3 April 2009

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To: RADM Cecil D. Haney, Department of the Navy, Chief of Naval Operations 2000, Navy Pentagon, Washington, DC. 20350-2000

Subj: Analyses of Acoustic Data Associated with the Loss of the USS SCORPION, Report Number Two

Ref: (a) HOW THE BATTLSHIP MAINE WAS DESTROYED, ADM H. G. Rickover, 1976 by the Naval History Division, Department of the Navy, and 1995 by the United States Naval Institute
(b) Originator's ltr of 14 March 2009 (SCORPION Analysis Report Number One)
(c) USS SCORPION (SSN 589) RESULTS OF NOL DATA ANALYSIS (U) (NOLTR 69-160 of 20 January 1970) Robert Price and Ermine Christian
(d) EVALUATION OF DATA AND ARTIFACTS RELATED TO USS SCORPION (SSN 589), Prepared for Presentation to the CNO SCORPION Technical Advisory Group by the Structural Analysis Group dated 29 June 1970. CAPT Harry Jackson, Messrs. Peter Palermo, Dr. R. T. Swim, Robert Price, et al.
(e) USS SCORPION SSN-589 - Court of Inquiry Findings

I. PREFACE

In 1974, ADM H. G. Rickover directed research that established the US battleship MAINE sank on February 15, 1898 in Havana Harbor because of an internal explosion and not because of a Spanish or Cuban mine. The Admiral took this action, 76 years after the MAINE sank, because, as discussed in the 1995 Forward to reference (a), "**the Admiral could not believe the Navy did not make use of all available information to determine the cause of so great a disaster**."

The same situation now exists with the USS SCORPION, 41 years after that submarine was lost on 22 May 1968.

Information provided by reference (b) and by this letter establishes conclusively that SCORPION was lost because two low-order explosions occurred within the pressure-hull at 18:20:44Z on 22 May 1968. These events prevented the crew from maintaining depth control. SCORPION collapsed 21-minutes and 50-seconds later at a depth of 1530-feet.

It is necessary for the Navy to acknowledge this information to counter conspiracy books that denigrate the professional capabilities of the SCORPION crew and accuse the Office of Naval Intellgence of a conspiracy to confiscate, suppress and destroy acoustic data to prevent the Navy's Court of Inquiry from determining what happened to SCORPION.

Such accusations should not be ignored because they do not "naturally expire," instead they become the basis of a misinformation legacy that persists and becomes part of the historical record as, for 76 years, did the conjecture that the MAINE was sunk by a mine.

This letter should be read in conjunction with reference (a), SCORPION Analysis Report Number One. For those disinclined to read the technical material in this letter, they should read Section II (SUMMARY), Section VIII (FINAL COMMENTS) and Section IX (RECOMMENDATION).

Certain technical information and derived conclusions provided by reference (b) are repeated in this letter to place the new information provided below in context.

II. SUMMARY

Eight of the 14 SCORPION-associated acoustic events (signals) detected during the 192.8-second period following pressure-hull collapse are established to have been produced by the collapses of small, more pressure-resistant structures within the fragmented hull. These structures survived pressure-hull collapse to fail at depths significantly below the 1530-foot collapse depth of the SCORPION pressure hull.

The conclusion by references (c) and (d) that these post-pressure-hull collapse signals could have been produced by impacts of large masses of machinery torn loose from their foundations by the collapse event and adrift within the telescoped SCORPION after hull sections is not supported.

This new assessment of post-pressure-hull collapse signal source-origin is based on (1) time-of-acoustic-event detection measurements made in March 2009 and on (2) technical considerations and data characteristics discussed and shown by reference (c) but not properly evaluated by the SCORPION Court of Inquiry (COI) primarily because of misinformation provided by the Technical Director of Research at the Naval Research Laboratory (NRL). This misinformation was derived from experiments conducted by the Naval Ordnance Laboratory (NOL) at the behest of Dr. John Craven to support his now disproven theory that SCORPION reversed course to deal with an onboard active torpedo. ((See enclosure (2) to reference (b).)

John Craven had a vested interest in explaining the absence of bubble-pulse energy which, if not explained, would have invalidated his theory when he originally propounded it in 1968. The irony is that it may have been the "success" of the erroneous Craven/NRL conclusion that a bubble-pulse could be "swallowed" by a submarine pressure-hull and not be acoustically detected that dissuaded the authors of reference (c) from more actively asserting their analysis-based assessment that a strong bubble-pulse was associated with the first SCORPION acousic event. As a consequence, the SCORPION COI basically ignored the acoustic data analysis and stated in OPINION 2.a.3. of reference (e) that "no bubble pulse frequency (was) recorded."

The most serious error made by those who directly contributed to the content of references (c), (d) and (e) was their failure to apply the formula on page C-4 of reference (c) using the estimated collapse depth of 2000-feet ((page 19 reference (c)) and the 5-Hz value ((paragraph C.3.3.3 page C-6 reference (c)) as a bubble-pulse frequency - which it has been proven to have been - to determine that the energy yield of the first SCORPION acoustic event would have been equal to 18,125-lbs of TNT at 2000-feet. That determination would have established conclusively that the first SCORPION acoustic event was hull collapse and could not have been an explosion from any source.

This error was compounded by the failure of anyone involved in the analysis of the SCORPION acoustic data to determine if bubble-pulse energy was detected when the pressure-hull of the USS THRESHER collapsed at great depth on 10 April 1963. Had that line-of-inquiry been pursued, it would have made the investigation John Craven initiated unnecessary and would have prevented the Technical Director of Research at NRL from misinforming the SCOPRION COI.

With respect to the specific content of references (c) (d) and (e), those who analyzed the SCORPION acoustic data in 1968-70 and those who evaluated the results of those analyses had many of the answers to critical questions before them but, for various reasons, looked the other way, and, by doing so, left a factual vacuum in which misinformation and conspiracy theories did - and still do - flourish.

The originator did not have access to any acoustic data not available in 1968 to the authors of references (c) and (d) nor did the originator apply any data processing or analytical techniques not available to, or known by, the authors in 1968.

One has only to carefully read the texts of references (c), (d) and (e) and examine the data figures in reference (c) to realize the improbability of the basic conclusions these documents provide, and yet these conclusions have stood unexamined and, consequently, unchallenged for 40 years.

III. INITIAL COMMENTS (FINAL COMMENTS IN SECTION VII)

Imagery indicates SCORPION collapsed at two locations separated by about 100-feet: the operations compartment and the after hull sections. For this to have occurred, the first collapse event would have had to trigger the second collapse event in less than the time required for the water-ram traveling at superonic velocity to traverse that 100-foot distance. Since the shock-wave created by the first collapse would have propagated through the pressure-hull at circa 15,000 f/s (10,200 mph), the velocity of sound in steel, it would have traversed that 100-foot distance in seven milliseconds (0.007s) or several times the velocity of the water-ram.

Imagery also indicates the pressure-hull of the separated SCORPION bow-section appears to be intact. Inspection of the 40-foot bow-section of the Soviet ballistic missile diesel submarine PL-722 indicates the pressure-hull of that platform also was intact forward of the break-point; however, the massive destruction observed within the PL-722 bow-section suggests that similar destruction could have occurred within SCORPION. Accordingly, it is unlikely any return to the SCORPION site with a capability to examine the wreckage internally would provide information from which cause could be separated from effect.

IV. TIME-OF-ACOUSTIC-EVENT DETECTION MEASUREMENTS

The SCORPION pressure-hull collapsed at 18:42:34Z on 22 May 1968. This event was detected by Columbia University Hydroacoustic Station Canaries (CUSHS) hydrophone A at 18:59:32Z at a range of 821 nautical miles (nm) and **191-seconds later** by the Sound Surveillance System (SOSUS) array 3141 at 19:02:43Z at range of 976 nm. SOSUS array 3131 did not detect pressure-hull collapse but did detect the sixth (and seventh and eighth) acoustic events. This numbering sequence is based on pressure-hull collapse as the first event.

The sixth event, which occurred at 18:44:22Z, was detected by CUHCS hydrophone A at 19:01:23Z, by array 3141 at 19:04:34Z, and by array 3131 at 19:05:27Z (at a range of 1021 nm).

By comparing the detection times of the sixth acoustic event at the known locations of these three sensors, the point of origin was determined, i.e., the geographical position where time-difference loci between different pairs of sensors intersected. The position derived by this technique in 1968 was the basis for the search for SCORPION and was where the wreckage was found.

This time-difference analysis could only have produced a refined point of signal origin if the sixth signal had followed a direct transmision path to each of the three sensors. Had any detection of the sixth signal involved a reflected path that delayed arrival at any of the three sensors, no point of origin could have been determined.

It therefore follows that any signal detected by SOSUS array 3141 190-191 seconds later than it was detected by CUHSC Hydrophone A had to have followed the same direct transmission paths and, consequentally, to have originated at the wreck-site.

SCORPION-associated signals three, four, six, seven, eight, nine, 10 and 11 all were detected by array 3141 between **190- and 191-seconds** later than each of these signals was detected by CUHSC hydrophone A. Therefore, each of these eight post-pressure-hull collapse signals represents an "original" event, i.e., none were reflections (echoes) from bathymetric features, e.g., seamounts.

The following event detection time measurements, accurate to the nearest second, were made in March 2009 from a tape recording of the CUHSC detections and from an Air Force Technical Applications Center (AFTAC) helicorder display of the 3141 detections. Section III of enclosure (1) to reference (b) provides discussions of the helicorder display system.

Event 3: by CUHSC at 19:01:04Z, by 3141 at 19:04:14Z; difference: 190-seconds
Event 4: by CUHSC at 19:01:08Z. by 3141 at 19:04:19Z; difference: 191-seconds
Event 6: by CUHSC at 19:01:23Z. by 3141 at 19:04:34Z; difference: 191-seconds
Event 7: by CUHSC at 19:01:26Z. by 3141 at 19:04:36Z; difference: 190-seconds
Event 8: by CUHSC at 19:01:33Z, by 3141 at 19:04:44Z; difference: 191-seconds
Event 9: by CUHSC at 19:01:45Z, by 3141 at 19:04:56Z; difference: 191-seconds
Event 10: by CUHSC at 19:02:01Z, by 3141 at 19:05:12Z; difference: 191-seconds
Event 11: by CUHSC at 19:02:04Z, by 3141 at 19:05:15Z; difference: 191-seconds

SCORPION-associated acoustic signals two, five, 12, 13, 14 and 15 were not detected by array 3141, therefore this association technigue cannot be applied to those events.

V. NOL ANAYSIS OF THE INTENTIONAL SINKING OF THE USS STERLET (SS-392)

The following information from appendix A to reference (c) is provided because it is relevant to assessing the sources of the post-pressure-hull collapse signals associated with SCORPION.

On 31 January 1969, the USS SARGO fired a Mk-37, Mod 2 torpedo at the USS STERLET as a weapon-test against a mobil surfaced target. A four-man STERLET crew had set controls to maintain a 1000-1200 yard diameter circle at six-knots before being removed by helicopter. All STERLET inner and outer torpedo tube doors were closed. The inner and outer hatches of the forward and after escape trunks were sealed as were the torpedo room doors. Other doors were closed but not sealed. The conning tower hatch was open and the diesel snorkel-tube was rerouted to provide a second airway to the center hull section.

The torpedo detonated at 1102 local near the after torpedo room. STERLET sank stern-first at 1105 at 21-39N, 157-15W (about 40 nautical miles ENE of Pearl Harbor) in 10,700 feet of water.

Acoustic data was collected near-field by a hydrophone suspended 980-feet below a float positioned at the center of the 1000-1200 yard circle, and far-field by Pacific Sound Surveillance System (PACSOSUS) arrays.

Analyses of data provided by Appendix A to reference (c) indicate the foward torpedo room, with a volume of 4460-cubic-feet, collapsed (imploded) at a depth of 1200-feet, about **three times** the STERLET test-depth. This event produced a bubble-pulse frequency of 9.17-Hz which required an energy release equal to 840-lbs of TNT at 1200-feet.

The after escape trunk, with a volume of 88-cubic-feet, collapsed at 9100-feet and produced a bubble pulse of 105.26-Hz equal to 84-lbs of TNT.

The forward escape trunk, with a volume of 43-cubic-feet, collapsed at 10,300-feet and produced a bubble pulse of 90.91-Hz equal to 175 lbs of TNT.

Although SARGO recorded "a multitude of small creaks, groans, tinkles and clanks" from STERLET as she sank, detections of these sources by the deployed near-field sensor were too weak to be measured to determine radiated noise levels. None of these weak sources were detected by the far-field sensors, the PACSOSUS arrays.

All three collapse events were detected by PACSOSUS arrays at ranges of 2200 nautical miles to the NE and 2400 nautical mles to the NW. As discussed below, the detectability of the metal-to-metal acoustic sources from STERLET, relative to the detectability of collapse events from that platform, provides information useful in evaluating the sources of post-pressure-hull collapse signals detected from SCORPION.

The average sink-rate of the STERLET in 10,700 feet of water was 21.8 feet-per-second (12.9 knots). No imagery was collected to assess the condition of the STERLET hulk on the bottom.

VI. 1970 NOL ASSESSMENT OF SCORPION POST- PRESSURE-HULL COLLAPSE ACOUSTIC SIGNALS.

Section VII below provides a discussion of bubble-pulse acoustic energy.

The conclusion in paragraph 5.8 on page 13 of reference (c) that SCORPION acoustic events 2-14 were neither explosions nor implosions appears to have been influenced by the apparent absence of bubble-pulse energy with these events.

As discussed in the SUMMARY section above, a correct assessment of the sources of SCORPION acoustic events 2-14 was complicated by FINDING OF FACTS eight and nine of reference (e) which state, respectively, "That recent experiments conducted by the Naval Ordnance Laboratory and further testimony by experts in underwater explosives confirmed that it is possible to detonate an explosive device against a submerged air-filled cylinder or a submarine without observing a bubble pulse," and "that the implosion of internal tankage due to pressure may or may not result in the detection of a bubble pulse."

As discussed by reference (b), the explosion of multiple torpedo warheads within the pressure-hull of the Russian nuclear submarine KURSK produced bubble-pulse energy detected seismically at 3100 statute miles. Section V above documents detection of bubble-pulse energy from the collapse of STERLET escape trunks at ranges as great as 2400 nm. This public-domain information refutes the two assessments by reference (e) that may have led the authors of reference (c) to the wrong conclusion about the sources of SCORPION post-pressure-hull-collapse acoustic events.

What is perplexing is that the authors of reference (c) identified the signal characteristics of the first SCORPION acoustic event that are unique to a collapse event and the signal transmission path anomalies that explain why events 2-14 could have been collapse events without detection of associated bubble pulse energy.

Basically, as discussed in the SUMMARY above, the authors of reference (c) had all the information needed to have made the correct SCORPION acoustic signal source assessments but veered away from that solution for reasons all of which cannot be "posthumously" identified but which, in combination with the John Craven-sponsored and now disproven "bubble-pulse swallowing" theory, led the COI to state, in OPINION 3 of reference (e), that "The first acoustic event...had no bubble pulse frequency recorded."

Here are the illuminating quotes from reference (c):

Page 13: "The spectrum of Event 1 is unique among the SCORPION signals in that it contains an extremely large amount of lower-frequency energy" (which we now know were the fundamental and the second and third harmonics of a 4.46 Hz bubble-pulse). This harmonic structure is clearly shown by Figure C.2 on page C-20 of reference (c). Even from this relatively low-resolution display it was possible in 2008 to measure the bubble-pulse frequency as about 4.52-Hz which compares favorably with the more accurat value of 4.46-Hz derived from analysis of the CUHSC tape recording. No apparent effort was made by anyone connected with the analysis of the SCORPION acoustic data to examine the USS THRESHER acoustic data to determine whether a bubble-pulse was detected and, if so, what the frequency was.

Page 3: "...we believe that most of the events in the SCORPION acoustic sequence (all after Event 1: hull collapse) resulted from random mechanical impacts."

One of the primary reasons for this conclusion (a mechanical-impact-origin assessment for the follow-on events) appears to have been that these acoustic signals did not contain the "large amount of lower frequency energy" observed with the first event (hull collapse), i.e., did not contain the bubble pulse energy expected from either an explosion or an implosion.

All well and good until we come to the quote two paragraphs below which discusses the characteristics of the acoustic signals detected by the CUHSC hydrophones from the eight 70-lb SUB-MISS explosive charges (calibration shots) detonated on 19 and 24 June 1968 at depths between 60 and 3470 feet at the SCORPION wreck site.

Since these calibration shots were explosions, **they had to have generated bubble-pulse energy** yet such energy was not clearly detected by the CUHSC hydrophones, i.e., the low-frequency spectra of these shots **did not** - as noted on page 13 - look anything like the first event (hull collapse). This anomaly is explained by the following assessment by reference (c):

Para 6 on page C-9: "The (calibration) shot spectra of Figure C.19 provides interesting examples of propagation channel effects at long ranges. The oceanic channel acts as a high pass filter and broadband signals measured at long ranges sometimes show evidence of excessive low-frequency attenuation. Explosion sources further complicate experimental investigations of the wave guide problem because the low-frequency end of the spectrum is not flat for deep charges."

Again, the paragraph immediately above appears to be explaining why few (none?) of the deep SUB-MISS calibration shots showed the expected excess of low-frequency acoustic energy normally associated with bubble-pulse signals that **must** have been generated by these explosive charges. Despite this observation/conclusion, TABLE C-1 on page C-10 of reference (c) lists observed bubble-pulse frequencies for all eight SUB-MISS calibration shots. It appears the authors of reference (c), faced with the anomalous lack of clear low-frequency bubble-pulse energy from the SUB-MISS shots (explosions), found enough signal excesses at higher frequencies to justify their classification of such energy as bubble-pulse-generated.

Now comes the problem which is: the spectra of the SUB-MISS calibration shots, as detected by the CUHSC hydrophones, show general - and sometimes striking - similarities to the spectra of SCORPION events 3, 4, 6, 7, 8, 10, 11 and 14 shown, respectively, on pages C-22, C-23, C-24, C-25, C-26, C-28, C-29 and C-32 of reference (c).

One cannot have it both ways, i.e., the absence of low-frequency bubble-pulse energy from the SUB-MISS shots was attributed to long-range propagation channel signal attenuation effects while a similar absence of low-frequency bubble-pulse energy from the post-collapse SCORPION acoustic events was attributed to the assessment that these signals were produced by metal-to-metal impacts and not by implosions which would have produced bubble-pulse energy.

The failure of PACSOSUS arrays to detect any of the metal-to-metal impact source signals produced by STERLET as the hulk sank indicates similar sources were unlikely to have been detected from SCORPION as was proposed by reference (c).

The most parsimonious explanation of this signal-source issue is that at least eight acoustic events (3, 4 and 6-11) that occurred after SCORPION hull collapse were produced by the collapse of small structures that survived in the collapsed hull sections to implode not more than 192.8-seconds after pressure-hull collapse at greater depth than hull collapse. The bubble-pulse energies of these follow-on collapse events were "distorted" by the same long-range propagation channel effects which attenuated the low-frequency spectra of the SUB-MISS calibration shots. **Only the first SCORPION acoustic event (pressure-hull collapse) had the bubble-pulse energy level required to overcome the effect of the excessive low-frequency attenuation discussed above.**

VII. DISCUSSIONS OF BUBBLE PULSE ENERGY

An understanding of the source mechanism associated with the production of acoustic energy by bubble-pulse events is essential to assessing the sources of many of the SCORPION post-pressure-hull collapse acoustic events. Accordingly, the following sub-paragraphs discuss that mechanism.

- A bubble pulse frequency can be created either by an explosion or by an implosion. In the case of SCORPION, a bubble-pulse frequency detectable at long-range was created by the implosion (collapse) of the submarine's pressure hull at 1530-feet. The energy associated with a collapse event (implosion) is produced by the essentially instantaneous conversion of potential energy (external sea pressure) to kinetic energy as water expands with supersonic velocity into the relative vacuum of a submarine pressure-hull. The intruding water meets at a focal point within the shattered structure and rebounds to form a cavity (an area of greatly reduced pressure: a bubble) that expands until the falling pressure of the shock wave is overcome by ambient sea pressure. The bubble then collapses to rebound and collapse again multiple times until the energy is dissipated by friction with the water and, only in the case of an implosion, by the distortion (weakening) of the expanding-contracting pressure (shock wave) front when it encounters what remains of the collapsed structure.

- The reciprocal of the length of time that is required for the first contraction-expansion cycle of the bubble is the frequency of the bubble-pulse. A collapse event begins with a negative motion of the water inward followed by a positive motion of the rebounding water outward.

- The primary source of noise from an explosion or implosion is the pulsing (oscillation) of the bubble created by the energy release; hence, the term "bubble-pulse." Cavitation is produced by a similar mechanism in which the area of reduced pressure that follows the passage of a propeller blade through water permits the air dissolved in the water to "come out of solution" and form bubbles (cavities) which collapse when the blade and its trailing area of reduced pressure moves away from the bubbles. Cavitation is more nearly a "one-time-event" for each bubble whereas several collapse-expansion cycles of the bubble cavities produced by an implosion (or explosion) can be detected before the energy level falls below detection threshhold. The frequency produced by the initial contraction-expansion oscillation of the cavity is a function of the size of the bubble: the larger the bubble cavity, the lower the frequency. At the onset of cavitation from a propeller, extremely small bubbles form at the trailing edge of the blade tips and can produce acoustic energy above 10-kHz when they collapse. Collapse event bubble-pulse frequencies can be as extremely low if they result from the release of great energy, e.g., the circa 3-Hz KURSK bubble-pulse was the product of an energy release equal to about 10,000-lbs of TNT at a depth of about 320-feet.

Conjecture that bubble-pulse energy could be contained (swallowed) within a collapsing submarine pressure hull also is not consistent with the temporal dynamics of the SCORPION collapse event. The estimated duration of the collapse event was less than 0.17 seconds ((Annex C.IV.5 reference (c)). This estimate is supported by data collected during the sinking of the USS STERLET discussed above. The SCORPION bubble pulse frequency of 4.46-Hz indicates the period of the first oscillation of the bubble from initial negative (inward) motion through complete collapse to positive (outward) motion to the point of pressure equalization was the reciprocal of 4.46 Hz or 0.22-seconds. These time values (0.17s vs 0.22s) indicate that by the time the bubble had re-expanded from the collapse point to the distance of the pressure-hull, the pressure-hull would have been destroyed (no longer intact); hence, there would have been no structure to contain the bubble, the oscillations of which, although probably distorted by the collapsed structure, were the strongest of the 15 acoustic signals detected from SCORPION by the CUHSC hydrophones on 22 May 1968. In other words, the pressure-hull collapse event that initiated the negative phase (inward contraction) of the bubble (cavity: air within the hull)) would have destroyed the pressure hull in less than the time required for the bubble to re-expand to the distance of the pressure-hull from the collapse point.

The observation that only the first SCORPION acoustic event contained bubble-pulse energy is consistent with the calculated energy release of that event: 13,200-lbs of TNT. **To repeat, only the first SCORPION acoustic event (pressure-hull collapse) had the bubble-pulse energy level required to overcome the effect of the excessive low-frequency attenuation discussed in Section VI above.**

Data provided by Appendix A to reference (c) provides a basis for determining the decay-rate of bubble-pulses created by underwater explosions, in this case, 4-lb charges dropped at the STERLET site starting six-minutes after STERLET sank.

These data, shown below, indicate that because of the friction between the expanding shock wave (pressure front) created by the explosion and the water, the period required for a complete cycle "decays" or decreases because the loss of energy does not permit the wave front to expand the same distance in consecutive cycles. Because the bubble-pulse frequency is the reciprocal of the length of the oscillation cycle, the frequency increases as the period decreases.

On average, the length of the second oscillation cycle is only 75 percent the length of the initial cycle. The length of the third oscillation cycle is, on average, only 62 percent the length of the initial cycle. Accordingly, the frequency of the bubble-pulse generated by the second cycle is 1.33 times the frequency of the bubble-pulse generated by the initial cycle. The frequency of the bubble-pulse generated by the third cycle is 1.61 rimes the frequency of the bubble-pulse generated by the initial cycle.

Because of such changes, only the frequency of the initial bubble-pulse oscillation cycle should be used as an input to the formula on page C-4 of reference (c) to determine the energy yield of explosive or implosive underwater events as was done with the SCORPION pressure-hull collapse event.

Charge Size	Depth	First Oscillation Period/Freq	Second Oscillation Period/Freq	Third Oscillation Period/Freq	Fourth Oscillation Period/Freq
4-lb	85 ft	130/7.7-Hz	107/9.3-Hz	87/11.5-Hz	Not Detected
4-lb	95 ft	122/8.2-Hz	100/10-Hz	83/12-Hz	Not Detected
4-lb	1525 ft	14.8/68-Hz	10.9/91-Hz	8.4/119-Hz	8.4/119-Hz
4-lb	2930 ft	8.6/116.-Hz	6.0/167-Hz	5.0/200-Hz	4.8/208-HZ
4-lb	3260 ft	7.2/139-Hz	5.8/172-Hz	4.8/208-Hz	4.0/250-Hz
4-lb	3560 ft	7.8/128-Hz	5.0/200-Hz	5.0/200-Hz	4.5/222-Hz
4-lb	3590 ft	7.8/128-Hz	5.2/192-Hz	4.2/238-Hz	4.0/250-Hz

Notes:

(1) Period is duration of an oscillation (pulse) cycle in milliseconds.
(2) Frequency is 1000 (milliseconds) divided by the period (in milliseconds).

VIII. FINAL COMMENTS

The originator has analyzed a high-resolution time-vs-frequency display of CUHSC hydrophone A acoustic data that covered the period from 1600Z to 2000Z on 22 May 1968. **There were no detections of a torpedo or any indication of main-propulsion activity by SCORPION**. The originator rejects assessments made by individuals who have, at various times, listened to the CUHSC tape recording and concluded they heard what sounded like a torpedo. Time-vs-frequency graphic displays provide the identification of the acoustic source characteristics required to discriminatively classify signals radiated in the area of the spectum to which the CUHSC hydrophones were sensitive. **Aural analysis cannot provide this information from the spectrum of the CUHSC hydrophones.**

As discussed in detail by enclosure (1) to reference (b), the initiating (precursor) events that resulted in the loss of the USS SCORPION were one, more probably two, low-order explosions contained within the pressure-hull that occurred within a half-second period at 18:20:44Z, 21-minutes and 50-seconds before pressure-hull collapse at a depth of 1530-feet.

These events are evaluated as explosions based on signal rise-time, duration of peak amplitude and signal decay-time, each probably less than 0.1-seconds, the maximum time-resolution of the CUHSC helicorder display. No event of mechanical origin, including the failure of rotating machinery, displays these temporal characteristics nor, as would have been the case with a failing rotating machine, were any signals detected that would have been generated by a decelerating rotational-mass, especially one that was experiencing eccentric forces, even for a period as short as several seconds.

Additionally, the characteristics of the two SCORPION signals are **identical** to an event that occurred onboard PL-722 at 11:59:43Z on 11 March 1968 and was the initial significant acoustic signal associated with the loss of that platform near 40-06N, 179-57E. The time-line of subsequent acoustic events establishes conclusively that the initial significant signal was internal to the PL-722 pressure-hull and did not breach the pressure-hull.

Still further, medical examination (not autopsies) of the remains of V. M. Kostyushko and/or V. A. Lokhov and/or V. G. Nosachev recovered from the bow section of PL-722 indicated they died from **explosion** and crushing.

All information provided by this report has been derived from analyses of unclassified documentary and tape-recorded data that have been in the public domain for 40 years. **To emphasize, the recording that has been analyzed to provide the conclusions by reference (a) and this report is one of many copies of the original CUHSC SCORPION tape in the public domain.**

IX. RECOMMENDATION

Direct the Naval History and Heritage Command (NHHC) to use ADM Rickover's book on the MAINE as guidance for the production of a document for public release that includes the results of the first reanalysis of SCORPION acoustic data in 40 years. The originator has additional technical material that can be provided to support the NHHC effort.

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