

Proposal Abstract K5(A66)

1. Arms Control Problem:

Nuclear weapons - comprehensive test ban

2. Verification Type:

- (a) Seismic sensors
- (b) On-site inspection - selective

3. Source:

Bullard, Edward. "The Detection of Underground Explosions".
Scientific American 215, no. 1 (July 1966): 19-29.

4. Summary:

This article discusses techniques for detecting underground nuclear explosions. Monitoring of tests involves detection, location and identification and must overcome problems with background "noise" in distinguishing explosions from earthquakes. Technological advances have made improvements in the ratio of seismic signal to noise which is caused by storms at sea, waves breaking on shore, the movement of trees and buildings, and traffic and machinery. The use of an array of seismographs instead of a single instrument has contributed to improvements in the ratio of signal to noise. A common arrangement for an array uses two lines of instruments on the arms of a cross each about 20 kilometres in length. A useful technique is to take the two records produced by summing the instruments on each arm of the cross array, to accentuate the similar parts of the records and to reduce the dissimilar parts. This can be accomplished by feeding the two records into a multiplier, multiplying them point by point and smoothing the results over time intervals of 1.5 or 2 seconds. The result is called a correlogram. In a test conducted in Yellowknife, Canada, it was possible to separate the signal of a .2 kiloton underground chemical explosion from the seismic effect produced by a preceding small earthquake with the use of correlograms and a seismic array 2,400 kilometres distant. This remarkable discovery shows that "an explosion of the size of significance for bomb-test detection will usually be detected" (p. 145), but identification of the event as an explosion is the main problem.

Earthquakes produce a seismic wave which is different from that yielded by explosions, so that seismic events can often be distinguished by wave characteristics. Seismic arrays have facilitated this identification. The determination of depth can also identify a large number of earthquakes. Any event occurring at a depth below eight kilometres is certainly an earthquake. A careful examination of records from arrays can permit an estimate of the depth of an explosion. An examination of worldwide samples of 161 earthquakes with depths of less than 50 kilometres published by the