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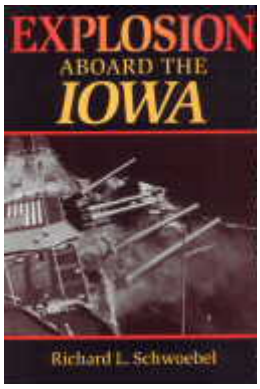
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J'ACCUSE

Explosion Aboard the Iowa *by* Richard L. Schwoebel
Naval Institute Press, 291 Wood Road, Annapolis, MD 21402-5034, USA, , , E-Mail:customer@usni.org: xxiv + 304 Pages: Publication Date - 1999, ISBN 1-55750-810-0: Price $ 34.95

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Richard L. Schwoebel



Richard Schwoebel holds a Ph.D. from Cornell University in engineering physics. In 1962 he joined *Sandia National Laboratories* in Albuquerque, where he later became director of various scientific and engineering organizations. In addition to his activities at Sandia, he has participated in several notable high-altitude balloon programs and was the flight and technical director for the first crossing of the Atlantic by manned balloon in 1978, and for a transcontinental flight in 1980.

At the request of the Senate Armed Services Committee, Schwoebel organized and led an independent investigation by Sandia of the explosion aboard the "Iowa". He testified before the Committee in May 1990.

Schwoebel retired from Sandia in 1995. He resides in Albuquerque with his wife Jennie.

One of the foremost tasks of a forensic pathologist is the investigation of explosions. We ran a comprehensive review of a book on explosion investigations in one of our previous issues (Volume 2, Number 2, July-December 2001, page 17). In the current issue, we discussed a book on the history of explosives (Volume 3, Number 1, January - June 2002, page 1). This time we discuss an important book on explosion investigation, which general readers would find very entertaining, interesting and useful.

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While the previous book was a general discussion on the investigation of explosions, this one concentrates on one particular case of explosion - the one aboard USS Iowa - which occurred on 19 April 1989, and which cost 47 innocent lives. The initial investigation by the Navy was shown to be shoddy and worse - biased. The latter investigation by the *Sandia National Laboratories* in Albuquerque, New Mexico brought out the true picture.

While the Navy had maintained that the explosion occurred as a result of a deliberate criminal act by one of the crewmen on board, the 24 year old Gunner's Mate 2d Class Clayton Michael Hartwig, the investigation by *Sandia* showed that the explosion was the result of inadequate training and procedures followed by the Navy. So important and far-reaching was the *Sandia* report that the Navy had to go back on their earlier statemennt. While earlier they had been maintaining that Clayton Hartwig caused the explosion deliberately, after the *Sandia* Investigation, they said that most likely he did not cause the explosion. Decommissioning of *Iowa class* Battleships was in the pipeline since quite some time (the ships were old and very manpower and cost intensive), but it was the *Sandia* investigation which perhaps hastened that decision. The *Sandia* report thus was very far-reaching in its effects. The book is written by the Chief Investigator of the *Sandia* team, Richard L. Schwoebel. The entire book concentrates on the brilliant investigation done by the *Sandia*, and how they tore apart the Navy's theory. Through this book, Schwoebel proves himself as a master storyteller. The entire book reads like a thriller. One can not put aside the book once he starts reading it.

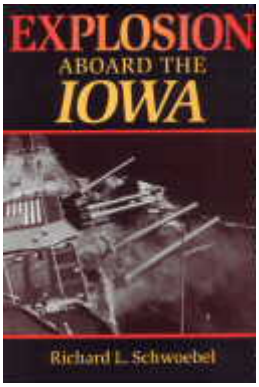
For the uninitiated, a little bit about the USS Iowa explosion. On 19 April 1989 - the day of the explosion - USS Iowa was cruising in light seas 330 nautical miles northeast of Puerto Rico. Weather was good by all accounts. The true wind was 13 knots from 130 degrees, and the waves were 2 to 4 feet high. There was a crew of 1500 on board. The ship was to conduct some routine exercises. The ship had three turrets (called turret I, II and III from fore to aft respectively), each containing three huge 16-inch guns. These massive guns were to fire during that exercise.

The exercise was to begin around 10.00 am local time. It was to fire 22 rounds from Turrets I and II. Firing from Turret III could also be done if the conditions were suitable.

Some facts about the massiveness of the turrets, projectile and the propellant bags. Each of the turrets in USS Iowa class battleships, weighs approximately 1800 tons, which is equal to the weight of an entire destroyer. Each of the 16-inch gun weighs 120 tons. Each projectile weighed 2700 pounds - equal to the weight of 20 adult healthy men!

Despite its heavy weight, the guns were so powerful that the projectile could be shot upto 20 miles with remarkable accuracy. The projectile could leave the barrel with a speed of approximately 2500 feet per second, and could penetrate 26 inches of armor. Two of these projectiles are equivalent to the total non nuclear ordnance that can be delivered by a modern combat jet fighter!

EXCERPTS



The book by Schwoebel is meticulously researched, fast-paced, often chatty in style, witty and always entertaining. This is how he describes the situation when he first went to meet Capt. Joseph D. Micelli, the director of the NAVSEA Technical Review Team. It was the afternoon of 7 December 1989, nearly eight months after the explosion. The following passages appear on pages 28-29.

I anticipated a cool reception bracing myself for remarks or attitudes reflecting that Sandia knew little about naval gun systems, forensics, or criminal investigations. All this was, of course, only too true... The two hour drive from National Airport to Indian Head gave me time to review once again my thoughts for the meeting.. . I turned into the parking lot outside the Indian Head security gate and saw Jerry Herley and Tim Stone standing near the gate office. The two GAO representatives were obviously waiting for me. I wanted to initiate the interaction with the Navy on my own before other organizations with their various agendas became involved.. .
Conscious that I am rarely successful in concealing my thoughts, I put on a friendly face as I greeted Jerry and Tim. "Tim and I thought we'd join you and the captain for the first meeting," Jerry said. "Hope you don't mind."

I asked how they heard about my meeting with the Navy team. "Captain Micelli called us," Jerry laughed. "He wants witnesses, I guess."

To propel this heavy projectile forwards, the gun required six bags of black powder! The book tells us that on that fateful day, the Navy bosses decided to use five bags of a different propellant instead (a high explosive technically known as D846). Each of these bags weighed 94 pounds. Thus a total of about 500 pounds of high explosive was used. This combination - the heaviest projectile and a faster-burning propellant - is normally disallowed. So the news that this combination was going to be used surprised everyone.

Schwoebel describes the various propellants in detail here. We are told that two kinds of propellant are usually used in ships. One is a smaller diameter D845, and the other is faster burning, larger diameter D846. Which propellant would be used for a particular projectile is predetermined according to its weight. A faster burning propellant can not be used with a very heavy projectile, because the projectile would move forward very slowly (because of its weight), and the faster burning propellant can generate dangerous pressures behind it. The D846 propellant cans in the magazine for Turret II were clearly marked: "WARNING DO NOT USE WITH 2700 LB (AP, BL&P) PROJECTILE." The turret also has placards inside it repeating the same thing. However the Navy bosses decided that if they use five bags of D846, (instead of the normal six), it would not generate dangerous pressures behind the projectile, and would keep the pressure in the barrel within acceptable limits.

Captain Fred P. Moosally, the commanding officer of the *Iowa* was not told about this rather unusual decision (*This is what the general perception is and this is what the book also says. However there are people who hold views to the contrary!*). He was merely told that turret II would be using "reduced charge". Normally this expression means that the charge would be of a smaller diameter. However in the sense in which the expression was *actually used* was that they would be using five bags instead of the normal six.

There were last minute reassignments of the crew in the Turret II. GMG3 Richard Lawrence was to be the gun captain for the center gun, but he missed the departure of *USS Iowa*, so GMG2 Clayton Hartwig was replaced for him. There were some other reassignments too.

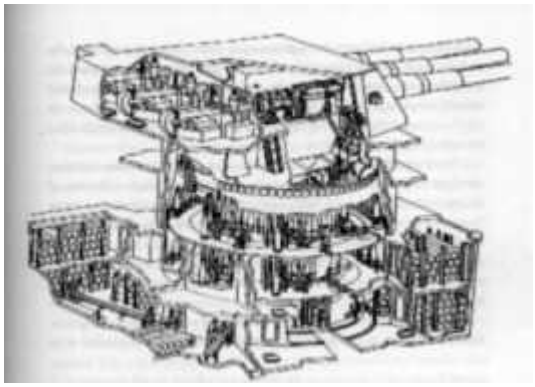
All gun stations were manned by 8.30 am. Turret I was ordered to load its 16-inch guns at 9.33 am. The projectile was 1900 pound in weight, and it did not carry an explosive charge. A projectile was inserted into each of the three guns of Turret I. After that reduced charges of D845 propellant were positioned. D845 is called a reduced charge, as it has a smaller diameter. At 9.38 am, the *left gun* was fired, but there was no reaction. A misfire had occurred. Schwoebel tells us that this was not uncommon with reduced charges, because the primer flash in the center of the breech may fail to ignite the black powder patch in the center of the smaller diameter bag.

After a misfire occurs, a misfire procedure has to be followed. It includes a waiting period of about one hour, during which a smoldering spark from the primer may eventually ignite the black powder pad at the aft end of the bag. If the breech is opened too soon after a misfire, the exposure of a lingering spark or ember to a sudden draft of air could lead to ignition of the bags and an open breech explosion in the gun room.

After this the center and right guns (of Turret I) were fired, and they fired successfully. All the three guns were then reloaded and fired once again, and the center gun once again failed to fire. The

other two guns fired normally once again. The left gun misfired for the third time, even after some technical corrections.

This drawing of the turret on *Iowa*-class battleships comes from page 77 of the book. There is a big caption below this diagram explaining all parts of the ship, and where exactly the problem occurred. The book is full of such explanatory diagrams. These help to understand the text very much, especially to those (like this reviewer), who don't know much about ships.



Captain Moosally ordered Turret II to fire. Normally if a gun misfires, this should properly be resolved before firing can start in other turrets. But this procedure was not followed. Ten rounds were to be fired from Turret II - two from the left gun, and four each from the center and the right gun.

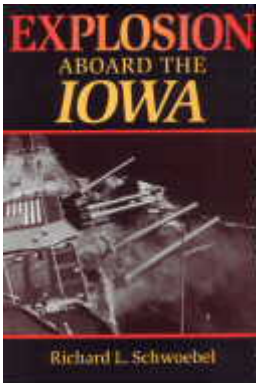
An aide to Admiral Johnson was taking a video film of the entire operation. It was this film which caught the explosion in full. It is also this film which shows the last minutes before the explosion. The camera shows that all the three guns of Turret II were pointing to the starboard. Normally when the order to "load" a gun is given, it is lowered in elevation. By making the gun more "horizontal", the breech end of the gun is lowered, so the projectile and the propellant bags can be inserted easily. After the loading is complete, the guns are again raised. The camera film showed that the left and the right guns had been raised, meaning thereby that the loading process had completed, but the center gun remained depressed. For some reason - not known to people standing outside - the loading process in the center gun had not completed. Later on, it was determined that the loading of the projectile was normal, but the loading of the propellant had not occurred. There could be several reasons for this. (i) Either the inexperienced upper powder hoist operator mislocated the powder car and a readjustment was required (ii) The new rammerman was confused by the counterintuitive nature of the powder door handle and this slowed the loading process (iii) Perhaps people inside were confused about the strange combination of the heavy projectile and the faster burning powder and were discussing the issue.

However the Navy thought there was an altogether different reason for this delay. The gun captain Hartwig, during this time, was inserting an ignition device instead of the lead foils into the propellant train and directed an overram to initiate the explosion!

At exactly 9.55 am local time the center gun of Turret II exploded! Almost 500 pounds of high explosive was set on fire in the confined space of the barrel. There was a intense fire all around. The firestorm engulfed the lower decks of the turret where it exploded an additional 2000 pounds of explosive, setting a second - albeit lower intensity - explosion. The overpressure inside the turret quickly climbed to more than a thousand pounds per square inch. The fires were quenched in

about 90 minutes. The memorial service was held on 24 April (Monday) in the largest hangar at the Norfolk Naval Station.

EXCERPTS



Schwoebel's meeting with Captain Micelli is very interesting. Schwoebel nags Micelli with piercing questions, and often catches him off-guard. Here is a brief example from page 34. Captain Micelli's theory that Hartwig had placed a chemical ignition device between the propellant bags was based on Navy's finding of certain foreign material on the projectile. This is how Schwoebel busts Micell's theory of foreign materials. This is a tête-à tête between Schwoebel and Micelli, with Schwoebel writing in first person.

"I've read your final report," I said, "and I'd like to ask some questions."
"Fine, fine," he replied, "go right ahead. Anything at all."
I began by citing a section of the report about foreign materials on the projectile. The report stated that "this [foreign] material was only replicated when a chemical device was used to initiate" an explosion. I asked about the uniqueness of this result, the use of the word "only": "Isn't it possible that there are other sources of such foreign materials? How can you be sure that what you call foreign materials were not contamination?"
"What do you mean by other sources of foreign materials?" Captain Micelli replied.
"Well, for example, steel wool cleaning pads might have been used for breech cleaning, and there certainly could be residues of oils in the breech that contain glycol. Also, the projectile had been exposed to maritime environment ever since it was manufactured - probably many years ago. Chlorine would probably be found on any such surface. Who knows how else the projectile may have been contaminated?"
The discussion goes on. The reader may want to read this full discussion (as well as several others like this) by referring to the original book. Many of the interesting dialogues come from Captain Micelli. He was obviously convinced that Hartwig and Truitt were homosexuals and Hartwig had set off the explosion mischievously. This is what he tells Schwoebel during one of their several meetings (page 83)

"You know," he (Micelli) said,"Hartwig and Truitt were real scuzbags. They were actually caught one night wrestling with each other. Can you imagine that? While Hartwig was on the watch?" He glanced at me (Schwoebel) as he laughed." The NIS [Naval Investigative Service] really tagged them." The captain clearly had a fixed opinion about these men.. .

This was certainly a very bizarre incident, and one would easily imagine that this was the first such explosion to occur. But the book tells us (page 245) that there had been earlier explosions of a similar nature with serious loss of lives. The first such explosion occurred in 1924 on the battleship *USS Mississippi* (BB-41). This ship was launched on 25 January 1917, and 14-inch rather than 16-inch guns were the standard at that time. During a gunnery exercise off San Pedro on 12 June 1924, an explosion in Turret II killed 48 crewmen. A second - almost similar - explosion occurred on 20 October 1943 on the same ship. The *Mississippi* had been overhauled in San Francisco and sailed from San Pedro on 19 October 1943 to take part in the invasion of the Gilbert islands. As the ship was participating in a bombardment of Makin on November 20, an explosion in the same turret killed 43 crewmen. Interestingly both these explosions - as well as the April 19, 1989 one - occurred in Turret II. The cause of the first two explosions was never established.

A third explosion occurred too before the *USS Iowa* incident. It occurred in 1972 during the Vietnam war. This time the explosion occurred in the number two 8-inch gun turret on the heavy cruiser *Newport News*. The casualty was less this time - 20 were killed and 10 were injured. The explosion occurred at 1.00 am local time on 1 October 1972. The cruiser at that time was the largest in the Seventh Fleet and carried a crew of about 1300. At the time of explosion, it was located near the DMZ, approximately 13 miles north-northeast of Quangtri City. It was shelling North Vietnamese positions.

Coming back to the 19th April, 1989 explosion. The US Navy conducted an extensive and costly investigation into this incident, which cost $25 million. Many agencies were involved in this investigation, including several naval facilities, the U.S. Army Ballistics Laboratory at Aberdeen, Maryland and the Federal Bureau of Investigation (FBI).

The Navy issued its report, "*Investigation into the 19 April 1989 Explosion in Turret II USS Iowa (BB-61)*" on 7 September 1989. Dated 15 July 1989, it was submitted to the commander, Naval Surface Force, U.S. Atlantic Fleet, by Rear Adm. Richard D. Milligan of US Navy. He was the Chief Investigating Officer. The director of the NAVSEA Technical Review Team was Capt. Joseph D. Micelli.

From the number of agencies that were involved in investigation, it would appear the outcome would be scientifically very rigorous and beyond any reproach. Unfortunately however, that was not to be. Its findings said that there was one seamen onboard who committed suicide by explosion. He was 24 year old Gunner's Mate 2d Class Clayton Michael Hartwig, who had a homosexual relationship with Petty Officer Kendall L. Truitt. Hartwig was the gun captain of the center gun of Turret II, where the explosion occurred. He had taken out his life insurance policy naming Truitt as the beneficiary. The policy was to pay Kendall $100,000 in the event of accidental death. This raised the possibility of murder initially. The possibility appeared quite strong, especially as Truitt was known to be involved in an auto theft back in 1987. Truitt was even transferred out of the *USS Iowa*, so that an impartial investigation could be carried out. He was transferred to the staff of the commander of Destroyer Squadron 8, based in Mayport, Florida. The official reasoning was that it was done because of the extensive publicity surrounding the Iowa explosion. However the possibility of Truitt involved in foul play was ruled out later.

How this suspicion arose in the first place is also an interesting story. Ten days after the explosion, Ms. Kathleen Kubicina, the sister of Clayton Hartwig, sent a letter to the Navy about a fifty-thousand-dollar double indemnity insurance policy on her brother. The letter was written to the

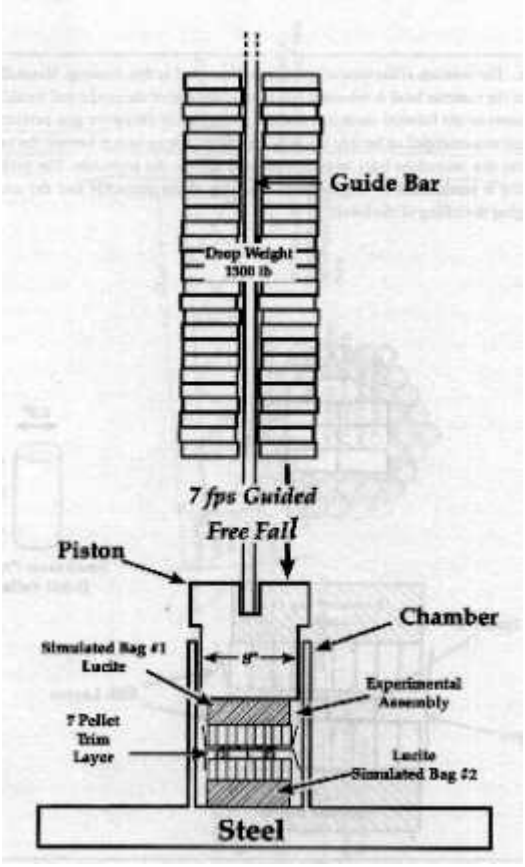
Commander of *USS Iowa*, Captain Fred P. Moosally. The beneficiary was Kendall Truitt, who was to get 100,000 dollars in case of the accidental death of Hartwig. Truitt was alive and Hartwig was dead, while both were on the same ship, and Truitt was the beneficiary of Hartwig's death. This immediately raised the possibility of a criminal act.

Admiral Milligan received a copy of this letter on May 7, three weeks into the incident, and an enquiry into this angle was started by the Navy Investigative Service on May 8th, 1989. However, as we have already seen, involvement of Truitt was ruled out later.

Then it was thought that it could be an act of suicide by Hartwig, with an intention to make it appear as if it was an accident.

The US Navy - quite inexplicably - switched from one theory to the other. Initially the Navy was working on the theory that the explosion was an accident. They thought that the propellant bags had been pushed too far into the barrel - a situation technically known as *the overram*. This overram - according to Navy's initial theories - caused friction, which generated heat, which in turn was responsible for the explosion. There were other theories doing the rounds too.

One of the several ingenious experiments done by Paul Cooper. A 1300 pound weight is dropped on the pellets to simulate a high-speed overram in a 16-inch gun. Fracture of trim-layer pellets by the dropping weight caused ignition of the black powder and small explosions in these experiments. These subscale experiments first demonstrated that an overram could cause an explosion and revealed an important but unrecognized safety problem in 16-inch guns systems. Videos of these experiments were shown to the Senate Armed Service Committee during the hearing on 25 May 1990. This line diagram appears on page 130 of the book



...Chapter 12 and 13 of the book concentrate on the Sandia Investigation, which according to this reviewer are the essence of this book. In these chapters Schwoebel shows how Sandia arrived at the correct cause of the explosion. The ingenious experiments done by Paul Cooper are particularly interesting to read. These are illustrated with several line diagrams. Readers can see one such diagram on the left...
A few theories were discarded by the Navy after some consideration. Because of the overram situation, the Navy considered the possibility of crushing propellant pellets. The exposed fracture surfaces of pellets emit burning particles when the fracture occurs. It was very obvious to conclude that the explosion occurred because of that. However Navy investigators concluded that the strength of the pellets was such that the rammer could not have exerted sufficient force to cause fracture. An interesting assumption was made by the Navy - that the rammer force of two thousand pounds would be uniformly applied to all the pellets over the rammer face, and this would "dilute" the force so much that no fracture of pellets would occur. However, as Sandia investigation later showed - this is what actually happened! Chapter 12 and 13 of the book concentrate on the *Sandia* Investigation, which according to this reviewer are the essence of this book. In these chapters Schwoebel shows how Sandia arrived at the correct cause of the explosion. The ingenious experiments done by Paul Cooper are particularly interesting to read. These are illustrated with several line diagrams.

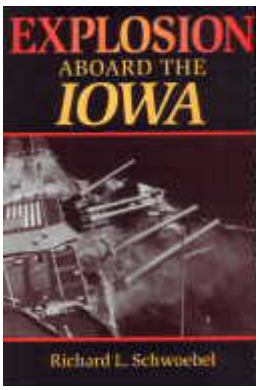
Another possibility of explosion considered by the Navy was that the propellant was 44 years old. A portion of it had been stored on river barges under conditions that resulted in exposure to high temperatures during summer months. Such conditions could lead to loss of a chemical stabilizer (incorporated within the propellant). Stabilizer is a chemical that is usually mixed in the powder grains. It keeps the propellant from becoming autocatalytic and spontaneously igniting at elevated temperatures. Sufficient loss of stabilizer could result in propellant spontaneously igniting at elevated temperatures. However Navy discarded this theory too, and decided that the concentration of the stabilizer was sufficient in the propellant.

One theory was *The burning ember theory*. This was the possibility of propellant ignition by friction or open flames. There was understandable concern about the open flames being present in the vicinity of the propellant as some of the crewmen killed in the turret were found to have lighters and other smoking items on their remains. These items were forbidden inside the turret.

One theory advanced was the possibility of static electricity generated sparks (ESD) or electromagnetic radiation (HERO) as a source of ignition. These theories were also discarded after some tests. Tests showed that that any possible static electric spark within the gun turret was too insignificant to ignite either the black powder or propellant. No mechanical failure in the gun room was found too that could have been or served as a source of ignition.

The Navy ultimately settled for the overram theory. Analysis of the reconstructed rammer placed the rammer head about 21 inches past its normal point inside the breech at the time of explosion. (The book however tells us that *Sandia*'s investigation proved this conclusion wrong too. It found that the head was 24 inches past - a full three inches more than what Navy had concluded!) According to the Navy, this overram of 21 inches caused the detonation to occur in between the first and second propellant bag (from the projectile in the breech). The Navy's report stated, "At this position the rammer would have pushed the five powder bags up to the base of the projectile."

EXCERPTS



Being a forensic pathologist, I was particularly interested in reading the testimony of the forensic pathologist who conducted the post-mortem examination on the casualties. He was Dr. Richard C. Froede, armed forces medical examiner of the Armed Forces Institute of Pathology. He appeared to testify at the Joint Hearing by the House of Representatives. Representative Larry J. Hopkins (R-Kentucky) questioned him. Some extracts from page 72.

Mr. Hopkins:..Several Naval Officers have made comments describing Hartwig as having been in an unusual position, for a gun captain, at the time of the explosion. For instance, some accounts have him reaching into the gun barrel for no clear purpose, while others have him standing to the side with his arms extended. Is that correct?
Dr. Froede:.. We were able in this case to place four people into that gunroom and put them in positions that were consistent with the patterns of injuries.
Mr. Hopkins: I am not doubting what you are saying to me, but I want to explore that further. I have a difficult time trying to imagine an explosion going off in a confined area, creating four thousand pounds per square inch, thus creating temperatures of three thousand degrees, followed by flooding of the area, followed by draining of the area, I have a hard time in my own mind determining how can you say for sure where these people were located.
Dr. Froede: .. The position of the powder that we found on Hartwig was found on the anterior, anterior right shoulder and right arm.. then we.. put them closer to the breech where the alleged explosion took place.
Mr. Hopkins: Back to my original question or one of my questions a little bit earlier. Some accounts have him reaching into the gun barrel. Other accounts have him standing to the side. Where was he? Which one of these do you agree with?
Dr. Froede: I cannot really give you an answer.
Schwoebel displays an extraordinary ability to describe incidents, especially meetings with people. This is how Schwoebel describes his meeting with the FBI official Ken Nimmich, who obviously was piqued at Captain Micelli's behavior with the FBI (pages 103-105)

After meeting with the Navy team at Sandia, it was essential to visit the FBI Laboratory in Washington, D.C. to get a firsthand report of its work related to the Iowa investigation.. . I found it difficult to accept that the FBI had not been fully supportive in the investigation as Captain Micelli had indicated. The basis for the conflict between the Navy and the FBI was unclear to me.. .
I arrived in Washington late on 23 January (1990). Early the next morning I boarded the Metro for the stop nearest the FBI Building, reviewing again my notes.. .The guard called Ken Nimmich's office, and in a few minutes he came into the badge office and introduced himself.

Schwoebel now goes on to describe, how Nimmich was initially given to believe by Captain Micelli that an electronic detonator was possibly used by Hartwig to set off an explosion, but later, without informing the FBI, Micelli changed his theory to that of a chemical ignitor. Nimmich was completely surprised. This is what Schwoebel writes on page 105:

Nimmich said he was dumbfounded when the captain mentioned a chemical device. He said to Captain Micelli, "Chemical ignitor? I thought we were looking for residues of an electronic initiator?" "No," Micelli replied, "we now have evidence that a chemical initiator was used." Nimmich goes on to say: ".. .The first scenario was an accident, the second an electronic detonator, and the third a chemical ignitor. Each of these scenarios had been considered the right answer by Micelli at one time or another. We packaged up the samples of rotating band and sent them back to the Navy."

The Navy had hypothesized that Clayton Michael Hartwig had placed an ignitor between the first and the second propellant bags, and this ignitor initiated the detonation when the overram occurred. But according the Navy's theory itself, it was not clear how the ignitor could have set off an explosion, when a gap of 3 inches still remained. The Navy conveniently chose to keep quiet about it.

This ignitor theory by Navy also swung often between whether it was an electronic or a chemical ignitor. Initially it was thought that Hartwig had placed an electronic ignitor and it was even mentioned in Admiral Millgan's report. But later the Navy thought that it was an improvised chemical ignition device. Admiral Milligan's report was not updated before it was released, but Captain Joseph D. Micelli, the director of the NAVSEA Technical Review Team was emphatic that it was inconsequential. The important thing according to him was that Hartwig had committed a criminal act. Micelli was quite enthusiastic about the latter "chemical ignitor" theory. He thought that the improvised igniter device consisted of a container of swimming pool HTH, a second container of a glycol containing fluid, like brake fluid, surrounded by steel wool. He thought that the overram was responsible for fracturing the two containers, which set off the explosion. The mixing of the chemicals in the two containers initiated a chemical reaction, that ignited a black powder patch and then five hundred pounds of propellant.

Captain Micelli said that they had found residues from the ignitor on the rotating band of the projectile. In particular, they found these residues in the cannelure of the rotating band, a region that was sealed when the projectile moved forward in the barrel by the explosion. The only person who was in a position to do so, was the gun captain. An FBI team substantiated Navy's belief was stating that Hartwig was suicidal.

The Navy had reasons to think that Hartwig knew about such a device. He told Schwoebel, the Chief investigator from *Sandia* and the writer of the book under review, "This device is common knowledge to anyone who's taken the EOD [Explosive Ordnance Disposal] course, and Hartwig had taken that course (page 34). It was also described in *Soldier of Fortune* magazine, copies of which were found in his locker aboard ship."

These findings (by the Navy) were presented in public hearings to two committees - the *Senate Armed Services Committee* (SASC) and the *House Committee on Armed Services*. The Chairman of SASC was Senator Sam Nunn, a Democrat from Georgia. Both committees found that the Navy study lacked rigor and thoroughness necessary to rule out an accidental cause for the explosion.

Committee members were also troubled by the Navy's apparent rush to judgment against a dead seaman whose alleged sexual preference, i.e. homosexuality, provided a convenient scapegoat. There was also a feeling that the Navy had rushed to judgments that were both speculative and insufficiently supported by specific facts. The House published a report entitled "*USS Iowa Tragedy: An Investigative Failure*".

The Senate Committee asked the Government Accounting Office (GAO) to review various aspects of the Navy's utilization of battleships and to seek a laboratory to conduct an independent assessment of the Navy's findings and associated conclusions. GAO's investigation of the utilization of the Iowa and the three other battleships concentrated on issues such as manning and training of personnel. Several deficiencies were noted in these and other areas and the GAO ultimately recommended that the battleships be decommissioned.

The GAO also sought the services of an independent laboratory to assess the Navy's conclusions. The task of this independent enquiry was entrusted with *Sandia National Laboratories* in Albuquerque, New Mexico. This selection was based in part on recommendations by the *National Academies of Engineering and Science*, and partly because of their engineering and scientific expertise and because of their work dealing with the safety of nuclear weapons. The Iowa investigation was a unique project for Sandia, the first independent assessment requested by a committee of Congress. The book under review concentrates on this investigation.

A little bit about *Sandia National Laboratories*. It was established in 1949 at the request of the then President Harry Truman. At that time Sandia was a part of Los Alamos Scientific Laboratory and was responsible for the development of militarized nuclear weapons using Los Alamos "physics packages". Following Harry Truman's intervention, AT&T took over the management of Sandia on 1 November 1949. Sandia had 1742 employees at that time, but with the continued development of nuclear weapons stockpile, the number grew to over 8000 by 1989.

It is one of the Department of Energy Laboratories in the U.S. nuclear complex that has responsibility for the safety, as well as for the performance and reliability, of all nuclear weapons possessed by United States. Imagine the disaster that would occur is some of the nuclear warheads possessed by the US were to set off all by themselves! The work of *Sandia National Laboratories* is to conduct research to prevent such types of nuclear disasters. Since *Sandia* was involved in this kind of research, i.e. safety operations, it was only natural to entrust this laboratory with this task. Physicist Richard Schwoebel was chosen to lead the Sandia team. Investigation by Sandia began in December 1989, about eight months after the disaster and three months after the Navy issued its report on the incident.

I will not concentrate in any detail on how the Sandia's Investigation was done. Readers would find these investigations in great detail in the book itself. But a few glimpses would suffice to indicate how thorough was their investigation. Their findings were that the explosion occurred because of lack of adequate crew training, use of aged high explosives dating to 1940s, and the explosives not being maintained under properly controlled conditions.

One would expect that the Navy may not have provided much assistance to the *Sandia* team. However the author says (page xv) that in the investigations, Navy team made significant contributions. It is an interesting fact that they did not try to push their opinions on *Sandia*'s experts. Though at several places Captain Micelli is depicted as someone who is overconfident perhaps to the extent of even being arrogant.

The *Sandia* team busted Navy's theory by conducting some ingenious experiments. Readers can find them in detail in the book. In this review however, I will mention about some "foreign materials" that were identified by the Navy in the gun. They were claimed by them to be the signature of a chemical ignition device which Hartwig had placed between the propellant bags. Two of these materials were *Calcium* and *Chlorine*. Schwoebel said that this was not true (page 156). He found Calcium and Chlorine in many locations within the turrets of *Iowa, Wisconsin*, and *New Jersey*. These elements were found in several places in these battleships - in the magazines, powder flats, projectile deck, gun rooms, and rotating bands of projectiles on the ship.

...This book is an absolute must for all those who love truth. Those people would especially enjoy it who want to know how science can separate chaff from grain. I would also strongly recommend this book to all forensic specialists, especially those who are involved in explosion investigation. An average general reader would enjoy the book for the sheer beauty of the narrative...

Navy had found some other foreign materials on the projectile too, which according to them also substantiated their *Chemical ignitor* theory. The Navy said that the rotating band from the projectile in Iowa's center gun contained traces of Aluminum, Silicon, Calcium, Barium and Iron Wire (page 50), all inorganic materials not found in an uncontaminated charge. According to the Navy, the presence of these substances indicated that a chemical ignitor device has been used by Hartwig.

But Schwoeble busted that theory too (page 34). According to Schwoebel, steel wool cleaning pads might have been used for breech cleaning, and there certainly could be residues of oils in the breech that contain glycol. Also, the projectile had been exposed to maritime environment ever since it was manufactured - probably many years ago. Chlorine would be found on any such surface.

It was the result of these findings that forced the US Navy to retract their earlier stand. In the fall of 1991, Adm. Frank B. Kelso II had to state this (page 286): "On behalf of the US Navy, I extend my sincere regrets to the family of GM2 Hartwig. There is no clear and convincing proof of the cause of the Iowa explosion. And the Navy will not imply that a deceased individual is to blame for his own death or the deaths of others without such clear and convincing proof."

It was also this investigation which exposed the way Navy tried to cover up its own follies. It left the Navy in bad taste in the public consciousness. Since the *Sandia* Investigation, several people have likened this incident to the infamous Dreyfus affair.

This book is an absolute must for all those who love truth. Those people would especially enjoy it who want to know how science can separate chaff from grain. I would also strongly recommend this book to all forensic specialists, especially those who are involved in explosion investigation. An average general reader would enjoy the book for the sheer beauty of the narrative.

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Personal Stories:
http://www.ussiowa.org/turret2/turret2_memorial.htm

http://www.ussiowa.org/turret2/personal_accounts/turret2_story.htm
http://www.ussiowa.org/turret2/personal_accounts/turret2_story1.htm

Newspaper articles: (from the 10 year memorial service)
http://www.ussiowa.org/turret2/news/later/html/focusonliving_vpls.htm
http://www.ussiowa.org/turret2/news/later/html/memories_vpls.htm

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