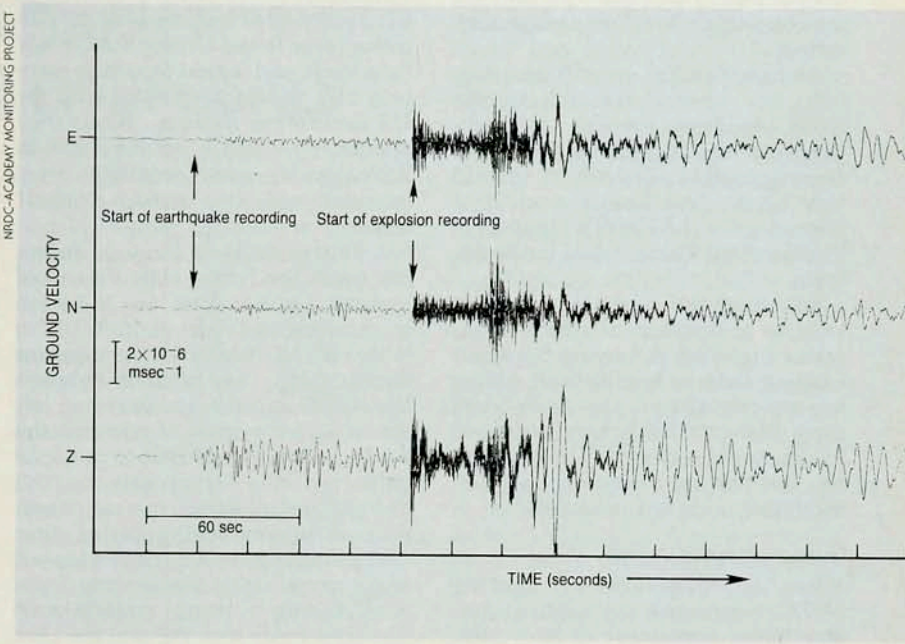
NUCLEAR TEST BAN VERIFICATION AGREEMENTS YIELD NEW SEISMIC DATA

New ground in the field of nuclear test ban verification will be broken next year under an agreement concluded in June between the Natural Resources Defense Council, an American advocacy organization that works primarily on environmental and arms control issues, and the Soviet Academy of Sciences. The agreement, the successor to another agreement between the two parties reached in May 1986 (PHYSICS TODAY, July 1986, page 63, and August 1986, page 57), provides for the establishment of five seismic stations in the Soviet Union at distances greater than 1000 kilometers from the Soviet test site in Kazakhstan. In contrast to the three existing NRDC–Academy stations, which are between 100 and 200 km from the test site, the five new stations will be permitted to record signals from Soviet nuclear weapon tests.

Implementing the agreement will involve moving the three existing seismic stations to locations more than 1000 km from the test site, establishing two entirely new stations and—starting on 15 July 1988—training academy personnel to operate the equipment with support, as needed, from the NRDC. "The academy will staff and operate the new and relocated stations with occasional assistance as required and requested from the NRDC," the agreement says. "All seismic data, including recordings of American and Soviet nuclear tests [made] at these five stations, will be available for both sides."

The purposes of the new five-station network will be, first, to test whether a low-threshold (on the order of 1 kiloton) test ban treaty could be verified with confidence by relying on a comprehensive network of stations spaced at intervals of about 1000 km and, second, to support an intergovernmental exchange of seismic data that is to take place next year under the auspices of the Ad Hoc Group of Scientific Experts of the disarmament conference in Geneva. The first such exchange, starting in 1984, involved basic information on matters such as arrivals of pulses and estimated event locations. Next year, binary waveform data—the actual seismograms—are to be traded among participating government agencies.

NRDC-ACADEMY MONITORING PROJECT



Seismometer recording from detonation of a 10-ton chemical explosive near the Soviet test site on 3 September. The first signals from the explosive arrived barely a minute after the first signals from an earthquake in the McQuarrie Islands, south of New Zealand. The higher frequency of the signals from the explosion distinguishes its signature from that of an earthquake. Three components of ground motion are shown: vertical (Z), east–west (E) and north–south (N).

The NRDC–Academy agreement also provides for an experiment to be performed in which the Soviet Union will detonate chemical explosives of known yield near the test site so that equipment at the three current seismic stations can be calibrated. Three such tests took place in early September, two with 10-ton charges and one with a 20-ton charge. According to Thomas B. Cochran, the NRDC physicist who first suggested establishment of the stations to the Soviets, the experiment was "successful beyond our wildest dreams."

The experiment was designed to see whether the stations would be able to pick up signals from a "decoupled" test of a low-yield nuclear weapon—that is, a test in which the explosive is placed inside a large cavern so that shock waves are muffled. In all three experiments, the stations picked up a rich mix of strong signals, including the high-frequency signals that are considered crucial to detecting decoupled tests and distinguishing weapons explosions from other seismic events such as earthquakes or industrial explosions.

By happy chance, an earthquake occurred moments before one of the tests, and the signals from the earth-

quake and the test proved to be readily distinguishable on seismometer recordings.

Summing up the results of the tests, Charles Archambeau of the University of Colorado has written: "It is apparent that high-frequency seismic signals could be easily detected to distances well beyond 1000 km from such small explosions. Since the explosions were designed to be seismically comparable to decoupled 1-kt nuclear explosions, this means that a decoupled 1-kt test, at or near the Soviet test area, could be detected over a very wide area (i.e., over an area exceeding 3 million square kilometers)."

Archambeau has overall responsibility for seismic research in the NRDC–Academy project. Jonathan Berger of the Scripps Institution of Oceanography is director of the US field team. Igor Nersesov, chief of seismology at the USSR's Institute of Physics of the Earth, heads the Soviet team.

Following the chemical explosive tests in September, the Soviets expressed interest in leaving the three existing stations in place and adding five entirely new ones at distances of more than 1000 kilometers. Berger has prepared a new plan and budget for the five new stations and has submitted them to the Soviets.

Bumpy background

When the Soviet academy and the NRDC negotiated the original test monitoring agreement in May 1986, the stated objectives were "to demonstrate that in-country nuclear weapons test verification is not an obstacle to a comprehensive test ban or a moratorium on testing, to demonstrate that scientists of the United States and the Soviet Union are prepared to cooperate to work toward a common goal of a CTB, and to obtain baseline seismic data that would be useful in designing and operating a seismic verification network."

Despite the Reagan Administration's unenthusiastic attitude toward the project, the NRDC succeeded in quickly obtaining Commerce Department approval for the export of seismic equipment to the Soviet Union, and with support from a number of private foundations, US and Soviet scientists managed within a few months to set up stations in the Soviet Union that were able to start gathering data on ambient ground noise and propagation of various wave types. This work confirmed that compression body waves (P waves) suffer less attenuation at the Kazakhstan test site than at the US test site in Nevada.

Efforts to establish similar stations in the United States were less successful. The Reagan Administration took the position that it would not grant visas to Soviet scientists unless they agreed to observe a demonstration at the Nevada test site of CORRTEX, a monitoring technique involving the placement of coaxial cable in a bore hole near the test explosive. When the Soviet government refused to authorize participation in such a demonstration, which it has regarded as irrelevant to the problem of verifying compliance with a comprehensive test ban treaty, its scientists were permitted to come to the United States only for a week, and in that time they were only able to select proposed sites for US monitoring stations. When they applied for visas a second time in February, the same conditions were imposed, and they remain without visas.

A further setback came in February when the Soviet Union resumed nuclear testing after an 18-month moratorium and ordered the NRDC to turn off its monitoring equipment during tests. Negotiations between the NRDC and the academy had left unresolved the issue of whether the stations would be allowed to continue gathering data during tests, but the two parties had agreed to a memorandum of understanding saying that "recording of tests of nuclear weapons is not necessary to the success of the joint research being undertaken." The Soviet side took the position that the point of the project was to verify compliance with a test ban, not to estimate yields of actual tests.

Achievements to date

With the resumption of Soviet testing and the reorientation of the bilateral monitoring project toward verification of low-threshold test bans, the original goal of demonstrating the feasibility of a comprehensive test ban has receded somewhat. Nonetheless, the project has demonstrated the political feasibility of establishing in-country monitoring stations. In addition, the project is providing—or will soon provide—a variety of information that until now was unavailable outside the Soviet Union:

▷ Ironically, as a result of the periodic orders to the NRDC to turn off its equipment, for the first time there is official notification of Soviet tests.

▷ From the September experiments with chemical explosives near the Soviet test site, the first local measurements are publicly available of how seismic waves propagate from well-defined and scheduled Soviet explosions.

▷ As a result of US tests of known yield in Nevada being monitored by the NRDC–Academy stations in the Soviet Union, scientists have obtained the first unclassified data on attenuation of compressional waves between the two test areas.

▷ With the establishment next year of the expanded network, the first local estimates of Soviet test yields will be publicly available.

Finally, for better or worse, the project may have helped contribute to the resumption of test ban negotiations and to a small but notable shift in the Reagan Administration's position on the ultimate goal of a comprehensive test ban. During Soviet Foreign Minister Eduard A. Shevardnadze's visit to Washington on 17 September, the two superpowers agreed to launch a multistage negotiation in which the goals would be first to improve verification of existing threshold test ban treaties—a step the USSR had previously resisted—and then to discuss intermediate, and presumably lower, test limits. The ultimate goal, according to an announcement the two sides released, would be the complete cessation of all nuclear weapon testing. Previously, the Reagan Administration's position had been that a complete test ban would not be worth discussing as long as the United States continued to rely on nuclear weapons for its security.

A fringe benefit?

In mid-September, Representatives Thomas J. Downey of New York, Bob Carr of Michigan and Jim Moody of Wisconsin visited the NRDC–Academy monitoring stations in the Soviet Union in the company of a larger party that included reporter William J. Broad of *The New York Times*. After arriving in the USSR, the party received permission—partly as a result of NRDC mediation—to visit the Soviet Union's controversial radar at Krasnoyarsk, exhibit A in the Reagan Administration's case that the USSR has not abided by the letter and spirit of the 1972 ABM treaty.

The highly publicized visit produced an ambiguous result and shed some light on the risks political leaders run when they dare to permit closer inspection of their most sensitive military installations. The US party concluded that the radar would indeed be a violation of the ABM treaty if it is ever brought into operation, but it also concluded that the installation was ill suited to be used for battle management of a missile-defense system, as the Pentagon had contended. Members of the party

described the facility as "shoddy," and one congressman said that the generals who built it should be court-martialed.

In the estimation of Jeremy Stone, staff director of the Federation of American Scientists, the radar visit "put a human face on a situation that was abstract before and dramatized that the Soviets are not denying the radar is there." Stone thinks the visit also conveyed that the Soviets are trying to be helpful to groups in the United States that favor arms control but that are handicapped by reports of alleged Soviet treaty violations.

Such efforts are not without pitfalls. Stone points out that Soviet scientists were quite annoyed about the denigrating language some of the American visitors used to describe the radar. He says one leading Soviet scientist remarked: "It's as though you invite guests to your home, and when they leave they report that you have dirty toilets. Naturally your wife tells you not to invite them back."

—WILLIAM SWEET

DEADLINES APPROACH FOR NSF COLLEGE GRANT PROPOSALS

Acting partly in reaction to a National Science Board report that expressed alarm last year about the state of undergraduate science and engineering education (PHYSICS TODAY, June 1986, page 65), the National Science Foundation has set up a new office of undergraduate science, engineering and mathematics education. The acting head is Robert F. Watson, a chemist who previously ran NSF's office of college science instrumentation.

The office of undergraduate science, engineering and mathematics education will manage undergraduate activities budgeted by the Science and Engineering Education Directorate, coordinate NSF activities in education foundation-wide and seek to stimulate involvement in undergraduate education by academic scientists and institutions, state governments, the private sector and other Federal agencies.

NSF has requested nearly $70 million for its fiscal year 1988 program in undergraduate science and engineering education. The main efforts will be in the following five areas: matching grants for instrumentation and laboratory development; research experience for undergraduates; faculty seminars and conferences on new developments and techniques; curriculum development, especially for calculus and engineering; and programs to encourage participation of women, minorities and the disabled in undergraduate science and engineering programs. Universities, four-year colleges and two-year colleges are eligible for all grants.

The deadlines for proposals are 20 November for instrumentation and laboratory improvement, 1 December for undergraduate research experience, 11 December (for summer 1988 projects) and 4 March (for academic year 1988–89) for faculty enhancement activities, 15 December for career access for women, minorities and the disabled, 1 March for engineering, and 1 February for calculus.

Guidelines for preparation of proposals can be obtained from the Forms and Publications Unit, Room 232, National Science Foundation, 1800 G Street NW, Washington DC 20550.

WATKINS STARTS WORK AS AIP SENIOR EDUCATION FELLOW

Sallie A. Watkins, dean of the college of science and mathematics at the University of Southern Colorado, has started work at the American Institute of Physics office in Washington, DC, as AIP's first senior education fellow. The position was created last year when AIP was seeking ways of making a greater contribution to improving physics education at all levels.

Watkins will develop an Education Coordinating Group to be made up of member society education officers or representatives, will arrange meetings in Washington, will make contacts with key government officials and will establish relationships with agencies and organizations that compile statistics pertaining to physics education. She will alert member societies to upcoming government decisions, brief persons testifying to Congress and inform the AIP Committee on Educational Policy of legislative proposals.

Watkins's principal mission will be to work on ways of bringing more women into physics. She will develop two programs, one oriented toward students at two-year colleges and one toward early elementary school pupils—groups she considers in especially great need of attention. The two-year college program will involve collection of information and may lead to a proposal to support visiting women physicists. The early elementary program will be developed in conjunction with the Girls Clubs of America and will include both in-school and after-school components. There will be an initial pilot project in a selected school system.

Watkins received her BS from Notre Dame College in Cleveland, Ohio, in 1945, and an MS in 1954 and a physics PhD in 1957 from Catholic University of America. She taught chemistry and physics in Cleveland area high schools from 1945 to 1950. She was a physics instructor at Notre Dame College from 1950 to 1953, a teaching assistant at Catholic University in 1955–56 and a research assistant for the Army Office of Ordnance Research in 1956–57. She became a professor at Notre Dame College in 1957, and from 1961 to 1966 she headed the college's physics department. In 1966 she joined the physics faculty at the University of Southern Colorado. Watkins was physics department chair at Southern Colorado in 1973–76 and 1982–85; from 1978 to 1981 she served as assistant academic vice president for research.

Watkins has published research results in reactor physics, in ultrasonics and biophysics, and in the history and philosophy of science. She is currently working on an annotated collection of Lise Meitner's letters and writing a popular book on her life.

Sallie A. Watkins