NU KU LAR Corner

https://anthonyalbanese.com.au/media-centre/stronger-in-the-world-united-at-home-lowy-institute

EAST COAST BASING OF NUCLEAR SUBMARINES IN AUSTRALIA

John Mortimer has graciously given me permission to air this one in the dailies

Australia has a long history of operating submarines as part of its naval forces. The initial boats, HMA Submarines AE 1 and AE 2, were based in Sydney at Garden Island Dockyard. Both were lost during the Great World, one to accident and the other on operations in Turkish waters. After the conflict six former British J class submarines were operated for a short time based at Sydney, and later Geelong. Two further submarines were acquired during the late 1920s, Oxley and Otway, and again these were based in Sydney for a short period before being returned to the Royal Navy.

During the Second World War Australia operated one ex-Dutch submarine for training activities based in Sydney. US submarines were also based in Fremantle and Brisbane, and for a short time some were forward deployed to North-West Cape, until this base was vacated for operational reasons.

After the Second World War the Royal Navy operated the Fourth Submarine Squadron from Sydney. For a while the submarines were based at HMAS Penguin at Balmoral until a major storm demonstrated the fragility of this site to environmental damage. This and the introduction of the new Oberon class resulted in the construction of a specialised submarine base in Sydney at Neutral Bay and commissioned as HMAS Platypus on 18 August 1967. As well as supporting submarine operations the base also contained torpedo maintenance and other submarine related support. This site had limited growth potential being surrounded by urban development.

Given the restraints of the Platypus site and the development of a 'Two Ocean Basing' policy it was later decided to relocate all of the Oberon class submarines at HMAS Stirling in Western Australia. This development resulted in all major submarine infrastructure being located on the west coast - logistics, training, maintenance (except for refits which were undertaken in either the west or later at Adelaide for the Collins class), ordnance storage and various ranges. Initial planning was that the submarines - Oberon and Collins classes - would deploy to the east coast on a regular basis. However, this policy was long in its gestation because of competing priorities for submarines and issues with submarine reliability.

Visits of foreign nuclear powered warships are currently only permitted to Australian ports, which have been assessed and approved as suitable in terms of strict Australian environmental and safety criteria. Approval of visits is subject to satisfaction of these general conditions, and include:

· visits will be for purposes such as medical emergency, crew rest and recreation, exercise briefings and preparations, embarkation and disembarkation of logistics associated with operations and normal voyage repairs and not for nuclear fuel handling or repairs to reactor plant (necessitating breach of reactor containment).

· visits will be subject to satisfactory arrangements covering liability and indemnity, and to provision of adequate assurances relating to the operation and safety of the warships while they are in Australian waters.

· movement of vessels must take place during daylight hours under conditions where visibility is not less than three-quarters of a nautical mile.

· navigational controls on other shipping will be applied during the time that nuclear powered vessels are entering and leaving port, and

· there must be a capability to remove the vessel, either under its own power or under tow, to a designated safe anchorage or a designated distance to sea if an incident should occur.

For each nuclear-powered warship visit a routine environmental radiation monitoring program is conducted of air and water in the vicinity of the vessel to provide means to confirm no release of radioactive material or emission of ionising radiation.

Department of Defence OPSMAN1, dated 7 December 2016, details sites as being available for nuclear powered ship and submarine visits. Only HMAS Stirling, Brisbane and Gladstone have alongside berths with adequate safety zones; while Fremantle, Albany, Melbourne, Hobart, Jervis Bay, Gladstone and Darwin have offshore anchorages which have adequate safety zones.

On 7 March 2022, Prime Minister Morrison announced the Government's intention to establish a second submarine base, in addition to HMAS Stirling, as part of the proposal to acquire eight nuclear powered submarines. He stated that several sites had been examined and that the choice was between Brisbane, Newcastle and Port Kembla on the east coast. The Prime Minister outlined key criteria as being close to sufficient infrastructure and large population centres and reasonably near Australia's primary maritime training and operational areas, deep water, weapons storage and loading facilities. Of the three ports suggested by the Prime Minister, only Brisbane is currently assessed as suitable to provide an alongside berth for an Australian nuclear-powered submarine.

On the surface, it does not appear that much consideration has been given to the practicalities of nuclear submarine operations from the preferred sites. The three sites identified by the Prime Minister have some considerable practical or strategic issues which counsel against their adoption.

Brisbane is remote from the main fleet base in Sydney, current East Australian Exercise Areas, naval logistics, including the ammunitioning wharf at Eden, and prospective berths are on a river which is subject to flooding and the risks of damage to underwater fittings and vents from waterborne debris. Access to Brisbane is also subject to a reasonably lengthy and narrow shallow water passage which might be blocked or mined. The recent (February/March 2022) floods in Brisbane highlight the significant risks which attach to any naval support infrastructure which might be contemplated along the river.

Newcastle, while closer than Brisbane to the main fleet base in Sydney, exercise areas and logistic support is also on a river which floods and poses risks to submarine maintenance and availability. Like Brisbane it is also accessed by a narrow and shallow channel which might be blocked or mined. Submarine operations might also be influenced by the frequent movement of large bulk carriers in and out of port. There is also frequently a significant number of very large ships anchored off the port stretching up and down the coast. This could also pose a threat to submerged operations in the area. Environmental conditions can sometimes close the port to shipping operations.

Port Kembla lies between Fleet Base East in Sydney and the East Australia Exercise Area. It is the closest option of the three contenders to existing naval infrastructure and support. Like Newcastle it has a number of large merchant ships often anchored off the coast. Numbers of ships are generally less than those found off Newcastle. The port is relatively small with numerous industrial enterprises located in its vicinity. Importantly, from a strategic perspective, it is probably the most vulnerable to interdiction of submarine operations, because of its very narrow harbour entrance, offshore islands and shallow water approach. Environmental conditions can sometimes close the port to shipping operations.

In comparison to the three options offered by the Prime Minister, the approaches to Fleet Base East in Sydney and the Jervis Bay complex is via the open ocean and a gap of approximately two nautical miles at their entrance. The Armament Wharf at Eden also has unimpeded access to the open sea. The threat of mining or blockage is considerably less severe in these three sites than those proposed for a strategically important asset like nuclear-powered submarines.

None of the three suggested locations appear to be particularly suitable for alongside work to be undertaken on the vessels nuclear power plant. For current visiting nuclear submarines a safety arc of some 600-metres from the berth is provided and nuclear related work is prohibited. Whether these restrictions on nuclear powered submarines remain, given the technological developments in nuclear propulsion and its safety, will need review. Nuclear submarine basing for attack type submarines in both the UK and USA see ships based at

Hawaii, San Diego, Plymouth and elsewhere near population centres. Submarines armed with intercontinental nuclear missiles involve different strategic considerations and warrant more remote basing.

In summary, all three options for an east coast nuclear submarine base have major strategic considerations which should counsel against their adoption. There would seem little point in developing major submarine infrastructure at a site on the east coast which could be untenable due to environmental or adversary operations. While it can be important to access existing civil infrastructure and population centres, strategic assets like nuclear powered submarines also require a degree of isolation to ensure their covert activities are not prejudiced. It is also important that they have some distance from population centres to ensure public safety.

It is not clear at present what level of maintenance, logistic, training and operational support would be provided in an East Coast base and how this might impact on infrastructure and workloads at HMAS Stirling, the civil ship repair work in the west, and the Submarine Construction Facility at Adelaide. For example, would refits continue to be performed on all submarines in Adelaide, or would this work be undertaken in the submarines home port. Similarly, where might the mid-cycle dockings and urgent repair work be performed? Having built up a new submarine construction facility and the various skills related to this in Adelaide, it would seem logical that refits and dockings be retained in Adelaide otherwise important skills generated during construction and setting to work would atrophy over time.

Major infrastructure to support submarine operations exists in HMAS Stirling, the Fremantle area, as well as in Adelaide. Much of this will need to be modified or constructed to support the new submarines. However, it is questionable whether as a nation we can afford the luxury of having three major areas of submarine infrastructure support for just eight vessels.

The planned expansion of the Navy with the purchase of eight or nine new frigates, a series of OPV for patrol, survey and MCM operations, together with eight new nuclear submarines, will require a significant expansion of service personnel numbers. Ever since the relocation of the submarine force to Western Australia there have been recruitment and retention challenges. This is no doubt in part due to the limited number of recruits, or personnel, who wish to have a career in Australia's west, with its remoteness from the members broader family support, who are mostly from Australia's south east. In these circumstances, it will be necessary to review the overall balance of east and west coast based forces, to provide some assurance that recruitment and retention targets have some chance of being achieved. In relation to the submarine force this might require, for example, a three boats west and five boats east base or another split ratio to be adopted. One option might be for the west coast functions to centre around training as this type of infrastructure and ranges are already at, or proximate to, Stirling though some additional facilities will be needed to support nuclear submarines.

Given the limitations of Brisbane, Newcastle and Port Kembla, the option of a major submarine base in Sydney, Jervis Bay or possibly Eden, warrants serious review. The existing infrastructure in Sydney and its surrounds could reduce the overall investment in a new base, and might be located on the eastern side of Garden Island in the vicinity of the small boat compound, possible extending down to the old escort maintenance mooring site. A breakwater would also be needed to protect the submarines from prevailing weather conditions from the east. Other options exist in Sydney and include redevelopment and extension of the current sites at HMAS Waterhen, HMAS Platypus, and the former dockyard at Cockatoo Island. In relation to Jervis Bay, potential sites could include development of the Creswell waterfront with a breakwater and berth complex, as well as sites in the vicinity of Murrays Beach, the site of the proposed Nuclear Power Station in the late 1960s and in the north of the Bay in the vicinity of Montague Roadstead which was earlier proposed as the site for a Naval Ammunition Depot. The option of Twofold Bay in Eden might be developed in conjunction with the current ammunition wharf.

Sydney, Jervis Bay and Eden, do not have the significant strategic vulnerabilities of the three currently favoured options. With existing naval infrastructure in both Sydney and Jervis Bay there should be enhanced opportunities for personnel stability and hence improved retention rates of personnel.

Swarm Optimization for Energy-Based Acoustic Source Localization: A Comprehensive Study https://www.mdpi.com/1424-8220/22/5/1894

The marine biologist NEVER mentions any version of the word sing, but the ABC reporter knows better when discussing this encounter with a female Killer whale -ORCAs don't sing and no females in any of the whale species have been known to to date. No, but let's run with the Star Trekish narrative- there's a seat for you at the top table in Defence Ellie Honeybone! What's the issue? you ask - well it is the same lack of attention to detail and refusal to accept facts that comes with a culture that uses 'they have a pedigree' as a basis for buying new capaliabilities.
https://www.abc.net.au/news/2022-03-05/orca-recorded-singing-at-bremer-canyon-wa/100882462?fbclid=IwAR2xOlZS4Rq4ONvap6fzOSLPS_0obzjFJ3qHzYxATzk4qoD5F39Qr6FINZA

Senator Rex Patrick

On Facebook Saturday·
DEFENCE INNOVATIONS PLANNING BLUNDER
https://www.innovationaus.com/defences-industry-tech-programs-simply-not-good-enough/?fbclid=IwAR2VAH8SiKtS15M7_4jxnsCAfJ9rraS9ema85mU85q2s5HhIg35atrh_o7U
I support the Department of Defence assisting Defence Industry develop capabilities for our Defence Force. Yet, in response to questions I asked of the Defence Minister it has been revealed that only 10 in 233 funded Defence Innovation Hub programs have been used by Defence or are close to it. That's a 5% success rate.
This is not the fault of Defence Industry. This is poor Government planning in throwing taxpayer's money at projects that don't have a pathway into service.
Prime Minister Morrison wants a khaki election, but only one focussing on the year 2040 in circumstances where there is so much geopolitical tension here and now and so many projects failing under his Government's watch - Attack submarines, MRH-90 and Tiger helicopters, submarine rescue systems and the Army's Battle Management System.
All these failures are costing the taxpayer billions upon billions and denying our service men and women modern capabilities with which to defend us.

the article at the Link

Defence's industry programs 'simply not good enough'

Joseph Brookes
Senior Reporter

6 March 2022

Fewer than 5 per cent of projects funded by federal government's flagship Defence innovation program have gone on to export success, and just 7 per cent have been close to acquisition by Australian Defence forces in the last six years.

The low translation rates are despite $441 million being poured into the projects by Defence during that time, and are a part of a downward trend in success rates since programs were established more than 20 years ago.

The return is "simply not good enough", according to South Australian independent senator Rex Patrick, who uncovered the information, while the local Defence industry says companies need more strategic support from the government.

Defence Industry Minister Melissa Price this week provided a breakdown of outcomes from Defence's Capability and Technology Demonstrator (CTD) program and its successor, the Defence Innovation Hub.

The programs aim to invest in innovative technologies that can enhance Defence capability and grow the Australian defence industry and innovation sector.

The original CTD program ran from 1997 to 2016, funding 132 projects over 20 rounds with at least $155 million invested. Defence was unable to say how much was spent on the program in its first decade due to "system changes" in 2007.

Some 14 of the 132 CTD projects resulted in a contract with a Defence acquisition program, including technologies like a mobile x-ray machine, a wide-band radio frequency receiver, and a Maritime electronic warfare system.

Ms Price said Defence does not have full visibility over which CTD projects were ultimately exported to foreign markets but is aware of at least eight doing so.

The program was rebranded in 2016 as the Defence Innovation Hub, with significantly more money invested by Defence. But procurement and export rates have worsened.

In seven years, the Defence Innovation Hub program has signed 233 contracts, including 10 which began as CTD projects, worth a total of $441 million.

Only 10 of the technologies funded through the current program have been used by Defence or are close to it. Only three have been confirmed to have been linked to overseas exports.

Mr Patrick said he is supportive of defence funding local industry, but evidence suggest the flagship programs have not been successful with procurement rates of around 10 per cent and five per cent each.

"There should be a plan. It's apparent there is no plan other than to spend money and not looking past that spend," he told InnovationAus.

The South Australian senator said industry's ideas aren't lacking and Defence has the budget to support them, but the department needs to do a better job of matching the projects it funds to future programs and then guiding it to them.

“You need to have these programmes in mind when you start, and then you need to steward them all the way through until they’re actually in service,” Mr Patrick said.

“Because the best outcome you can possibly get is a support contract. That really does keep industry alive and keep those skills going. And it allows then potentially for even further development.”

Australian Industry Defence Network chief executive Brent Clark said a more strategic approach with fully developed capability roadmaps and ongoing support from Defence would improve outcomes, both for Defence and for local companies.

“If you’re committing to develop technology in Australia, you can’t be ‘half pregnant’,” he told InnovationAus.

Too often the programs have helped a local company develop a technology to a market-ready level, only for Defence to then look elsewhere or hand responsibility to a prime contractor, he said, making the programs a “pointless exercise” in some cases.

“Part of the commitment [from Defence] should be if the technology is proved, and proven to be a technology that Defence wants, that they do not then go to market for the [same] technology,” Mr Clark said. “Defence should be working with the company to do it.”

The low export rates are not surprising, Mr Clark said, because if the technology is not being procured in Australia, it becomes “really difficult” to sell overseas.

“You’re already in a difficult position because you’re trying to sell Defence equipment into a foreign country. If your own people won’t even buy it, it just makes it even tougher.”

Mr Patrick said it was alarming the programs appear to be struggling despite the increased funding for the Defence Innovation Hub.

“It’s really easy to spend taxpayers’ money. It’s a bit harder to spend it wisely,” he said.

“It’s a case that I’m seeing more generally that government looks at success on the basis of programs it announces and the expenditure associated with them, rather than looking at the execution and delivery of the program.”

The office of Minister for Defence Industry Melissa Price was contacted for comment.

Being possibly one of the last people standing that remember running DID (Defence Industry Development) Programs (when the program was closed I was given all of the maritime ones to 'see out' -I think there were 7) and, given that experience, vocal in opposition to the way in which the CTDs were implemented and even named. It meant that a proposal had to get past DSTO who saw many proposals as a threat to the TTCP circuit, or worse, capable of implementation without their involvement. Either case saw them putting their happy hippo stamp back in their purse.

And if a proposal got past that point it had to run the gauntlet of CDG, which at the time, in answer to a question of what I was up to from FASFDA, when she saw me come out of B Block, 'just visiting the Industry shopfront' was a pretty good description of the place. The same place that ACMAT-N (Nick Hammond RIP) would soon tell the RAN Staff College students - 'DGFD(Sea) can't tell me what he needs, but he can SURE tell me where to buy it'. So if one of the sports sponsors or suchlike didn't like somebody's proposal, then frisbee into the bin time. And then you had the CDG standard

unspoken response 'I don't know what a mousetrap is so so I really cannot comment on any proposal to build a better one without looking like a Delta Hotel' expressed overtly as 'Not a requirement' - pretty hard to argue against Pontius Pilate when the warrior can say that without fear of being asked why: so more into the bin.

90% of the DID and the most of the misdirected CTD proposals should have gone straight into the AC-Matteries, especially after the SPOs were formed - Any System Program Office worth its salt, should/would know how many of the industry proposals, with a bit of tweaking could long term shave the Total Cost of Ownership of existing systems and have a strategy that would proliferate the good'uns within and around one's SPO and, by sheer association with the fleet users,, creep the notions into the capability space as those ship operators drew the short straw and got posted to the sponge. And as a SPO, when you are running literally dozens of interwoven little activities, the savings and the positive capability impact in terms of every metric you could dream up can be incredible. Even the high fliers,who choose not to know the details could not use their reported cleverness or super intellects to disparage what works, particularly because what works performs invisibly to the untrained eye: THE whole basis of High Reliability Organisations.

I, before, have told the story of the visiting ACTD director from the US probably 25 years ago now when the program was young, and the ADF CTD director asked me to outline my measures of success. He didn't know I knew the USN bloke from the the fast fit days and replied 'If I can't find it or get it back I am on a winner' - The RAAF CTD people in particular sucked all the oxygen out of the room in shock and the Yank said -ha I have exactly the same one and went on to recount 2 current warries in his program.

Designing and building a self-cleaning dunny that will work in a water and power scarce environment IS a capability issue but you really can't be asking those who think theirs doesn't stick for an opinion. It has been a capability issue everywhere for as long as I can remember -it was even identified on paper in the USN before they pulled the 'Red Book' from general consumption. It is an enabler that has significant impacts across the FICs (including freeing up the ROs to be ROs ha)- but Defence doesn't have a 'Red Book' mentality to look at all the things that could make a myriad of costly, annoying, retention affecting etc etc just go away - AND have the ticker to impose them on the Primes AT TENDER for any solutions they choose to offer.

DMO exacerbated the detrimental impact by doing its own Pontius Pilate and washing its hands of the CTD management to contractors - thus taking fantastic personnel development opportunities away from its young in every domain. A pretty good clue as to SLG awareness of the ants on the floors below. Here were programs that had no sheep station impacts on the SLGs reputations and would let the young learn the Commonwealth Procurement Rules, learn how to be a contract owner and manager, learn how to spot derailments before they occur, learn how to be a fettler and get the train back on the tracks ASAP learn the difference between a job, a development and a project and what it take to drive them, how to interact with operators, S&T, Academia, user, like and unlike projects, the loggies and so on all with specialist mentors - Nope TFH- give it to KBR. - If nothing else These programs need to be run internally to TRAIN and EDUCATE the future big project/program managers by letting them run all facets of a meat grinder when they are young and experience that risk taking is far more useful than risk avoiding in the greater scheme of things - something they can carry to the top of their game.

Plus the ADO just couldn't get a US SBIR-like program to fly - why - well you might have to ask the operators that question -because it involved, like the US Red Book, operators scoping out a capability issue that they felt needed looking at. The Yanks used to do it across all their Commands, and if 11 Commands identified a common issue; well S&T and A&L: you got your priority 1 list

kiddies. It was, I assume it still exists in some form, a very good and ageless system; and the SBIR is too - BUT it has a single point of failure - OPERATOR input. Not a problem for the USN because their JOs are allowed to talk, but one I can see here; given the way the CTDs were decided.

One in four medical researchers fails to declare conflict of interest, study claims

A study into the link between money and medical research has found undeclared payments to some researchers averaged around $9000. a Paywall story so no details but the headline - pretty relevant given my comments about CTD selection. Difference here was ego drove the COI, not backhanders.

Leading Practices: Agency Acquisition Policies Could Better Implement Key Product Development Principles

https://www.gao.gov/products/gao-22-104513

GAO-22-104513 Published: Mar 10, 2022. Publicly Released: Mar 10, 2022.
Fast Facts

Together, the Departments of Defense and Homeland Security and NASA invest hundreds of billions of dollars each year to develop and deliver a wide range of systems, from stealth jets to lunar rovers.

Leading companies rely on certain principles to ensure product development success. But we found that these federal agencies aren't generally required to meet such principles. For example, DOD's policies don't require acquisition staff to consider dropping less urgent requirements to stay on schedule—a key development principle (made me laugh - could you imagine that process in a SLG reputation driven organisation?).

Why This Matters

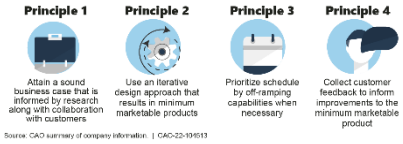
Each year, the Departments of Defense (DOD) and Homeland Security (DHS) and the National Aeronautics and Space Administration (NASA) together invest hundreds of billions of dollars to buy stealth jets, cutters and ships, and lunar rovers, among other things, all with complex software. However, GAO's annual reviews of these agencies' major acquisitions find they often take longer and spend more money than planned to deliver capabilities to users.

Key Takeaways

Leading companies take a disciplined approach to develop innovative products that satisfy their customers' needs, and to deliver them to market on time and within planned costs. The 13 leading companies GAO interviewed perform similar activities when developing new products, such as

iterative design in hardware and software development. These activities in the development process align with the four key principles that help project teams deliver innovative products to market quickly and efficiently (see figure). GAO found that the department-wide acquisition policies of DOD, DHS, and NASA implement some key product development principles. But, they have yet to fully implement others. This gap limits agencies from ensuring a consistent approach to developing and delivering products with speed and efficiency.

Leading Companies Use Four Key Principles for Product Development



For example, leading companies focus on designing a minimum marketable product—one with the minimum capabilities needed for customers to recognize value. Leading companies also prioritize a project's schedule: they release the features most critical to the customer and will off-ramp non-critical product features—an industry term for removing them from the current release—as necessary, in order to maintain schedule. Leading companies have mechanisms to solicit and implement feedback from customers early and often throughout development to ensure the product is relevant to customer needs, among other things.

Primary DOD, DHS, and NASA acquisition policies incorporate many aspects of the four key principles, to varying degrees. However, agencies miss opportunities for positive outcomes by not addressing some sub-principles in their policies.

- DOD's policies do not require all programs to consider off-ramping non-critical capabilities in order to achieve schedule, hindering programs' best chance of maintaining time frames.
- DHS's policies do not require all programs to utilize modern design tools during hardware and software development, limiting consistent opportunities for programs to successfully improve revisions to the design.
- NASA's policies do not include mechanisms for programs to obtain and utilize product feedback from stakeholders or end users—such as astronauts using spacecraft or the science community benefiting from NASA projects—in order to identify challenges or new features to include in subsequent projects.

GAO previously found that other factors beyond policies can affect agency outcomes, including structural differences between government and private industry. However, GAO's prior work also demonstrates that key principles from private industry can be thoughtfully applied to government acquisition to improve outcomes, even with the different cultures and incentives.

How GAO Did This Study

This report examines principles that guide leading companies' product development efforts and the extent to which primary, department-wide DOD, DHS, and NASA acquisition policies reflect the companies' key principles and result in similar outcomes. GAO identified the 13 leading product development companies based on rankings in well-recognized lists; interviewed company representatives; analyzed department-wide acquisition policies from DOD, DHS, and NASA; and interviewed agency officials. The report is the first product in a planned body of work. In future

work, GAO will explore how government agencies can apply some of the key principles outlined in this report.

Skip to Recommendations

Recommendations

GAO is making nine recommendations to DOD, DHS, and NASA to update acquisition policies to fully implement key principles of product development. All three agencies concurred with our recommendations.

The following is from Poopie Suits and Cowboy boot - it is long and techo I am assuming it is some thing Bruce Rule extracted from his book on the loss of the boat

https://www.amazon.com/Books-Bruce-Rule/s?rh=n%3A283155%2Cp_27%3ABruce+Rule

Having interacted with many of you over the last 4+ years during the writing of our six submarine books and the administration of this group, we have worked hard to establish ourselves as a straightforward, reliable, and trustworthy source of information about topics that are sometimes very sensitive. Many of you have sent us materials for possible publication, and we are careful in what we choose to disseminate and what we determine is better left unsaid/unshared.
Today, we would like to share some relatively new information about the loss of the Scorpion in May of 1968. This was sent to us by a trusted source. The writer of this paper is a highly experienced expert, but that being said, we wish to be explicit in stating that our sharing of his analysis is for your consideration only. We neither approve nor disapprove of the conclusions presented. It is a very technical read, but for those interested in the topic, here is the paper (reprinted here with the expressed consent of the author):

The US Nuclear Submarine SCORPION Was Lost When Hydrogen Out-Gassed . by the TLX-53A Main Battery Exploded at 18:20:44 GMT on 22 May 1968
A technical assessment based on metallurgical analysis of recovered wreckage, analyses of acoustic detections of the event, and imagery/visual observations of the wreckage by the crew of the US submersible TRIESTE

The author of this document has been involved with continuing analyses of acoustic detections of submarine loss events for almost 60 years; from the USS THRESHER in 1963 to the Argentine (ARA) submarine SAN JUAN (S42) in 2017, and five Soviet Russian submarines lost between 1968 and 2000. He has published major assessments: THRESHER and SCORPION (royalties declined), and has contributed pro bono to numerous books and articles on submarine loss events. He was the lead acoustic analyst at the US Office of Naval Intelligence for 42 years.

Preface

Those who receive this assessment are encouraged to further disseminate it electronically to individuals and organizations who are privately or professionally concerned with the loss of SCORPION or, more generally, with submarine safety training, analyses of acoustic detections of submarine loss events, analysis of images of submarine wreckage or exploitation of recovered submarine wreckage.

I. Acknowledgements

The writer gratefully acknowledges critical contributions by retired senior US submarine officers (resources) and four civilian resources - including a consulting engineer - to the development of three assessments not previously provided in the 22 May 2018 edition of this document. These contributions consisted of SCORPION bulkhead, escape trunk and hydraulic system design characteristics, the SCORPION Structural Analysis Group report - without which this assessment could not have been written - and collapse depth and compressive force calculations. These new assessments are summarized immediately below, and are discussed in detail in Section VII of this document entitled "Analyses of Imagery and Visual Observations of the SCORPION Wreckage."

II. Summary Assessment

This article elucidates the cause of - and the temporal dynamics and forces associated with - the loss of the USS SCORPION..

The US nuclear submarine SCORPION (SSN 589) was lost on 22 May 1968 because the explosion at 18:20:44 Greenwich Mean Time (GMT) of hydrogen out-gassed by the TLX-53-A main battery created over-pressures that were more than several times the 100-percent fatal level in spaces forward of the reactor compartment and at lower, survivable levels in spaces aft of the reactor compartment. SCORPION was at periscope depth when the battery explosion - which did not breach the pressure-hull - occurred. At least one member of the crew successfully exited SCORPION through the after escape trunk.

Over the following 21m, 50s, SCORPION sank vertically at an average of 1.1 m/s (67 f/m) (0.66 knots) to collapse (implode) at 18:42:34 GMT at a depth of 466m (1530-feet) in 37milliseconds (ms), 1/27th of a second, with an energy release equal to the explosion of 6000 kg (13,200 lbs) of TNT created by the essentially instantaneous conversion of potential energy ((sea pressure of 46.3 bars (680 psi)) to kinetic energy, the motion of the water-ram which entered the SCORPION pressure-hull with an estimated average velocity of about 900 m/s (2000 mph). It was this compressive force that "telescoped after sections of the pressure-hull, moving frame 90 forward to frame 67 ((a distance of 17.27m (56.66 feet)) at an average velocity of 467 m/s (1044 mph). The Engineering Spaces telescoped into the Auxiliary Machinery Space (AMS) and Reactor Compartment because of the failed transition joints in the AMS. This action produced an average applied force 643 times normal gravity (643g). ((The estimated final velocity was 915m/s (3,000f/s/2045mph)). The estimated final force was 2500g. This calculation by a consulting engineer is consistent with the conclusion that the still-articulated body sighted in the debris field was neither within the pressure-hull nor the after escape trunk when SCORPION collapsed. Bodies subjected to compressive forces of the magnitude associated with collapse at SCORPION's pressure-hull at a depth of 466m do not remain intact.

Three special notes:

(1) The extraordinary measured values discussed above, which are consistent with the calculated kinetic energy release of the SCORPION collapse at a depth of 466m (1530-feet), represent unique information not previously known and not reliably derivable from simulations.

(2) These values can be applied in general terms to other submarine pressure-hull collapse events for which the depth and the duration of the compression phase of the event can be determined from acoustic data, Knowing these values will support assessments of the cause of such events based on images of the wreckage.

(3) These values can also provide a basis for estimating the condition of internal structures not available from imaging of wreckage.

The time of the battery explosion and the position of the wreckage indicate that - when lost - SCORPION was on the planned course of 290 and about 35 nautical miles (nm) behind her Projected Intended Movement (PIM) based on a planned speed-of-advance (SOA) of 18 knots and the 0001

GMT, 22 May position reported in the last message sent by SCORPION at 2354 GMT, 21 May 1968, 18 hours and 27 minutes before the battery explosion.

III. Two Special Assessments

(1) The observed (from examination of recovered wreckage) and derived (from analyses of the acoustic data) characteristics of the loss of the USS SCORPION are consistent with a single cause of the tragedy: the explosion of hydrogen out-gassed by the TLX-53-A main battery.
(2) At least one member of the SCORPION crew survived the battery explosion because of the special compartmentation associated with the nuclear reactor. See Section VIIb. Had SCORPION not been nuclear-powered, it is probable the different compartmentation required for a diesel-powered submarine - such as the ARA SAN JUAN - would have resulted in the nearly instantaneous (circa 30ms) death of the entire crew from exposure to the flame-front/pressure-pulse of the hydrogen event which would have propagated through the pressure-hull with a velocity of 1400m/s (3130 mph).

IV. Note to the Reader

Once the disproven conjectures about the loss of the USS SCORPION have been dismissed, the critical so far unanswered - and indeed, apparently unasked - question comes into focus. (See Section X.)

V. Analyses of Physical Evidence

Ten months after the USS SCORPION (SSN 589) was lost in the east-central Atlantic on 22 May 1968, the US Naval Ships Command issued a change to NAVSHIPS Technical Manual, Section 9623.718, March 1969 Edition.
That Section - which discussed "Submarine Storage Batteries" - stated the following: "Do not enter the battery well of ships having open tank ventilation systems while a charge is in progress." The Section further stated that "Experience has shown that all individual (battery) cell explosions have occurred while personnel were working in the battery tank during charge." Note: a technical resource" of the highest credibility found this 1969 NAVSHIP's assessment to be "unsatisfactory with respect to definition of terms and conditions extant during a charging event. Based on microscopic, spectrographic and X-ray diffraction analyses of SCORPION battery components (recovered from the wreck debris field by the US submersible TRIESTE) by the Portsmouth Naval Shipyard Analysis Group, Section 7.1.3, page 72 of the SCORPION Structural Analysis Group Report of 29 June 1970 (hereafter SAG Rpt) stated: “....the general battery damage is violent. The high-velocity intrusion of pieces of the flash arrestor into both the inside and outside surfaces of the retrieved plastisol (battery) cover attest to violence in the SCORPION battery well. Battery cell debris is in evidence over the entire SCORPION debris field."

Section 5.3.1, page 5.13 of the SAG Rpt states: "The debris field is located primarily to the north of the major hull sections and covers an area approximately 240m (800-feet) north and south by 120m (400 feet) east and west."
The SAG included the Navy's leading experts in submarine design, submarine structures, and the effect of underwater explosions, respectively, Peter Palermo, CAPT Harry Jackson, and Robert Price.

Page 7.8 of the SAG Rpt notes the estimated over-pressure in the SCORPION battery well from the explosion (of hydrogen) was 10.2-13.6 bars (150-200 psi), multiple times the 100-percent fatal value discussed by reference (1).

Further, Section 5.3.6, page 5.17 of the SAG Rpt states: "...the available evidence indicates the battery probably exploded at some time before flooding of the battery well occurred. A review of Figure 5-13 indicates that the threads on the terminal posts were sheered off and there are no cover

seal nuts remaining. The covers were completely blown off. Had the pressure been applied on the outside of the covers, the cover support flange on the terminal posts would have held pieces of the cover and it is expected that the cover seal nuts would have remained in place in at least some instances."

Section 5.3.6e, page 5.18 of the SAG Rpt states; "Some 20 equally small (nearly sub-visible) fragments of material were imbedded at high velocity in both the inside and outside of the battery) sample. The trajectories of the fragments were essentially random, ranging from grazing to vertical incidence. Metallurgical analyses revealed these fragments are identical in composition and structure to the aluminum flash arrestors used on the batteries in SCORPION."
Page 5.13 of the SAG Rpt states: "All identified debris was originally located either external to the pressure hull or internal to the pressure hull in the operations compartment..." The operations compartment was located above the battery well."

Para 7.4.10, page 7.7 of the SAG Apt states that.. "the damage to the negative tank top and the tearing out of the negative tank operating mechanism all combine to indicate a violent force moving from fore to aft and low in the battery well."

Collectively, these findings confirm the explosion of hydrogen out-gassed by the SCORPION battery was the initiating event responsible for the loss of SCORPION on 22 May 1968. That event may have occurred because activities by a member of the crew in the battery well created a static electricity spark that ignited hydrogen already present at explosive levels. Resource comment: "If ventilation was abnormally interrupted during a charge and if H2 increased to > 8% with O2 present, 'holy hell will break loose' given even the slightest ignition. There are numerous ignition sources available in addition to human activity)"

VI. Analyses of Acoustic Evidence

In 2008, Dan McMillin (1929-2015), an electrical and mechanical engineer who was part of the Bell Telephone Laboratory "brain-trust" integrally involved in the development of the Sound Surveillance System (SOSUS), and who also was extensively involved in the initial analysis of the Canary Island acoustic sensor (bottom-mounted hydrophone) detections of the loss of the USS SCORPION, provided the writer with a copy of a tape recording and graphic displays of the Canary Island and Sound Surveillance System acoustic data associated with the event.
In 2011, the writer published a detailed technical analysis of those signals, royalties declined (2). That analysis - the first reanalysis of the SCORPION acoustic data in 40 years - confirmed the SAG conclusions in 1970 that:
(1) The acoustic event that occurred onboard SCORPION at 18:20:44 GMT was produced by an explosion. In January 2003, Peter Palermo, the Chairman of the SAG and the Head of all Ship's Structures at the Naval Sea Systems Command from the late 1960's to the 1980's stated that "An acoustic signal detected from SCORPION 20-plus minutes before the initial breaking up sounds had all the characteristics of a small internal event. This was felt to be a battery cell."
(2) The acoustic event that occurred onboard SCORPION at 18:42:34 GMT was produced by the collapse of the pressure-hull. That event produced a strong bubble-pulse frequency of 4.46 Hz. The duration of the collapse phase was 37 milliseconds (ms), 1/27th of a second. The minimum human cognitive reaction time is 80-100 ms. (Note: the reaction time of Uşain Bolt to the starting gun during the finals of the 100m sprint event in the 2016 Olympics – which he won - was 155ms.) Based on the empiric relationship that exists between the volume of an air-filled structure and the number of times in one second the pressure differential created by collapse (implosion) of that structure cycles from compression to expansion back to compression - the bubble pulse frequency - can be used to determine the depth of the collapse event. The derived depth value can then be used to determine the energy required to produce the acoustically-detected bubble-pulse frequency at

the derived depth. In the case of SCORPION, the measured bubble-pulse frequency of 4.46 Hz indicated collapse occurred at a depth of 466m (1530 feet) (2.2 times test-depth) with an energy release equal to the explosion of 6000 kg (13,200 lbs) of TNT at that depth. The formula for this derivation is provided on page C4 of the following document: USS SCORPION (SSN 589) RESULTS OF NOL ANALYSIS (U) NOL LTR SER 69-160 of 20 January 1970, Robert Price and Ermine Christian.

VII. Analyses of Imagery and Visual Observations of the SCORPION Wreckage

a. SCORPION Was At Periscope Depth When the Battery Exploded

Page 5.8 of the SAG Rpt states that imagery of the wreck obtained by the US submersible TRIESTE indicated: "The number 2 periscope, the AT-317/BRR VLF loop antenna, and the AN/BRA-9 helical whip are raised. SCORPION is assumed to have been at periscope depth. The design of the hoisting mechanism for the Number 2 periscope is such that when the fairwater (sail/fin) separated from the hull, sea pressure would not tend to raise the hydraulic hoist cylinder.* Page 5.9 of the SAG Rpt states that "the snorkel appears to be housed."

When the SCORPION pressure-hull collapsed at a depth of 466m (1530 feet), equalization with sea pressure (46.3 bars/680 psi) occurred in 0.037s (37 milliseconds). The hydraulic raising of the involved masts used a system with a pressure of 204 bars (3000 psi) and required about 10 seconds. These relative values support the SAG assumption that SCORPION was at periscope depth with three masts raised when the battery explosion occurred.

b. Some SCORPION Crew Members in Spaces Att of the Reactor Compartment Survived the Battery Explosion

If SCORPION had been ventilating while at periscope depth, sometime before the battery explosion, the normal ventilation lineup could have been: forward reactor compartment watertight (W/T) bulkhead door "on the latch," bulkhead flappers open.

As previously discussed, the atmospheric over-pressure generated by the hydrogen explosion is estimated to have been 10.2-13.6 bars (150 to 200 psi) in the battery well and at lower but still fatal levels in areas beyond the well. The WIT bulkhead doors were rated at 10.6 bars (160 psi), equal to sea pressure at a depth of 107m (350-feet).

Under those conditions, fatal over-pressure would have been produced by the battery explosion in all spaces forward of the reactor compartment and at lower, survivable pressures in spaces aft of the reactor compartment because the pressure wave would have been attenuated with transmission limited to bulkhead flappers if they were open. If the flappers were closed, most personnel in spaces aft of the reactor compartment should have survived the flame-front/pressure-pulse of the battery explosion. Resource comment: "....the point is that the battery exploded. Why it exploded is subject to several scenarios; however, if the Type Commanders were to admit the primal cause as a battery explosion, they in good conscience should explore all avenues and head them off by better personnel training and procedures."

Based on observations and imagery by the TRIESTE, Page 5.11 of the SAG Rpt states: "The after escape trunk access hatch is still attached to the hull and appears to be in the normal open position. The seating ring for the access hatch does not appear to be distorted. The main deck fairing cover for the after escape hatch appears to be tilted partially open indicating that the after escape hatch (to which the cover is attached) is also at least partially open and attached to the hull."

Exhibit 7.1 page 7.9 of the SAG Rpt is a letter of 16 Feb 1970 from LT R.E. Saxon, a member of the TRIESTE crew, which provides his observations during a dive on the SCORPION wreck of a body wearing a pair of "nuclear power type" coveralls and what appeared to have been a Kapok type life jacket

Exhibit 7-2, page 7-10 of the SAG Rot, a memo of 25 Feb 70 from LTD.T. Bymes, another member of the TRIESTE crew, provides a sketch (page 7.11) of the body lying approximately midway between the bow and the telescoped after sections of the SCORPION hull which are separated by about 45m (150 feet) after having fallen from collapse depth of 466m (1530-feet) to the bottom: depth of

3384m (11,100 feet). The sketch indicates the body appears to be "articulated with one leg at an angle to the body suggesting it had been broken.
Exhibit 7.3, pages 7-12 - 7-16 of the SAG Rpt provides a memo by LT John B. Fields, the third member of the TRIESTE crew, which further discusses the sighting of the body. Had the body been in spaces aft of the reactor compartment or in the after escape trunk when collapse occurred, a consulting engineer - using the duration of the compression phase of the collapse event (0.037s), and the distance of 17.27m (56.66-feet) by which the after sections of the SCORPION pressure hull telescoped in that time - calculated that the compressive force acting on that body would have been an average of 643 times normal gravity or 643g, sufficient to have significantly deformed the body. Reference (5) states that the highest g force a human has transiently experienced and survived was 46.2g.
Collectively, these observations, calculations and the open and apparently undamaged condition of the after escape trunk access hatch and its seating ring indicate at least one member of the SCORPION crew used the after escape trunk to exit SCORPION.
Since the capacity of the escape trunk was about six individuals, the question that might be asked is: "Why were more bodies not sighted in proximity to the major sections of the wreck?" That is the wrong question. The right question is: "Why was one body sighted in the immediate vicinity of the major hull sections?" Bodies - especially with buoyant life jackets - should have sunk only after long immersion and; hence, should have been carried by the northward trending current far from the major sections of the wreck which sank vertically; i.e., carried to areas beyond those investigated by the TRIESTE on any of her nine dives. These observations are difficult to explain with an entirely satisfactory theory; currently available information does not resolve this apparent anomaly.
Resource comment: As discussed by the SAG Rpt, there is confusion about which "hatch(es) are being described; there are 3 hatches on the trunk; the upper and lower hatches are vertically in line at the top and bottom of the trunk; a 3rd hatch is the 'escape' hatch and is at the end of a slanted tunnel coming off the side of the trunk. With the body on the bottom, it is very hard to imagine that a live person could escape the trunk; if he escaped before the implosion, how did he wind up on the bottom in the middle of the debris field?"

c. Why SCORPION Collapsed Both Fore-and-Aft

In 1970, the SCORPION Structural Analysis Group, which included the Director of the Naval Ship Systems Command Submarine Structures Division, Peter Palermo (1929-2009), concluded from analysis of imagery of the SCORPION wreckage that the torpedo room was intact, though it had been deformed by excessive sea pressure. The operations compartment had collapsed at frame 33, the king frame of the hull, when it reached its structural limit. The conical/cylindrical transition piece at frame 67 also failed and the after sections of the pressure-hull were driven forward (telescoped) 17.27m (56.66-feet). SCORPION was broken in two by massive hydrostatic pressure (46.3 bars / 680 psi) at the collapse depth of 466m (1530-feet).
Analysis of acoustic data confirmed that the duration of the compression phase of the collapse event was 0.037s, 1/27th of a second. The estimated average velocity of this forward compressive motion of the telescoping after hull sections was 467ms (1531f/s/1044mph). The estimated average multiple of normal gravity (19) was 6439. The estimated final velocity was 915m/s (3000f/s / 2045 mph). The estimated final force was 2500g.
It was this massive, forward-moving force that tore the main shaft - with the propeller still attached - from the thrust bearing and out of the hull where it fell vertically - and separately - to lie within the SCORPION debris field.
The question that arises from these force values is: how could there appear to have been two collapse events that had to have occurred in less than 0.037and were separated by 25.5m? If the second collapse was a "sympathetic" event initiated by the first event, the initiating force had to have been transmitted through the 25.5m of the pressure-hull from the first site to the second site faster than the compression velocities cited above, the highest of which was 915m/s (2045 mph).

That force was the shock-wave created by the initial collapse which was transmitted through the entire SCORPION pressure-hull at the velocity of sound in steel: 5790m/s (18,996 f/s / 12,950 mph), 6.3 times the final velocity of the forward-moving after hull sections during the telescoping compression event.
Unless the initiation times of each collapse event can be determined from acoustic data to have occurred within less than the sound (energy) transmission time of the initial event shock-wave in steel for the distance separating the two SCORPION collapse sites (25.5m /83.8-feet): 0.0044s (1/227th of a second), one of the two SCORPION collapse sites most probably was a sympathetic event, i.e., the first collapse "triggered" the other collapse. Note: when the first SCORPION collapse event occurred, the entire pressure-hull would already have been hydrostatically stressed to a level at which any additional stress - such as the shock-wave - could trigger additional failures.
The problem is that the relative acoustic signal detection times for multiple collapse events can be affected by variables of greater duration than 0.0044s. These variables include the aspect SCORPION presented to the sensor at the moment of collapse and the strength of each event absolutely and as a function of aspect. These unquantifiable variables preclude - in the case of SCORPION - and probably in most all other acoustic detections of collapse events - the identification of collapses that are not sympathetic, i.e., occurred independently.
It is only an apparent anomaly that time-difference localization (acoustic triangulation) of an event can - at best - achieve a position accuracy of one nautical mile in the broad ocean area while relative accuracies (one position relative to another) can - if detected in temporal proximity - provide accuracies within less than 10m (33-feet). This is possible because the sensors - both bottom-mounted hydrophones in the SCORPION case - did not move during the measurement period and because the sound energy produced during that 111.6s period would have followed almost exactly the same transmission path and consequently have had the same sound-travel time.

VIII. Disproven Conjectures

a. SCORPION Reversed Course to Deactivate a Torpedo

In 1968, Dr. John Craven (1925-2015) conjectured SCORPION had reversed course to disarm a Mk-37 torpedo that had become active in its launch tube. That conjecture was based on an estimated change of two seconds in the delay of signal detection times between acoustic sensors located to the east and to the west of the loss position over a 111.6s period. If valid, that change in the relative detection times of signals detected over that period would have required a course reversal by SCORPION from a course of 290 to an easterly heading for a distance of about 4900-feet in 111.6 seconds for an average speed of 26 knots.
To address that conjecture, Dan McMillin analyzed magnetic tape recorded from the Canary Island acoustic sensor located to the east of the SCORPION Wreck site (Canary Island single hydrophone A) to achieve signal detection timing accuracies of 0.01s and high-time resolution VisiCorder displays to achieve a timing accuracy of at least 0.1$ for the signals detected by a sensor system located to the west of the SCORPION wreck site.
McMillin's analysis of the same data reviewed by Craven - established that the change in detection times was only 0.04s which equated to a speed of 0.5 knots, not Craven's values of 2.0s and 26 knots. McMillin's original data/calculation sheet is reproduced on the last page of Chapter 1 of reference (2). That sheet includes a note that McMillin called Craven at 2130 EDT on 18 July 1968 to inform him of the more accurate measurement.
Note: SCORPION was not capable - from a propulsion standpoint - of reversing course and achieving an average speed of 26 knots during a maneuver with a duration of 111.69.
The writer's reanalysis of these SCORPION signals in 2008 confirmed McMillin's event timing values and also confirmed the SAG assessment that the signal at the start of the 111.6s period was produced by the collapse of the SCORPION pressure-hull. Additionally, it was determined in 2008 that collapse occurred at a depth of 466m (1530-feet) and that two of three other signals that

occurred during the 111.6s period were produced by the collapse of two of the six SCORPION torpedo tubes at depths near 1027m (3370 feet) and 1143m (3750-feet).

In summary, during the 111.6s period conjectured by Craven to have involved a high-speed course reversal, the SCORPION wreckage was sinking vertically at a speed of 10-13 knots with a horizontal displacement of less than 15m (50-feet) over a vertical distance of about 670m (2200 feet) which is consistent with the conclusion that the third signal was also produced within the bow section of the wreckage.

It is only an apparent anomaly that time-difference localization (acoustic triangulation) of an event can - at best - achieve a position accuracy of one nautical mile in the broad ocean area while relative accuracies (one position relative to another) can - if detected in temporal proximity - provide accuracies within less than 10m (33-feet). This is possible because the sensors - both bottom-mounted hydrophones in the SCORPION case - did not move during the measurement period and because the sound energy produced during that 111.6s period would have followed almost exactly the same transmission path and consequently have had the same sound-travel time.

b. SCORPION Was Lost Because of the Explosion of a "Large Charge Weight External to the Pressure-Hull."

John Craven also conjectured that acoustic energy produced by the collapse of a submarine pressure hull at great depth could be "swallowed" within the collapsing structure and not be acoustically detected. Based on that assertion, the SCORPION Court of Inquiry (COI) concluded that the exceptionally strong signal that occurred at 18:42:34 GMT on 22 May 1968 was the "explosion of a large charge weight external to the SCORPION pressure-hull," an assessment not accepted by the SAG who maintained the signal was produced by collapse of the SCORPION pressure hull.

Specifically, Para 7.4.3, Page 7.5 of the SAG Rpt states that "The first of approximately 15 SCORPION acoustic events was not caused by a large external explosion, as from a torpedo explosion."

Craven's conclusion is not in consonance with the known dynamic characteristics of collapse events. Any SCORPION structure that might have "swallowed" (contained) the acoustic signal produced by collapse of the pressure-hull was destroyed during the compression phase of the event. The highest levels of acoustic energy associated with a collapse event are produced during the expansion phase of the event when there would not have been any still intact structure that could have "swallowed" the signal. (Note that the SCORPION battery (hydrogen) explosion – which was contained within the pressure hull – was acoustically detected as a weak source at a range of 821 nm. (2)

Neither Craven nor members of the SCORPION COI appear to have researched the acoustic detectability of the collapse of the USS THRESHER (SSN 593) pressure-hull at 09:18:24R on 10 April 1963 at an estimated depth of 730m (2400-feet) ((73 bars (1070 psi)) with an energy yield equal to the explosion of 10,230 kg (22,500 lbs) of TNT at that depth. (3) The failure of the SCORPION COI to research the THRESHER data was a critical error compounded by failure to accept the technical assessments of the SAG.

That THRESHER-associated collapse event signal was detected by 13 SOSUS hydrophone arrays in the western Atlantic with signal-to-noise ratios sufficient to have been detected at ranges greater than the circumference of the earth had there been an unobstructed deep-water transmission path, i.e., no bathymetric occlusion. Reflections (echoes) of the collapse event signal from the Mid-Atlantic Ridge were detected by SOSUS. Basically, the THRESHER collapse (implosion) signal briefly "insonified" the entire western North Atlantic Basin.

The SCORPION collapse event signal was detected at a range of 821 nm to the east and at a range of 1021 nm to the west; hence, this signal was not "swallowed."

These assessments - based on analyses of acoustic data - Invalidate the COI conclusion that SCORPION was lost because of the explosion of a "large charge weight external to the hull."

c. Loss of the Propeller Shaft Caused the Loss of Ship

As discussed above, the collapse of the conical/cylindrical transition piece at frame 67 allowed after sections of the SCORPION pressure-hull to collapse ("telescope") forward a distance of 17.27m (56.66 feet) in 0.037s producing enormous compressive force that tore the main shaft - with the

propeller still attached - from the thrust bearing and out of the hull where it fell vertically - and separately - to lie within the SCORPION debris field.
The estimated average velocity of this forward-moving compressive force at the calculated collapse depth of 466m (1530-feet) was 467ms (1531f/s / 1044mph). The estimated average multiple of normal gravity (19) was 6439. The estimated final velocity was 915m/s (3000f/s/2045 mph). The estimated final force was 2500g. If - as conjectured - the propeller shaft had been ejected from the pressure-hull at normal operating depth, assessed to have been not more than 400-feet by direction, and was the initial event that caused the loss of SCORPION, immediate and catastrophic flooding would have subjected the internal bulkheads to a pressure equal to or greater than their rated value of 350-feet (10.6 bars / 155 psi). Collapse of these bulkheads would have flooded (pressure-equalized) the hull before it sank to collapse depth where the acoustically detected catastrophic collapse event occurred.
But this is not what happened. As previously discussed, analysis of the bubble-pulse acoustic signal produced by the collapse of the SCORPION pressure-hull confirmed collapse occurred at a depth of 1530-feet which would have been possible only if the pressure-hull was intact (no flooding) before collapse.
If the conjecture contends that the propeller shaft was lost because the propeller "threw a blade producing severe imbalance (vibrations) that tore the shaft loose from its retention flange, such an event would have transmitted enormous low-frequency acoustic energy into the SCORPION pressure-hull where it would have been amplified by coincidence with the basic SCORPION hull resonance frequency and radiated to extreme ranges. Further, the speed at which the eccentrically rotating mass of the decelerated shaft would have modulated this broadband energy at the propeller shaft-rate, detectable at the 800-plus nm mile range of the SCORPION to the Canary Island acoustic sensors, even if the total duration of the event was seconds. No such signal was detected during the comprehensive analysis of acoustic detection of the loss of SCORPION as displayed on high time-resolution systems: Helicorders, Reference (2) discusses this analysis effort in depth.
Based on these assessments, the conjecture that the loss of the propeller shaft was the initiating event responsible for the loss of the USS SCORPION is rejected. The loss of the shaft was the result of the destructive collapse of SCORPION, not the cause.

d. Involvement of Hostile Forces in the Loss of SCORPION.

At 2354 GMT on 21 May 1968, SCORPION sent a last message that reported a 220001 GMT position of 31-21N, 27-36W, an intended course of 290 and a planned speed of advance (SOA) of 18 knots for the remaining five-day transit to Norfolk, Virginia, with an arrival time of 1700 GMT on 27 May.
At 18:20:44 GMT on 22 May, a battery-related explosion killed those members of the SCORPION crew in spaces forward of the reactor compartment and caused extensive structural damage within those spaces. SCORPION sank vertically at an average of 0.66 knots until the pressure-hull collapsed (imploded) at a depth of 466m (1530-feet) at 18:42:34 GMT. The wreckage then continued to sink vertically. The position of the SCORPION wreckage - first identified on 28 October 1968 - is 32-55N, 33-09W. That position lies 297 nautical miles, bearing 290 from the position SCORPION reported 18 hours and 27 minutes before the time of the battery explosion.
The SOA required to transit that distance in that time is 16.1 knots which placed SCORPION about 35 nm behind her Projected Intended Movement (PIM) at the time of the battery explosion, well within the moving position "box" established for the transit to avoid interference with other US submarine operations.
Thus, SCORPION was on course and only slightly behind her PIM when lost because of a battery-related explosion contained within the pressure hull. Interactions with hostile forces - as conjectured by conspiracy theorists - could not have occurred.
Thus, SCORPION was on course and only slightly behind her PIM when lost because of a battery-related explosion contained within the pressure hull. Interactions with hostile forces - as conjectured by conspiracy theorists - could not have occurred.

Resource comment: "Submarine Type Commanders should request the Navy take action to stop the 54-year perpetuation of the erroneous SCORPION COI conclusions by following the facts and publicly correcting the COI findings."

IX. Why the Loss of SCORPION is NOT a Mystery

The headline of an Internet posting of 22 May 2018 ((reference (4) below)) reads; "NORFOLK, Va. (W EC) - An (unidentified) Navy admiral called it one of the greatest unsolved sea mysteries of our era."

The information provided above unequivocally identifies the event that set in motion the loss of ship.

As discussed in the first section of this assessment, the Navy's own experts, the SCORPION Structural Analysis Group (SAG), concluded in 1970 that - as supported by metallurgical analysis of a recovered battery fragment - SCORPION was lost because the main battery exploded at 18:20:34 GMT on 22 May 1968.

That event would have produced a flame-front/pressure-pulse that - as discussed above - instantly killed those members of the SCORPION crew in spaces forward of the reactor compartment. They would not have been aware of the event. It occurred too fast to be cognitively recognized. That limit is 80-100 milliseconds.

Although the SCORPION Court of Inquiry did not accept the SAG assessments - primarily because of the above described erroneous assessments provided by John Craven - the evidence derived from the metallurgical analysis, supported by a comprehensive analysis of the acoustic data and observations by TRIESTE, made it indisputable in 1968 - and still indisputable in 2021 - that a battery explosion was the event responsible for the loss of SCORPION in 1968.

Resource comment: "The free Hydrogen - Oxygen explosive potential of Lead-Acid batteries has been an operational risk for submarines for almost a century. The transition from diesel boats to nuclear challenged personnel experience and focus as well as a needed examination of ship and battery operational procedures. A recognition of the actual cause of the loss of SCORPION is overdue. Importantly, it would demand now, (2021) a re-examination of action taken then, (1968) relative to training and procedures following the loss of the Scorpion by NAVSEA and Type Commanders."

Resource comment: "Submarine Type Commanders should request the Navy take action to stop the 54-year perpetuation of the erroneous SCORPION COI conclusions by following the facts and publicly correcting the col findings."

X. The Critical Question About the Loss of the USS SCORPION

The critical question that remains after the dismissal of unsupported conjectures about the loss of SCORPION is: "Why was the crew apparently unaware of the build-up of hydrogen to explosive levels?"

There are several possible answers to that question; however, none of them can be reasonably evaluated with currently available information. The objective of this assessment is to debunk existing conjectures about the loss of SCORPION, not to propound new conjectures that have no factual support.

References:

(1) Glasstone and DOLAN, 1977; TM 5-1300, 199 (2) WHY THE USS SCORPION (SSN 589) WAS LOST, Nimble Books, 31 October 2011 (3) WHY THE USS THRESHER (SSN 593) WAS LOST, Nimble Books, 31 December 2017, (4)hips://www./3new show.com/article/news/militar 50-vears-later-questions-remain-about-the-ss-scorpions sinkiny/297-556797190 (5)https://www.medicaldaily.com/breaking-point-whats...

Bruce Rule 31 Oct