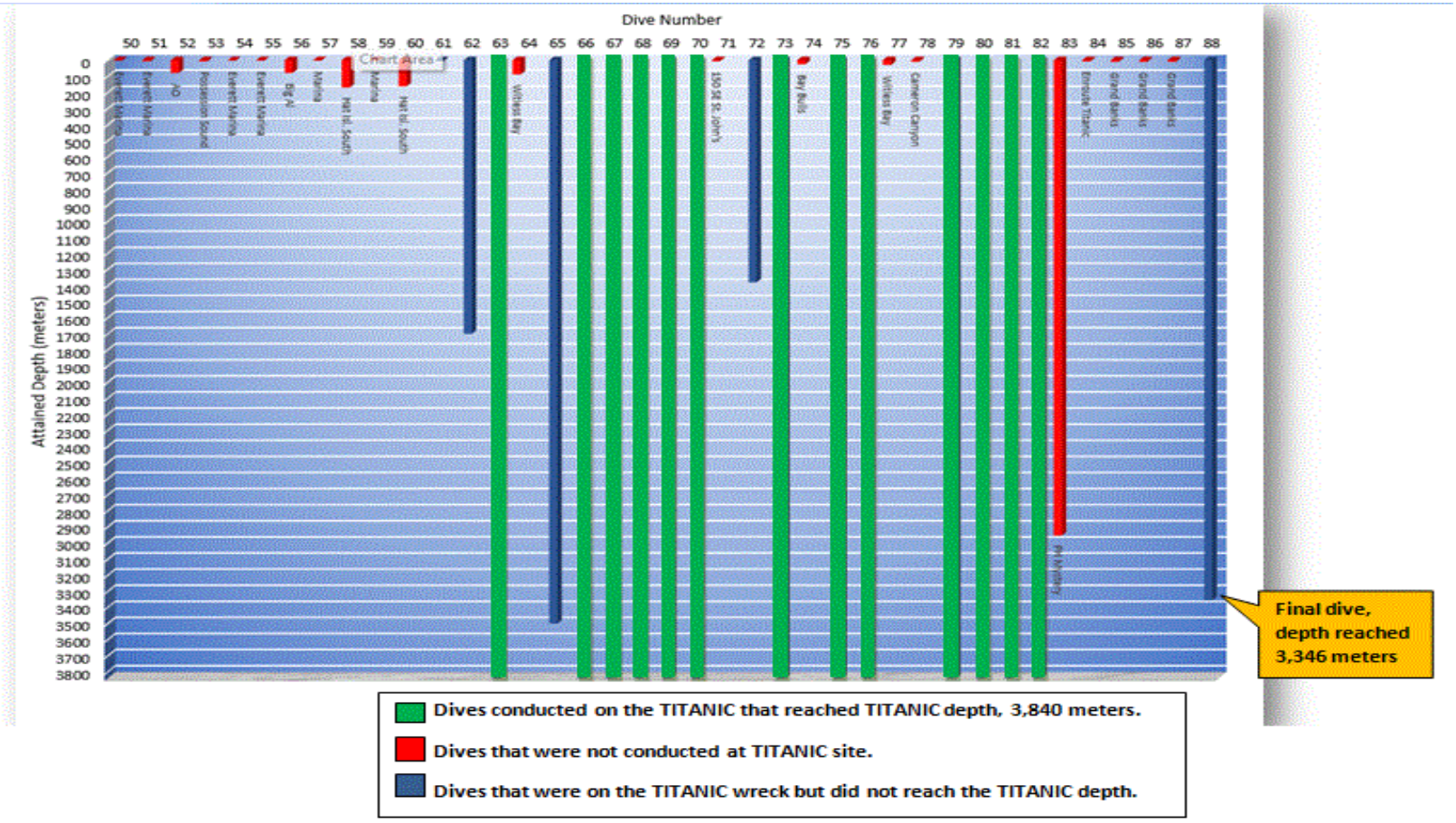
<u>2022 Expedition</u>: June 14th to July: 25th, 13 dives attempted, 7 successful to TITANIC (3,840M)

- Conducted 1 test dive to 7M, with passengers, prior to diving to depth.
- 48 equipment issues documented during expedition. Major Incidents include batteries died on TITAN, extending the time inside TITAN to 27 hours; platform damaged during recovery, TITAN aft fairing torn off, Data Voyage Logger INOP below 500M, TITAN damaged during recovery, drop weights malfunction, thrusters mapped in reverse.
- Upon completion of Expedition, TITAN was stored at shoreside facility in parking lot along dock without protection from elements (uncovered) from July 26th, 2022 – Feb 6th, 2023.
- St. Johns Airport Weather Data for July 2022 thru April 2023: High Temp: 84.2 Deg F, Low Temp: 1.4 Deg F, Average Temp: 39 Deg F.

TITAN in winter storage Winter 2022-2023, Source: Mr. Phil Brooks

TITAN transported to the Marine Institute of Memorial University February ,2023 – Source: Mr. Phil Brooks

Summary of Depths, Dive 50 - 88 Attained by TITAN



Prepared by the USCG Marine Safety Center

2023 TITANIC Expedition

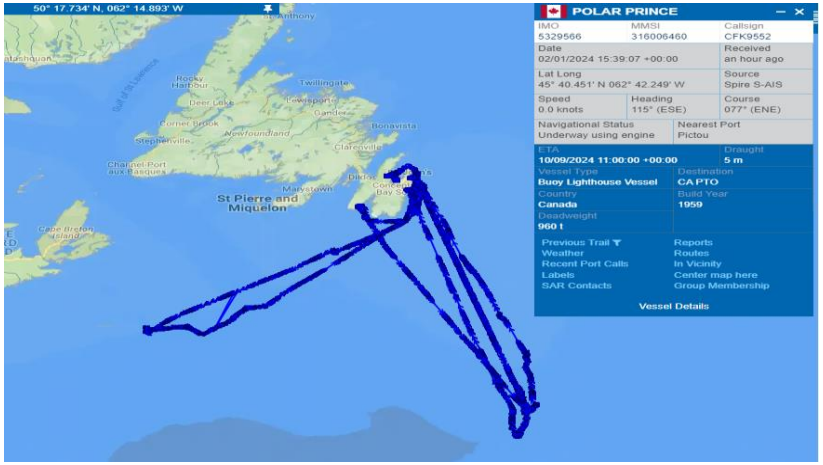
- According to witness testimony, due to high charter rates and non-availability of support vessels based on increase in offshore oil production, 2023 Expedition utilized the M/V POLAR PRINCE, a Canadian Flagged Research Vessel (Old Canadian CG Tug).

- Due to the lack of deck space, launching appliances, and weight handling equipment, the LARS/ TITAN were to be towed behind the POLAR PRINCE for the entirety of each mission.

- Missions 1 thru 4: Which began on May 12th, transited a total ~3,600 nautical miles with TITAN in tow (configuration below). Completed 4 dives, none of which left platform (10M).

Lars/ TITAN towed behind POLAR PRINCE. Source: Mr. Grant Nemirow

POLAR PRINCE. Source: USCG



POLAR PRINCE 2023 Expedition, Track of the POLAR PRINCE, Source: USCG Pole Star

Significant Events TITANIC Expedition 2023

Mission #1 (May 11 – May 19)

- POLAR PRINCE departed on May 11th to Conception Bay to rendezvous with the TITAN (which was at the Marine Institute Holyrood Launch) to conduct "familiarization" training. No Mission Specialists were aboard. No dives completed.

Mission #2 (May 20 – May 28)

- POLAR PRINCE departed St. Johns on May 20th enroute TITANIC with TITAN in tow at an average speed of 7.4 knots (8.4 mph). May 22nd, conducted unmanned dive to 8 meters (Dive 84). On May 24th, after a night of high seas and fog, the TITAN and its platform were found partially sunk in the morning with the tail cone fairing ripped off. May 27th conducted post incident test dive, recorded 13 equipment issued requiring correction.

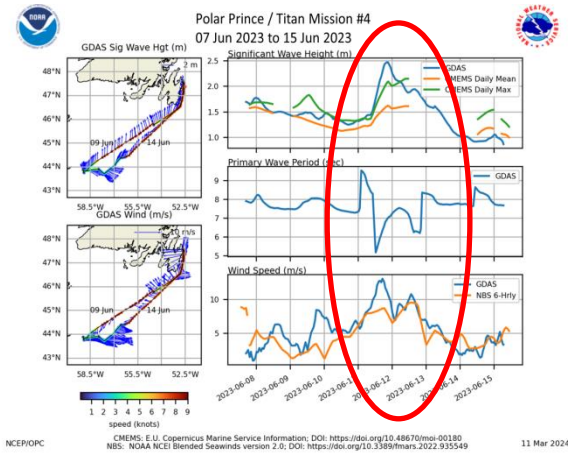
Mission #3 (May 29 – June 6)

- POLAR PRINCE departed St. Johns on May 29th and proceeded to Witless Bay to continue checks from the May 24th incident. Completed dives on May 30 tl (not logged) and May 31st (Dive 85) completed to 10M. On June 5th, completed Dive 86 with and 3 Mission Specialists.

Mission # 4 (June 7 – Jun 15)

- POLAR PRINCE departed St. Johns on June 7th. Due to weather at the TITANIC site, the POLAR PRINCE transited 400 nautical miles to the northwest of the TITANIC site. On June 12th, while conducting Dive# 87, TITAN experienced a variable ballast tank issue, upon resurfacing, an error caused platform to become inverted to ~45 degrees with the bow of the TITAN up, slamming all 5 persons to the aft of the submersible. The TITAN became partially disconnecte to the LARS and with the approximate 6 foot, slammed the submersible and the occupants for ~1 hour until the platform was corrected.

TITAN on Morning of May 24, 2023, LARS Partially Sunk. Source: Mr. Marcus Morrissey



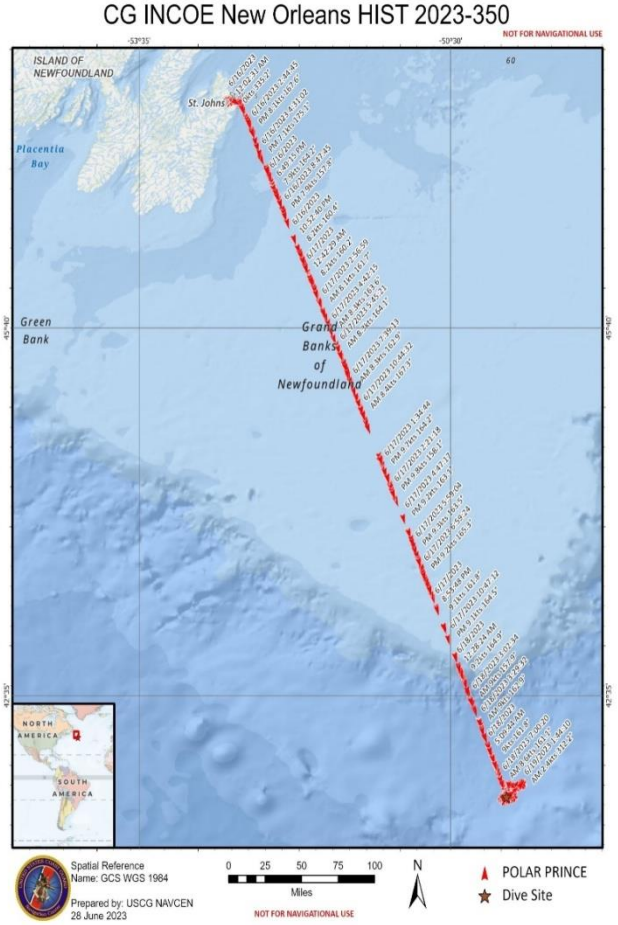
NOAA weather for location of Dive 87. Source: National Oceanographic and Atmospheric Administration

2023 TITANIC Expedition

Mission 5:

- June 16th: POLAR PRINCE departed St. Johns at 09:31 a.m. (**local Newfoundland Daylight Time NDT – 2.5 hours behind Universal Coordinated Time**) with 42 total persons on board (17 crew, 24 clients, and one non-designated person) enroute TITANIC wreck site.
  - The 17-crew consisted of POLAR PRINCE crew members.
  - The 24 "clients" consisted of 7 OceanGate employees, 11 3rd party contractors, 4 "Mission Specialists" and 2 "Mission Specialist Companions."
- According to the POLAR PRINCE deck logbook, after departing the harbor, the tow was set to 250 meters astern of the vessel.
- June 17th: Day spent with an all-hands meeting, training, lunch, presentation, more training, dinner and a dive plan review that evening.

POLAR PRINCE towing the LARS platform with TITAN onboard out to sea, Source: Dr. Steven Ross



Track of POLAR PRINCE towing the LARS platform with TITAN to the RMS TITANIC site, Source: USCG

2023 TITANIC Expedition

Mission 5

- June 18th: at 5:15 a.m. (local), the POLAR PRINCE arrived in vicinity of the TITANIC wreck site location and according to their logbook, they shortened the tow. The average speed throughout the transit of the POLAR PRINCE with the TITAN and LARS in tow was approximately 8.3 knots.

- At 5:30 a.m. (local), according to the **TITAN Dive Plan C2_0088**, a 15-minute final dive brief was held in the helicopter hangar.

- The final risk index for Dive 88 was calculated at 35.

Titan Dive Plan - C2_0088

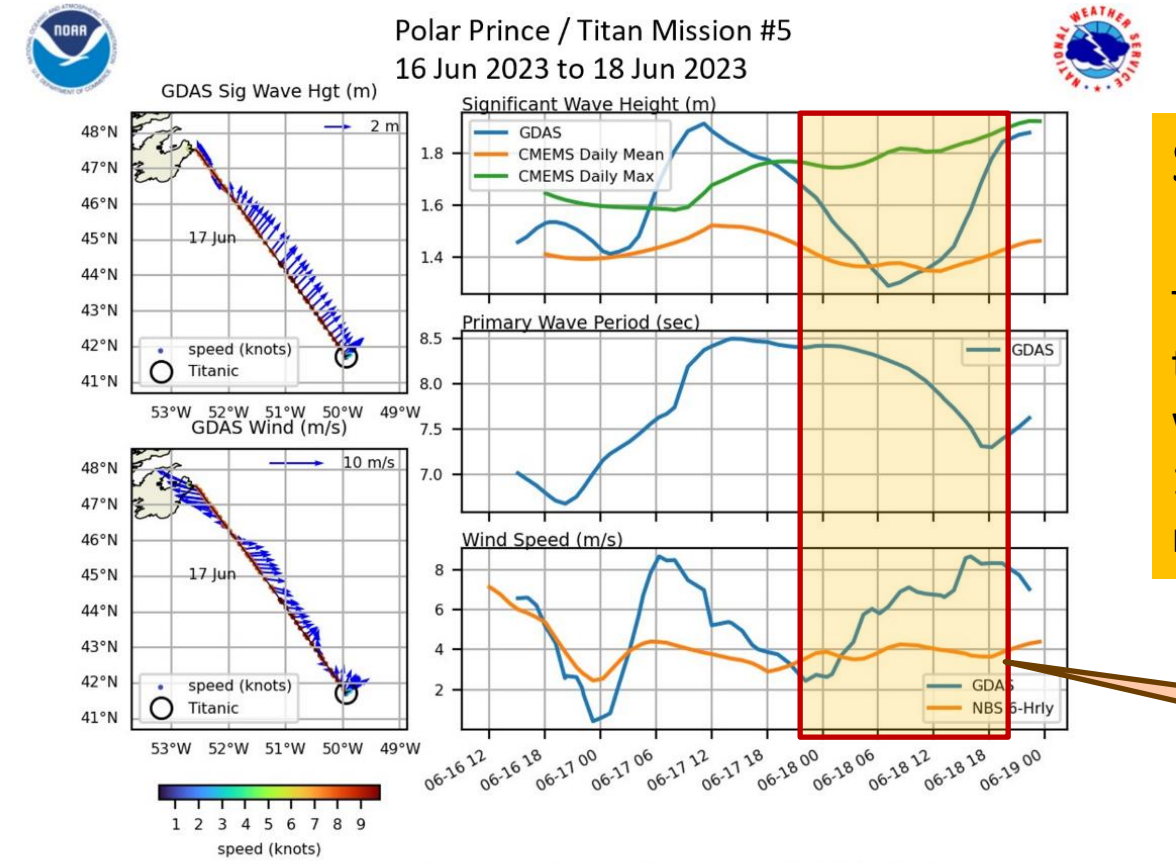
Date: 6/18/2023
Operating Channel: Ch 69
Objectives: Wreck Scans
Primary Location: Titanic
Risk Index: 35
Configuration: Biological Observation

Schedule

Task	Start Time	Duration	End Time	
Ship slows and shortens tow	5:00	0:15	5:15	
Dinghy checks	5:00	0:30	5:30	
Pre Brief in heli hangar	5:30	0:15	5:45	
Launch Max with dive gear and divers	5:45	0:15	6:00	
Remove hatches prep platform for dome crew	6:00	0:30	6:30	
Launch Stewie and transit w dome crew	6:00	0:15	6:15	
Lower Tracking pole	6:15	0:15	6:30	
Close/Open Dome	6:15	0:20	6:35	
Sub Vessel Checks	6:35	1:00	7:35	
Load Crew in Stewie & transit to platform	7:35	0:30	8:05	
Load sub & vacuum	8:05	0:30	8:35	
Platform Prep	8:35	0:15	8:50	
Stopski	8:50	0:05	8:55	
Sink platform	8:55	0:05	9:00	
Remove lock(s)	9:00	0:10	9:10	
Dive	9:10	9:00	18:10	
Raise platform	9:40	0:15	9:55	When sub thru 1,000m
Service Sub/Platform/Dive Gear	9:55	1:30	11:25	
Recovery team mobilizes	17:40	0:30	18:10	When sub thru 1,000m
Sink platform	18:10	0:10	18:20	When ship abeam
Titan Lands	18:20	0:20	18:40	
Remove/Insert lock	18:40	0:10	18:50	
Raise platform	18:50	0:10	19:00	
Close/Open Dome	19:00	0:20	19:20	
Load vessels & transit to ship	19:20	0:15	19:35	
Post Dive Secure	19:35	0:30	20:05	

Source: OceanGate

Weather at Time of Incident



Simplified Weather:

The on-scene weather in the vicinity of the TITANIC wreck site was SW winds 13-19 knots with 2–3-meter wave heights.

Accident Day

NOAA weather for location of Dive 88. Source: National Oceanographic and Atmospheric Administration

2023 TITANIC Expedition, June 18, 2023

Mission 5: June 18

- At 5:48 a.m. (Local), the accommodation ladder had been placed over the side of the vessel. An accommodation ladder is a set of stairs used for transitioning from a vessel to another vessel or dock.
- At 5:58 a.m. (local), a 16’ Seamax rigid hull inflatable boat (RHIB), was launched, which was crewed by the Dinghy Captain, Diver #1, Diver #2, and Dive Support.
- At 6:24 a.m. (local), another RHIB was launched and transited to the platform. This was the same type of vessel as the other and was crewed by the Dingy Captain, Platform Operator, and Platform Assistant.
- At ~6:30 a.m. (local), the divers commenced their dive and TITAN vessel checks commenced.
- At ~7:35 a.m. (local), one of the rigid hull inflatable boats was loaded with the Dive 88 crew to transport them to the LARS platform.
- At ~8:30 a.m. (local), the five members of Dive 88 were loaded into the TITAN and the forward dome was secured.
- At 8:55 a.m. (local) the platform was vented, causing it to sink to the operational depth of 30 feet below the surface of the water.

2023 TITANIC Expedition (Continues)

Mission 5: June 18 (Continues)

- At 9:14 a.m. (local), according to the POLAR PRINCE Deck Log, the TITAN disengaged from the platform, maneuvered away, and proceeded to dive with five persons on board.
- At 9:18:16 a.m. (local), the POLAR PRINCE sent a "*k*" communication to the TITAN. According to the OceanGate Communications Sheet, "*k*" means comms check. The approximated depth of the TITAN was 165 meters (M). 44 seconds later, the TITAN requested a comms check with a communication of "*k*" to the POLAR PRINCE. The POLAR PRINCE received a "ping" from the TITAN approximately every 5-10 seconds.
- Communications continued throughout the descent, there were no transmissions which indicated trouble or any emergency aboard the TITAN.
- At 10:47:27 a.m. (local), the TITAN messaged, "dropped two wts". The depth of the TITAN was approximately 3341 M. This was the last message that was sent from the TITAN.
- 6 seconds later at 10:47:33 a.m. (local), the TITAN was pinged for the final time. The TITAN's location was 41.73441N; -49.9424E. The depth of the TITAN was 3346 M.

2023 TITANIC Expedition (Continues)

Mission 5: June 18 (Continues)

- At 10:49:50 a.m. (local), the POLAR PRINCE sent a message to the TITAN that stated, “lost tracking.” There was no response. The POLAR PRINCE continued messaging the TITAN two to three times per minute, with no response

- At 11:15 a.m. (local), the Master of the POLAR PRINCE was advised that as of approximately 10:47 a.m., there was a loss of communication with the TITAN.

- According to the Mission Director, they followed the missed communications protocol outlined in the OceanGate HSE Manual

- According to the Mission Director, in accordance with the OceanGate HSE procedures, based upon the last know position of the TITAN and given a 2M per minute ascent rate, the TITAN was expected to surface at approximately 3:00 p.m. (local).

2023 TITANIC Expedition (Continues)

Mission 5: June 18 (Continues)

- When the TITAN did not surface, OceanGate followed their HSE procedure, and the POLAR PRINCE began a grid pattern surface search. The grid pattern search resulted in negative sightings.

- The Master of the POLAR PRINCE stated, *At 1827 following a meeting in my cabin with amongst others OceanGate staff (REDACTED Names) I called the Joint Rescue Coordination Centre (JRCC) Halifax by sat-phone but communications with JRCC were shortly thereafter cut-off. When I re-established communications, I was informed by JRCC that the area of the Titanic wreck is under the Search and Rescue jurisdiction of RCC Boston*.

- At 7:10 p.m.(local) , on June 18, 2023, in accordance with OceanGate loss of communications protocol, after three hours of searching the surface with negative results, the POLAR PRINCE contacted the Canadian Coast Guard, who referred them to the U. S. Coast Guard Rescue Coordination Center Boston. Upon receiving the notification, the First Coast Guard District Command Center entered the distress phase 4.

Location of Accident and Final Location of Wreckage of TITAN

On June 22nd, 2023, at 10:50 a.m. (local), the Pelagic Research Services 6000, remotely operated vehicle (ROV), which had been searching since arrival at the distress location discovered the aft tail cone and other debris of the TITAN on the seafloor after extensive searching. This discovery led to the conclusive evidence of the catastrophic loss of the submersible TITAN and the death of all five members aboard.

ROV image of TITAN tail cone. Source: Pelagic Research Services, June 2023

Recovery Operations

- During the two recovery operations, presumed human remains were recovered from the TITAN ocean floor site.

- The remains were recovered and respectfully transported to shore.

- The Armed Forces Medical Examiners System, specifically the DOD DNA Identification Laboratory located in Dover, Delaware positively identified DNA profiles for the five victims and the Rhode Island Medical Examiner coordinated decedent affairs with the families.

END