Soviets Agree to Broad Seismic Test

The only precondition is that the United States agree to a moratorium on nuclear tests, which it is unlikely to do

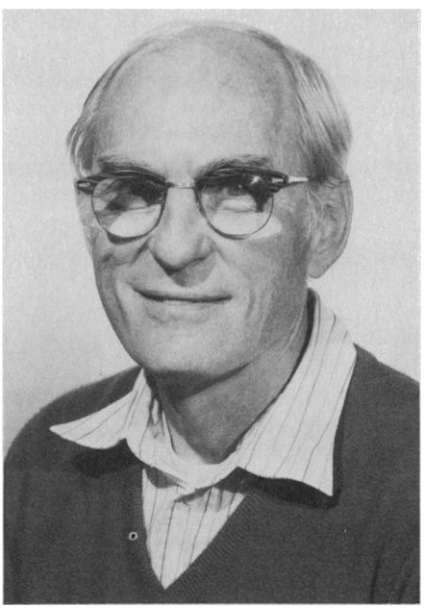
In a potentially significant new proposal, the Soviet Union has agreed to let the United States establish a broad seismic monitoring network inside its borders in exchange for U.S. participation in a nuclear testing moratorium. The agreement, which came in a previously undisclosed telegram to the U.S. Geological Survey (USGS), is apparently intended in part as a response to criticism in the West that such a moratorium would be unverifiable.

According to several sources, the Soviet agreement was generated by an, informal, unpublicized USGS proposal in May to establish an experimental network of seismic monitoring stations at up to 18 sites within the Soviet Union. The proposal was designed to address what some scientists consider to be the principal technical uncertainty about verification of compliance with a low yield or comprehensive nuclear test ban, namely whether there are sufficient sites for monitoring relatively high-frequency seismic signals, presently considered the best means for detecting surreptitious underground nuclear explosions.

The principal author of the USGS proposal was Jack Evernden, a research geophysicist who believes that up to 25 such high-frequency monitoring sites can be found in the Soviet Union, and that the installation of sophisticated equipment at each site would enable the United States to detect and identify any nuclear explosion with a yield of more than 1 kiloton. Although a lengthy article by Evernden and two others supporting this theory was published in the May issue of *Reviews of Geophysics*, it remains somewhat controversial within the seismological community and Evernden's aim was either to confirm or disprove the theory through direct measurement.

After discussing the idea with experts at the U.S. Department of Energy and the Defense Advanced Research Projects Agency (DARPA) and obtaining what he describes as positive feedback, Evernden presented the idea in July to a scientific workshop in Moscow cochaired by Yevgeniy Velikhov, the vice president of the Soviet Academy of Sciences, and M. A. Sadovskii, the director of the U.S.S.R. Institute of the Physics of the Earth. Although at first it appeared that the Soviets would agree, they decided instead to accept a similar but separate offer by the Natural Resources Defense Council to establish only a small network of three seismic stations in the vicinity of their principal nuclear test site at Semipalatinsk (*Science*, 13 June, p. 1338).

Then, in a telegram to a USGS official on 3 June, shortly after Evernden returned to the United States, the Soviets agreed to the idea "in principle" and indicated that modern seismic equipment—potentially including that designed to record in the high-frequency range, between 5 and 50 hertz—could be installed immediately in Garm, a village near the Afghanistan border where the Soviets have a major seismic research center. Under a low key, existing arrangement, the USGS had equipped and partially manned a small U.S. seismic monitoring network in Garm in the late 1970's, but it was fairly insensitive and is now defunct.



Jack Evernden, *principal author of the USGS proposal.*

The telegram, signed by Sadovskii, also said that as soon as the United States joined the Soviets' existing nuclear test moratorium, "we would be able to set up joint research work" of the type that USGS proposed "widely on the territory of both countries." According to John Filson, chief of the USGS earthquake, volcanoes, and engineering office, this means that the Soviets "are clearly willing to proceed in more detailed discussions with us, although they have tied a wider deployment to political agreements reached at a higher level." The proposal specifically called for monitoring stations to be established for a period of several months at six sites within the Soviet Union, perhaps as early as July 1987, with subsequent movement to 12 additional sites. The Soviets would in return establish a similar number of stations within the United States, presumably in 1988. Each would send small teams of scientists to the other country to maintain the equipment and help collect the data.

According to various seismologists both inside and outside the government, such networks could be used to learn roughly how much high-frequency seismic interference exists within both countries and what effect it might have on more elaborate monitoring networks. More importantly, they could also be used to determine how well high-frequency seismic signals are transmitted through different regions and at various depths. The expense of the network in the Soviet Union alone may be as high as $841,000. But prior to Evernden's visit to Moscow, both DARPA and the Energy Department had expressed a willingness to support the proposal with appropriate funds and equipment. Sandia National Laboratory had pledged to help assemble and test the equipment before shipment to the Soviet Union.

Due to the present political sensitivity of the test ban issue, the possible pitfalls for the agreement are many. Most important is the Administration's strong opposition to new nuclear testing constraints, partly because they would interfere with development of the new nuclear weapons to be used in a ballistic missile defense, or "Star Wars" system. As Defense Secretary Caspar Weinberger recently wrote in a letter to Capitol Hill, "as long as we must depend on nuclear weapons to ensure our security, we must continue to test. . . . It is only through

actual explosive testing of our nuclear devices that we can ensure that our weapons are safe, reliable, effective, and survivable."

Objections might also be raised about sharing the U.S. monitoring technology with the Soviets and about the uncertain duration of the project. As originally conceived, the verification experiment would last only 6 months or so, while the moratorium would presumably last much longer.

Nonetheless, many experts consider the Soviet offer highly interesting. Herbert York, the principal U.S. negotiator for a comprehensive nuclear test ban during the Carter Administration, says that "it would be the most elaborate [verification] experiment in the Soviet Union that I'm aware of." During the negotiations, which were suspended by the Reagan Administration in 1981, both sides had tentatively agreed to install at least ten monitoring stations in each country, York says, but this would be done only after the treaty came into effect. "We did propose to put one station in the country on an experimental basis while the negotiations were going on, but they expressed a lot of doubt and never gave us a firm answer," he adds.

Paul Stokes, an engineer and verification expert at Sandia National Laboratory, praises the idea on strictly scientific grounds, as do several other government seismologists. "We simply do not know very much about seismic propagation, especially at high-frequency ranges," Stokes says. "Without the kind of information we can get from an experiment like this, we really won't ever know much about propagation in the Soviet Union. It makes good technical sense, but there clearly are substantial political problems."

The conditional Soviet acceptance of the proposal may be a topic of discussion between the superpowers on or about 25 July, when various officials meet in Geneva to discuss nuclear testing issues. The meeting, which was suggested by President Reagan, is apparently viewed by the Soviets as a forum to press for a resumption of bilateral test ban negotiations, while the Administration plans to press for new measures to verify compliance with an existing treaty that limits explosive yields to 150 kilotons. The leader of the U.S. delegation will be Robert Barker, a former official of Los Alamos National Laboratory who serves as a deputy assistant director of the Arms Control and Disarmament Agency. Barker is a forceful test ban opponent, and is presently awaiting Senate confirmation as the new special assistant to the Secretary of Defense for atomic energy, with overall responsibility for nuclear weapons production. ■

R. JEFFREY SMITH

NASA Responds to the Rogers Commission

The agency is reassessing its activities at every level; meanwhile, the shuttle may not fly again until 1988

In response to President Reagan's request for a 30-day progress report, the National Aeronautics and Space Administration (NASA) on 14 July released a summary of its efforts to carry out the recommendations of the Presidential Commission on the Space Shuttle Challenger Accident (the commission headed by former Secretary of State William P. Rogers). In releasing the report, agency administrator James C. Fletcher also announced that the target date for the next shuttle flight has been postponed from July 1987 until the first quarter of 1988, to allow ample time for redesigning and testing the solid rocket boosters that failed so catastrophically on 28 January. Echoing a widely held opinion in the space community, Fletcher admitted that the earlier date had been "a little optimistic." It remains to be seen how much this new delay will add to the rapidly growing backlog of military and civilian launches.

NASA has taken action on all of the Rogers Commission's nine major recommendations, said Fletcher. In the area of flight safety, for example:

■ *Solid rocket boosters.* On 24 March, shortly after taking over as head of the space shuttle program, Rear Admiral Richard Truly organized a team to redesign the solid rocket motor joint. The team includes personnel from several NASA centers, from industry, and from the astronaut office; it will be assisted by a 12-member expert advisory panel, which will include six members from outside NASA. In accordance with another Rogers Commission recommendation, meanwhile, the National Research Council has established an independent oversight group under H. Guyford Stever. This group will report directly to Fletcher.

At the moment, Truly and his engineers are confident that the required safety margins can be met by modifying the present joint design, which will allow the agency to use the booster hardware that it already has on hand. However, as a contingency in case the modified designs prove inadequate, says Truly, the booster team is also developing a totally new design that does not utilize existing hardware.

■ *Launch abort and crew escape.* On 7 April, NASA initiated a Shuttle Crew Egress and Escape Review and a Launch Abort Reassessment Team. Among other things, these studies will assess options for crew escape during controlled gliding flight. Final reports are due on 1 October.

■ *Landing safety.* A new Landing Safety Team has been established. The Rogers Commission made particular reference to the shuttle's tires, brakes, and nose-wheel steering, which have been safety concerns since long before the Challenger accident. New brakes are already under development; other systems will be reviewed and upgraded as necessary.

■ *Critical item review and hazard analysis.* On 13 March, NASA began a complete review of all shuttle failure modes, together with a reassessment of every piece of critical equipment on the shuttle. The goal is to catch any other potential disasters that may have slipped through the system the same way the infamous O-rings did. This activity will culminate in a comprehensive final review with NASA Headquarters beginning in March 1987.

In other actions, meanwhile, NASA has responded to the Rogers Commission's critique of the pressure to launch and the unrealistic flight schedule:

■ *Flight rate.* In March, NASA established a working group to assess the constraints on the shuttle flight schedule at the Kennedy Space Center, where the spacecraft and payloads are made ready for flight, and at the Johnson Space Center, where the shuttle crews are trained and the flight software is developed. This working group will report on 15 August. In parallel, the National Research Council is conducting an independent review of the shuttle flight schedule, and NASA headquarters is formulating a new policy on shuttle cargo manifests designed to minimize disruptive last-minute changes.

■ *Maintenance.* NASA is developing a new and comprehensive maintenance plan for the shuttle system. Furthermore, to stop the practice of removing parts from one orbiter to supply another, which has been a safety concern since the shuttle's early