The Sinking of the Unsinkable (again)



Wendy Owen revisits a newsletter article from last year on the Titan submersible accident (June 2023), and uncovers a sorrowful tale of wayward tourism, bucket-lists of the rich, rogue designers, paid-off whistleblowers, a whole suite of independent assessors, test facilities, accreditation bodies and regulators "with no teeth", and dubious legal waivers…

As mentioned in my previous article on this topic ("A Brief Quest for Lesser-Spotted News Articles in Dependability", SCSC Newsletter Feb 2024), I feel reasonably qualified and experienced to talk about this as I've worked on similar submersibles in the distant past. The moral of the tale last time was that just because it appears reliable, dependable or a fantastic innovation, it doesn't mean it's safe, and doesn't mean you can ignore implementing a comprehensive reliability testing plan.

Over a year on, much more information has come to light as it has been through the courts – and it is worth revisiting this case. By the time of publishing this article, I'd hope that the investigation should have mostly concluded (hearings were ongoing during September and October 2024, but it then went quiet).

Firstly, I can confirm that the vessel was owned by an American tourism/expeditions company named OceanGate, and that towards the end of its dive it suffered a hull failure and imploded, with instant deaths of all five occupants. To ascertain how this occurred, we need to look back at a chain of events – in this case, the chain of events turned out to be much longer than I was expecting. Thus, this is a rather long article.

Why did Titan exist in the first place?

Tourism, for the wreck of the Titanic, sunk in 1912. The wreck lies at a depth of 12,500ft / 3,810m, 590km / 370 miles from the coast of Newfoundland. Apparently, by 2012, a century later, 140 people had visited the wreck site. One could ask why people have a need to view old shipwrecks 12,500ft below sea level, but shipwrecks feature in many maritime museums and obviously the Titanic is particularly famous. OceanGate realised that visiting shipwreck sites was a good income stream, and they could also charge a premium for the Titanic. Titan appears to have served no other purpose than for tourism, bucket-lists of the rich, and media attention – which ultimately, it received excessive amounts of, but for all the wrong reasons.

I propose a few other reasons for its continued existence during this article, namely; rogue inventors, designers who didn't whistle-blow, designers who did whistle-blow but were paid off, independent assessors who walked away from the scene at crucial points, test facilities who got worrying results but didn't halt testing, naïve businessmen, unbelievable legal waivers (presumably written by lawyers/solicitors), plus engineering industry societies, safety accreditation bodies and regulators "with no teeth". From a design and safety management perspective, this is a whole chain of very serious stuff! If you put a Swiss cheese model up against Titan's safety credentials, you would end up with grated parmesan.

What was its modus operandi?

Dives by Titan to the Titanic wreck occurred as part of multi-day excursions. The excursions were referred to as "missions", as per military language, and passengers were even referred to as "mission specialists"; they paid $250,000 each (on occasion discounted for multiple tickets). They would sail to and from the wreckage site aboard a support ship and then spend five days in the ocean above the Titanic wreckage site; eight-days in total.

Usually, two dives were attempted during each excursion, though dives were often aborted due to weather or technical malfunctions. Each dive typically had a pilot, a guide, and three paying passengers on board. Once inside the submersible, the hatch would be bolted shut and could only be reopened from the outside. The descent from the surface to the wreck took about two hours, with a full dive taking about eight hours.

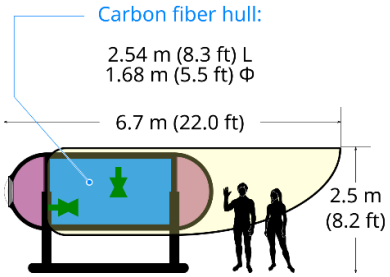
According to OceanGate, the vessel contained monitoring systems to continuously monitor the strength of the hull and the vessel had life support for five people for 96 hours.

Throughout the journey, the submersible was expected to emit a safety "ping" every fifteen minutes, monitored by the above-water crew. The vessel and surface crew were also able to communicate via brief text messages. There is no GPS underwater; the support ship monitored the position of Titan relative to its target, and sent brief text messages to Titan providing distances and directions.

Five missions occurred in the middle of each of the two previous years, 2021 and 2022. Titan imploded during the fifth mission of 2023; it was the first mission that year in which a dive came close to the Titanic, previous attempts being aborted due to poor weather.

How was it designed and by whom?

It was formerly called Cyclops 2. Apparently, there were problems with Cyclops 1 (not investigated further here). Its basic design looked like this.



It wasn't very big. It was constructed from carbon fibre and titanium. weighed 10,432kg and could hold up to 5 people. Essentially, it was a pressure vessel made up of two titanium domes with matching titanium interface rings bonded to a carbon fibre-wound cylinder. One of the titanium hemispherical end caps could be detached to provide the hatch and was fitted with a 15-inch diameter acrylic window.

Titan could move at up to ~3 knots (5.6 km/hr, 3.5mph) using four electric thrusters, arrayed two horizontal and two vertical. Its steering controls consisted of a Logitech F710 wireless game controller with modified longer joysticks. The University of Washington Applied Physics Laboratory (UW APL) assisted with the control design on Cyclops 1 using a similar video game controller, which for Titan was substituted with the Logitech controller. Its steering gadgets were thus quite basic. The use of game controllers is nowadays not uncommon for some remote-control systems such as Uncrewed Aerial Vehicles (UAVs), bomb disposal robots and periscopes.



Titan steering control – Logitech F710

OceanGate claimed that Titan was the only crewed submersible that used an integrated real-time monitoring system (RTM) for safety. This system, patented by Rush – one of OceanGate's engineers - in 2021, used acoustic sensors and strain gauges at the pressure boundary to analyse the effects of increasing pressure as the vessel went deeper into the ocean and to monitor the hull's integrity in real time. This would supposedly give early warning of problems and allow enough time to abort the descent and return to the surface.

OceanGate claimed that Titan had several backup systems intended to return the vessel to the surface in case of emergency, including ballasts that could be dropped, a balloon, thrusters, and sandbags held by hooks that dissolved after a certain number of hours in saltwater (in theory this would release the sandbags, allowing the vessel to float to the surface). An OceanGate investor explained that if the vessel did not ascend automatically after the elapsed time, those inside could help release the ballast either by tilting the ship back and forth to dislodge it or by using a pneumatic pump to loosen the weights. Of course, this all assumed that the vessel remained intact and didn't travel beyond its bounding conditions.

In 2020, Rush said that the hull, originally designed to reach 4,000m/13,000ft below sea level, had been downgraded to a depth rating of 3,000m/9,800 ft after demonstrating signs of cyclic fatigue (recall that Titanic was at nearly 4,000m depth). A 1/3-scale model of the Cyclops 2 pressure vessel was built and tested at UW APL; the model was able to sustain a pressure of 4,285 psi (29.54 MPa), corresponding to a depth of about 3,000m. In 2020 and 2021, the hull was repaired or rebuilt (recall that dives occurred in 2021 and 2022).

In 2023, OceanGate claimed on its website that Titan was "*designed and engineered by OceanGate Inc. in collaboration [with] experts from NASA, Boeing, and UW*". After the implosion, these earlier associates disclaimed involvement with the project.

- Rush had told Travel Weekly that the carbon fibre for the hull had been sourced at discount from Boeing because it was too old for use in aeroplanes, but Boeing said they had no records of this. A Boeing spokesperson claimed Boeing "*was not a partner on Titan and did not design or build it*"
- UW claimed the APL had not been involved in the "*design, engineering, or testing of the Titan submersible*"
- A NASA spokesperson said that their Marshall Space Flight Centre had a Space Act Agreement with OceanGate, but had no connection to Titan

It subsequently became evident, however, that both UW and Boeing had put forth numerous design recommendations and rigorous testing requirements, which Rush apparently ignored despite the implosions during trials at UW APL. The partnerships dissolved as Rush refused to work within quality standards.

Safety Approvals and Use of Waivers

A note that this section is, for the most part, presented in reverse chronological order.

OceanGate had initially not sought safety certification for Titan, arguing that excessive safety protocols hindered innovation. Additionally, because Titan operated in international waters and did not carry passengers from a port, it was also not subject to (marine) safety regulations. It was also not certified by Lloyd's Register. Thus, it was not certified as seaworthy by any regulatory agency or third-party organisation.

A reporter who completed an expedition in 2022, as part of a CBS News feature, said that all passengers who enter Titan signed a waiver confirming their knowledge that it is an "*experimental*" vessel "*that has not been approved or certified by any regulatory body, and could result in physical injury, disability, emotional trauma or death*". A television producer who completed the expedition said the waiver "*mentioned death three times on page one*".

"At some point, safety just is pure waste. I mean, if you just want to be safe, don't get out of bed"

Stockton Rush

In a 2022 interview, Rush told CBS News, "*At some point, safety just is pure waste. I mean, if you just want to be safe, don't get out of bed. Don't get in your car. Don't do anything.*" In a 2021 interview he said "*I've broken some rules to make [Titan]. I think I've broken them with logic and good engineering behind me. The carbon fibre and titanium, there's a rule you don't do that. Well, I did.*" A 2019 article published in Smithsonian magazine referred to Rush as a "daredevil inventor", where he commented that the U.S. Passenger Vessel Safety Act of 1993 "*needlessly prioritized passenger safety over commercial innovation*".

Lloyd's Register refused OceanGate's request to class the vessel in 2019.

In 2018, OceanGate's director of marine operations, Lochridge, composed a report documenting safety concerns he had about Titan:

- He urged the company to have Titan assessed and certified by the American Bureau of

Shipping, but OceanGate had refused to do so, instead seeking classification from Lloyd's Register (who, as per above, refused)

- He said that the transparent viewport on its forward end, due to its nonstandard experimental design, was only certified to a depth of 1,300m/4,300ft - only a third of the depth required to reach the Titanic's wreck
- He said the RTM would "*only show when a component is about to fail – often milliseconds before an implosion*" and could not detect existing flaws in the hull before it was too late.
- He was concerned that OceanGate would not perform non-destructive testing on the vessel's hull before undertaking crewed dives and alleged that he was "*repeatedly told that no scan of the hull or Bond Line could be done to check for delaminations, porosity and voids of sufficient adhesion of the glue being used due to the thickness of the hull*"

Elsewhere, evidence pointed to the viewport being rated to only 650m/2,130ft; the viewport's engineer also prepared an analysis from an independent expert that concluded that the design would fail after only a few 4,000m dives.

OceanGate said that Lochridge – who was not an engineer – had refused to accept safety approvals from their engineering team and that their evaluation of the hull was stronger than any kind of third-party evaluation. OceanGate sued Lochridge for allegedly breaching his confidentiality contract and making fraudulent statements. He counter-sued, stating that his employment had been wrongfully terminated as a whistleblower for stating concerns about Titan's ability to operate safely. The two parties settled the case a few months later before it came to court. He (rightly) filed a whistleblower complaint with (American) Occupational Safety and Health Administration, but – crucially and unfortunately – withdrew it after the lawsuit was filed.



Late 2018, a group organized by Kohnen, the chair of the Submarine Group of the Marine Technology Society, drafted a letter to Rush expressing "*unanimous concern regarding the development of 'TITAN' and the planned Titanic Expedition*", indicating that the "*current experimental approach ... could result in negative outcomes (from minor to catastrophic) that would have serious consequences for everyone in the industry*". The letter said that OceanGate's marketing of the Titan was misleading because it claimed that the submersible would meet or exceed the safety standards of classification society DNV, even though the company had no plans to have it formally certified by DNV.

While the letter was never sent officially by the Marine Technology Society, it did result in a conversation with OceanGate that resulted in some changes, but in the end Rush "*agreed to disagree*" with the rest of the civilian submarine community. Kohnen told the New York Times that Rush had telephoned him after reading it to tell him that he believed industry standards were stifling innovation.

Another engineering signatory, Kemper, agreed to sign the letter because of OceanGate's decision not to use established engineering standards like ASME Pressure Vessels for Human Occupancy (PVHO) or design validation. He said the submersible was "*experimental, with no oversight*". Kohnen and Kemper stated OceanGate's methods were not representative of the industry; they were both members of the ASME Codes and Standards committee for PVHOs, which develops and maintains the engineering safety standards for submarines, commercial diving systems, hyperbaric systems, and related equipment. Kemper has published several technical papers on submarine windows, ironically including discourse on a need to innovate.

In March 2018, one of Boeing's engineers involved in the preliminary designs, Negley, carried out an analysis of the hull and emailed Rush directly stating, "*We think you are at high risk of a significant failure at or before you reach 4,000m. We do not think you have any safety margin.*" Apparently he included an ingenious graph of the strain of the design with a skull and crossbones at a red line of 4,000m (this approach could also be adopted elsewhere!)

Also in March 2018, McCallum, a major deep sea exploration specialist, emailed Rush to warn him he was potentially risking his clients' safety and advised against the submersible's use for commercial purposes until it had been tested independently and classified: "*I implore you to take every care in your testing and sea trials and to be very, very conservative.*" Rush replied that he was "*tired of industry players who try to use a safety argument to stop innovation ... We have heard the baseless cries of 'you are going to kill someone' way too often. I take this as a serious personal insult*". McCallum then sent Rush another email in which he said: "*I think you are potentially placing yourself and your clients in a dangerous dynamic. In your race to Titanic, you are mirroring that famous catch cry: 'She is unsinkable*". This prompted OceanGate's lawyers to threaten McCallum with legal action.

> **"… in your race to Titanic, you are mirroring that famous catch cry: 'She is unsinkable'"**
>
> **McCallum**

I can envisage your hair standing on end reading these enlightening paragraphs. In a nutshell, the vessel was operating beyond several of its structural subsystem's safety margins. Yet no one stopped it. The consequences were virtually inevitable.

Let's now look at what else occurred before the inevitable happened.

Previous incidents

In 2021, as mentioned, a new hull was constructed – this was after a previous hull cracked after only fifty dives, only three of which were to 4,000m. Scale models of the hull imploded at UW APL, so a different method of curing the hull was developed and this passed a full-sized pressure test at a facility in Maryland. Rush refused to construct new domes and other components from the failed submersible and instructed the engineers to salvage and reuse parts. Anonymous former employees told Wired that damage to the components could have weakened the join with the new hull. They also added lifting rings, which was previously warned against by engineers because the submersible could not handle any tension or load.

In 2022, Pogue, a reporter, was aboard the surface ship when Titan became lost and could not locate the wreck of the Titanic during a dive. His report for CBS News Sunday Morning,

which questioned Titan's safety, subsequently went viral on social media in June 2023 after the submersible lost contact with its support ship. In the report, Pogue commented to Rush that "*it seems like this submersible has some elements of MacGyvery jerry-rigged-ness*". He mentioned the Logitech game controller and that construction pipes were used as ballast.

In a 2022 dive to the wreck, one of Titan's thrusters was accidentally installed backwards and the submersible started spinning in circles when trying to move forward near the sea floor. In the BBC documentary "*Take Me To Titanic*", this issue was bypassed by steering while holding the game controller sideways. According to court filings, OceanGate reported that, in a 2022 dive, the submersible suffered from battery problems and, as a result, had to be attached manually to a lifting platform, causing damage to external components.

On 15 July 2022 (dive 80), Titan experienced a "*loud acoustic event*" as it was ascending, which was heard by the passengers aboard and picked up by Titan's real-time monitoring system (RTM). Data from the RTM later revealed that the hull had permanently shifted following this event.

Also in 2022, British actor and television presenter Ross Kemp, who had previously participated on deep sea dives for Sky History, had planned to mark the 110th anniversary of the sinking of the Titanic by recording a documentary in which he would undertake a dive to the wreck using Titan. Kemp's agent said that the project was cancelled after checks by Atlantic Productions deemed the submersible to be unsafe and "*not fit for purpose*".

The fatal dive

Here I will only summarise what happened on the day of the accident, as to do otherwise would significantly extend this already long article, and I purposely want to draw more attention to the design and pre/post-accident discussions.

The voyage was booked in early 2023. One American businessman was offered two tickets at discount ($150,000 each) with Rush claiming it was "*safer than crossing the street*" – the businessman declined due to safety concerns. The excursion was due to happen in May but due to untoward weather (apparently the worst in Newfoundland in 40 years) it was delayed until a better window in June. The MV Polar Prince transported Titan and the expedition's crew to the dive site on 16-17th June. The dive was on 18th June.

For the first hour and a half of the descent, Titan communicated with Polar Prince via text about every fifteen minutes and received a "ping" every 5-10 seconds. Final communications were sent at 10:47 at an approximate depth of 3,341m/10,961ft. At the point of implosion, the submersible had completed, or almost completed, its dive. Comms messages indicated they had visibility of the Titanic. It was expected to resurface at 16:30. The US Coast Guard (USCG) was notified that the vessel was missing at 19:10.

Search and Rescue efforts took around 4 days; at the time, it was viewed as search & rescue rather than a wreckage recovery. The search area was informed by the US Navy's sonar detection of an acoustic signature consistent with an implosion around the time communications with the submersible ceased, suggesting the hull had imploded while Titan was descending. Search efforts involved the USCG, Canadian coast guard, US Navy (including a US Navy deep-sea salvage system that arrived but didn't get used), Royal Canadian Air Force, US Air National Guard, a Royal Canadian Navy ship, several commercial and research ships

and Remotely Operated underwater Vehicle (ROVs), and passing aircraft. The surface was searched as well as underwater, by sonar. The search covered 10,000 square miles.

The remote location, weather, darkness, sea conditions and water temperature all made the search difficult. Many submersibles have acoustic beacons, but apparently Titan did not. There were a few false alerts to noises and debris. Eventually, an ROV owned by Pelagic Research Services discovered a debris field containing parts of Titan, five hours into its search.





Remains of Titan on Ocean Floor

At a U.S. Coast Guard press conference in Boston, they said that pieces of Titan had been found in two areas on the sea floor approximately 500m northeast of the bow of the Titanic. The debris consisted of the tail cone (not part of the pressure vessel) and the forward and aft end bells (both part of the pressure vessel) with the aft-end bell lying separate from the front-end bell and the tail cone. They also said that the debris was consistent with a "catastrophic loss of the pressure chamber" i.e. an implosion.



Pelagic Research Services confirmed on 23rd June that a new mission to the Titan debris field was already underway and that it had taken the ROV one hour to reach the site to continue searching and documenting debris. The debris was too heavy for Pelagic's ROV to lift and a recovery would need to occur at a later time.

On 24th June, Polar Prince returned to St. John's harbour, where investigators boarded the ship, and also, the launch and recovery system (LARS), which Titan used.

Shortly after the disaster, a well-known deep sea Canadian filmmaker indicated that it was likely the submersible's early warning system alerted the passengers to an impending delamination of the hull, saying *"we understand from inside the community that they had dropped their ascent weights and were coming up, trying to manage an emergency*." A retired Naval officer (Ballard, the discoverer of the Titanic wreck) also said that the crew was likely "*experiencing difficulties*" and was trying to ascend at the time of the implosion. However, in September 2024, Catterson, an OceanGate contractor who was aboard the Polar Prince at the time of the disaster, testified at the United States Coast Guard's inquiry that there was no indication that the crew was aware of any problems before the implosion.

The last human-written communication by Titan indicated that they dropped two weights, amounting to 32 kg, about a tenth of the drop weights on board, but this was apparently routine to adjust the Titan's buoyancy from negative to neutral as it approached the seabed, and was an indication that the crew was not aware of any emergency situation. The last automatic ping was received by the Polar Prince approximately six seconds later, after which contact was lost.

Simulations developed in 2023 suggest the implosion of the vessel took less than one second, likely only tens of milliseconds, faster than the brain can process information; there would not have been time for the victims to experience the collapse of the hull, and they would have died immediately.

"the implosion of the vessel took less than one second, likely only tens of milliseconds, faster than the brain can process information"

On 28th June, Horizon Arctic returned to St. John's Harbour with the remains of Titan that were recovered from the debris field. Photographs and videos showed the titanium covers on both ends of Titan intact, with the single viewport missing, mangled pieces of the tail cone, electronics, the landing frame and other debris. The debris was to be transported to the U.S. as evidence for the investigation. The USCG confirmed that presumed human remains were found within the debris, and that American medical professionals would conduct an analysis. In September 2024, during the public hearing by the Marine Board of Investigation, USCG confirmed that the Armed Forces DNA Identification Laboratory positively identified DNA profiles for the five victims.

On 30th June, Insider published an analysis of the recovery photos by Plymouth University professor Graham-Jones. He concluded that a failure of the carbon-fibre hull was the most likely cause of the loss, given that no large pieces of carbon fibre are known to have been recovered. Another possible cause was the acrylic viewing window, since the window was absent from its bell housing when it was recovered. While the salvage team may have removed the window before salvaging its bell housing, they more likely would have left it in place. He said that if the window had failed before the hull rather than after, he would have expected larger pieces of carbon fibre to be recovered.

In early October, engineers recovered the endcap and the rest of the debris.

Financials and Taxpayers

A defence budget expert estimated the costs of U.S. Coast Guard operations alone at about $1.2 million of taxpayers' money, with the additional operations to recover the debris not included. A Canadian taxpayer's estimate was at least $3 million. The US National Association for Search and Rescue said the search for Titan was likely to cost millions of dollars of public funds; however, the USCG refused to give an estimate, saying they "*do not associate cost with saving a life*". According to a U.S. attorney, the USCG is generally prohibited by federal law from collecting reimbursement related to any search or rescue service.

The incident renewed past debates about whether taxpayers should bear the cost of search and rescue missions involving wealthy people engaged in high-risk adventuring. The costs and scale of the search and rescue efforts for Titan sparked criticism in the media when compared to those for the Messenia migrant boat disaster. This occurred only days earlier and involved a fishing boat that sank while carrying an estimated 400 to 750 migrants,

resulting in around 100 deaths, 100 rescued, and hundreds more missing and presumed dead. This event also received significantly less media attention (noted by former US president Barack Obama).

Investigations and Lawsuits

On 23rd June, both the Canadian and the United States federal governments announced that they were beginning investigations of the incident. They were subsequently joined by authorities from France (Bureau d'Enquêtes sur les Événements de Mer, BEAmer) and the UK's Marine Accident Investigation Branch (MAIB); the final report is expected to be issued to the International Maritime Organization (IMO). Whether any lasting reforms will result from the investigation is uncertain, because the IMO may not have appropriate regulatory authority. Either way, parties are advising that the investigation is a complex and ongoing effort.

Even the Royal Canadian Mounted Police (RCMP) announced that it was performing a preliminary examination of the incident in order to determine whether to begin a full investigation, which will occur if it determines that criminal, federal or provincial laws were broken.

From 2021 to 2023, the Titan conducted seven dives in Canadian waters and three dives in Canada's Exclusive Economic Zone (EEZ). During this same timeframe it also conducted nineteen dives outside Canadian waters and Canada's EEZ, which included its dives to the Titanic. For each of these dives, the Titan was transported to the dive site from a Canadian port and returned to a Canadian port, using a Canadian-flagged vessel. During these operations, the Titan and its launch platform were not registered or certified in Canada or any other country. The investigation also identified other submersibles operating within Canadian waters and Canada's EEZ, both before and after June 2023. Some are registered in Canada; some are registered outside of Canada; and some are not registered. As a result of this information, the TSB issued a marine safety information letter (MSI 01/24) to Transport Canada advising of the risk posed by submersibles operating in Canadian waters.

The investigation is now in the report phase. On 6th August 2024, the family of Nargeolet (one of the deceased) sued OceanGate for wrongful death.

In the Media

Scott-Beddard, the CEO of White Star Memories Ltd, a Titanic exhibition company, observed that the likelihood of performing future research at the Titanic wreck decreased due to the incident.

James Cameron, who directed the 1997 movie Titanic, visited the Titanic wreck 33 times, and piloted Deepsea Challenger to the bottom of the Mariana Trench, said he was *"struck by the similarity*" between the submersible's implosion and the events that resulted in the Titanic disaster. He noted that both disasters seemed preventable and were caused indirectly by someone deliberately ignoring safety warnings from others. He criticised the choice of carbon-fibre composite construction of the pressure vessel, saying it has "*no strength in compression*" when subject to the immense pressures at depth; the wound carbon fibre of Titan's hull had seemed like a bad idea to him from the beginning. He stated that it was long known that composite hulls were vulnerable to microscopic water ingress, delamination, and progressive failure over time.

He also criticised Rush's real-time monitoring of the hull as an inadequate solution that would do little to prevent an implosion. Cameron expressed regret for not being more outspoken

about these concerns before the accident and criticised the "*false hopes*" presented to the victims' families; he and his colleagues realised early on that for communication and tracking to be lost simultaneously, the cause was almost certainly a catastrophic implosion.

Also in the media:

- Apparently the Logitech F710 game controller used to steer Titan sold out on Amazon soon after the incident, described as "*a more benign form of disaster tourism*" by the New York weblog The Cut
- Titan became widely discussed on social media as the story developed and was the subject of "*public schadenfreude*" inspiring grimly humorous Internet memes, namely interactive video game recreations and image macros that ridiculed the submersible's deficient construction, OceanGate's perceived poor safety record, and the individuals who died. The memes were criticised as insensitive, and some have felt the negative reaction to the victims may be a response to past news coverage of other expeditions by billionaires. The incident was widely treated on social media as entertainment. Major elements include the allure of disasters, fascination with the wealthy, conspiracy theories, uncertainty, and the mythology of the Titanic, as well as the romance of rescue operations
- In September 2023, it was announced that a new movie about the Titan submersible incident, named *Salvaged*, was in development
- The 2024 American Broadcasting Company (ABC) special *Truth and Lies: Fatal Dive to the Titanic* examined the implosion of Titan
- In February 2024, a movie inspired by the events of the Titan submersible incident, entitled *Locker*, was announced
- In March 2024, a two-part documentary by ITN Productions*, Minute by Minute: The Titan Sub Disaster*, was broadcast by Channel 5 (UK). The documentary included interviews with the Canadian air crew that searched the surface, the Pelagic ROV team that found the wreckage, and members of the Marine Technology Society (Kohnen and Kemper, mentioned above). Analysis of the mysterious "*banging*" sounds that seemed to indicate the occupants were still alive was a main feature of the first part

End Notes. What is Tolerability?

The investigation discovered the company had not sought certification for the vessel, arguing that "*excessive safety protocols and regulations*" hindered innovation. I commented previously that in this case it became obvious that 'successful' operations and the purported reliability of the missions to date (not many) had been prioritised over real design safety margins, by a long chalk. Issues were raised by the design team but ignored. It hadn't been rigorously tested before going into operation. These assertions still hold.

Yet, the court case has also revealed a plethora of other issues; **it was clearly being operated beyond its design safety margins but the passengers signed legal waivers essentially alerting them of their impending death. This gives a whole different perspective to the concept of 'tolerability' and 'acceptability' beyond the norms of what one would usually come across** in a civil or military ship safety case. Safety in the maritime sector covers concept, feasibility, design, build, test, operation and maintenance, plus intentional, inadvertent or accidental disposal, and now, evidently, disaster tourism.

The lack of regulation – or, more specifically, regulation with teeth – for such vessels is an obvious loophole in the current system. Maybe regulators didn't think such a dangerous vessel operating well beyond its safety margins would ever be encountered, so it was not on anyone's radar. The rogue inventor scenario was not considered. The wealthy who would take the risk in the rogue invention were not considered. There were too many 'Yes Men' in the chain of events, and one too many out-of-court settlements for whistleblowers. The fact that there had been whistleblowing on technical matters should have raised red flags somewhere. It seems lawyers were happier to support settlements than safety.

Moreover, safety and reputation don't matter to some people when their end goal is publicity, bravado and extreme tourism, regardless of what anyone else thinks. Not 'following the rules' and ignoring red is no excuse to you and me, but you must get inside the mind of those who see it as a big blocker to understand why they evade them – it's a blocker to their own personal pursuits. But it is to their own blinkered peril.

This is a very different situation to the Titanic; a well-built, large, purportedly unsinkable ship with many safety features that happened to be unlucky enough to crash into a ship-sinking iceberg. No one who designed or built Titanic was seen as a rogue inventor, although there are reports of the captain being a bit of a rogue operator ignoring warnings of icebergs. The fares were also a lot cheaper – apparently £1,000-£3,000 in today's money.

Wendy Owen

Wendy has 35 years' experience in systems safety and assurance across a wide range of highly regulated industries covering energy, defence, transport and process sectors. Her career has largely been in engineering consultancy, also with time in product development, research and regulatory. She is a Fellow of the Safety & Reliability Society and WES, and within SCSC a task lead in SiSWG and a member of the Steering Group. Early in her career she was involved in safety cases for various frigates, S, T & V Class submarines and other naval submersibles, and dockyards. One of her great-grandfathers was a 'marker-off' at Barrow shipyard, one grandfather was a sea-based merchant who rode on similar vessels to the Titanic, the other was a printer for a national newspaper covering such stories, her father was a Royal Marines Commando, and a former manager was an advisor to the Kursk submarine accident. She lives by the sea and does not have a boat.

References

At time of writing, the Wikipedia entry for the Titan accident has nearly 200 references, such is the appetite for people writing about this case. In writing this article, we have distilled data/information from various websites, to make all of it more readable for a safety-oriented audience. A references list is therefore not included on this occasion as it would take up the whole newsletter, although ironically perhaps this article may end up on that list one day.

Key websites referred to are those of the 'regulators' and other industry bodies discussing the court case and incident reports, as mentioned in the text.

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