Comprehensive Nuclear Test-Ban Treaty Indicators

COMPREHENSIVE NUCLEAR TEST-BAN TREATY

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READINESS DTIRP THROUGH AWARENESS

This pamphlet was prepared by the Defense Treaty Inspection Readiness Program (DTIRP) to promote ***Readiness Through Awareness*** at Department of Defense (DoD) and defense contractor facilities potentially impacted by future implementation of the Comprehensive Nuclear Test-Ban Treaty (CTBT).

Additional copies of this pamphlet and other information about arms control security and treaty implementation can be obtained by contacting the DTIRP Outreach Program Coordinator or by downloading products directly from the DTIRP Website (http://dtirp.dtra.mil).

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Prepared for:
DTIRP Outreach Program
Defense Threat Reduction Agency
8725 John J. Kingman Road, Stop 6201
Fort Belvoir, VA 22060-6201
1.800.419.2899
Email: dtirpoutreach@dtra.mil
Web: http://dtirp.dtra.mil

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INTRODUCTION

The Comprehensive Nuclear Test-Ban Treaty (CTBT) bans all types of nuclear explosions including nuclear weapon test explosions. The Treaty was approved by the United Nations General Assembly and opened for signature in September 1996, but is not yet in force. The international organization responsible for implementing the Treaty is the Comprehensive Nuclear Test-Ban Treaty Organization (CTBTO).

As of November 2006, 177 states had signed the Treaty and 137 states had ratified it. Signatories include all five acknowledged nuclear weapon states—China, France, Russia, the United Kingdom, and the United States—but the CTBT will not enter into force (EIF) until 180 days after it has been ratified by the 44 states possessing nuclear power or research reactors. These states are listed in Annex 2 to the CTBT.

Although the United States signed the CTBT on September 24, 1996, the U.S. Senate voted not to ratify the Treaty on October 13, 1999. In January 2002, following the release of the Nuclear Posture Review, the United States determined that its nuclear testing and research infrastructure needed to be upgraded to ensure that the United States would be capable of conducting nuclear testing in a relatively short period of time in the event such testing should become necessary. However, the United States remains committed to abiding by its voluntary moratorium on nuclear testing.

In the event that the United States ratifies the CTBT in the future and the Treaty enters into force, it is possible that an on-site inspection could be conducted at a U.S. facility for the purpose of resolving a compliance concern. These inspections would be conducted by inspectors sent from the CTBTO Technical Secretariat (TS). Such an inspection would need to be requested by another State Party and this request would need to be approved by the CTBTO Executive Council (EC).

Although the Treaty allows on-site inspections to be conducted when necessary to resolve an ambiguous event, it is expected that when a compliance concern arises, it will almost always be resolved through the process of consultations and clarifications specified in the Treaty. Unlike the Strategic Arms Reduction Treaty (START) and the Chemical Weapons Convention (CWC), the CTBT will **not rely on an on-site inspection regime as its primary means for verifying compliance.**

The CTBTO will rely primarily on the data collected by the global International Monitoring System (IMS) to verify treaty compliance. The IMS is capable of detecting a nuclear explosion occurring anywhere in the world. It consists of a network of monitoring stations and laboratories that collect data remotely and passively using four distinct technologies: seismic (ground waves), hydroacoustic (sound through oceans), infrasound (sound through atmosphere), and radionuclide (detection of radioactive matter and gases in the atmosphere). Currently, there are 321 monitoring stations: 170 seismic stations, 11 hydroacoustic stations, 60 infrasound stations, and 80 particulate radionuclide stations. There are also 16 radionuclide laboratories.

The data collected by the IMS is sent to the CTBTO TS via an International Data Center (IDC). When received, the TS processes and analyzes the data and informs the CTBTO Executive Council of its findings. When a compliance concern arises, the consultations and clarifications process begins.

It is important to be aware that false alarms are possible when analyzing IMS data. These are likely to create a compliance concern, which, in some cases, could be resolved only by conducting an on-site inspection. For example, a compliance concern could arise as the result of a naturally occurring event, such as an earthquake, or from a legitimate commercial activity, such as mining. A compliance concern could also arise as a consequence of conducting a large subcritical test near a suspected nuclear test site.

In the United States, prior to 1992, the Department of Energy (DOE) conducted underground nuclear tests at the Nevada Test Site (NTS). If certain natural or manmade events occurred in Nevada, or in nearby areas, these events could lead other States Parties to request clarification from the United States. In addition, since the San Andreas Fault lies only 275 miles away from the NTS, a tremor in southern California could also cause a compliance concern and lead, potentially, to an on-site inspection being conducted in the United States.

After the CTBT enters into force, any State Party will have the right to submit a request to the CTBTO asking that an on-site inspection be conducted to clarify whether a nuclear weapon test explosion has occurred. If this request is approved by the EC, the TS will send an inspection team to the inspected State Party. This team may arrive at the point of entry in as few as six days after the inspection request was received and may remain at the inspection site for up to 60 days. An extension of an additional 70 days on site is also possible, pending EC approval.

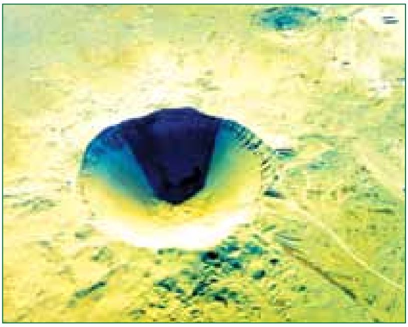
At facilities where activities are conducted that produce emanations, or other data resembling a nuclear explosion, facility commanders and security officers could be required to participate in consultations, clarifications, or on-site inspections to resolve a compliance concern under the CTBT. This pamphlet is designed to assist facility staff and treaty implementers with identifying and protecting higher-risk facilities. It provides an overview of a number of factors that could serve as signs or "indicators" of nuclear explosive testing that could increase a facility's susceptibility to an on-site inspection under the CTBT.

INDICATORS OF NUCLEAR TESTING

A facility's susceptibility to a potential CTBT inspection may, in part, be determined by the presence or absence of certain key indicators such as surface and subsurface geological formations, facility features, equipment and structures, effects on surrounding flora and fauna, and radionuclide emissions. These combinations are uncommon in industrial practice and may be suggestive of nuclear explosive testing. While the presence of such indicators at a facility is by no means proof of nuclear testing, these indicators could lead to further scrutiny by another State Party through the CTBTO.

Geological Formations

Some of the more obvious indicators of nuclear explosions conducted above or below ground involve geological formations resulting from the blast. When an underground nuclear explosion occurs, the shock wave produced by the blast vaporizes and melts the rock in the immediate vicinity of the nuclear detonation. Both the shock wave and the vaporized rock produce an outward motion, resulting in the creation of a cavity with high internal pressure. This cavity will expand until the internal pressure decreases to the point where rock is no longer deformed. The rock above the cavity, no longer supported by high internal pressure, then collapses into the cavity. This collapsed rock creates a "rubble chimney" possibly extending to the surface in a variety of unique formations.



For example, surface materials may be accelerated to the point where they are launched outward, leaving a surface **crater** surrounded by ejected surface materials. These craters are typically circular in shape, and range in diameter and depth from 10 meters to several hundred meters, depending on the depth and yield of the detonation, and on the geology of the area.

Another geological surface formation involves **collapse sinks**. These formations are the result of rubble chimneys that successfully migrate to the surface from the detonation. Rock and soil sink under the chimney to form a bowl-shaped crater ranging in size from tens of meters to nearly a kilometer in diameter. The crater volume is proportional to the size of the cavity needed to produce it. Thus, a large collapse sink might suggest a large detonation cavity—perhaps large enough to contain a nuclear test.

Underground nuclear tests also can form **depressions** and **fractures**. Depressions result from the subsidence of broad areas over underground tests. The depressed areas are generally circular in shape, but can take on an oblong shape if they interact with local geological structures, such as faults. Fractures are cracks in surrounding rock and soil. They are a manifestation of rock movement and the subsidence of the chimney zone and crater resulting from the detonation.

Other features resulting from underground nuclear testing include **pressure ridges**, or linear zones of broken ground that is elevated from the surrounding surface. Also indicative is a **water table rise**, which decreases water depth in wells and can produce new surface seepage and water movement in ponds or tanks. **Rock falls**, **thermal anomalies**, **disturbed ground**, and **ground slump** can also be geological surface features indicative of underground testing.

Subsurface geological features also result from underground nuclear explosions. For example, nuclear detonations can create **fractures** in tunnel complexes well below the surface. **Microfracturing** can occur in the zone near an explosion with little distinguishable cracking, but significant rock weakening. Nuclear explosions can also create detectable subsurface **faults**, **water seeps**, **thermal anomalies**, and **rock hardness variations**.

Site and Facility Features

Some features common to legitimate mining and excavation activities can suggest nuclear explosive testing. Sites conducting nuclear testing usually require facilities and equipment not normally associated with commercial operations, such as added security and safety measures.

These may include specialized **structures** to house sensitive equipment and nuclear materials, as well as structures to house scientific personnel. Additionally, roads leading to a nuclear test site may generally be of better quality than the surrounding commercial roads, in order to facilitate the safe transport of nuclear materials.

Buildings within the facility will generally be more secure and weatherproof than similar commercial facilities, and the area will require extensive surface excavation, treatment, and grading. Finally, facility structures for nuclear testing programs will likely require wellheads and casings for emplacing an explosive device, subsurface instrumentation, and post-shot sampling tools.

In most cases, facilities that support nuclear testing programs will require more specialized **equipment** than commercial mining and excavation activities. For example, a nuclear testing program usually will require lifting and backfilling equipment for vertical explosive emplacement. Tunnel emplacements require loading and handling equipment not typical of commercial operations. Instrumentation for nuclear testing programs should differ from commercial activities, as should requirements for power, compressed air, ventilation utilities, and sophisticated electrical equipment. Such facilities also require large cables for data acquisition that are made of extensive coaxial or fiber-optic materials to facilitate high-speed, high-quality data transmissions.

Finally, such a site or facility would require low permeability materials, equipment, and activities. These may be used to seal a shaft or a tunnel to contain radioactive gas, or to keep debris from escaping into the atmosphere, for example.

Flora and Fauna Effects

The ground acceleration produced by underground nuclear explosions can be sufficient to disrupt the surrounding surface flora and fauna. For example, explosions can fell trees and disturb the ground at the base of trees. Vegetation-filled concentric or radial lineations might indicate previous cracking caused by a nuclear test. Underground nuclear explosions may also disorient or agitate wildlife and destroy animal burrows.

Radionuclide Emissions

The containment of radionuclides during nuclear explosive testing is usually the goal. However, argon and xenon radionuclides, indicative of a nuclear explosion, could eventually rise to the surface from the underground detonation cavity through geological faults via atmospheric depressions. Several months may pass before the gases reach the surface and permit radionuclide detection.

Other Features

There are other detectable indicators of nuclear testing activity that, when found in conjunction with previously mentioned indicators, may cause further scrutiny.

- **Affiliates**. If a facility is affiliated with a laboratory or research center known to conduct nuclear testing activities, or if a facility possesses equipment that suggests such activities, the facility may receive more scrutiny than similar facilities without such links. Affiliations to consider include ownership, partnership, or contractual relationships. Open source information, shipping manifests, container labels, and other facility records can be used to identify affiliates.

- **Historical precedence**. If a facility has been associated with nuclear weapons testing in the past, or if a previous owner used the facility for this purpose, such activity could greatly increase the facility's susceptibility to a CTBT inspection.

- **Location**. The location of a facility in a remote, isolated area, distanced from well-populated regions—especially in combination with other indicators—can be a strong indicator. Facilities located near salt or dry alluvium deposits—both known to dampen body magnitudes of explosions—might also be more susceptible to inspection.

- **Medical**. A medical surveillance program that monitors the health of employees and keeps track of radioactive exposure is an indicator of nuclear-related activities. A high incidence among employees of medical problems and ailments that are symptomatic of radioactive exposure is also cause for suspicion.

- **Security precautions**. Indicators of unusual security activity might include special entry and exit controls such as guard posts, double or high security fences, gates, coded door locks, video monitoring, special lighting, and armed security for incoming and outgoing shipments. Special restrictions placed on a facility or its surrounding area, unusual or irregular plant operating schedules (such as night-only operations), and warnings signs and placards (especially if coded to disguise their meaning) are other indicators. The presence of security guards, especially if armed, is an obvious sign that something unusual is occurring at a facility and might be used to further justify an on-site inspection.

- **Public Information**. Substantial, readily-accessible, open source information combined with other indicators or IMS data, might lead a State Party to target a facility or area for inspection. This information could include promotional literature, government publications, newspapers, trade journals, industry association letters, and other marketing materials. Such information and records kept by facility managers could provide significant background about a facility's history, operation, contractual relationships, physical characteristics, and technical capabilities.

CONCLUSION

This pamphlet has provided a quick overview of CTBT compliance verification provisions and of certain indicators that could increase a facility's susceptibility to consultations and clarifications and even to an on-site inspection. Although the CTBT has not entered into force, work is underway to prepare for future treaty implementation.

While on-site inspections will be a last resort rather than a routine occurrence, this pamphlet has focused on the importance of being aware of key indicators relating to surface and subsurface geological formations. Key indicators may also include equipment and structures, visible effects on plants and wildlife, and emissions. Having an awareness of these indicators could help facility staff avoid the need for an on-site inspection under the CTBT.

For more information about arms control security and treaty implementation, or to request on-site assistance, contact the DTIRP Outreach Program Coordinator at 1-800-419-2899, or send an email to dtirpoutreach@dtra.mil. You may also contact your local Defense Security Service (DSS) Industrial Security Representative or your government sponsor.

Additional information and training materials can be downloaded directly from the DTIRP website at: http://dtirp.dtra.mil.

LIST OF ABBREVIATIONS

CTBT	Comprehensive Nuclear Test-Ban Treaty
CTBTO	Comprehensive Nuclear Test-Ban Treaty Organization
CWC	Chemical Weapons Convention
DOE	Department of Energy
DSS	Defense Security Service
DTIRP	Defense Treaty Inspection Readiness Program
DTRA	Defense Threat Reduction Agency
EIF	Entry into force
IDC	International Data Center
IMS	International Monitoring System
NTS	Nevada Test Site
START	Strategic Arms Reduction Treaty
TEI	Technical Equipment Inspection

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8725 John J. Kingman Road, Stop 6201

Fort Belvoir, VA 22060-6201

Email: dtirpoutreach@dtra.mil

Web: http://dtirp.dtra.mil