Why the USS SCORPION (SSN 589) Was Lost 50 years Ago

Revised from the 22 May 2018 Assessment

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 was the lead acoustic analyst at the US Office of Naval Intelligence for 42 years, testified before the THRESHER Court of Inquiry in April 1963, published major assessments of the losses of THRESHER and SCORPION (royalties declined) and has contributed pro bono to numerous books and articles on the losses of Soviet submarines including the GOLF Class SSB K-129 which was lost because two R-21/D4 missiles fired to fuel exhaustion (95.2s and 95.4s) within the pressure-hull. For access to more than 100 articles that discuss submarine related subjects including a probable Russian SSBN "dead-man" launch capability and the characteristics of the BOREY Class Russian SSBN hybrid propulsion system, search the Internet for Commentaries of Bruce Rule.

I. Acknowledgements

The writer gratefully acknowledges critical contributions by senior submarine officers (resources) and three 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 in italics and bold, and are discussed in detail in Section V of this document entitled **Analyses of Imagery and Visual Observations of the SCORPION Wreckage.**

II. Summary Assessment

This article - written in August 2018 - elucidates the cause of - and the temporal dynamics and forces associated with - the loss of the USS SCORPION 50 years ago.

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 0.36 m/s (0.7 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 Auxilliary 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 g-force was 2,500g. This calculation by a consulting engineer is consistent with the conclusion that the still-articulated human 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) Additionally, these values can provide a basis for estimating the condition of internal structures not available from imaging.

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. All times are onboard event times.

III. 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: Peter Palermo, CAPT Harry Jackson, and Robert Price.

Page 7.8 of the SAG Rpt notes that 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 alumina 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 Rpt 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 50 years ago. 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)"

IV. 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 (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 onboard 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 Usain Bolt to the starting gun during the finals of the 100m sprint event in the 2016 Olympics 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 that the pressure differential created by collapse (implosion) of that structure initially 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.

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

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 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.

Some SCORPION Crew Members in Spaces Aft 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 would 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 W/T 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 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 a Kapok type life jacket.

Exhibit 7-2, page 7-10 of the SAG Rpt, a memo of 25 Feb 70 from LT D.T. Byrnes, 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 15m/50 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 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 issue: apparent anomalies.

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?”

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 (1g) was 643g. The estimated final velocity was 915m/s (3000f/s / 2045 mph). The estimated final g-force was 2500.

The question that arises from these values is: how could there appear to have been two collapse events that had to have occurred in less than 0.037s and 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 additionl stress - such as the shock-wave - would 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.

Conclusion: when submarine pressure-hulls collapse at great depth, the initial failure can trigger additional failures that can occur with a time delay consistent with the velocity of the shock-wave in steel from an initial event site and the distance between the documented (observed) sites. It is probable that most (all?) surveyed wrecks will display multiple collapse sites and consequent fragmentation of the pressure-hull. In the case of the USS THRESHER, which collapsed at a depth of 730m (2400-feet), with an energy release equal to the explosion of 10,230 kg (22,500 lbs) of TNT at that depth, the wreck is reported to have been in five or six major sections.

VI. Disproven Conjectures

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 0.1s for the signals detected by a sensor system located to the west of the SCORPION wreck site: Sound Surveillance System SOSUS) hydrophone array 3131.

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 ETD on 18 July 1968 to inform him of the more accurate measurement.

Note: SCORPION was not capable - from a propulsion capability standpoint - of reversing course and achieving an average speed of 26 knots during a maneuver with a duration of 111.6s.

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 SCORPON 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.

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 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 a 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 signal – the bubble-pulse frequency of 3.4 Hz – was detected by 14 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.”

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 0.36 m/s (0.7 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 PIM (Projected Intended Movement) 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.**

VII. 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. (WVEC) – An (unidentified) Navy admiral called it 'one of the greatest unsolved sea mysteries of our era.'”

The information provided above unequivocally leads to 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 incorrect conclusions 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 1970 – and still indisputable in 2018 - that a battery explosion was the event responsible for the loss of SCORPION 50 years ago.

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, (2018) a re-examination of action taken then, (1968) relative to training and procedures following the loss of the Scorpion by NAVSEA and Type Commanders.”

So – There is no “unsolved sea mystery.” Submarine Type Commanders should request the Navy take action to stop the nearly 50 year perpetuation of the erroneous SCORPION COI conclusions by following the facts and publicly correcting the COI findings.

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)*https://www.13newsnow.com/article/news/military/50-years-later-questions-remain-about-the-uss-scorpions-sinking/291-556797190*
(5)https://www.medicaldaily.com/breaking-point-whats-strongest-g-force-humans-can-tolerate-369246