BLACK SEA EXPERIMENT ONLY A START

By THOMAS B. COCHRAN

Last July, on the Black Sea near Yalta in the Soviet Union, Soviet and American scientists began a program of experiments to study the utility of various tools for verifying limits on nuclear weapons at sea. On the basis of the first experiment, a principal recommendation is that the United States and Soviet Union should agree to remove, for the time being, all nuclear weapons—or at least all nuclear sea-launched cruise missiles (SLCMs)—from surface combatants, and begin a program of joint verification experiments to determine whether a ban on nuclear SLCMs on surface ships can be adequately verified. I believe it can.

The Black Sea experiment was a good start toward designing a verification package and it produced important and unexpected results with major implications for naval nuclear arms control. The Soviet and American scientists who conducted the experiment will meet this month for a final review of the results. It is clear that additional experiments would be useful, and they should be conducted regardless of any progress or policy positions at the Geneva Strategic Arms Reduction Talks (START).

The U.S. government reluctantly agreed at the December 1987 summit to initiate joint experiments with the Soviets on SLCM verification. Thus far it has done nothing to fulfill this commitment, and in fact opposed the Black Sea experiment. The U.S. government has prejudged the outcome of further research and is afraid the findings may undermine its position in START.

The Black Sea exercise was conducted by a private environmental organization, the Natural Resources Defense Council, in conjunction with the Soviet Academy of Sciences, with which the NRDC has enjoyed a close working relationship over the past three years. With the first experiment now completed, government and nongovernment scientists have expressed strong interest in the results.

Verifying limits on nuclear SLCMs will not be easy. But as the Intermediate-Range Nuclear Forces Treaty demonstrated, it will be far easier if all, rather than some, weapons are eliminated. Paul Nitze, arms control adviser during the Reagan administration, has proposed eliminating all tactical naval nuclear weapons, including long-range cruise missiles. Last July the Soviets sent up a trial balloon, when Col. Gen. Nikolai Chervov proposed eliminating all nuclear cruise missiles if the United States did the same.[1] Although the U.S. Navy finds both proposals unacceptable, there is a logical intermediate position: provide a breathing space, during which surface-ship-based naval nuclear weapons would be stored on land rather than deployed at sea. During this period, the United States and the Soviet Union, without prejudging the conclusion, can conduct joint experiments and demonstration exercises to determine whether, in fact, the elimination of nuclear weapons from surface ships is verifiable.

Until scientists have time to work out foolproof verification methods, nuclear weapons should be removed from ships.

I was one of five members of the U.S. scientific team who boarded the Soviet cruiser *Slava* on July 5 for the 4-hour series of observations. We were accompanied by a team of more than two

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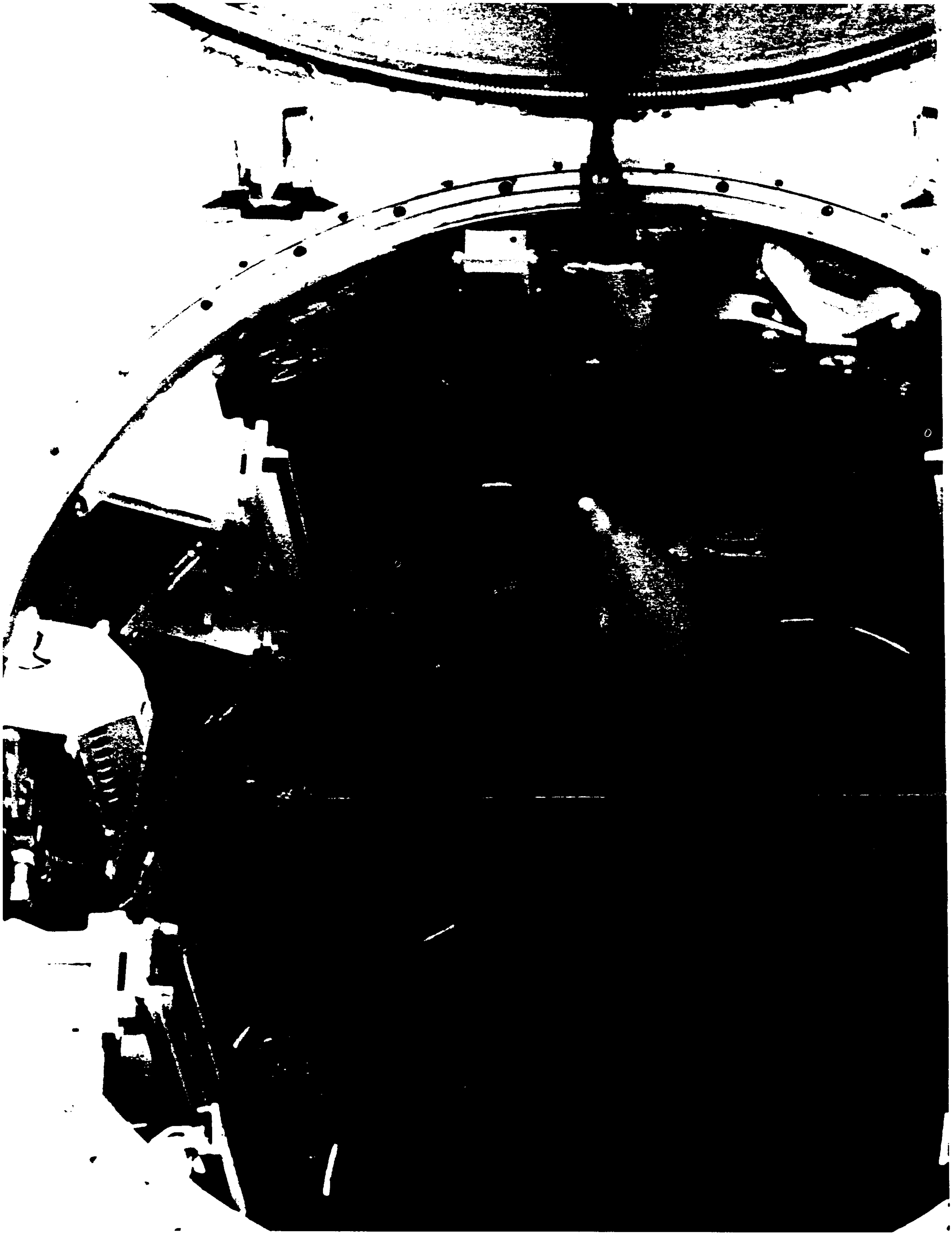
A Soviet "Sandbox" nuclear-tipped cruise missile in its tube aboard the cruiser *Slava*.



The U.S. government opposed the exercise because it didn't want Soviets to inspect U.S. ships.

dozen Soviet scientists, under the supervision of Academician Yevgeni P. Velikhov, director of the Kurchatov Institute of Atomic Energy; by additional observers from both countries; and by journalists from around the world.

Homeported at the Black Sea Fleet headquarters in Sevastopol, the *Slava* has a crew of 600, including 100 officers. The ship is equipped with launcher tubes for 16 cruise missiles, eight on each side of the ship. For the experiment, all the cruise missiles were removed except for a single nuclear-armed SS-N-12 Sandbox medium-range (300 nautical miles) antiship cruise missile in the forward exterior starboard launcher. The Soviet designation for the missile, which is about 11.7 meters long, is P-35.[2]

The most remarkable achievement was the exercise itself. The Soviet government permitted U.S. scientists to measure radiation from an operational warhead on a principal Soviet combatant. We were allowed to use some of the most sensitive instruments available: germanium gamma spectrometers, which can unambiguously identify radioactive isotopes by identifying gamma-ray emissions characteristic of their radioactive decays or those of their decay products.[3] (No gamma detectors, much less high-resolution germanium-based spectrometers, have been formally approved as verification tools for any treaty.) And we were allowed good access to the weapon, in terms of proximity and counting time.

The U.S. government opposed the exercise because the U.S. Navy feared establishing a precedent that could lead to similar visits by Soviet inspectors aboard U.S. warships. Such visits, we were told at a State Department briefing last June, would challenge the navy's policy of neither confirming nor denying the presence of nuclear weapons aboard U.S. warships, and they might reveal details of U.S. warhead design. Naval representatives and others argued that the exercise would be meaningless, because it is possible to conceal naval nuclear weapons by two means: shielding and/or concealing warheads below deck, and concealing warheads on shore.

The Black Sea experiment answered the Energy Department's concern about revealing design details. We recorded the gamma spectrum of a Soviet warhead with a sensitive germanium detector by placing the detector directly on the launcher, about 70 centimeters from the center of the warhead, and counting for 20 minutes. Analysis of the data, undertaken by Steve Fetter of the University of Maryland, failed to reveal warhead design details of any military significance, including the weapon's yield. If we had been permitted to take a series of measurements several centimeters apart

The *Slava*. The slanting tubes to the fore are cruise missile launchers. Yalta is in the background.

instead of a single reading, we may have discovered whether the weapon had two stages, and if so, the distance between them. Even if limitations imposed on the number and locations of measurements are judged to be insufficient, it is clear that one can further protect design information without degrading the capability to detect fissile material. This can be done by using a multichannel analyzer designed to record selectively the presence or absence of discrete spectral lines while revealing nothing about others. Thus, there is a straightforward technical solution to the argument that high-resolution germanium detectors are too intrusive to be used as verification tools.

One of the most interesting discoveries was the presence of thallium 208, a daughter product of uranium 232. Thallium 208 would not be present in weapon-grade uranium made from freshly mined uranium. Its presence indicates that the Soviets have used uranium from reprocessed reactor fuel to make the highly enriched product necessary for nuclear weapons. Thallium 208 emits high-energy gamma rays. If this is a common feature of Soviet warheads, they will be easier to detect than was previously thought.

There were other surprises as well, which demonstrated that experimental results cannot always be predicted from theory. The best theoretical study of the limitations of passive radiation detectors is a June 1988 report from a joint project of the Federation of American Scientists and the Committee of Soviet Scientists for Peace.[4] While its analysis and basic conclusions were correct, the report's quantitative analysis was based on four warhead models designed to represent the range of alternative warhead designs. On the basis of these models and an understanding of warhead design from the unclassified literature, many of us expected to detect a strong signal from uranium 238 but not from uranium 235, which we assumed would be shielded by the uranium 238. Also, because we were told a month earlier that we would not be permitted within five meters of the missile, we did not expect to see gamma emissions from plutonium 239. But using the high-resolution germanium detectors on top of the launcher, we detected strong signals from uranium 235 and plutonium 239 and, to our surprise, only a weak uranium 238 signal (from highly enriched uranium used in the weapon).

In one of the more interesting experiments, scientists from the Kurchatov Institute used large neutron detectors mounted in two Soviet helicopters and flew past the *Slava*, taking about one-and-a-half minutes to traverse the length of the 600-foot cruiser. At a distance of about 30 meters from the warhead, the neutron emissions from plutonium 240 (an isotope normally found in weapon-grade plutonium) were clearly detected. Even 70 meters from the cruiser, neutron emissions from the warhead were detectable. Both the U.S. and Soviet measurements confirmed that despite their limitations, passive radiation detectors can play a useful role as a verification tool.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The author, seated in front of an unidentified journalist, with Soviet scientist Mikhail Gokhberg (standing, center) and Steve Fetter of the University of Maryland. A germanium detector is in the foreground.

It is true that passive radiation detectors, used on ships, can be thwarted by shielding the weapon or by simply leaving it on land until a crisis comes. But no verification tool is foolproof when used alone. The challenge is to find a battery of tools that can be used together to provide an acceptable level of verification.

George Lewis, a member of a Stanford team analyzing SLCM verification who was also aboard the *Slava*, has noted that it appears impossible to move an assembled cruise missile below deck on any surface combatant without cutting through the deck. (The exception is aircraft carriers, which do not have the launchers for cruise missiles in any case). Thus, a workable verification package might include shore-based portal active radiation detectors[5] and a program of tagging and sealing cruise missile canisters and launchers. In this way a regime can be

The U.S. delegation, in front of a pair of missile tubes on the *Slava* deck. Left to right: John Adams, Tom Cochran, Jacob Scherr, Barry Blechman, Martin Zucker, Robert "Stan" Norris, Steve Fetter, Frank von Hippel, George Lewis, Lee Grodzins, Harvey Lynch (kneeling), Bill Arkin, Valerie Thomas, Cong. Jim Olin.

devised to insure that non-nuclear cruise missiles could not be converted to nuclear variants at sea by retrieving hidden warheads and inserting them into missiles. With challenge inspections, passive detectors like those used in our experiment could provide added insurance that the cruise missiles, which are in launchers accessible from the deck, were indeed non-nuclear.

Given the risk of a nuclear war starting at sea, it would be to everyone's advantage to eliminate sea-based tactical nuclear weapons. But the U.S. Navy worries that the Soviets could break out of such an agreement and rebuild their forces more quickly than the United States. It is hard for me to take this concern seriously. After all, the Soviets have, in effect, already broken out, since they now extensively deploy short- and intermediate-range nuclear cruise missiles at sea. Debate over this issue, however, need not hold up progress on naval arms control. If both countries agreed to remove all nuclear weapons from surface ships and store them on shore for a specified period, perhaps two to five years, the breakout issue is reduced to the question of whether either side would have a militarily significant advantage in the time required to restore the weapons to the ships. During a period of low tension like the present, this is hardly an overriding consideration.

War with the Soviets is not likely in the next few years. If these weapons have any deterrent value during periods of low tension, they would maintain that value if they were stored on shore. Taking the tactical warheads off of the surface combatants would solve the U.S. Navy's neither-confirm-nor-deny problem, because there would simply be no nuclear weapons on its ships. And should tensions increase, or should evidence develop that either party is putting nuclear weapons back on its ships, the other party could withdraw from the moratorium. Such a proposal is in keeping with the Bush administration's goal of engaging in verification experiments before signing treaties. ■

1. *Washington Post*, July 14, 1989, p. A1.
2. Thomas B. Cochran et al., *Nuclear Weapons Databook, Vol. IV: Soviet Nuclear Weapons* (New York: Harper & Row, 1989), pp. 176–77.
3. The U.S. team furnished a portable, 35 percent efficient, high-purity germanium detector by Princeton Gamma-Tech (Model IGC 3520 intrinsic germanium "P"-type coaxial detector with a 5 liter MPS cryostat), coupled to a portable 4,096-channel multichannel analyzer manufactured by Davidson Co. (Model 2056-B MPCA).
4. Steve Fetter et al., "Detecting Nuclear Warheads" (Washington, D.C.: Federation of American Scientists, June 8, 1988).
5. Active detectors work by emitting as well as receiving radioactivity.