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## Fire on Soviet Nuclear-Powered Submarine

An Intelligence Memorandum

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## Fire on Soviet Nuclear-Powered Submarine

### Summary

On 21 August 1980 a Soviet nuclear-powered submarine had a serious accident at sea, which resulted in the death of at least nine men. The submarine—an E-class, torpedo attack unit—had a complete loss of power. As a result, it could not communicate and had to send its distress message from a British merchant ship that responded to its distress flares.

We believe that the accident occurred while the submarine was surfaced and probably involved a hydrogen fire/explosion compounded by the generation of toxic gases. The cause of the accident was probably a failure of the battery ventilation system, which led to a buildup of hydrogen. Human error almost certainly was a contributing factor.

There is no evidence that there was any problem with the nuclear reactor either before or after the accident. We believe that the reactor safety circuits operated properly and shut down the reactor when the accident occurred. Extensive monitoring showed no evidence of radioactive leakage.

*The above information is*

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## Fire on Soviet Nuclear-Powered Submarine

### Introduction

At 0550 (local time), just before sunrise, on 21 August 1980, the officer of the watch and lookouts on a British liquefied natural gas carrier, the Gari, sighted distress flares about 15 nautical miles away. The Gari altered course to investigate and shortly afterwards identified the vessel in distress as a Soviet E-class nuclear-powered torpedo attack submarine, located about 90 nautical miles east-northeast of Naha, Okinawa.

Ships rendering assistance during a distress situation are required to keep a detailed record of events and the times they occur. We have received excerpts from the Gari's official deck log that include descriptions of actions and observations concerning this incident.

### Excerpts From the Gari's Log

As the Gari approached the submarine, it observed manual distress signals and a number of men on deck. By 0635 the Gari had closed to about 100 meters of the submarine. There were at least 50 men on the deck of the submarine with what appeared to be bed linens draped around their heads and shoulders. Several covered bodies also were on deck, and two men were giving artificial respiration to a man on the afterdeck. Very light smoke or fumes, not black smoke or flames, were emanating from the open afterdeck hatch, and men wearing breathing apparatus were working around the hatch.

At 0700 the Gari lowered a lifeboat in the charge of its chief officer. The lifeboat proceeded to the submarine and later reported "five injured and nine dead as a result of fire on board" (see figure 1). Several men were throwing buckets of seawater down the afterhatch of the submarine (see figure 2). At no time did there appear to be any power on the submarine, and no one on deck seemed to be in charge.

The lifeboat returned to the Gari about 0730 with three men from the submarine—a radio operator, an interpreter, and a man who appeared to be a junior officer. From conversation with these men, it was understood that a fire had occurred about 0450, one hour before the Gari saw the distress signals, and that nine men had died. The Soviets requested morphine, which was provided by the Gari.

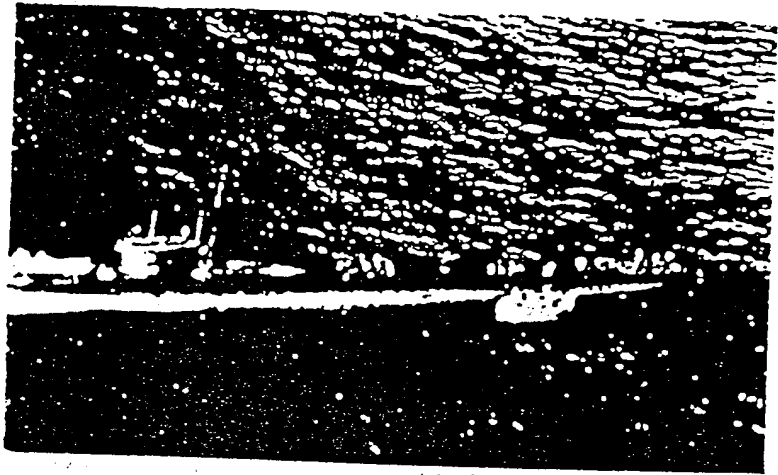
\* Five E-1-class submarines were completed in the early 1960s. They originally were armed with six cruise missile launchers and carried the land attack version of the SS-N-3. In the late 1960s and early 1970s, they were converted to torpedo attack units by removing the launchers and streamlining the superstructure and, thereafter, were referred to as E-class submarines.

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Figure 1

Lifeboat From Gari Alongside E-Class Submarine

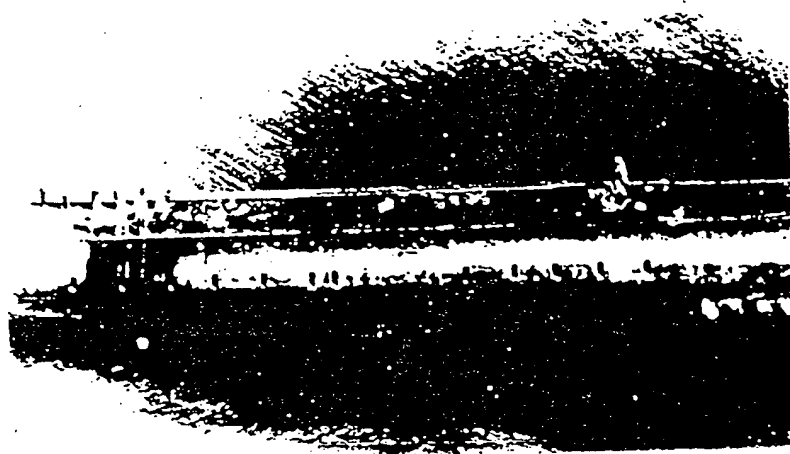


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Figure 2

Activity Around Afterhatch of E-Class Submarine



The men from the submarine also requested that the Gari send various unspecified messages to the USSR. We do not know the nature of these messages. The Master of the Gari, however, only permitted the Soviets to repeat the general distress call in the Russian language and to send a message to the Soviet Ambassador in Tokyo. The Soviet merchant training ship Meridian answered the distress call and indicated it would proceed to the scene. When the three Soviets were informed that a Japanese helicopter was en route, they seemed confused, and the Master of the Gari formed the opinion that only assistance from a Soviet ship would be welcome.

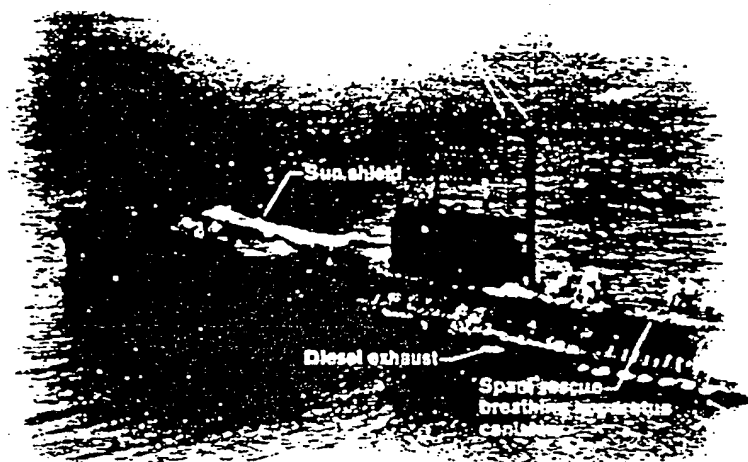
The three Soviets were returned to the submarine at 0930. The Gari supplied drinking water in all available containers. The rescue helicopter arrived a few minutes later and made repeated attempts to contact the submarine. These attempts were ignored by the submarine. The Gari's lifeboat was recovered at 1045. At about the same time, the helicopter departed for its base. There was no further contact between the Gari and the submarine.

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Figure 3

Activity on Forward Portion of E-Class Submarine



Just before noon the Meridian reported an estimated time of arrival on the scene of 1400. The Gari observed that the crew of the submarine continued to throw seawater into the afterhatch. Awnings of what appeared to be bed linen had been rigged forward of the sail during midmorning (see figure 3).

At 1425 the Meridian arrived and lowered its lifeboat, which immediately began transferring men from the submarine to the ship. A few minutes later, the Gari resumed its voyage, having received permission from the Japanese Maritime Safety Agency.

Comments and  
Observations of  
Gari Officers

On 23 August 1980, after the Gari arrived in Japan, the Master and three of the ship's officers were debriefed on the incident. Their comments, which supplement the excerpts from the ship's deck log, are as follows:

- Initially there were about 50 men on deck. The number increased to over 70 (one Gari officer counted 76) as the morning wore on. All remained aft until a sun shade was rigged forward; then most of the men moved forward.

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- Six bodies were observed on deck. There were no obvious signs of burns on the torsos and legs of the partially covered bodies or on any of the other men on deck. The Soviets later stated that there were in fact nine dead and three injured men.

- The submarine had no power. There was no movement of the propellers, control surfaces, or masts. Photography shows that one periscope, one high-frequency (HF) antenna, one very-high-frequency (VHF) antenna, and the intercept antenna were all in the raised position (see figure 3). No machinery noises were heard. The submarine appeared to be fully buoyant with no trim or list (confirmed by photography).

- Both the fore and aft deck hatches were open. No steam, smoke, or flames were seen, although "white fumes," which had an acrid odor, were rising from the afterhatch. When pressed to identify the odor, Gari officers said it might have been that of chlorine, but they were uncertain.

- A few men on the submarine were observed entering and exiting the afterdeck hatch. They were dressed in protective clothing and wore rescue breathing apparatus. For at least four hours, one or two men were noted pouring buckets of seawater down the afterhatch.

- The men on deck appeared confused, disorganized, and leaderless, and none seemed over 21 years old. No one seemed to be in charge or able to direct the mooring of the Gari's lifeboat. Eventually an older crewman came topside, went below, and returned with a younger man who spoke some English. This man along with the radio operator and apparently a young junior officer went to the Gari to send the distress message. They asked the Gari officers for a position to put in the distress message

#### Monitoring Radioactivity

Conducted extensive monitoring for radioactivity in the vicinity of the submarine. Water samples were obtained about 13 hours after the incident occurred. Additional samples were taken two days later, about 550 to 450 meters astern of the submarine as it was being towed home. None of these samples showed any evidence of radioactive leakage. Airborne sampling also was negative. The Gari, its officers and crewmen who had been in contact with the Soviets, and their clothing were monitored for radioactivity when they arrived in Japan. No abnormal activity was detected

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#### Status of Submarine

It is clear that the submarine was without power. None of the three sources of power (nuclear reactors, diesel generators, or storage battery) was able to provide power. This is indicative of a major electrical casualty. The fact that the Soviets had to go aboard a British merchant ship to send a distress message shows that there was not even battery power for the radios. Both HF and VHF antennas were erected and could have been used if a radio set were operational. A complete loss of power also would have caused all ventilation blowers to be inoperative.

The fact that no Soviet officer, other than the young officer who went to the Gari, was seen or identified suggests that most of the officers were killed or disabled in the incident. Comments by the Gari officers about the lack of leadership support this premise. An alternative explanation is that the officers remained below to fight the casualty. We do not believe this to be the case, however, because almost six hours elapsed between the accident and the last contact by Gari officers. The fact that the Soviets had to ask a Gari officer for a position to put in their distress message indicates that the navigator and other senior officers did not survive the accident. It also indicates that the third compartment, where a navigation chart with the submarine's current position would have been located, was inaccessible some three hours after the accident.

Photography taken between 1000 and 1030 (about five to six hours after the accident) shows the submarine riding at or above its normal waterline with no trim (see figure 3). This shows that there was no significant flooding, if any, and suggests that the submarine was surfaced at the time of the accident. The fact that radio antennas were erected also suggests that the submarine was surfaced.

#### Reconstruction of the Accident

We have reconstructed the accident that occurred on the E-class submarine based on an analysis of the sequence of events recorded in the Gari's log and observations made by the officers and crew of the Gari. We believe that the submarine was proceeding on the surface and nearing the end of a battery charge when the accident occurred.

The accident probably was a hydrogen-fueled flash fire and explosion in the battery compartment, resulting in high-amperage short circuits and the evolution of toxic gas and possibly acid fumes. A lead-acid storage battery always evolves hydrogen. But the rate of evolution when the battery is on charge, as it may have been at the time of the accident, is much greater than when it is on discharge or on open circuit.

The accident probably was caused by a failure of the ventilation system for the battery. A loss of ventilation during a battery charge is a mandatory signal to terminate the charge. If this is not done immediately, the hydrogen

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concentration increases dramatically. Slow action by personnel and/or inadequate or faulty monitoring of the atmosphere could compound the mechanical failure of the ventilation system and, in this case, probably did. A 4-to-8 percent mixture of hydrogen and air will burn. Concentrations above 8 percent will explode with increasing force as the hydrogen concentration increases. Because a spark to ignite such a mixture is almost always present in a submarine, the only safe way to prevent a fire or explosion is to keep the hydrogen concentration below 3 percent.

The fire/explosion most likely caused major damage to the battery and its connectors, which caused high-amperage short circuits. Electrical transients undoubtedly caused a reactor scram and ultimately the loss of all power.

Carbon monoxide and hydrocarbons from oxidized material undoubtedly were generated by the fire. In addition, three toxic gases—phosgene, phenol, and chlorine—could have been generated given certain circumstances.

Phosgene is generated when freon refrigerant is oxidized at high temperatures. It is virtually impossible to completely eliminate all freon leaks from air conditioning and refrigeration equipment. But good maintenance can keep the freon concentration below 25 parts per million, an acceptable nontoxic level. Two other products of the oxidation of freon are hydrofluoric and hydrochloric acid fumes.

Phenol gas is generated when fire and electrical arcing break down phenolic resin laminates. If such laminates are still used in switchboards and mountings for electrical equipment in Soviet submarines, some phenol may have been formed. The use of these laminates is considered a serious design deficiency, and the United States has not used them in electric power systems for submarines since 1950.

Chlorine gas is generated when seawater contacts battery electrolyte. It is not likely that chlorine would have formed, unless there was an ill-advised attempt to extinguish the battery fire with seawater.

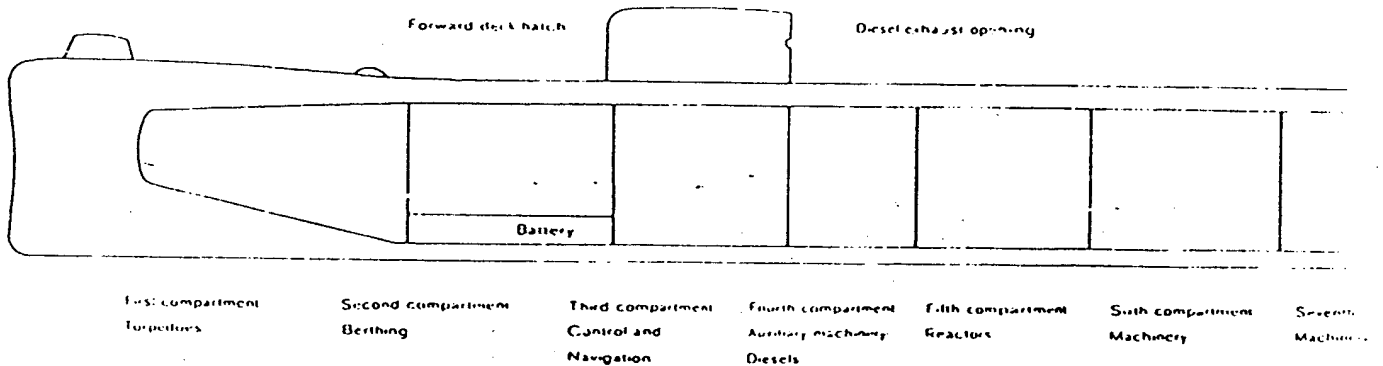
The officers of the Guri mentioned the presence of an acrid odor. Phosgene has the odor of freshly cut grass, but hydrofluoric and hydrochloric acid fumes have acrid odors. Phenol and chlorine also have an acrid odor, particularly in low concentrations.

Officer berthing and the storage battery are located in the second compartment of the E-class submarine, the control center and the radio room are in the third, and the diesel generators are in the fourth (see figure 4). A toxic

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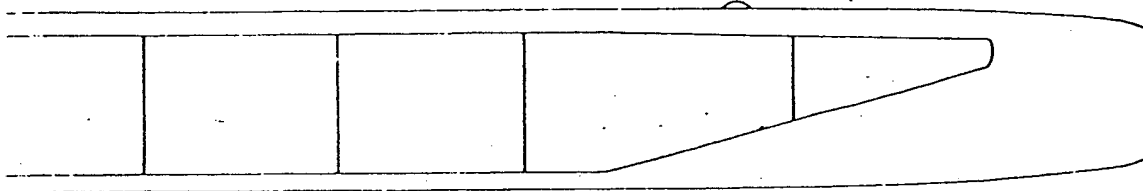
Figure 4

Compartmentation of E-Class Submarine



opening

Afterdeck hatch



Fifth compartment  
Towers

Sixth compartment  
Machinery

Seventh compartment  
Machinery

Eighth compartment  
Machinery

Ninth compartment  
Torpedoes

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gas generated by the flash fire may have incapacitated most, if not all, of the men in these compartments. We do not believe that the diesel generators were damaged by the accident because the port generator was running two days later.

The specific request for morphine rather than other medication or less effective painkillers is consistent with the painful and disabling type of injuries caused by a flash fire and the inhalation of toxic gas and acid fumes. Observations by Gari officers that there were no burns on the torsos and legs of the bodies on deck also are consistent with this type of injury.

We do not understand why seawater was being poured down the afterhatch of the submarine, except possibly to cool men using rescue breathing apparatus and fully enclosed in protective clothing. The men on deck were wearing what appeared to be sheeting around their heads and shoulders to protect themselves from the hot sun.

There is no evidence to suggest that there was any problem with the nuclear reactor either before or after the accident. We believe that the safety circuits operated properly and shut down the reactor when the fire/explosion occurred. With the loss of the battery and no diesel power available, it would not have been possible to restart the reactor. Without power and with most of the leadership dead or incapacitated, the submarine was completely crippled.

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