

A R M S C O N T R O L
S E C U R I T Y
GLOSSARY

INCLUDES NUCLEAR TERMS
AND NUCLEAR FUNDAMENTALS



Product No.

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This glossary is intended to provide arms control treaty implementers – especially those located at facilities subject to on-site inspection – with a handy reference guide to arms control treaty and security-related terms. The glossary was developed by the Defense Treaty Inspection Readiness Program (DTIRP) to increase *Readiness through Awareness* throughout the Department of Defense (DoD) and defense contractor community.

Additional copies of this glossary, as well as other relevant products, news, information and materials are available on the DTIRP website at <http://dtirp.dtra.mil> or by contacting the DTIRP Outreach Program at 1-800-419-2899 or by sending an email to dtirpoutreach@dtra.mil.

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GLOSSARY ORGANIZATION

This glossary is divided into three parts. Part I contains definitions for arms control security-related terms relevant to implementing a wide range of arms control treaties and agreements such as the Open Skies Treaty and Chemical Weapons Convention.

Part II contains definitions for nuclear terms and terms relevant to implementing nuclear-related arms control treaties and agreements. These treaties include the new Strategic Arms Reduction Treaty (New START), nuclear safeguards agreements between the United States and the International Atomic Energy Agency (IAEA), the Nuclear Nonproliferation Treaty (NPT), and potentially emerging treaties such as the Comprehensive Nuclear Test-Ban Treaty (CTBT) and Fissile Material Cutoff Treaty (FMCT).

Part III provides a brief tutorial on the basic concepts of nuclear fission and the nuclear fuel cycle. Part III also contains colorful graphics illustrating these concepts and includes a list of elements with their atomic numbers and the periodic table.

Red text is used in definitions to indicate terms defined elsewhere in Part I or Part II of the glossary.

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PART I

The arms control treaty and security-related terms provided in Part I pertain to the implementation and compliance verification activities specified in a wide range of arms control treaties and agreements. These treaties include the Chemical Weapons Convention (CWC), the Open Skies Treaty and the Conventional Armed Forces in Europe (CFE) Treaty, among others.

Definitions are designed to assist facility personnel and other treaty implementers with preparing for and conducting on-site inspections and other arms control treaty activities.



ARMS CONTROL SECURITY TERMS

Active Mission (for the United States)

Under the **Open Skies Treaty**, when the United States flies an observation mission over another **State Party**. The United States, as the observing Party, may fly the mission using its own Open Skies certified aircraft or the Open Skies certified aircraft of the observed Party (it is the observed Party's decision).

Active Overflight System (AOS)

Mission planning computer system used in conjunction with the **Transportable Operational Planning System** for planning Open Skies missions.

Active Quota

Under the **Open Skies Treaty**, the annual number of **observation flights** one **State Party** may fly (as the **observing Party**) over another State Party (the **observed Party**). A Party's active quota may not exceed its **passive quota**. The initial active quotas for specified Parties are listed in Annex A, Section II of the treaty. The actual annual active quotas for each State Party are negotiated each year in the **Open Skies Consultative Commission**.

Advance Team

A small number of arms control implementation specialists, including arms control security experts, under the auspices of the **Lead Agency** or Service component who deploy to a facility immediately following **notification** of an inspection and in advance of the arrival of the **inspection team**, to help with last-minute site preparation activities.

Affected Site List (ASL)

List composed of organizations desiring to receive notifications only when their facility, programs, or operations could be impacted by an **Open Skies** observation mission.

After-Action Report (AAR)

Organized analysis of an exercise or activity. Includes summaries of information shared and lessons learned. May also occur after an inspection.

Air Force Office of Special Investigations (AFOSI)

Air Force office which seeks to identify, investigate, and neutralize espionage, terrorism, fraud, and other major criminal activities which may threaten Air Force

and Department of Defense resources. Primary responsibilities include criminal investigative and counterintelligence services. Provides professional investigative service to commanders of all Air Force activities.

Air-Launched Cruise Missile (ALCM)

Air-launched, unmanned, self-propelled weapon-delivery vehicle capable of sustaining flight through the use of aerodynamic lift over most of its flight path.

Air Mobility Command (AMC)

Air Force component of the United States Transportation Command. Provides airlift, air refueling, special air missions, and aeromedical evacuation for U.S. forces. Supplies forces to theater commands to support wartime tasking. Single manager for air mobility.

Air-to-Surface Ballistic Missile (ASBM)

Ballistic missile with a range in excess of 600 kilometers installed in an aircraft or on its external mountings for the purpose of being launched from an aircraft.

Ambiguities

Doubts concerning some facet of information critical to the determination of compliance or **non-compliance** with a treaty or agreement revealed during an **on-site inspection**. Requires clarification by the **inspected State Party**.

Anti-Ballistic Missile Treaty (ABM)

Bilateral treaty signed by the United States and the Soviet Union on May 26, 1972, which entered into force on October 3, 1972. Both Parties agreed to limit qualitative improvement of their anti-ballistic missile (ABM) technology and to have only two ABM deployment areas. Both nations later signed a Protocol to the treaty, reducing the number of ABM deployment areas from two to one; the Protocol entered into force in 1976. The United States formally notified Russia on December 13, 2001, of its decision to withdraw; this decision took effect on June 13, 2002.

Approved Equipment

Under an arms control agreement, the devices, instruments, administrative supplies, and recording material necessary for the performance of the **inspection team's** duties, as approved by the States Parties. The United States will certify/inspect this equipment for use at U.S. facilities.

Area of Operation (AO)

Operational area defined by the joint force commander for land and naval forces. Typically does not encompass the entire operational area of the joint force commander, but should be large enough for component commanders to accomplish their missions and protect their forces.

Armored Combat Vehicle (ACV)

As defined in the [Conventional Armed Forces in Europe \(CFE\) Treaty](#), a self-propelled vehicle with armored protection and cross-country capability. Includes **armored personnel carriers**, armored infantry fighting vehicles, and heavy armament combat vehicles. Treaty-limited piece of equipment under the CFE treaty.

Armored Infantry Fighting Vehicle (AIFV)

As defined in the [Conventional Armed Forces in Europe Treaty](#), an **armored combat vehicle** designed and equipped primarily to transport a combat infantry squad, which normally provides the capability for the troops to deliver fire from inside the vehicle under armored protection and which is armed with an integral or organic cannon of at least 20 millimeters caliber and sometimes an antitank missile launcher.

Armored Infantry Fighting Vehicle Look-Alike

As defined in the [Conventional Armed Forces in Europe Treaty](#), an armored vehicle based on the same chassis as, and externally similar to, an **armored infantry fighting vehicle**, which does not have a cannon or gun of 20 millimeters caliber or greater and which has been constructed or modified in such a way as not to permit the transportation of a combat infantry squad.

Armored Personnel Carrier (APC)

As defined in the [Conventional Armed Forces in Europe \(CFE\) Treaty](#), an **armored combat vehicle** designed and equipped to transport a combat infantry squad and which, as a rule, is armed with an integral or organic weapon of less than 20 millimeters caliber. Treaty-limited piece of equipment under the CFE treaty.

Armored Personnel Carrier Look-Alike

As defined in the [Conventional Armed Forces in Europe \(CFE\) Treaty](#), an armored vehicle based on the same chassis as, and externally similar to, an **armored personnel carrier**, which does not have a cannon or gun of 20 millimeters caliber or greater and which has been constructed or modified in such a way as not to permit the transportation of a combat infantry squad. The treaty excludes armored personnel carrier ambulances from this definition.

Arms Control Implementation Unit (ACIU)

Defense Threat Reduction Agency On-Site Inspection Directorate unit, located within United States embassies in Russia, Kazakhstan, Belarus, and Ukraine, designed to aid U.S. inspection teams during in-country inspections.

Artillery

A treaty-limited piece of equipment under the Conventional Armed Forces in Europe (CFE) Treaty defined as a large caliber system capable of engaging ground targets by delivering primarily indirect fire. Large caliber artillery systems are guns, howitzers, artillery pieces combining the characteristics of guns and howitzers, mortars, and multiple launch rocket systems with a caliber of 100 millimeters and above.

Assessment/Assistance/Advance Team (AT)

Group of individuals who travel to a site prior to inspection in order to help that particular facility prepare for inspection by a foreign inspection team.

Attack Helicopter

As defined in the Conventional Armed Forces in Europe (CFE) Treaty, a combat helicopter equipped to employ anti-armor, air-to-ground, or air-to-air guided weapons and equipped with an integrated fire control and aiming system for these weapons. Treaty-limited piece of equipment under the CFE treaty. Treaty definition includes specialized and multi-purpose attack helicopters.

Battle Tank

A treaty-limited piece of equipment under the Conventional Armed Forces in Europe (CFE) Treaty defined as a self-propelled armored fighting vehicle, capable of heavy firepower, primarily of a high muzzle velocity direct fire main gun necessary to engage armored and other targets, with high cross-country mobility, with a high level of self-protection, and which is not designed and equipped primarily to transport combat troops. Battle tanks are tracked armored fighting vehicles which weigh at least 16.5 metric tons unladen weight and which are armed with a 360-degree traverse gun of at least 75 millimeters caliber.

Bilateral Destruction Agreement (BDA)

Agreement between the United States of America and the Soviet Union on the Destruction and Non-Production of Chemical Weapons and on Measures to Facilitate the Multilateral Convention signed June 1, 1990, also referred to as the Bilateral Destruction Agreement. Calls for the destruction of most of the State Parties' chemical



weapons (CW) capability and prohibits production of CW. The verification protocol was never completed and the BDA was superseded by the **Chemical Weapons Convention**.

Biological Weapons Convention (BWC)

International convention opened for signature April 10, 1972; entered into force March 26, 1975. Prohibits **States Parties** from developing, producing, stockpiling, acquiring, or retaining: 1) biological agents or toxins of types and in quantities having no justification for prophylactic, protective, or other peaceful purposes; and 2) weapons, equipment, or means of delivery designed to use such agents or toxins for hostile purposes or in armed conflict. Obligates States Parties to destroy such material within 9 months of **entry into force**, but permits defensive biological research.

Blinding Software

Software used with analytical equipment, which indicates only whether or not a sample contains a specific treaty-controlled chemical. Also known as blinder software.

Certification

United States **technical equipment inspection** and approval process for treaty-specified equipment designated for use in **verification** activities. Under the **Chemical Weapons Convention**, for example, the United States must certify **Organization for the Prohibition of Chemical Weapons technical secretariat** equipment from safety, security, and environmental standpoints before the items can be brought to, and used at, U.S. (Department of Defense) facilities. Also establishes baseline data for comparative analysis during subsequent equipment inspections pursuant to inspection activities.

Challenge Inspection

Under arms control agreements, a **non-routine inspection**, on short notice, of any facility in the territory or in any other place under the jurisdiction or control of a **State Party** requested by another State Party. The inspection may be generated as a right of the requesting party or for a **non-compliance** concern of the requesting party. Under some agreements, a right of refusal exists.

Chemical Transfer Facility (CTF)

Site at the Aberdeen Proving Ground, Edgewood Area, Maryland, which contains a Single Small Scale Facility (a facility for production of Schedule 1 chemicals to be used for purposes not prohibited by the **Chemical Weapons Convention**), a Schedule 1 Storage Facility, and a Chemical Destruction Facility.

Chemical Weapons (CW)

Toxic chemicals and their **precursors**, munitions, and devices specifically designed to cause death or other harm through the toxic properties of those chemicals, and any equipment specifically designed for use directly in connection with the employment of those munitions and devices.

Chemical Weapons Convention (CWC)

International convention opened for signature January 13, 1993; entered into force April 29, 1997. Prohibits **States Parties** from developing; producing; otherwise acquiring, stockpiling, or retaining **chemical weapons (CW)**; transferring CW, directly or indirectly, to anyone; using CW; engaging in military preparations to use CW; using **riot control agents** as a method of warfare; or assisting, encouraging, or inducing anyone to engage in any activity prohibited under the Convention. Requires States Parties to destroy CW they own or possess, or are located anywhere under their jurisdiction or control; destroy all CW they abandoned on the territories of other States Parties; and destroy or convert any CW production facilities they own or possess. In addition, the Convention monitors non-prohibited chemical activities through industry declarations and **on-site inspections**.

Chemical Weapons Destruction Facility (CWDF)

Facility mandated by the **Chemical Weapons Convention** to destroy **chemical weapons** on the territory of a **State Party**.

Chemical Weapons Implementation Working Group (CWIWG)

Department of Defense working group, which reviews **Chemical Weapons Convention implementation** issues on a regular basis.

Chemical Weapons Production Facility (CWPF)

Under the **Chemical Weapons Convention**, any equipment, as well as any building housing such equipment, designed, constructed, or used at any time since January 1, 1946, as part of the stage in the production of chemicals or for filling **chemical weapons**.

Chemical Weapons Storage Facility (CWSF)

Facility where **chemical weapons** are stored. Subject to inspection under the **Chemical Weapons Convention**.



Combat Aircraft

A treaty-limited piece of equipment under the **Conventional Armed Forces in Europe (CFE) Treaty** defined as a fixed-wing or variable-geometry wing aircraft armed and equipped to engage targets by employing guided missiles, unguided rockets, bombs, guns, cannons, or other weapons of destruction, as well as any model or version of such an aircraft which performs other military functions such as reconnaissance or electronic warfare..

Combat Helicopter

A treaty-limited piece of equipment under the **Conventional Armed Forces in Europe (CFE) Treaty** defined as a rotary wing aircraft armed and equipped to engage targets or equipped to perform other military functions. The CFE definition includes attack and combat support helicopters; does not include unarmed transport helicopters.

Commonwealth of Independent States (CIS)

Association established December 8, 1991, by Russia, Belarus, and Ukraine as the successor to the Union of Soviet Socialist Republics (USSR) in its role of coordinating the foreign and economic policies of its member nations. All former republics of the USSR, excluding the Baltic states, are members of the CIS, which is headquartered in Minsk, Belarus.

Communications Security (COMSEC)

Protection resulting from all measures designed to deny unauthorized persons information of value, which might be derived from the possession and study of telecommunications, or to mislead unauthorized persons in their interpretation of the results of such possession and study. Includes cryptosecurity, transmission security, emission security, and physical security of communications security materials and information.

Compliance

Activities conducted which: 1) support **implementation** of an arms control agreement; 2) are not in violation of provisions of an arms control agreement; or 3) ensure existing and future programs and operations are in accord with the international obligations of an arms control agreement.

Compliance Review Group (CRG)

Department of Defense working group designed to conduct an executive-level review of **compliance** issues. Established for each arms control agreement as needed. Meets on an *ad hoc* basis to address critical issues.

Conference of States Parties

The Conference of States Parties is the principal organ of the [Organization for the Prohibition of Chemical Weapons](#) (OPCW). The Conference oversees [Chemical Weapons Convention](#) implementation, acts to promote its object and purpose, and oversees the activities of the [executive council](#) and [technical secretariat](#) (the two other OPCW organs). The Conference is composed of one representative from each OPCW member and is entitled to consider any questions, matters or issues related to the [Chemical Weapons Convention](#).

Confidence- and Security-Building Measures (CSBM)

Activities such as notifications, exchanges of [observers](#), prior notification of military movements, and visits by observers. Accompanied the activities of the Conference for Security and Cooperation in Europe and were first introduced by the Helsinki Final Act in 1975 to reduce the dangers of armed conflict, misunderstanding, or miscalculation of military activities. Many of these features are now embedded in arms control and other agreements in the form of data exchanges/declarations, missile launch notifications, inspection activities, and voluntary presentation for [national technical means](#).

Confidential Business Information (CBI)

Information considered sensitive or proprietary requiring protection from disclosure or exploitation.

Confidentiality

Under the [Chemical Weapons Convention](#), a “Confidentiality Annex” requires the [Organization for the Prohibition of Chemical Weapons](#) to collect only the minimum amount of information and data necessary to execute its responsibilities and take measures to ensure all sensitive and proprietary information pertaining to the [verification](#) of civil and military activities and facilities be kept confidential and protected. New and emerging treaties and agreements may have similar confidentiality provisions.

Constitutional Rights

Rights of persons (individuals or corporations) derived from the United States Constitution. Issues of constitutional rights may arise in connection with the [implementation](#) of the [Chemical Weapons Convention](#), particularly with respect to [personnel interviews](#) (Fifth Amendment) and [challenge inspections](#) (Fourth Amendment).

Continuous Monitoring

Under the **Chemical Weapons Convention**, denotes the presence of inspectors at a specified facility (24 hours a day, 7 days a week) for the purpose of observing compliance **verification** activities.

Conventional Armaments and Equipment Subject to the Treaty

As defined in the **Conventional Armed Forces in Europe (CFE) Treaty**, **battle tanks**, **armored combat vehicles**, **artillery**, **combat aircraft**, primary trainer aircraft, unarmed trainer aircraft, **combat helicopters**, unarmed transport helicopters, armored vehicle launched bridges, **armored personnel carrier look-alikes**, and **armored infantry fighting vehicle look-alikes** subject to information exchange in accordance with the Protocol on Information Exchange.

Conventional Armed Forces in Europe (CFE) Treaty

Multilateral treaty originally signed by the 22 North Atlantic Treaty Organization and Warsaw Pact nations November 19, 1990; entered into force November 9, 1992. Establishes equal East-West limits on five categories of conventional armaments (**battle tanks**, **armored combat vehicles**, **artillery**, **combat aircraft**, and **attack helicopters**) between the Atlantic Ocean and the Ural Mountains. Following the dissolution of the Soviet Union, all Soviet successor states with territory in the CFE area of application joined the treaty, so that States Parties now number 30. Adaptation Agreement signed November 19, 1999, replaces treaty's obsolete bloc-to-bloc structure with nationally-based limits, enhances **transparency** by requiring States Parties to provide more information than they provided on their forces previously and increasing quotas for mandatory **on-site inspections**, strengthens requirements for host nation consent to the presence of foreign forces, and opens the treaty to other European states, subject to approval by all 30 States Parties.

Cooperative Threat Reduction (CTR)

United States program established in 1991 to provide assistance to eligible states of the former Soviet Union in order to dismantle weapons of mass destruction and to reduce the threat of proliferation.

Countermeasures (CM)

Under arms control treaties, employment of devices, techniques, or both to protect national security, proprietary, or other **critical information** while fulfilling **State Party** treaty obligations.

Critical Information

In the context of arms control inspections, information that is intrinsically harmful if obtained by an inspector's nation and that would likely result in undermining the objectives of a program in whole or a significant part by providing the inspector's nation an unacceptable advantage.

Danger Area

Under the [Open Skies Treaty](#), an airspace of defined dimensions, within which activities dangerous to the flight of aircraft may exist at specified times. This is one of the three types of areas that are covered under the term "hazardous airspace," on the basis of the International Civil Aviation Organization Convention.

Data Declaration

Under arms control agreements, a required report issued by facilities on treaty-monitored activities, items, or armaments and equipment.

Database Management Facility (DMF)

Support module of the [Open Skies Management and Planning System](#). A database that organizes site information passed to the [Defense Threat Reduction Agency](#) into the [Standard Calling List](#) and the [Affected Site List](#).

Declared Facility (DF)

Installation, factory, or plant declared by the United States Government in accordance with the requirements of an arms control agreement.

Declared Perimeter

External boundary of the facility declared by the [inspected State Party](#); usually depicted on a site map or [site diagram](#).

Declared Site

Commonly used interchangeably with [declared facility](#).

Defense Equity

Department of Defense component and Services, facilities, programs, operations, information and activities.

Defense Messaging Systems (DMS)

Under the [Open Skies Treaty](#), communications network used by the military to transmit messages.



Defense Security Service (DSS)

Agency of the Department of Defense, under the direction, authority, and control of the Assistant Secretary of Defense (Command, Control, Communications, and Intelligence), which provides security services to the Department of Defense through the integration of personnel security, industrial security, information systems security, and counterintelligence. Facilitates the application of threat-appropriate security measures through the integration of security services, combined with intelligence threat data.

Defense Threat Reduction Agency (DTRA)

Agency of the Department of Defense that serves as the Department of Defense's focal point for addressing the proliferation of weapons of mass destruction. Seeks to reduce the threat to the United States and its allies from nuclear, biological, chemical, conventional, and special weapons and **technology transfers**; conducts inspection and escort activities under various international arms control agreements.

Defense Treaty Inspection Readiness Program (DTIRP)

Department of Defense arms control awareness program which develops and provides services and products to assist program, facility, and site managers in the protection of national security, proprietary, or other critical interests during arms control activities.

Demonstration Flight

Flight which may be requested under the **Open Skies Treaty** to verify the aircraft's **sensors** are in compliance with treaty limits and are in accordance with aircraft **certification** materials and data.

Department of Commerce (DOC)

Executive Branch department of the Federal Government that promotes and administers domestic and foreign commerce. Also, **Lead Agency** for coordinating **verification** activities of commercial industrial facilities which fall under the **Chemical Weapons Convention** (CWC). Through its Bureau of Industry and Security, conducts an industry education and awareness outreach program which provides advice and assistance in preparation for verification activities, as well as support during **on-site inspections**, designed to facilitate industry **implementation** of the CWC.

Detailed/Draft Facility Agreement (DFA)

Agreement or arrangement between a **State Party** and the **Organization for the Prohibition of Chemical Weapons** (OPCW) **technical secretariat** relating to a specific

facility subject to **on-site inspection** pursuant to Articles IV, V, and VI of the **Chemical Weapons Convention**. This agreement (based on an OPCW model), prepared with the help of the facility and negotiated with the **inspection team** during the **initial inspection**, defines inspection parameters to be followed in subsequent inspections.

Director-General (DG)

Head and chief administrative officer of the **technical secretariat** of the **Organization for the Prohibition of Chemical Weapons (OPCW)**, and of the provisional **technical secretariat** of the **Comprehensive Nuclear Test-Ban Treaty Organization (CTBTO)**. Responsible in part for the associated activities of the OPCW or CTBTO.

Discrete Organic Chemical (DOC)

Under the **Chemical Weapons Convention**, any chemical belonging to the class of chemical compounds consisting of all compounds of carbon except for its oxides, sulfides, and metal carbonates.

DTIRP Coordination Group (DCG)

Interagency group comprised of representatives from the Military Services, defense agencies, and United States government organizations involved with arms control activities. Also serves as a coordinating body for consensus-building during development of individual **Defense Treaty Inspection Readiness Program (DTIRP)** outreach products.

Dual-Purpose/Use Chemical

Chemical which: 1) is produced for purposes not prohibited by the **Chemical Weapons Convention (CWC)**; 2) may be stockpiled as a chemical weapon (CW); and 3) may pose a risk to the objectives of the CWC by virtue of its physical, chemical, and toxicological properties being similar to those of CW. Some dual-purpose chemicals are contained in Schedules 2 and 3 of the CWC **schedules of chemicals**.

Entry into Force (EIF)

Initial date the provisions of a treaty become effective.

Exceptional Access

Under the **Chemical Weapons Convention**, a method of limiting the access of an international **inspection team** by allowing only selected inspectors to view the interior of a building, room, vehicle, or container. Might be employed for reasons of national security, proprietary concern, or operational safety.



Executive Council (EC)

Executive organ of the [Organization for the Prohibition of Chemical Weapons](#) or the [Comprehensive Nuclear Test-Ban Treaty Organization](#). Supervises activities of the technical secretariat.

Exit Monitoring

Under the [Chemical Weapons Convention](#), during [challenge inspections](#), both the inspected [State Party](#) and the [inspection team](#) conduct exit monitoring. The former is required, not later than 12 hours after the inspection team arrives at the [point of entry](#), to begin collecting information on vehicular exit activity at [requested perimeter](#) exit points for land, air and water vehicles. The records of that activity are to be provided to the inspection team upon its arrival at the site. The latter has the right, upon its arrival at the alternative perimeter or final [perimeter](#) (whichever occurs first) and throughout the inspection, to engage in exit monitoring activities, which include identifying vehicular exits, making traffic logs, taking photographs, making video recordings of exits and exit traffic, and other agreed activities. The inspection team also has the right to inspect non-personal vehicular traffic exiting the site.

Facility Agreement (FA)

See [detailed/draft Facility Agreement](#).

Facility Security Officer (FSO)

Head of security operations at a particular facility.

Flight Monitor/Representative

With regard to the [Open Skies Treaty](#), an individual who, on behalf of the [observed Party](#), is onboard an observation aircraft provided by the [observing Party](#) during the [observation flight](#), and who performs duties in accordance with Annex G to the treaty.

Flight Plan

Under the [Open Skies Treaty](#), specified information provided to air traffic services units relative to an intended flight or portion of a flight of an aircraft.

Foreign Intelligence Service (FIS)

Any non-United States intelligence service which collects information of potential value concerning the capabilities, intentions, and activities of any foreign power, organization, or associated personnel.

Former Soviet Union (FSU)

Collection of states which comprised the Union of Soviet Socialist Republics prior to its breakup and demise in 1991.

Global Positioning System (GPS)

Constellation of 24 satellites operated by the United States Department of Defense for navigation and precise geodetic position measurements.

Ground Resolution

Under the [Open Skies Treaty](#), the minimum distance on the ground between two closely located objects at which they are distinguishable as separate objects. The methodologies for determining the capability of individual sensors to achieve a specified ground resolution, including the minimum altitude from which such a resolution can be achieved, were developed by the [Open Skies Consultative Commission](#) during the treaty's period of provisional application.

Hazardous Airspace

Under the [Open Skies Treaty](#), the prohibited areas, restricted areas and danger areas, defined on the basis of Annex 2 to the Convention on International Civil Aviation, that are established in accordance with Annex 15 to that Convention in the interests of flight safety, public safety and environmental protection and about which information is provided in accordance with International Civil Aviation Organization Convention provisions.

Host State Party (HSP)

Nation in which representatives or organizations of another state are present because of government invitation and/or international agreement. Also, under the [Chemical Weapons Convention](#), the state on whose territory lie facilities or areas of another state which are subject to inspection.

Host Team (HT)

For inspections of United States' facilities under the [Chemical Weapons Convention](#), group of U.S. Government representatives responsible for negotiating with an [inspection team](#) (IT) and accompanying the IT throughout the inspection where the United States is the [inspected State Party](#). For inspections where the Department of Defense (DoD) is the [Lead Agency](#), the [host team](#) may include representatives from the Office of the Secretary of Defense (Policy), the Joint Staff, the [Defense](#)



Threat Reduction Agency Escort Team Chief, the affected DoD Components, and the inspected facility. The Commander in Chief's (CINC) representative from a unified command is on the **host team** for facilities outside the continental United States.

Implementation

Management process, including publication of directives, instructions, regulations, and related documents, which defines administrative guidance and operational procedures necessary to ensure people, programs, and facilities comply with the provisions of arms control agreements.

Implementation and Compliance Planning

Under arms control agreements, the process ensuring a **State Party** is prepared to implement and comply with treaty provisions.

Implementing Legislation

Basic law applying the conditions of a specific treaty and its **verification** activities to United States citizens and industries. Failure to comply with these laws may result in civil or criminal legal consequences for an individual or organization. The Chemical Weapons Convention Implementation Act of 1998 is one of several such statutes.

In-Country Escort

Individuals specified by the inspected **State Party** to accompany and assist the **inspection team** during the **in-country period**.

In-Country Period

Total period of time from the arrival of the inspectors at the **point of entry** until their departure from the country through the **point of exit**.

Infrared Line-Scanning Device (IRLS)

Under the **Open Skies Treaty**, a **sensor** capable of receiving and visualizing thermal radiation emitted in the invisible infrared part of the electromagnetic spectrum by objects due to their temperature and in the absence of artificial illumination. Line-scanning devices were selected instead of other types of infrared sensors to avoid technology transfer problems that might arise with more sophisticated systems.

Initial Inspection

The first **on-site inspection** of **declared facilities** to verify declarations and to plan future **verification** activities, and potentially negotiate a **facility agreement**.

Inspectable Area

Area of an installation in which the **inspection team** has the right to conduct **verification** activities.

Inspected State Party (ISP)

State Party on whose territory or in any other place under its jurisdiction or control an inspection takes place, or the State Party whose facility or area on the territory of a host state is subject to such an inspection.

Inspecting Party

Party which conducts inspections or **continuous monitoring** activities under an arms control treaty or agreement.

Inspection Assistant

Under the **Chemical Weapons Convention**, an individual designated by the **technical secretariat** to assist inspectors in an inspection or visit, such as medical, security, and administrative personnel and interpreters.

Inspection Equipment

Treaty-authorized **verification** equipment used for an **on-site inspection** under an arms control treaty or agreement. Specifically authorized under a given treaty.

Inspection Mandate

Under the **Chemical Weapons Convention**, the authority and instructions issued by the **Organization for the Prohibition of Chemical Weapons technical secretariat** to the **inspection team** for the conduct of a particular inspection.

Inspection Notification

Communication to the **State Party** to be inspected of a treaty partner's or treaty organization's intent to conduct an inspection.

Inspection Plan

Plan initially prepared by the **inspection team** after arrival at the site for the conduct of its inspection.

Inspection Report

Factual findings or results from an inspection. Required in all treaties, but differs according to each.



Inspection Site

Any facility or area at which an inspection is carried out and which is specifically designated in the respective **facility agreement**, inspection request, or mandate. The final **perimeter** precisely bounding the physical limits of the facility or area may be a matter for negotiation between the **inspected State Party** and **inspection team**.

Inspection Team (IT)

Group assembled for the purpose of conducting an on-site visit to make observations and obtain data and information contributing to treaty **compliance** evaluations.

Inspectorate

Body of inspectors assigned to carry out **verification** under an arms control treaty or agreement.

Integrated Data Annotation, Recording and Mapping System (IDARMS)

A digital computer system interfaced with the aircraft sensor suite to provide **Open Skies Treaty** required data annotation onto recorded media (i.e. photographic film). The system also provides the capability for the collection and recording of mission/sensor events, **sensor** status, and flight/navigation data for post-mission analysis and reporting. The integration of digital map information, mission route data, sensor status, aircraft navigation information, and other data generates a continuously updated map display of current aircraft location, planned and actual flight path, sensor footprints, and other related information to provide situational awareness and verify system operation and treaty compliance.

Interagency Working Group (IWG)

Existing working group for policy formulation. Composed of representatives from the National Security Council staff, Department of State, Department of Justice, Department of Energy, **Department of Commerce**, Office of the Secretary of Defense, and the Joint Staff. May be expanded to include other United States government agencies as necessary.

Inviolable

Secure from destruction, violence, infringement, search, seizure, or desecration. Inviolability of inspectors, as used in arms control agreements, is the same as that afforded diplomatic agents, pursuant to Articles 29 and 31 of the Vienna Convention on Diplomatic Relations.

Joint Training Flights (JTF)

Since 1993, Open Skies mission training flights have been conducted between **States Parties**. Before the **Open Skies Treaty** entered into force on January 1, 2002, signatory states participated in JTFs to increase confidence and refine operational procedures. It is estimated that a small number of JTFs will continue as new States Parties accede to the treaty

Jointly Sealed

Method for securing documents, records, or **inspection equipment** at a point of entry or inspectable site in a container with locks and/or seals of each party affixed.

Lead Agency

United States government agency designated to have primary responsibility to coordinate arms control **verification** activities.

Managed Access

The use of methods, other than granting full access, to protect **critical information** while demonstrating **compliance** with an arms control treaty or agreement. Examples of managed access methods include: removal of non-related, sensitive items; **shrouding** of sensitive displays, stores, and equipment; logging off computer systems and turning off data-indicating devices; **random selective access**, whereby inspectors are requested to select only a certain number, or percentage, of areas, buildings, or items for inspection; **exceptional access**, whereby the inspected party limits access to certain parts of the **inspectable area** to individual inspectors rather than allowing the full team access; allowing inspectors to view a sensitive area only from a window or doorway rather than granting them full access to the area; restricting access to sensitive areas only during specified times; pre-planning the manner in which inspectors are escorted onto a site and from area-to-area, building-to-building, and room-to-room; limiting inspector access to personnel by dismissing non-essential personnel; monitoring the use of, or operating, **inspection equipment** for inspectors; proposing personnel for interviews; and volunteering records for review. Whenever less than full access is provided, the inspected party is obligated to make every reasonable effort to demonstrate **compliance** by alternate means; for example, by partially removing a shroud or by showing inspectors convincing photos or documentation related to the compliance concern rather than granting physical access to an area.

Maximum Flight Distance

The term “maximum flight distance” means the maximum distance over the territory of the **observed Party** from the point at which the observation flight may commence to the point at which that flight may terminate, as specified in Annex A in the **Open Skies Treaty**.

Memorandum of Agreement (MOA)

Any written agreement as to how a treaty protocol or a program will be administered.

Missile Defense Agency (MDA)

Department of Defense organization, established by Defense Directive 5134.9, which manages, directs, and executes the Missile Defense Program. Objectives include developing and deploying Theater Missile Defenses to meet existing missile threats to U.S. and allied forces, developing options to deploy a National Missile Defense for the United States, and continuing to support research on more advanced missile defense technologies.

Mission Plan

Under the **Open Skies Treaty**, a document that is presented by the **observing Party** to the **observed Party** and forms the basis for the elaboration of the **flight plan**. The mission plan contains the route, profile (altitudes), order of execution and support required to conduct the **observation flight**.

Mock Inspection

Testing procedure used to evaluate inspection readiness. Involves role-playing for United States government escorts, base escorts, and international **inspection team** members.

Model Facility Agreements (MFA)

Document specifying the general form and content for a **facility agreement** negotiated between a **State Party** and the **Organization for the Prohibition of Chemical Weapons** for fulfilling **Chemical Weapons Convention** verification provisions.

Monitor

Individual specified by a **State Party** to conduct **continuous monitoring** activities and included on the State Party's list of monitors.

National Authority (NA)

Each **State Party** to the **Chemical Weapons Convention (CWC)** is required to establish or designate a National Authority. The Department of State is the United States National Authority responsible, in coordination with an interagency group designated by the President, for **implementation** of the CWC. The Secretary of State is its Director. The National Authority serves as liaison with the **Organization for the Prohibition of Chemical Weapons** and other States Parties.

National Escort

State Party government representative trained and expert in the provisions of a specific treaty or agreement as well as escorting inspection and monitoring teams. National escorts from the **Defense Threat Reduction Agency** normally greet inspectors at the point of entry, provide translation services when required, arrange for transportation to the inspected facility, and accompany the inspectors and facilitate their activities throughout their stay in the United States. (Also see **in-country escort**.)

National Security Information (NSI)

Information pertaining to national defense and foreign relations protected in accordance with Executive Order 12958.

National Technical Means (NTM)

Techniques, such as taking pictures from photo-reconnaissance satellites, which are strictly under national control and are used to monitor **compliance** with the provisions of an agreement.

Non-Compliance

Conduct of activities prohibited by a certain treaty or agreement, or the non-performance of actions mandated or required by a certain treaty or agreement.

Nondestructive Evaluation Methods (NDE)

Equipment enabling an inspector to determine the contents of an **item of inspection** without actually opening or tampering with it.

Object of Verification (OOV)

Under the **Conventional Armed Forces in Europe (CFE) Treaty**, any formation at the brigade/regiment, wing/air regiment, independent battalion/artillery battalion, independent squadron, or equivalent level holding **treaty-limited equipment (TLE)** in service of the armed forces of any **signatory**, any TLE storage site, or any TLE reduction site.

Observation Flight

The flight of the observation aircraft conducted by the **observing Party** over the territory of the **observed Party**, as provided in the **flight plan**, from the **point of entry** or **Open Skies airfield** to the **point of exit** or **Open Skies airfield**.

Observation Period

Under the **Open Skies Treaty**, a period of time during an **observation flight**, specified by the **observing Party**, when a particular **sensor** installed on the observation aircraft is operating. There is no limit on the number or duration of such observation periods during an observation flight. Sensors may be operated for the entire duration of a flight, as long as the observation aircraft does not deviate from the agreed flight path and the flight altitude is appropriate for each sensor. Information on such sensor operating periods is required because the film or other recording medium has to be annotated with such information. Such information permits all **States Parties** to know when and where data was collected, and permits third Parties to request data taken during specified periods.

Observed Party

The **State Party** or group of States Parties over whose territory an **Open Skies observation flight** is conducted or over whose territory an observation flight is intended to be conducted.

Observer

Representative of a requesting **State Party** or third State Party to observe inspection activities. (See **Requesting State Party Observer**.)

Observing Party

The **State Party** or group of States Parties that intends to conduct an **Open Skies observation flight**, or conducts an observation flight, over the territory of another State Party or group of States Parties.

On-Site Inspection (OSI)

Physical presence of inspectors at facilities subject to **verification** activities, and the exercise of inspector access to equipment, armaments, and structures housing them for the purposes of collecting treaty-required information.

On-Site Inspection Directorate

The directorate within the **Defense Threat Reduction Agency** responsible for **on-site inspection** assistance and support.

Open Skies Airfield (OSA)

An airfield designated by the **observed Party** as a point where an **observation flight** may commence or terminate. An **Open Skies** airfield may be a **point of entry** or a **point of exit**, or it may be a separate airfield designated solely as an Open Skies airfield.

Open Skies Consultative Commission (OSCC)

OSCC is the international forum established to oversee and facilitate the provisional application and implementation of the **Open Skies** regime and for handling any compliance issues.

Open Skies Management and Planning System (OSMAPS)

A mission planning computer system consisting of the **Active Overflight System**, **Passive Overflight Module**, **Transportable Operational Planning System**, and **Operational Planning System** used to plan observation missions under the **Open Skies Treaty**.

Open Skies Treaty

A multinational treaty signed in March 1992 and entered into force January 1, 2002, which establishes an aerial observation regime for the purpose of building confidence and increasing military openness. **States Parties** may fly over the territory of other States Parties using unarmed aircraft equipped with treaty-approved **sensors** to collect data. These imaging sensors include optical panoramic and framing cameras, video cameras, **infrared line-scanning devices**, and **sideways-looking synthetic aperture radar**.

Operations Plan (OPLAN)

Plan for a single or series of connected procedures to be carried out simultaneously or in succession. Usually based on stated assumptions, and the form of directive used by higher authorities to permit subordinate commanders to prepare supporting plans and orders. Explains the who, what, when, where, and how of a mission. All armed military services have an operations plan.

Operations Security (OPSEC)

Process of identifying **critical information** and subsequently analyzing friendly actions attendant to military operations and other activities to: 1) identify those actions which can be observed by adversary intelligence; 2) determine indicators adversary intelligence systems might obtain which could be interpreted or pieced together to derive critical information in time to be useful to adversaries; and 3) select and execute measures to eliminate or reduce vulnerabilities of friendly actions to an acceptable level.

Organization for the Prohibition of Chemical Weapons (OPCW)

International organization established by the [Chemical Weapons Convention](#) to ensure implementation of the Convention's provisions, including those for [verification of compliance](#) with the Convention, and to provide a forum for consultation and cooperation among its [States Parties](#). The OPCW consists of three bodies: the [Conference of States Parties](#), the [executive council](#) and the [technical secretariat](#). All States Parties to the Chemical Weapons Convention are members of the OPCW.

Overflight

A confidence-building measure permitted by treaties such as the [Open Skies Treaty](#), [Conventional Armed Forces in Europe \(CFE\) Treaty](#), and the [Chemical Weapons Convention](#).

Passive Mission (for the United States)

Under the [Open Skies Treaty](#), when another [State Party](#) flies an observation mission over the United States. The [observing Party](#) may fly the mission using its own Open Skies certified aircraft or the U.S. Open Skies aircraft (it is the United States' decision).

Passive Overflight Module (POM)

A component of the [Open Skies Management and Planning System](#) used by the [Defense Threat Reduction Agency's \(DTRA's\) Open Skies Division](#) to analyze the flight path for each passive mission flown over the United State under the [Open Skies Treaty](#); to identify the facilities that could be within range of aircraft sensors during the mission; and to generate notification messages (transmitted by DTRA's [Telephone Notification System \(TNS\)](#) and [Defense Messaging Service \(DMS\)](#)) to keep subscribed facilities informed of mission status and the location of the Open Skies aircraft.

Passive Quota

Under the [Open Skies Treaty](#), the passive quota is the number of [observation flights](#) each [State Party](#) is obliged to accept over its territory. The allocation passive quotas among the States Parties is specified in Annex A, Section I of the treaty. Within this quote, number, unlike the distribution of active quotas, is not subject to annual review by the [Open Skies Consultative Commission](#).

Perimeter

External boundary of the [inspection site](#), defined by either geographic coordinates or description on a map.

Perimeter Activities

Under the **Chemical Weapons Convention**, during a **challenge inspection**, monitoring activities conducted by the **inspection team (IT)** at the **perimeter** of an inspected site. Activities include **exit monitoring**, vehicle inspections, photography, and environmental sampling. The IT may also conduct any additional activities agreed to by the **inspected State Party**.

Perimeter Continuous Monitoring Area

Space within which the **inspecting State Party** has the right to establish, operate, and maintain a **perimeter and portal continuous monitoring** system and to carry out **continuous monitoring**.

Period of Inspection

Period of time from the arrival of the **inspection team** at the **inspection site** until its departure from the **inspection site**.

Personnel Interview

Activity granted to the **inspection team** under the **Chemical Weapons Convention**. Entails questioning and interviewing of personnel affiliated with the particular site being inspected.

Point of Entry/Exit (POE)

Location designated by the observed or **inspected State Party** for the in-country arrival/departure of inspection or observation teams.

Precursor

Any chemical reactant which takes part at any stage in the production by whatever method of a toxic chemical. Includes any key component of a binary or multicomponent chemical system.

Pre-Inspection Briefing

Requirement of site representatives under arms control agreements, conducted upon arrival at the inspection site and before the start of the actual inspection. Includes an introduction of key site personnel, a visual orientation/explanation of the site, and an overview/explanation of general activities conducted at the **declared site**.

Preparatory Commission/Committee (PREPCOM)

Temporary international body designed to bridge the period between a treaty's signing and **entry into force**. These bodies establish structures, modalities, and documentation, and provide a forum for signatories to discuss treaty implementation.

Production Facility

A facility engaged in the production, construction, or assembly of armaments, equipment, or items subject to **verification** activities.

Prohibited Area

Under the **Open Skies Treaty**, an airspace of defined dimensions, above the territory of a **State Party**, within which the flight of aircraft is prohibited, in accordance with specified conditions. This is one of the three types of areas that are covered under the term "hazardous airspace," on the basis of the International Civil Aviation Organization Convention.

PSF Chemical

Unscheduled **discrete organic chemical** containing phosphorus, sulfur, or fluorine. The **Chemical Weapons Convention's verification** regime applies to chemical production facilities which produce certain levels of these chemicals.

Random Selective Access

Under the **Chemical Weapons Convention**, a method of managing the access provided an **inspection team** by allowing inspectors to choose a percentage of buildings or containers within an area, or a percentage of rooms in a building, to be inspected.

Ratification

Declaration by which a nation formally accepts, with or without reservation, the content of an arms control treaty or agreement.

Recategorization

Under the **Conventional Armed Forces in Europe (CFE) Treaty**, a process for the conversion of multipurpose **attack helicopters** into combat support helicopters involving the permanent removal of specified features and capabilities and **certification** by an **inspection team**.

Requested Perimeter

Initial requested **perimeter** specified by the **inspection team** during a **challenge inspection** under the **Chemical Weapons Convention**. The requested perimeter is presented to the **inspected State Party** (ISP). If an agreement is not reached after negotiation, an alternative inspection perimeter is finally proposed by the ISP. Twenty-four hours are allotted at the **point of entry** for perimeter negotiations.

Requesting State Party Observer (RSO)

Representative of the requesting **State Party**, or a third State Party, designated by that State Party to observe the conduct of a **challenge inspection** under the **Chemical Weapons Convention**.

Resolution

Under the **Open Skies Treaty**, measurement of a **sensor's** capability to distinguish between detached objects. Indicates the minimum distance required for detached objects to be distinguished as separate objects. Normally expressed in centimeters.

Restricted Area

Under the **Open Skies Treaty**, an airspace of defined dimensions, above the territory of a **State Party**, within which the flight of aircraft is restricted in accordance with specified conditions. This is one of the three types of areas that are covered under the term "**hazardous airspace**," on the basis of the International Civil Aviation Organization Convention.

Riot Control Agent (RCA)

Under the **Chemical Weapons Convention**, any chemical not listed in a Schedule which can rapidly produce in humans sensory irritation or disabling physical effects that disappear within a short time following termination of exposure.

Risk Assessment

The process of evaluating potential security risks—based on analysis of an arms control event—to a facility, system, or operation. The risk assessment is designed to identify unrelated information or areas which could heighten an inspector's rationale to request access to specific information or areas; e.g., **restricted areas**, enhanced physical security characteristics, hazardous material signs, etc. Also, an assessment by the **technical secretariat** of the **Organization for the Prohibition of Chemical Weapons** to determine the number, intensity, duration, timing, and mode of



inspections for a particular facility. Based on the risk to the object and purpose of the **Chemical Weapons Convention** posed by the quantities of chemicals produced, the characteristics of the facility, and the nature of the activities carried out.

Routine Inspection

Under the **Chemical Weapons Convention**, commonly employed unofficial term used to denote any inspection other than a **challenge inspection**.

Sampling and Analysis

Under arms control agreements, the process of collecting air, soil, effluent, and other materials and analysis to determine the presence or absence of treaty-prohibited or monitored substances.

Schedules of Chemicals

Collectively refers to the three lists of **toxic chemicals** and precursor chemicals monitored under the **Chemical Weapons Convention**. There are three lists of scheduled chemicals: Schedule 1, Schedule 2, and Schedule 3.

The chemicals listed in Schedule 1 are toxic chemicals that have been developed or used as **chemical weapons** (CW), or are precursors to those chemicals, and have little or no use in industrial processes not prohibited by the Chemical Weapons Convention. Schedule 2 chemicals are toxic chemicals, and their precursors, that pose a significant risk to the object and purpose of the convention but also have industrial uses when used in small quantities. Schedule 3 chemicals are toxic chemicals that have been used as CW, or are their precursors, which are produced and used in large quantities for purposes not prohibited by the convention.

Security Countermeasures

Devices and/or techniques used to protect national security, proprietary, or other **critical information** while fulfilling United States arms control treaty obligations.

Self-Monitoring

Monitoring by the **inspected State Party** of vehicles exiting the **perimeter** during a **challenge inspection** under the **Chemical Weapons Convention**. Must begin no later than 12 hours after the arrival of the **inspection team** at the **point of entry**, and involve the collection of factual information on all vehicular exit activity from the **requested perimeter**.

Sensor

Any equipment which detects, and may indicate and/or record objects and activities, by means of energy or particles emitted, reflected, or modified by objects. Under the [Open Skies Treaty](#), equipment of a category specified in Article IV of the treaty that is installed on an observation aircraft for use during the conduct of [observation flights](#). The categories of equipment specified in Article IV are: optical and framing cameras; video cameras with real-time display; [infra-red line-scanning devices](#); and sideways-looking [synthetic aperture radar](#).

Sensor Cover

Devices placed over [Open Skies](#) aircraft [sensors](#) to ensure that no unauthorized sensor operations are conducted. The covers are removed just prior to beginning [observation flights](#).

Sensor Resolution

Under the [Open Skies Treaty](#), a [sensor's](#) ability to collect useful data depends upon the permitted ground resolution. Sensors are subject to specified sensor ground resolution limits. Ground resolution limits are 30 centimeters for optical and video cameras; 50 centimeters for infrared line scanners; and 3 meters for synthetic aperture radar.

Sequential Inspection

An inspection that follows a previous inspection by the same [inspection team](#) during one stay in country through the same [point of entry](#).

Shrouding

A [security countermeasure](#) used to cover and/or conceal sensitive, classified, or proprietary assets to protect them from being detected by an [inspection team](#)

Signatory

In most cases, a signatory is a country that has signed an arms control treaty or agreement but has not yet ratified it. After ratifying or acceding to a treaty, the country would be a [State Party](#) to the treaty.

Site Assessment

The process used by an external and/or internal team to identify, evaluate, and appropriately address the potential risks of inadvertently disclosing national security, proprietary, or other sensitive information during an [on-site inspection](#).



Site Assistance Team (SAT)

A team, usually a Service-deployed team similar to an **advance team**, tasked to provide pre-inspection security, logistical, and treaty requirements support to facilities immediately following **notification** of an inspection, in advance of the arrival of the **inspection team**.

Site Assistance Visit

A mission conducted by a team of arms control security experts at facilities subject to **on-site inspection** to provide advice on selecting and implementing cost effective, treaty compliant, arms control security **countermeasures** to protect critical information during inspection activities.

Site Diagram

Diagram used to specify the location of declared facilities. Drawn to scale and indicates boundaries of the facility. May include road and rail entrances and exits, all structures, significant geographical features, true north arrows, the exact location of a facility within a larger complex, geographic coordinates of a point within the facility, or a legend to identify symbols and scale used on the diagram.

Site Escort

Representative from an inspected facility designated to work with **national escorts** to facilitate the inspection process. Should be intimately familiar with the geography and functions/activities of the facility being inspected. Accompanies inspectors from area to area and building to building, and guides them through the facility during the inspection.

Site Preparation

Activities conducted to prepare a facility for an inspection. Enables managers to prepare for the presence of foreign inspectors at their respective facility by helping them implement appropriate, cost-effective **security countermeasures** to protect vulnerable information from disclosure during the inspection.

Site Recovery

Occurs after an inspection as the inspected facility returns to normal operating conditions and assesses the impact of the inspection, inspection planning **implementation**, and the effectiveness of the **security countermeasures** employed.

Standard Calling List (SCL)

List composed of organizations that require all available information regarding **Open Skies** implementation activities.

Standard/Standing Operating Procedures (SOP)

Set of instructions covering those features of operations that lend themselves to a definite or standardized procedure without loss of effectiveness. Procedure is applicable unless ordered otherwise.

State Party (SP)

State or nation legally bound by a treaty (or agreement) either through **ratification** or accession to the treaty.

Susceptibility

Arms control **operations security** process that determines whether or not a particular treaty provides or denies an **inspection team** access to a particular facility.

Synthetic Aperture Radar (SAR)

Under the **Open Skies Treaty**, observation aircraft may be equipped with sideways-looking synthetic aperture radar. SAR is a high **resolution** ground mapping technique which takes advantage of the forward motion of a vehicle that is carrying a pulsed radar to synthesize the effect of a large antenna aperture. In other words, the larger the radar antenna (aperture), the higher the radar picture's resolution. SAR uses a radar with a very small antenna (such as can be carried in an aircraft) that synthesizes a series of recurring radar pulse returns to simulate the effect of a much larger antenna aperture; thus, the name "synthetic" aperture. SAR is effective in detecting large objects day or night, even through cloud cover.

Systematic Verification

Chemical Weapons Convention term encompassing **on-site inspection** (including the continuous presence of inspectors) and monitoring with on-site instruments. **Chemical weapons** (CW) storage, production, and destruction facilities and Schedule 1 chemical facilities are subject to systematic verification. In addition, systematic verification may be applied to abandoned CW if deemed appropriate as a result of on-site inspection. Schedule 2 and 3 chemical plant sites, as well as discrete organic chemical plant sites, are subject to data monitoring and, if certain quantitative activity **thresholds** are met, on-site inspection.

Taxi Option

Under the **Open Skies Treaty**, a treaty provision that gives the **observed Party** the right to demand that its observation aircraft, along with its flight crew and **sensors**, be used to carry out an **observation flight** over its territory requested by an **observing Party**.

Team Chief (TC)

Head of an inspection or escort team under any treaty regime.

Technical Equipment Inspection (TEI)

Inspection conducted at the **point of entry** by the **Defense Threat Reduction Agency** in the presence of visiting **inspection team** members, both upon the team's arrival and departure. Verifies the equipment used in an inspection has been certified and approved by the United States and does not perform in a manner outside its intended purpose and complies with safety and other underwriting licensing requirements.

Technical Secretariat (TS)

Operational element of the **Organization for the Prohibition of Chemical Weapons** specifically mandated to carry out **on-site inspections** and other **verification** measures to ensure **compliance** with the **Chemical Weapons Convention**. Among its other responsibilities, the TS maintains a list of accredited inspectors and schedules inspection activities.

Technology Transfer

The transfer of a category of information or materials deemed to be of critical military or economic importance. Technology transfer occurs in authorized (voluntary or purposeful) and unauthorized (inadvertent, unintentional, undesired) forms. Loss of technology during arms control activities is a security consideration.

Telephone Notification System (TNS)

Under the **Open Skies Treaty**, computer-based auto dialer system that transmits **Passive Overflight Module** (POM)-generated notifications via voice, fax, and pager directly to addresses listed on the POM database.

Threshold

Under the **Chemical Weapons Convention**, a quantity level at which production, consumption, use, storage, import, or export of monitored chemicals are subject to **verification** activities.

Toxic Chemical

Any chemical which through its chemical action on life processes can cause death, temporary incapacitation or permanent harm to humans or animals.

Transit Flight

A flight of an observation or transport aircraft conducted by or on behalf of an **observing Party** over the territory of a third **State Party** en route to or from the territory of an **observed Party**.

Transparency

Measures taken by **States Parties** to lend confidence in treaty compliance as mandated under certain confidence and security-building treaties such as the **Conventional Arms Forces in Europe (CFE) Treaty**, the **Vienna Document**, and the **Open Skies Treaty**. Pertaining specifically to arms control inspections, refers to the application of certain security countermeasures that are intended to not be apparent to the inspectors.

Transportable Operational Planning System (TOPS)

A portable computer used by **Open Skies** escort personnel to copy the foreign observers' proposed **mission plan** and transit, via modem, to the **Passive Overflight Module** team at the **Defense Threat Reduction Agency**. Consists of a laptop computer with global positioning system carried onboard a foreign aircraft to record flight events.

Treaty-Limited Equipment (TLE)

Battle tanks, armored combat vehicles, artillery, combat aircraft, and attack helicopters subject to numerical limits, are required to be inspected, eliminated, reduced, or destroyed under the **Conventional Arms Forces in Europe Treaty**.

Treaty Manager

Individual(s) responsible for U.S. **implementation** of, and **compliance** with, particular arms control treaties or agreements.

Verification

Process of **data declarations, on-site inspections, and imaging overflights** to gather information to assess a treaty partner's **compliance** with an arms control agreement.



Vienna Document of 2011 (VDOC)

The Vienna Document of 2011 is composed of politically binding **confidence- and security-building measures**. These measures are designed to promote mutual trust and security among the 56 participating States of the Organization for Security and Cooperation in Europe

Vulnerability

As it applies to arms control operations security, an assessment of the relative risk of compromise of previously identified information when analyzed in the context of inspector activities, capabilities, and intentions.

Vulnerability Assessment

An arms control vulnerability assessment conducted by a team of arms control security experts with specialized backgrounds to evaluate a facility, site, weapons systems, technology, operation, or program to determine its susceptibility to arms control **implementation** activities and to perform risk analyses and develop **security countermeasure** recommendations.

PART II

The nuclear-related terms appearing in this section are intended to provide treaty implementers with a quick reference guide to basic nuclear terminology and the terms used when implementing nuclear-related arms control treaties and agreements. Basic nuclear terms are defined in accordance with the definitions provided by the International Atomic Energy Agency (IAEA) and the U.S. government for implementing the New Strategic Arms Reduction Treaty (New START), the U.S.-IAEA Safeguards Agreement and the U.S.-IAEA Additional Protocol.

NOTE: Throughout this section, isotopes are denoted by the use of superscripts in conjuncture with chemical symbols, e.g. U^{238} .

NUCLEAR-RELATED TERMS

Accountancy

See [nuclear material accounting](#).

Actinides

Elements with [atomic numbers](#) from 90 to 103 inclusive. That group of elements is given this designation in chemical analogy to the group designated “lanthanides.”

NOTE: Actinium is not part of that group. Similarly, lanthanum is not part of the lanthanide group.

Activation

The process by which [stable isotopes](#) are converted to radioactive ones, usually by neutron capture. (See also [transmutation](#), [radioactive decay](#).)

Additional Protocol

See [U.S.-IAEA Additional Protocol](#) or [Model Additional Protocol](#)

Additional Protocol (AP) Declaration

A list of nuclear or nuclear-related activities disclosed by [States Parties](#) to the [International Atomic Energy Agency](#) (IAEA) for verification. The IAEA may request complementary access to verify the completeness or correctness of declared activities.

Additional Protocol Reporting System (APRS)

The web-based, unclassified virtual private network and database management system developed and operated by the [Department of Commerce](#) for collecting, processing, storing, and distributing [U.S.-IAEA Additional Protocol](#) Declarations and associated information. The APRS shall be used to aggregate all declared activities submitted by the U.S. Lead Agencies into a proposed [Additional Protocol Declaration](#), or subsequent update, for interagency reviews and approvals.

Ad Hoc IAEA Inspections

The [U.S.-IAEA Safeguards Agreement](#), in Article 69, states: “The Agency [the [International Atomic Energy Agency](#)] may make *ad hoc* inspections in order to: a) verify the information contained in the initial reports submitted [by the United States on all [nuclear material subject to safeguards](#)]; b) identify and verify changes in the situation which have occurred since the date of the relevant initial

report; and c) identify and if possible verify the quantity and composition of the nuclear material subject to safeguards under this Agreement in respect of which [export or import]information has been provided to the Agency [by the United States, in accordance with pre-existing arrangements.]”

Adjustment

Per the **U.S.-IAEA Safeguards Agreement**, an entry into an accounting record or a report showing a **shipper/receiver difference** or **material unaccounted for** (MUF).

Afterwinds

Wind currents set up in the vicinity of a nuclear explosion directed toward the burst center, resulting from the updraft accompanying the rise of the fireball.

Air Base

With regard to **New START**, a facility at which **deployed heavy bombers** are based and their operation is supported.

Aircrew Member

With regard to **New START**, an individual who performs duties related to the operation of an airplane and who is included on the inspecting State Party's list of aircrew members.

Air-Launched Cruise Missile (ALCM)

With regard to **New START**, an air-to-surface **cruise missile** of a type, any one of which has been flight-tested from an aircraft or deployed on a bomber after December 31, 1986.

Air Sampling

The collection of samples of air to measure the **radioactivity** or to detect the presence of radioactive material, particulate matter, or chemical pollutants in the air.

Alpha Decay

Radioactive decay in which an **alpha particle** is emitted. This lowers the **atomic number** of the **nucleus** by two and its mass by four.

Alpha Particle

A positively charged particle ejected spontaneously from the nuclei of some radioactive elements. It is identical to a helium nucleus that has a mass number of

4 and an electrostatic charge of +2. It has low penetrating power and a short range (a few centimeters in air). The most energetic alpha particle will generally fail to penetrate the dead layers of cells covering the skin and can be easily stopped by a sheet of paper. Alpha particles are hazardous when an alpha-emitting **isotope** is inside the body.

AP Declaration

List of those peaceful nuclear or nuclear-related activities disclosed by the United States to the **IAEA** for verification under the **U.S.-IAEA Additional Protocol (AP)**. The IAEA may request complementary access to verify the completeness or correctness of declared activities.

Arming System

As applied to weapons and ammunition, the changing from a safe condition to a state of readiness for initiation.

At or Near

With regard to **IAEA** access, the proximity (or relative position, space, or time) of Department of Defense locations, sites, or facilities or associated information or activities of direct national security significance to an eligible or potentially eligible **facility**, or a declared or potentially declarable activity.

Atom

The smallest particle of an element that cannot be divided or broken up by chemical means. It consists of a central core of **protons** and **neutrons**, called the **nucleus**. **Electrons** revolve in orbits in the region surrounding the nucleus.

Atomic Bomb

See **atomic weapon**.

Atomic Energy

Energy released in nuclear reactions. Of particular interest is the energy released when a **neutron** initiates the breaking up or fissioning of an atom's nucleus into smaller pieces (**fission**), or when two nuclei are joined together under millions of degrees of heat (**fusion**). It is more correctly called nuclear energy.

Atomic Mass, Atomic Weight

The sum of the number of **protons** and **neutrons** in the **nucleus** of an **atom**.

Atomic Number

The number of positively charged **protons** in the **nucleus** of an **atom**.

Atomic Vapor Laser Isotope Separation (AVLIS)

The AVLIS process for uranium **enrichment** consists of a laser system and a separation system, which contains a vaporizer and a collector. Metallic **uranium** is melted and vaporized to form a vapor stream. That stream flows through the collector where it is illuminated by light from a precisely tuned laser; only the U^{235} absorbs the light. When the U^{235} **atom** has absorbed enough light energy, it ejects an **electron**, and becomes a positively charged atom which can then be deflected by an electromagnetic field to the collector. Although many countries are pursuing AVLIS research and development, no country has yet deployed this process, which is difficult and expensive to implement, especially with limited technical resources.

Atomic Weapon

Any device utilizing atomic energy, the principal purpose of which is for use as, or for development of, a weapon, a weapon prototype, or a weapon test device. (See also **gun-type nuclear weapon**; **implosion weapon**.)

Back End (of the **nuclear fuel cycle**)

The series of steps after fuel is burned in the **reactor**, including the handling of discharged fuel elements from the reactor, chemical **reprocessing**, recycling of recovered **fissile** and **fertile material**, and **radioactive waste** disposal. (See nuclear fuel cycle diagram on pages 116-117.)

Background Radiation

Radiation from cosmic sources; naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material) and global fallout as it exists in the environment from the testing of nuclear explosive devices. It does not include radiation from source, byproduct, or **special nuclear material** regulated by the **Nuclear Regulatory Commission**. The typically quoted average individual exposure from background radiation is 360 millirems per year.

Ballistic Missile

With regard to **New START**, a missile that is a weapon-delivery vehicle that has a ballistic trajectory over most of its flight path.

Basing Area

With regard to **New START**, an area within an **intercontinental ballistic missile (ICBM) base** for **mobile launchers of ICBMs**, in which **deployed mobile launchers of ICBMs** are based and in which **fixed structures for mobile launchers of ICBMs** are located.

Batch

Under the **U.S.-IAEA Safeguards Agreement**, a portion of **nuclear material** handled as a unit for accounting purposes at a **key measurement point** and for which the composition and quantity are defined by a single set of specifications or measurements. The nuclear material may be in bulk form or contained in a number of separate items.

BENT SPEAR

A Department of Defense term used to identify and report a nuclear incident involving a **nuclear weapon/warhead** or nuclear component. In the Army and Air Force, this term includes a “significant incident” as defined in DoD Directive 5100.52. (See also **nuclear weapon incident** and **BROKEN ARROW**.)

Beryllium (in reactor operations)

Beryllium is a low-density, gray metal used in many industries because of its high permeability to x-rays, light weight, and high tensile strength. Beryllium is a source of **neutrons** when bombarded with **alpha particles**; it is used as a neutron reflector, as a neutron moderator, and, when used in a mixture with **plutonium** or americium, as a neutron source in **nuclear reactors**. Beryllium is also used in aerospace structures and inertial guidance systems.

Beta Decay

Radioactive decay in which a **beta particle** is emitted or in which orbital electron capture occurs.

Beta Particle

A charged particle emitted from a **nucleus** during **radioactive decay**, with a mass equal to 1/1837 that of a **proton**. A negatively charged beta particle is identical to an **electron**. A positively charged beta particle is called a **positron**. Large amounts of beta radiation may cause skin burns, and beta emitters are harmful if they enter the body. Beta particles may be stopped by thin sheets of metal or plastic.

Bilateral Consultative Commission (BCC)

With regard to **New START**, the negotiating forum established by the treaty where the two Parties meet to resolve technical issues regarding treaty **implementation** and **compliance verification** procedures.

Boiling Water Reactor (BWR)

A **reactor** in which **light water**, used as both **coolant** and **moderator**, is allowed to boil in the **core**, with resulting steam used to drive a turbine-generator and produce electricity. The BWR uses enriched **uranium** fuel and zirconium alloy **cladding** in the **fuel element** similar to those in the **pressurized-water reactor** (PWR).

Bomber

With regard to **New START**, an airplane of a type, any one of which was initially constructed or later converted to be equipped for bombs or air-to-surface missiles.

Book Inventory (of a material balance area)

Under the **U.S.-IAEA Safeguards Agreement**, the algebraic sum of the most recent **physical inventory** of that **material balance area** and of all **inventory changes** that have occurred since that physical inventory was taken.

Boost

The process by which the **fission** output of the primary is increased by **neutrons** from the **fusion** of **deuterium-tritium** gas.

BROKEN ARROW

A Department of Defense term used to identify and report an accident involving a **nuclear weapon/warhead** or nuclear component. In the Navy this includes a "significant incident" as defined in DoD Directive 5100.52.

(See also **nuclear weapon incident** and **BENT SPEAR**.)

Brown Oxide

See **uranium dioxide**.

Calutrons

See **electromagnetic isotope separation**.

CANDU (Canadian deuterium-uranium) Reactor

The CANDU reactor uses **natural uranium** as a fuel and **heavy water** as a **moderator** and a **coolant**.

Cask

A heavily shielded container used to store and/or ship radioactive materials. Lead and steel are common materials used in the manufacture of casks. (See also [spent fuel cask](#) and [transportation cask](#).)

Centrifuge

A rotating cylinder that employs centrifugal force to separate [isotopes](#) in a gaseous form. (See also [gas centrifuge](#).)

Chain Reaction

A series of nuclear fissions, each one stimulated by a [neutron](#) emitted in a previous [fission](#). A chain reaction occurs when at least one of the two or more neutrons released in a fission initiates another fission.

Cladding

The thin-walled metal tube that forms the outer jacket of a nuclear [fuel rod](#). It prevents corrosion of the fuel by the [coolant](#) and the release of fission products into the coolant. Aluminum, stainless steel, and zirconium alloys are common cladding materials.

Closed-Down Facility or Closed-Down Location Outside Facilities

The [U.S.-IAEA Additional Protocol](#), in Article 18, paragraph D, states: “An installation or location where operations have been stopped and the [nuclear material](#) removed but which has not been decommissioned.” (See also [decommissioned facility or decommissioned location outside facilities](#).)

Command Disable

A subsystem of command and control features that destroy a weapon’s ability to produce nuclear [yield](#).

Complementary Access Visit or Inspection

Article 4 specifies the [U.S.-IAEA Additional Protocol](#)’s provisions for allowing [IAEA](#) inspectors to request complementary access for purposes of “[assuring] the absence of undeclared [nuclear material](#) and activities.” IAEA inspectors also have the right to request complementary access on short notice to pursue questions relating to compliance and the possible diversion of nuclear material for weapons use. The United States foresees no circumstances under which the IAEA would have a reason to request complementary access in this country.

Comprehensive Nuclear Test-Ban Treaty (CTBT)

International arms control treaty banning all nuclear explosions. The United States signed the CTBT on September 24, 1996, but has not ratified the treaty and the CTBT is not yet in force. **Verification** of treaty **compliance** relies primarily on a global information collection and monitoring network consisting of a worldwide, 337-station **International Monitoring System** (IMS) and an **International Data Center** (IDC) being constructed by the Preparatory Commission for the **Comprehensive Nuclear Test-Ban Treaty Organization**. The treaty's verification regime also provides for confidence-building measures as well as for consultations, clarifications, and **on-site inspections** to be conducted when necessary to investigate ambiguous events indicating that a nuclear explosion has occurred.

Comprehensive Nuclear Test-Ban Treaty Organization (CTBTO)

International treaty **implementation** organization established by the **Comprehensive Nuclear Test-Ban Treaty**. Located in Vienna, the CTBTO is headed by an Executive Secretary and consists of a Conference of the States Parties, an Executive Council, and a Technical Secretariat. The CTBTO promotes the treaty's **entry into force** and is building the treaty's comprehensive **verification** regime. The United States is a Member State of the CTBTO.

Concentration Plant

See **uranium mine and ore processing plant**.

Containment

Structural features of a nuclear **facility** or equipment which enable the IAEA to establish the physical integrity of an area or item by preventing undeclared access to or movement of nuclear or other material; or interference with the item, IAEA safeguards equipment, or data. Examples are the walls of a storage room or of a storage pool, transport **flasks** (i.e., **casks**), and storage containers. The continuing integrity of the containment itself is usually assured by seals or surveillance measures (especially for containment penetrations such as doors, vessel lids, and water surfaces).

Containment Vessel

A gas-tight shell or other enclosure around a **nuclear reactor**.

Control Rod

A rod, plate, or tube containing a material such as hafnium, boron, etc., used to control the power of a **nuclear reactor**. By absorbing **neutrons**, a control rod prevents the neutrons from causing further fissions.

Control Room (in reactor operations)

The room in a **nuclear power plant** where operators monitor and control the operations of the plant. The equipment in the control room informs the operators of what is happening in the **nuclear reactor** and other parts of the plant.

Conversion (reactor technology)

The operation of a **reactor** in such a fashion that one fissile species is produced while another is consumed.

Conversion or Elimination Facility

As defined by **New START**, a specific **facility** designed for the elimination or conversion of treaty-limited items of inspection, such as **intercontinental ballistic missiles (ICBMs)**, **submarine-launched ballistic missiles (SLBMs)**, **launch canisters**, **mobile launchers of ICBMs**, first stages of ICBMs which remain after static testing, **SLBM launchers**, **heavy bombers**, or **former heavy bombers**.

Coolant

A substance circulated through a **nuclear reactor** to remove or transfer heat. The most commonly used coolant in the United States is water. Other coolants include heavy water, air, carbon dioxide, helium, liquid sodium, and a sodium-potassium alloy.

Core

The central portion of a **nuclear reactor** containing the **fuel elements**, **moderator**, neutron poisons, and support structures.

Critical Assembly (or critical facility)

A research tool consisting of a configuration of **nuclear material** which, by means of appropriate controls, can sustain a **chain reaction**. It is distinguishable from a **research** or **power reactor** in that it normally has no special provisions for cooling, it is not shielded for high power operation, has a core designed for great flexibility of arrangement, and uses fuel in a readily accessible form which is frequently repositioned and varied to investigate various reactor concepts. A critical assembly may, depending on fuel design, be classified as an item or a bulk handling facility for safeguards purposes.

Critical Facility

See [critical assembly](#).

Critical Mass

The minimum amount of [fissionable material](#) required to sustain a [chain reaction](#). The exact mass varies with many factors, such as the particular [fissionable isotope](#) present, its concentration and chemical form, the geometrical arrangement of the material, and its density.

Criticality

A term used in reactor physics to describe the state when the number of [neutrons](#) released by [fission](#) is exactly balanced by the neutrons being absorbed (by the fuel and poisons) and escaping the reactor [core](#). A reactor is said to be “critical” when it achieves a self-sustaining nuclear [chain reaction](#), as when the [reactor](#) is operating.

Cruise Missile

With regard to [New START](#), a missile that is an unmanned, self-propelled weapon-delivery vehicle that sustains flight through the use of aerodynamic lift over most of its flight path.

Daughter Products

[Isotopes](#) that are formed by the [radioactive decay](#) of some other isotope. In the case of Ra^{226} (Radium-226), for example, there are 10 successive daughter products, ending in the [stable isotope](#), Pb^{206} (Lead-206). (See also [parent](#)).

Decay Chain

The series of decays that certain [radioisotopes](#) such as U^{235} go through before reaching a stable form such as Pb^{207} (Lead-207).

Decay Heat

The heat released as radioactive elements spontaneously disintegrate.

Decay Product

See [daughter product](#).

Declared Data

As defined by [New START](#) (the data the accuracy of which may be confirmed during [on-site inspection](#) activities):

- (a) Data with respect to items subject to New START, specified according to categories of data contained in Part Two of this Protocol;
- (b) Data included in notifications provided in accordance with Part Four of this Protocol that update the data according to categories of data contained in Part Two of this Protocol;
- (c) Information on technical characteristics of new types of strategic offensive arms included in notifications provided in accordance with Part Four of this Protocol that update the data according to categories of data contained in Part Two of this Protocol, and that have been confirmed during exhibitions; and
- (d) Information that the **inspected State Party** provides to inspection teams during pre-inspection procedures.

Declared U.S. Facilities (to the IAEA)

See **listed U.S. facilities**.

Decommissioned Facility or Decommissioned Location Outside Facilities

The **U.S.-IAEA Additional Protocol**, in Article 18, paragraph C, states: "An installation or location at which residual structures and equipment essential for its use have been removed or rendered inoperable so that it is not used to store and can no longer be used to handle, process, or utilize **nuclear material**." (See also **closed-down facility or closed-down location outside facilities**.)

Decon (in reactor operations)

A Department of Energy method of decommissioning in which the equipment, structures, and portions of a **facility** and site containing radioactive contaminants are removed or decontaminated to a level that permits property to be released for unrestricted use shortly after cessation of operations.

Defense Equity

Activities of direct national security significance: Any current or former Department of Defense (DoD) Component activity associated with military, national security, or homeland defense capability or intent including but not limited to operations and training; intelligence; materiel production, maintenance, and supply; research, development, test, and evaluation; and infrastructure support, manning, or readiness.

Locations, sites, or facilities or associated information or activities of directional security significance: Any current or former DoD-owned, -leased, -funded, -used

space, structure, **facility**, installation, or land occupied by, or associated with, national security or homeland defense, including but not limited to military operations or training; intelligence; materiel product, maintenance, or supply; research, development, test, or evaluation; infrastructure or personnel.

Information associated with activities of direct national security significance: Any unclassified or classified information (including data, text, drawings, or graphics) that is communicated or recorded in any form (including hardcopy, electronic or softcopy, verbal, or as imagery, signals, or materials) related to national security or homeland defense, including but not limited to military operations or training; intelligence; materiel production, maintenance, or supply; research, development, test, or evaluation; infrastructure or personnel.

Personnel-related activities, locations, or information: Including but not limited to hospitals or medical care, administration, housing, mess, or community activities or facilities associated with military personnel or their families.

Delivery System

The military vehicle (e.g., ballistic or cruise missile, artillery shell, airplane, submarine) by which a **nuclear weapon** would be delivered; most **warheads** have been designed for specific delivery systems (analogous to “carrier”).

Demilitarization

The process of eliminating or reducing military weapons, materials, other hardware, and organizational structures.

Depleted Uranium

Uranium having a smaller percentage of U^{235} than the 0.71% found in **natural uranium**. It is obtained from some spent fuels or as the “**tails**” of uranium **enrichment**.

Deployed Heavy Bomber

As defined by **New START**, a **heavy bomber equipped for nuclear armaments**, other than a **test heavy bomber** or a **heavy bomber** located at a **repair facility** or at a **production facility**.

Deployed Intercontinental Ballistic Missile (ICBM)

With respect to **New START**, an **intercontinental ballistic missile (ICBM)** that is contained in or on a **deployed launcher of intercontinental ballistic missiles**.

Deployed Launcher of Intercontinental Ballistic Missiles

As defined by **New START**, an **intercontinental ballistic missile (ICBM)** launcher that contains an ICBM and is not an ICBM **test launcher**, an ICBM **training launcher**, or an **intercontinental ballistic missile launcher** located at a **space launch facility**.

Deployed Launcher of Submarine-Launched Ballistic Missiles

As defined by **New START**, a **submarine-launched ballistic missile (SLBM)** launcher installed on a submarine that has been launched, that contains an **SLBM**, and is not intended for testing or training.

Deployed Mobile Launcher of Intercontinental Ballistic Missiles

As defined by **New START**, a **mobile launcher of intercontinental ballistic missiles (ICBMs)** that contains an ICBM and is not a mobile **test launcher** or a mobile launcher of ICBMs located at a **space launch facility**.

Deployed Submarine-Launched Ballistic Missile

With respect to **New START**, a **submarine-launched ballistic missile (SLBM)** that is contained in a **deployed launcher of submarine-launched ballistic missiles**.

Design Information

The **U.S.-IAEA Safeguards Agreement**, in Article 43, and the Protocol to that Agreement, in Article 6, state with respect to each facility identified by the IAEA that the United States is to provide the following information, when applicable: a) “[refers to standard identification information]; b) a description of the general arrangement of the **facility** with reference, to the extent feasible, to the form, location, and flow of **nuclear material**, and to the general layout of important items of equipment which use, produce, or process nuclear material; c) a description of features of the facility relating to material **accountancy, containment, and surveillance**; and d) a description of the existing and proposed procedures at the facility for nuclear material accountancy and control, with special reference to **material balance areas** established by the operator, measurements of flow, and procedures for **physical inventory** taking.”

Detonation

An explosion; a heat-liberating chemical reaction that moves so quickly into the unreacted material that the reaction front exceeds the speed of sound and the advancing front is preceded by a shock wave.

Detonator

A device containing a sensitive explosive intended to produce a detonation wave for setting off a high explosive element. In a **nuclear weapon**, it triggers the ignition of the main chemical explosive which, in turn, compresses the **special nuclear material** in order to explode the nuclear weapon.

Deuterium (D or H²)

A heavier, **stable isotope** of hydrogen, having one **proton** and one **neutron** in the **nucleus**.

Diffusion

See **gaseous diffusion**.

Direct-Use Material

Nuclear material that can be used for the manufacture of nuclear explosive components without **transmutation** or further **enrichment**, such as **plutonium** containing less than 80% Pu²³⁸, HEU (**high enriched uranium**), and U²³³. Chemical compounds, mixtures of direct-use materials (e.g., **MOX**), and plutonium contained in **spent fuel** also fall into this category.

Disassembly

Process of taking apart a nuclear warhead and removing the subassemblies, components, and individual parts.

Disposition

Determination of the long-term status of materials.

Distinguishable

With respect to **New START**, different on the basis of the totality of external and functional differences that are observable by **national technical means** of verification, or, when such observations may be inconclusive in the opinion of the **inspecting State Party**, that are visible during **inspection activities**.

Dual-Use Commodities

Material and industrial equipment with non-nuclear industrial applications that would be of significant value if used in a nuclear explosives program or in a **nuclear fuel cycle** activity.

Dual-Use Components

Commodities, with non-nuclear industrial applications, that would be of significant value if used in a nuclear explosives program or in a **nuclear fuel cycle** activity.

Dual-Use, Nuclear-Related Dual Use

Equipment or technology that can be and is used in both **nuclear energy** applications and non-nuclear energy applications.

DULL SWORD

A Department of Defense term used to identify and report a **nuclear weapon** safety deficiency. (See also **nuclear weapon deficiency**.)

Effective Kilogram

A special unit used in the safeguarding of nuclear material, reflecting its strategic value. The **U.S.-IAEA Safeguards Agreement**, Article 90, paragraph G, states: "The quantity in 'effective kilograms' is obtained by taking: a) for **plutonium**, its weight in kilograms; b) for **uranium** with an enrichment of 0.01 (1%) and above, its weight in kilograms multiplied by the square of its **enrichment**; c) for uranium with an enrichment below 0.01 (1%) and above 0.005 (0.5%), its weight in kilograms multiplied by 0.0001; and d) for **depleted uranium** with an enrichment of 0.005 (0.5%) or below, and for **thorium**, its weight in kilograms multiplied by 0.00005."

Electromagnetic Isotope Separation (EMIS)

One of the major processes used by the United States during the Manhattan Project for the production of U^{235} . Equipment units were known as calutrons, and some are still in service to supply small quantities of various **isotopes** for research purposes.

Electromagnetic Pulse (EMP)

A sharp pulse of radio-frequency (long wavelength) electromagnetic radiation is produced when a nuclear explosion occurs in an unsymmetrical environment, especially at or near the earth's surface or at high altitudes. The intense electric and magnetic fields can damage unprotected electrical and electronic equipment over a large area.

Electron

An elementary particle with a negative charge and a mass $1/1837$ that of the **proton**. Electrons surround the positively charged **nucleus** and determine the chemical properties of the **atom**.

Electronvolt (eV)

A unit of energy used to describe particles of **radiation**. For instance, x-rays have energies in the range of roughly 1–1,000 kiloelectronvolts (keV), while **gamma rays** have energies of 1,000 keV or greater or equivalently 1 Megaelectronvolt (MeV) or higher. **Fast neutrons** have energies in the range of 1–10 MeV while **thermal neutron** energies are about 25 millielectronvolts (meV).

Eligible Facilities List (EFL)

See **listed U.S. facilities**.

EMPTY QUIVER

A Department of Defense term used to identify and report the seizure, theft, or loss of a **nuclear weapon** or nuclear component.

Enhanced Nuclear Detonation Safety (ENDS)

The current standard for nuclear detonation safety implemented through the use of sophisticated electrical **firing system** safety devices; specifies that the probability for unintentional nuclear detonation will be less than 1 in 10^9 in normal environments and less than 1 in 10^6 in an accident or in abnormal environments.

Enrichment

Per the **U.S.-IAEA Safeguards Agreement**, Article 90, paragraph H, “the ratio of the combined weight of the **isotopes** of U^{233} and U^{235} to that of the total **uranium** in question.”

Escort Team

See **In-Country Escort**.

Exhibition

Under **New START**, specified as an **inspection activity** enabling the other Party to confirm the distinguishing features and technical characteristics of new **strategic offensive arms** (SOA) and to confirm the conversion of SOA and facilities subject to the treaty. (See also **Type Two Inspections**.)

Facility

The **U.S.-IAEA Safeguards Agreement**, in Article 90, paragraph I, and the **U.S.-IAEA Additional Protocol**, in Article 18, paragraph H, both state: “Facility means: a) a **reactor**, a **critical facility**, a conversion plant, a fabrication plant, a reprocessing plant, an

isotope separation plant, or a separate storage installation; or b) any location where **nuclear material** in amounts greater than one **effective kilogram** is customarily used.”

As defined by **New START**, an **intercontinental ballistic missile (ICBM) base**, **submarine base**, **air base**, **maintenance facility**, **basing area**, **silos launcher group**, **intercontinental ballistic missile (ICBM) loading facility**, **submarine-launched ballistic missile (SLBM) loading facility**, **production facility**, **repair facility**, **storage facility**, **training facility**, **conversion or elimination facility**, **test range**, **heavy bomber flight test center**, or **space launch facility**.

Facility Attachment

A document included in the **subsidiary arrangements** between the United States and the **IAEA** for each **facility** the IAEA identifies pursuant to the **U.S.-IAEA Safeguards Agreement**. The document contains, *inter alia*: a) a short description of the facility; b) a provision to submit to the IAEA changes in the information on the facility; c) **accountancy** measures for the facility; d) provisions for **containment** and **surveillance** measures; e) specific provisions and criteria for termination of and exemption from **safeguards** of **nuclear material**; f) a detailed description of the records and reports system; g) a description of the mode and scope of IAEA **routine inspections**; and h) provisions for administrative procedures concerning the facility.

Fast Neutron

Neutrons travelling at high velocities, or equivalently, with high energies. Fast neutrons from fission have energies in the range of 1–10 Megaelectronvolt (MeV). Fast neutrons produced by deuterium-tritium **neutron generators** have energies of 14 MeV. (See also **electronvolt** and **thermal neutron**.)

Feed Materials

Refined **uranium** or **thorium** metal or compounds suitable for use in fabricating reactor **fuel elements** or as feed to uranium enrichment facilities. The term differentiates these materials from raw materials (ores and concentrates).

Fertile Isotope

See **fertile material**.

Fertile Material

A material, not itself fissionable by **thermal neutrons**, but which can be converted into a **fissile material** by **irradiation** in a **reactor**. There are two basic fertile materials,

U^{238} and Th^{232} . When these fertile materials capture **neutrons**, they are converted into fissile Pu^{239} and U^{233} , respectively.

Fireball

A luminous sphere of hot gases formed by the sudden extreme heating of air by x-rays in the thermal **radiation** from a nuclear explosion.

Firing System, Firing Set, Fireset

The system of components in a **nuclear weapon** that converts (if necessary), stores, and releases electrical or chemical energy to detonate the weapon when commanded by the **fuzing system**.

Fissile Isotope

See **fissile material**.

Fissile Material

Material composed of **atoms** which readily fission when struck by a **neutron** of any energy. U^{233} , U^{235} , and Pu^{239} are examples of fissile materials.

Fissile Material Cutoff Treaty (FMCT)

A Fissile Material Cutoff Treaty would prohibit the production of weapons-usable **fissile material** or any such material not currently subject to the application of **safeguards** by the IAEA. The treaty would also prohibit **States Parties** from assisting other states with **plutonium** separation or with producing **highly enriched uranium** for weapons use. The treaty is not in force and is awaiting negotiation.

Fission (Fissioning)

The splitting of a **nucleus** into at least two other nuclei and the release of a relatively large amount of energy. Two or three **neutrons** are usually released during this type of transformation.

Fissionable Isotope

See **fissionable material**.

Fissionable Material

Commonly used as a synonym for **fissile material**, the meaning of this term has been extended to include material that can be fissioned by **fast neutrons**, such as U^{238} . (See also **special fissionable material**.)

Fission Products

The product nuclei resulting from the **fission** of a heavy **nucleus**, such as U^{235} or Pu^{239} .

Fission Weapon

A nuclear warhead whose material is **uranium** or **plutonium** that is brought to a **critical mass** under pressure from a chemical explosive detonation to create an explosion that produces blast, thermal **radiation**, and **nuclear radiation** through **fission**. The complete fission of one pound of **fissionable material** has a **yield** equivalent to 8000 tons of TNT.

Fission Yield

The amount of energy released by **fission** as distinct from that released by **fusion** in a thermonuclear (fusion) explosion.

Fixed Structure for Mobile Launchers of Intercontinental Ballistic Missiles

As defined by **New START**, a unique structure, within a **basing area**, designed to contain **mobile launchers of intercontinental ballistic missiles**.

“Fizzles”

See **preinitiation**.

Flask

See **cask**.

Formerly Declared Facility

With regard to **New START**, a **facility** at which a **Type Two** inspection may be conducted to confirm that the facility is not being used for purposes inconsistent with the treaty.

Formerly Restricted Data (FRD)

Subset of **restricted data** which concerns the military utilization and deployment of nuclear weapons. Although the name implies otherwise, Formerly Restricted Data is classified information and is also not subject to the automatic declassification provisions of Executive Order 12958.

Front End (of the **nuclear fuel cycle**)

The series of steps in the fuel cycle before fuel is consumed in the **nuclear reactor**, including **uranium** exploration, mining, **milling**, **conversion**, **enrichment**, and fuel element fabrication. (See the nuclear fuel cycle diagrams on pages 116-117.)

Front Section

As defined in *New START*, that portion of the payload of the final stage of an **intercontinental ballistic missile** or **submarine-launched ballistic missile** that contains the **reentry vehicle** or reentry vehicles and may, depending on design, include a reentry vehicle platform, penetration aids, and a shroud.

Fuel Assembly

A cluster of **fuel rods** (or plates). Also called a fuel element. Many fuel assemblies make up a reactor **core**.

Fuel Cycle

See **nuclear fuel cycle**.

Fuel Element

See **nuclear fuel element**.

Fuel Fabrication Plant

See **nuclear fuel fabrication plant**.

Fuel Pellet

A small body of fuel, often cylindrical, designed to be stacked in a can to form a **fuel element**.

Fuel Reprocessing

See **reprocessing**.

Fuel Rod

A long, slender tube that holds **fissionable material** (fuel) for use in a **nuclear reactor**. Fuel rods are assembled into bundles called **fuel elements** or **fuel assemblies**, which are loaded individually into the reactor **core**.

Fusion

The formation of a heavier **nucleus** from two lighter ones (such as hydrogen isotopes), with the attendant release of energy (as in a **hydrogen bomb**).

Fusion Weapon

Two-stage nuclear warhead containing **fusion** materials, such as **deuterium** and **tritium**, that are brought to critical density and temperature conditions by use of a primary **fission** reaction in order to initiate and sustain a rapid fusion process. This

process in turn creates an explosion that produces blast, thermal **radiation**, and **nuclear radiation**. This type of device is commonly known as a **hydrogen bomb** or **thermonuclear weapon**.

Fuzing System

A fuzing system—sometimes in conjunction with other subassemblies—providing the signal to fire in a **nuclear weapon**.

Gamma Ray, Radiation

High-energy electromagnetic radiation emitted by nuclei during nuclear reactions or **radioactive decay**. These rays have high energy and a short wave length. **Shielding** against gamma radiation requires thick layers of dense materials, such as lead. Gamma rays or radiation are potentially lethal to humans, depending on the intensity of the flux.

Gas Centrifuge, Advanced Gas Centrifuge (AGC)

A method of effecting uranium **isotope separation** through the use of the **centrifuge**, employing gaseous **uranium hexafluoride** as the working fluid. A rotating cylinder spins the heavier uranium isotope U^{238} to concentrate at the walls of the container, leaving uranium enriched in U^{235} near the center.

Gaseous Diffusion

A method of isotope **enrichment** based on the fact that gas **atoms** or molecules with different masses will diffuse through a porous barrier (or membrane) at different rates. The method is used to separate U^{235} from U^{238} . It requires large gaseous diffusion plants and significant amounts of electric power.

Graphite

A form of carbon, similar to the lead used in pencils, used as a **moderator** in some **nuclear reactors**.

Gun-Type Nuclear Weapon

A device in which gun propellants are used to move two or more **subcritical** masses of **fissile material** together to produce an explosion.

Half-Life

The amount of time needed for half of the **atoms** of a radioactive material to disintegrate or decay. The **half-life** is a characteristic property of each radioactive species and is independent of its amount or condition. (See also **decay chain**.)

Heavy Bomber

With regard to **New START**, a bomber of a type, any one of which, satisfies either of the following criteria:

- (a) Its range is greater than 8000 kilometers; or
- (b) It is equipped for **long-range nuclear air-launched cruise missiles**.

A bomber shall not be considered to be a **heavy bomber** if it meets neither criterion (a) nor criterion (b) or if otherwise agreed by the **States Parties**.

Heavy Bomber Equipped for Non-Nuclear Armaments

With regard to **New START**, a **heavy bomber** that is not equipped for **long-range nuclear air-launched cruise missiles**, nuclear air-to-surface missiles, or nuclear bombs.

Heavy Bomber Equipped for Nuclear Armaments

With regard to **New START**, a **heavy bomber** equipped for **long-range nuclear air-launched cruise missiles**, nuclear air-to-surface missiles, or nuclear bombs.

Heavy Bomber Flight Test Center

With regard to **New START**, a **facility**, other than a **production facility** for **heavy bombers**, at which **test heavy bombers** are based and their operation is supported.

Heavy Metal

The fuel materials, including **uranium**, **plutonium**, and **thorium**, with **atomic numbers** of 90 and above, used in **nuclear reactors** and **nuclear weapons**.

Heavy Water (D₂O)

Water containing significantly more than the natural proportions (1 in 6,500) of heavy hydrogen (**deuterium**, D) **atoms** to ordinary hydrogen atoms. Heavy water is used as a **moderator** in some **reactors** because it slows down **neutrons** effectively and also has a low probability of absorption of neutrons.

Heavy-Water Reactor (HWR)

A **reactor** that uses **heavy water** as its **moderator** and **natural uranium** as fuel. (See also **CANDU reactor**.)

High Enriched Uranium (HEU)

Uranium enriched to 20% U²³⁵ or more. HEU is considered as **special fissionable material** and as **direct-use material**. (See also **weapons-grade material**.)

High-Level Waste (HLW)

High-level radioactive waste (HLW) means (1) irradiated (spent) reactor fuel; (2) liquid waste resulting from the operation of the first cycle solvent extraction system, and the concentrated wastes from subsequent extraction cycles, in a facility for reprocessing irradiated reactor fuel; and (3) solids into which such liquid wastes have been converted. HLW is primarily in the form of **spent fuel** discharged from commercial **nuclear power reactors**. It also includes some reprocessed HLW from defense activities, and a small quantity of reprocessed commercial HLW. (See also **nuclear waste**.)

Host Team

The group of designated government representatives responsible for accompanying and negotiating with the **IAEA** inspectors.

Hydroacoustic Stations

Used by the **International Monitoring System** (11 worldwide) to detect sound waves from explosions occurring in the ocean as a means of detecting nuclear explosions and verifying compliance with the **Comprehensive Nuclear Test-Ban Treaty**.

Hot Cells

Shielded rooms with remote handling equipment for examining and processing radioactive materials. In particular, hot cells may be used for reprocessing relatively small **batches** of **spent fuel**. The **U.S.-IAEA Additional Protocol**, in Annex I, paragraph (xv) states: "Hot cells means a cell or interconnected cells totaling at least 6 cubic meters (m³) in volume with **shielding** equal to or greater than the equivalent of 0.5 m of concrete, with a density of 3.2g/cm³ or greater, outfitted with equipment for remote operations."

Hydrogen Bomb

See **thermonuclear weapon**.

IAEA

See **International Atomic Energy Agency (IAEA)**.

Identified (or "selected") U.S. Facilities

Facilities on the current list of facilities declared by the United States to the **IAEA** where the IAEA has informed the United States it wishes to apply safeguards in accordance with the terms of U.S.-IAEA **Safeguards** agreements.

Implosion Weapon

A spherical device in which a quantity of **fissionable material**, less than a **critical mass** at ordinary pressure, has its volume suddenly reduced by compression—a step accomplished by using chemical explosives—so that it becomes **supercritical**, producing a nuclear explosion.

Improvised Nuclear Device (IND)

A device incorporating radioactive materials designed to result in the dispersal of radioactive material or in the formation of a nuclear-yield reaction. Such devices may be fabricated in a completely improvised manner or may be an improvised modification to a U.S. or foreign **nuclear weapon**.

Improvised Nuclear Device Incident

An event resulting from a deliberate act, involving **nuclear weapons** or **nuclear materials**, which includes the sabotage, seizure, theft, or loss of a nuclear weapon or radiological nuclear weapon component or the fabrication and employment of an **improvised nuclear device** (IND) or a credible threat of either.

In-Country Escort

As defined in **New START**, a group of individuals designated by the **inspected State Party** to accompany and assist **inspectors** and **aircrew members** throughout the **in-country period**.

In-Country Period

As defined by **New START**, the period of time from the arrival of the **inspection team** or **aircrew members** at the **point of entry** until their departure from the country through the point of entry.

Infrasound Stations

Used by the **International Monitoring System** (60 worldwide) to detect ultra-low frequency sound waves (inaudible to the human ear) on the Earth's surface emitted by large explosions as a means of detecting a nuclear explosion and verifying compliance with the **Comprehensive Nuclear Test-Ban Treaty**.

Inspection Activities

With regard to **New START**, inspections and **exhibitions** conducted to verify treaty compliance. (See also **Type One Inspections** and **Type Two inspections**.)

Inspection Site

With regard to **New START**, a location at which **Type One** or **Type Two** inspections may be conducted.

Inspection Team

The group of inspectors assigned by an inspecting **State Party** or treaty implementation organization to conduct particular **inspection activities**.

Inspector

With regard to **New START**, an individual specified by one of the States Parties to conduct **inspection activities** and included on that Party's list of inspectors.

Intercontinental Ballistic Missile (ICBM)

As defined in **New START**, a land-based ballistic missile with a range in excess of 5,500 kilometers.

Intercontinental Ballistic Missile (ICBM) Base:

As defined by **New START**:

- (a) For **mobile launchers of intercontinental ballistic missiles**, an area in which one or more **basing areas** and one associated **maintenance facility** are located;
- (b) For **silo launchers of intercontinental ballistic missiles**, an area in which one or more groups of silo launchers of intercontinental ballistic missiles and one associated maintenance facility are located.

Intercontinental Ballistic Missile (ICBM) Launcher

With regard to **New START**, a device intended or used to contain, prepare for launch, and launch an **intercontinental ballistic missile**.

Intercontinental Ballistic Missile (ICBM) Loading Facility

With regard to **New START**, a **facility**, outside an **intercontinental ballistic missile (ICBM) base** and outside a **test range**, where ICBMs for **mobile launchers of intercontinental ballistic missiles** are loaded onto or unloaded from mobile launchers of ICBMs.

Intermediate-Range Nuclear Forces (INF) Treaty

Treaty originally signed by the United States and the Soviet Union December 8, 1987; entered into force June 1, 1988. Required destruction of the Parties' ground-launched ballistic and cruise missiles with ranges between 500 and 5,500 kilometers, their launchers, associated support structures, and associated support equipment within 3

years after the treaty entered into force. All treaty-limited items were eliminated as of May 1991. Following the dissolution of the Soviet Union, the United States considers the successor states (less the Baltic republics) INF treaty successors. Inspections under the INF treaty ceased on June 1, 2001; however, the treaty is of unlimited duration.

International Atomic Energy Agency (IAEA)

An agency affiliated with the United Nations established in 1957. World's central intergovernmental forum for scientific and technical cooperation in the nuclear field. Also, the international inspectorate for the application of **safeguards** and **verification** measures covering civilian nuclear programs.

International Atomic Energy Agency (IAEA) Information Circular (INFCIRC)

Primary means whereby the **IAEA** publishes documents, including agreement texts.

International Data Centre (IDC)

International center which receives, collects, processes, analyzes, reports on, and archives data from the **International Monitoring System** established by the **Comprehensive Nuclear Test-Ban Treaty Organization**, including the results of analysis conducted at certified laboratories on possible nuclear test activities.

International Monitoring System (IMS)

International network of data-collection stations established by the Preparatory Committee for the **Comprehensive Nuclear Test-Ban Treaty Organization (CTBTO)** to verify compliance with the **Comprehensive Nuclear Test-Ban Treaty**. When complete, the IMS will consist of 337 facilities worldwide: 50 primary and 120 auxiliary **seismic stations**; 11 **hydroacoustic stations**; 60 **infrasound stations**; and 80 **radionuclide stations** supported by 16 radionuclide laboratories. These facilities monitor the planet to detect signs of a nuclear explosion. The data collected by the IMS is transmitted to the **International Data Centre** and is available to all CTBTO Member States. As of December 2012, more than 90 percent of the IMS stations were complete and operational.

Inventory Change

Under the **U.S.-IAEA Safeguards Agreement**, an increase or decrease, in terms of **batches**, of **nuclear material** in a **material balance area**.

Ion

An **atom** or molecule in which the number of **electrons** does not equal the number of **protons**. A negative ion, or anion, has one or more excess electrons. A positive ion, or cation, lacks one or more electrons.

Ion Exchange

Chemical methods of recovering products or removing impurities from solutions involving the exchange of **ions** between the solution and an insoluble resin. This process is used in uranium **milling** to recover **uranium** from acid leach liquors and in fuel processing for final production decontamination and the separation of certain fission products from **high-level waste**. Ion exchange is preferable to solvent extraction to acquire small quantities or low concentrations of enriched fuels.

Ionization

Any process by which an **atom**, molecule, or ion gains or loses **electrons**.

Ionizing Radiation

Any **radiation** which causes displacement of **electrons** from **atoms** or molecules, thereby producing **ions**.

Irradiation

Exposure to **neutrons** in a **nuclear reactor**, or more generally, exposure to any source of **radiation**.

Isotopes

Atoms of the same chemical element whose nuclei contain different numbers of **neutrons** and hence have different masses, even though chemically identical. Isotopes are specified by their **atomic mass** number, that is, the total number of **protons** plus neutrons, and a symbol denoting the chemical element, e.g., U^{235} for **uranium-235**. (See also **stable isotope** and **unstable isotope**.)

Isotope Separation

A process in which a mixture of isotopes of an element is separated into its component **isotopes** or in which the abundance of isotopes in such a mixture is changed. Several types of isotope separation are currently in use or in development. (See also **Atomic Vapor Laser Isotope Separation (AVLIS)**; **Electromagnetic Isotope Separation (EMIS)**; **Jet-nozzle separation method**; **Laser Isotope Separation (LIS)**; **Molecular Laser Isotope Separation (MLIS)**; **Plasma Separation Process (PSP)**; and **Plutonium Uranium Extraction (PUREX)**).

Item of Inspection (IOI)

Particular equipment designated for inspection under **New START**. The type of inspection and **inspection site** determines which equipment may be an item of inspection.

Jet-Nozzle Separation Method, Aerodynamic Enrichment Method

A process of uranium **enrichment** that uses a gas (**uranium hexafluoride**) flowing at high speed through a nozzle along curved walls. A knife-edge separates the heavy fraction from the light fraction in the gas.

keV

A kiloelectronvolt, 1000 electronvolts.

Key Measurement Point

Per the **U.S.-IAEA Safeguards Agreement**, Article 90, paragraph K, “a location where **nuclear material** appears in such a form that it may be measured to determine material flow or inventory. Key measurement points thus include, but are not limited to, the inputs and outputs (including measured discards) and storages in **material balance areas**.”

Kiloton (kt)

The energy of a nuclear explosion that is equivalent to the explosion of 1000 tons of trinitrotoluene (TNT) high explosive.

Laser Isotope Separation (LIS)

Metallic **uranium** vapor is subjected to laser beams which selectively excite only U^{235} **atoms**, enabling the excited atoms to be charged in the vapor phase and collected as solid metal.

Launch

As defined by **New START**, the initial motion and subsequent flight of an **intercontinental ballistic missile** or **submarine-launched ballistic missile**.

Launch Canister (LC)

A container, as defined by **New START**, directly associated with an **intercontinental ballistic missile (ICBM)** or **submarine-launched ballistic missile (SLBM)**, that can be or has been used for transporting and storing an assembled ICBM or SLBM, with or without its **front section**, and from which an ICBM or SLBM can be or has been launched.

Launcher of Missile Defense Interceptors

A device, as defined by **New START**, intended or used to contain, prepare for **launch**, and launch missile defense interceptors.

Lead Agency

Under the U.S.-IAEA **Safeguards** agreements, the executive department or agency having jurisdiction over locations with declarable activities and/or national security equities, as well as those having responsibility for providing information and declarations to the IAEA and for providing **complementary access** during **on-site inspections**. U.S. lead agencies for implementing safeguards agreements with the IAEA are the: Department of Energy, Department of Defense, Department of Commerce, and the **Nuclear Regulatory Commission**.

Light Water

Ordinary water (H_2O) as distinguished from **heavy water** (D_2O).

Light Water Reactor (LWR)

A term used to describe **reactors** using ordinary water as **coolant**, including **boiling water reactors** (BWRs) and **pressurized water reactors** (PWRs), the most common types used in the United States.

Limited Test Ban Treaty (LTBT)

Treaty signed by the United States, the Soviet Union, and the United Kingdom on August 5, 1963; entered into force on October 10, 1963. Bans nuclear testing above ground, under water, and in outer space.

Listed (or “eligible”) U.S. facilities

Under U.S.-IAEA **Safeguards** agreements, the United States provides the IAEA with a list of U.S. facilities eligible for the application of safeguards by the IAEA. A **facility** is subject to IAEA Safeguards when selected from this list.

Lithium (Li)

Lithium is a silvery white metal often used in the manufacture of alloys and fuels for aircraft and missiles. Li^6 (lithium-6) is produced as a radioactive **isotope** that is usually compounded with **deuterium** as a thermonuclear fuel constituent.

Location Outside Facilities

The **U.S.-IAEA Additional Protocol**, in Article 18, paragraph J, states: “Any installation or location, which is not a facility, where nuclear material is customarily used in amounts of one **effective kilogram** or less.”

Location-Specific Environmental Sampling

The [U.S.-IAEA Additional Protocol](#), in Article 18, paragraph F, states: “The collection of environmental samples (e.g., air, water, vegetation, soil, smears) at, and in the immediate vicinity of, a location specified by the Agency [the [IAEA](#)] for the purpose of assisting the Agency to draw conclusions about the absence of undeclared [nuclear material](#) or nuclear activities at the specified location.”

Long-Range Air-Launched Cruise Missile (ALCM)

As defined in [New START](#), an [air-launched cruise missile](#) with a range in excess of 600 kilometers.

Long-Range Nuclear Air-Launched Cruise Missile (LRNA)

As defined in [New START](#), an [air-launched cruise missile](#) that is nuclear-armed.

Low Enriched Uranium (LEU)

Uranium enriched to less than 20% U^{235} .

Low-Level Waste (LLW)

A general term for a wide range of radioactive wastes that includes materials such as laboratory wastes and protective clothing that contain only small amounts of radioactivity, pose few health hazards, and are usually disposed of by shallow land burial. (See also [nuclear waste](#).)

Maintenance Facility

With regard to [New START](#), a facility that is part of an [intercontinental ballistic missile \(ICBM\)](#) base and at which ICBMs and ICBM launchers are maintained and their operation is supported.

Managed Access

Procedures to avoid the inadvertent disclosure of national security, proprietary, or proliferation-sensitive business information, or safety requirements while facilitating [IAEA](#) access to activities, locations, or information relevant to demonstrating U.S. compliance with [Safeguards](#). As provided by Article 7 of [U.S.-IAEA Additional Protocol \(AP\)](#), and in the [Subsidiary Arrangement](#) in the AP, the types of managed access the United States intends to employ include: removing sensitive papers from offices; shrouding sensitive equipment, displays, and stores; logging off computer systems and turning off data indicating devices; restricting safeguards equipment or environmental sampling to the purposes of access; restricting access to sensitive

areas only during specified times; pre-planning the manner in which inspectors are escorted onto a site and from area-to-area, building-to-building, and room-to-room; limiting inspector access to personnel by dismissing non-essential personnel; and giving only individual inspectors access to certain parts of an inspection location (in exceptional circumstances). This list is not exhaustive, and other measures consistent with [Lead Agency](#) guidance may also be appropriate.

Maraging Steel

An important component in the design of [gas centrifuge](#) rotors. It allows for very high rotor wall speed necessary to separate U^{238} from U^{235} . This type of steel is the most popular rotor material for proliferant countries to use in building [isotope separation](#) facilities.

Material Accounting

See [nuclear material accounting](#).

Material Balance Area

Per the [U.S.-IAEA Safeguards Agreement](#), Article 90, paragraph M, “an area in or outside a [facility](#) such that: a) the quantity of [nuclear material](#) in each transfer into or out of each material balance area can be determined; and b) the [physical inventory](#) of nuclear material in each material balance area can be determined when necessary in accordance with specified procedures, in order that the material balance for Agency [IAEA] safeguards purposes can be established.”

Material Unaccounted For (MUF)

The small amounts of radioactive materials lost or imbedded in equipment during normal operating procedures at a [nuclear reactor](#). This gain or loss can be as a result of measurement uncertainty, measurement bias, human blunders, unknown or unmeasured flow streams, or unmeasured holdup (such as residue in pipes), or diversion. MUF can also be referred to as inventory difference, or the quantity obtained by subtracting ending inventory and removals from beginning inventory and additions to the inventory. The [U.S.-IAEA Safeguards Agreement](#), in Article 90, paragraph N, defines MUF as: “The difference between [book inventory](#) and [physical inventory](#).”

Megaton (MT)

In the context of [nuclear weapons](#), an explosive force equal to that of one million tons of TNT.

Megawatt (MW)

One million watts.

MeV

A Megaelectronvolt, 1 million [electronvolts](#).

meV

A millielectronvolt, 1/1000 of an [electronvolt](#).

Milling

A process by which ore containing only a very small percentage of [uranium](#) is converted into material containing a high percentage (80%) of U_3O_8 , referred to as [yellowcake](#). (See also [uranium mine and ore processing plant](#).)

Missile Technology Control Regime (MTCR)

A joint effort of 23 member countries led by the United States to control the proliferation of missiles (and missile technology) capable of delivering [nuclear weapons](#), including unmanned missiles, rockets, and cruise missiles, with at least a 500-kilogram payload and a range of at least 300 kilometers.

Mixed Oxide (MOX)

A reactor fuel consisting of a mixture of the oxides of [uranium](#) and [plutonium](#). MOX is used for recycling of reprocessed spent fuel (after the separation of waste) into thermal nuclear reactors (thermal recycling) and as a fuel for fast reactors. MOX is considered as [special fissionable material](#) and as [direct-use material](#).

Mobile Launcher of Intercontinental Ballistic Missiles

As defined by [New START](#), an erector-launcher mechanism for launching [intercontinental ballistic missiles](#) and the self-propelled device on which it is mounted.

Model Additional Protocol (INFCIRC/540)

The model Additional Protocol is designed for States having a [Safeguards Agreement](#) with the [IAEA](#), in order to strengthen the effectiveness and improve the efficiency of the safeguards system as a contribution to global nuclear nonproliferation objectives. (See [U.S.-IAEA Additional Protocol](#)).

Model Safeguards Agreement (INFCIRC/153)

The model **Safeguards** Agreement is intended to allow the **IAEA** to monitor a country's declared nuclear activities to ensure **nuclear materials** are not being diverted for the development of **nuclear weapons** or other nuclear explosive devices. (See **U.S.-IAEA Safeguards Agreement**.)

Moderator

A material used in a **reactor** to slow down **neutrons** from the energies at which they are released to some lower energy. Neutrons lose energy as a result of scattering collisions with nuclei of the moderator. Hydrogen (in water or organic compounds), **deuterium** (in **heavy water**), beryllium, and **graphite** have uses as moderators.

Molecular Laser Isotope Separation (MLIS)

A separation process similar to **Atomic Vapor Laser Isotope Separation** except that U^{235} hexafluoride molecules, rather than **atoms** of **uranium**, are excited in a vapor to trigger the separation.

Monazite

The principal form of **thorium** ore. Monazite sands are exploited in Australia, India, and Brazil.

Monitoring

The use of sampling and detection equipment to determine the levels of **radiation** or other toxic materials in land, air, or water.

MOX

See **mixed oxide**.

MUF

See **material unaccounted for (MUF)**.

Mutual Reciprocal Inspection (MRI)

Confidence- and security-building measures established between the United States and Russia to host mutual reciprocal inspections at facilities containing **plutonium** or **high enriched uranium** removed from dismantled **nuclear weapons**. Designed to lead to and ensure "the **transparency** and irreversibility of the nuclear arms reduction process" between both parties.

National Security Exclusion

The **U.S.-IAEA Safeguards Agreement**, in Article 1(a), states: “The United States undertakes to permit the Agency [the IAEA] to apply safeguards, in accordance with the terms of this Agreement, on all **source** or **special fissionable material** in all **facilities** in the United States, excluding only those facilities associated with activities with direct national security significance to the United States, with a view to enabling the Agency to verify that such material is not withdrawn, except as provided for in this Agreement, from activities in facilities while such material is being safeguarded under this Agreement.” The U.S.-IAEA Additional Protocol, in Article 1(b), states: “The United States shall apply, and permit the Agency to apply, this Protocol, excluding only instances where its application would result in access by the Agency to activities with direct national security significance to the United States or to locations or information associated with such activities.”

National Security Information (NSI)

Any information that has been determined pursuant to Executive Order 12356 or any predecessor order to require protection against unauthorized disclosure and is so designated. The classifications TOP SECRET, SECRET, and CONFIDENTIAL are used to designate such information.

National Technical Means (NTM)

Large assets such as observation satellites and phased-array radars a country may use to verify compliance with an arms control treaty or agreement. With regard to **New START**, the Parties have a right to use NTM in a manner consistent with generally recognized principles of international law and are obliged not to use concealment measures or to otherwise interfere with the other Party’s use of NTM as a means of verifying treaty compliance.

Natural Uranium

Uranium as it naturally occurs in nature; having an **atomic weight** of approximately 238 and containing minute quantities of U^{234} , 0.7% U^{235} , and 99.3% U^{238} . Uranium is usually supplied in raw form by uranium mines and ore processing plants as **yellowcake**.

Neutrino

A massless subatomic particle with no electric charge that is produced in the **beta decay** process.

Neutron

An uncharged elementary particle with a mass slightly greater than that of the **proton**, and found in the **nucleus** of every **atom** heavier than hydrogen.

Neutron Generator

A source of **neutrons** that uses an electromagnetic linear accelerator rather than **fission**. The accelerator typically accelerates deuterons (i.e., nuclei of Deuterium atoms) into a **tritium** target. Miniature neutron generators are also used in contemporary **nuclear weapons** to furnish neutrons at a precise instant to begin fission reactions in fissile **cores**.

Neutron Initiator

A special component that is used to start neutron fission **chain reactions** in **nuclear weapons**. This can be a radioactive initiator which produces neutrons by a nuclear reaction from mixing an alpha emitter with a light element such as beryllium. A neutron initiator can also be in the form of a particle accelerator which produces a burst of neutrons by the electrical acceleration of **ions**.

New START

See [New Strategic Arms Reduction Treaty](#).

New Strategic Arms Reduction Treaty (New START or NST)

The Treaty Between the United States of America and the Russian Federation on Measures for The Further Reduction and Limitation of Strategic Offensive Arms was signed on April 8, 2010 and entered into force on February 5, 2011. Within seven years after entry into force, each Party is obliged to reduce the number of their deployed and non-deployed **strategic offensive arms (SOA)** to: no more than 1,550 deployed **warheads**; 800 deployed and non-deployed **intercontinental ballistic missile (ICBM) launchers**, **submarine-launched ballistic missile (SLBM) launchers**, and **heavy bombers**; and to have reduced their **deployed intercontinental ballistic missiles**, **deployed submarine-launched ballistic missiles**, and **deployed heavy bombers** to no more than 700.

To verify compliance, the treaty establishes an extensive regime providing for **on-site inspections** (**Type One inspections**, **Type Two inspections**, and **exhibitions**), notifications, data exchanges, exchanges of **telemetric information**, and the use of **national technical means**.

New Type

As defined by **New START**, for an **intercontinental ballistic missile (ICBM)** or **submarine-launched ballistic missile (SLBM)**, a type of ICBM or a type of SLBM, the technical characteristics of which differ from the technical characteristics of an ICBM or SLBM, respectively, of each type declared previously in at least one of the following respects):

- (a) Number of **stages**.
- (b) Type of propellant of any stage.
- (c) Either the length of the assembled missile without **front section** or the length of the first stage, by more than three percent.
- (d) Diameter of the first stage, by more than three percent.

Non-Deployed Heavy Bomber

As defined by **New START**, a **test heavy bomber** or a **heavy bomber** equipped for nuclear armaments located at a **repair facility** or at a **production facility**.

Non-Deployed Intercontinental Ballistic Missile

As defined by **New START**, an **intercontinental ballistic missile (ICBM)** not contained in a **deployed launcher of ICBMs** or on a deployed launcher of ICBMs.

Non-Deployed Launcher of Intercontinental Ballistic Missiles

As defined by **New START**, an **intercontinental ballistic missile (ICBM) test launcher**, an ICBM **training launcher**, an **intercontinental ballistic missile launcher** located at a **space launch facility**, or an ICBM launcher, other than a **soft-site launcher**, that does not contain a deployed ICBM.

Non-Deployed Launcher of Submarine-Launched Ballistic Missiles

As defined by **New START**, a **submarine-launched ballistic missile (SLBM) launcher**, other than a **soft-site launcher**, that is intended for testing or training, or an SLBM launcher that does not contain a **deployed submarine-launched ballistic missile**.

Non-Deployed Mobile Launcher of Intercontinental Ballistic Missiles

As defined by **New START**, a **mobile launcher of intercontinental ballistic missiles** that does not contain an **intercontinental ballistic missile (ICBM)**, or a mobile **test launcher** of ICBMs, or a mobile launcher of ICBMs located at a **space launch facility**, unless otherwise agreed by the States Parties.

Non-Deployed Submarine-Launched Ballistic Missile

As defined by **New START**, a submarine-launched ballistic missile (SLBM) not contained in a **deployed launcher of submarine-launched ballistic missiles**.

Non-Nuclear Weapon State(s) (NNWS)

All States Parties to the **Nuclear Nonproliferation Treaty (NPT)** except for the five states (China, France, Russia, United Kingdom, and United States) recognized by the NPT as **nuclear weapon states (NWS)**. NNWS are obliged not to acquire or produce **nuclear weapons** or nuclear explosive devices, but may develop nuclear technologies for peaceful purposes. All States Parties to the NPT (NWS and NNWS) are obliged not to transfer nuclear weapons, other nuclear explosive devices, or their technologies to any NNWS.

NPT

See **Nuclear Nonproliferation Treaty (NPT)**.

Nonpower Reactor

Reactors that are not connected to electrical generators and may be used for research, training, or testing purposes, or for the production of **radioisotopes** for medical and industrial uses.

Nuclear Applications

The use of **nuclear reactors** to generate power for electricity or heat; to power surface ships, submarines, merchant ships, aircraft, and rockets; to produce **plutonium, tritium**, and various **isotopes** for weapons programs; or for medical, academic, and scientific research.

Nuclear Armaments

As defined by **New START**, nuclear armaments refer to those for **heavy bombers, long-range nuclear air-launched cruise missiles**, nuclear air-to-surface missiles, or nuclear bombs.

Nuclear Energy

The energy liberated by a nuclear reaction (**fission** or **fusion**) or by spontaneous **radioactivity**.

Nuclear Fuel

Fissionable material used or usable to produce energy in a **reactor**. It includes both fissile and fertile materials. Commonly used nuclear fuels are natural and **low-enriched uranium**; **high-enriched uranium** and **plutonium**.

Nuclear Fuel Cycle

The sequence of operations for nuclear power generation, consisting of fuel manufacture, its **irradiation** in a **nuclear reactor**, handling, and storing the **spent fuel** elements following discharge from the reactor. In the “once-through” cycle, the spent fuel is sent to a long-term repository; alternatively, in a “closed” cycle, spent fuel is **reprocessed** to separate **plutonium**, which is “recycled” with **uranium** in the form of “**mixed oxide**” fuel. (See the nuclear fuel cycle diagrams on pages 116-117.)

Nuclear Fuel Cycle-Related Research and Development Activities

As defined in the **U.S.-IAEA Additional Protocol**, in Article 18, paragraph A: “Those activities which are specifically related to any process or system development aspect of any of the following: **conversion of nuclear material**; enrichment of nuclear material; nuclear fuel fabrication; **reactors**; **critical facilities**; **reprocessing of nuclear fuel**; or processing (not including repackaging or conditioning not involving the separation of elements, for storage or disposal) of **intermediate** or **high-level waste** containing **plutonium**, **high enriched uranium** or U^{233} ; but do not include activities related to theoretical or basic scientific research or to research and development on industrial radioisotope applications, medical, hydrological and agricultural applications, health and environmental effects, and improved maintenance.”

Nuclear Fuel Element

A rod, tube, plate, or other mechanical shape or form into which **nuclear fuel** is fabricated for use in a **reactor**.

Nuclear Fuel Fabrication Plant

A **facility** where **nuclear material** (e.g., enriched or **natural uranium** and possibly **plutonium**) is fabricated into **fuel elements** to be inserted into a **reactor**.

Nuclear Material

The **U.S.-IAEA Safeguards Agreement**, in Article 90, paragraph O, states: “Any **source** or **special fissionable material** as defined in Article XX of the Statute [of the **IAEA**]. The term nuclear material shall not be interpreted as applying to ore or ore residue. Any determination by the Board [of Governors] under Article XX of the Statute after entry

into force of this Agreement which adds to the materials considered to be source material or special fissionable material shall have affect under this Agreement only upon acceptance by the United States.”

Nuclear Material Accounting

The activities carried out to establish the quantities of **nuclear material** present within defined areas and the changes in those quantities within defined periods. Essential elements of nuclear material accounting are the establishment of accounting areas (i.e., **material balance areas**), material measurements, record keeping, preparation and submission of accounting reports, and verification and analysis of these accounting data to determine correctness and the accuracy of **material unaccounted for** (MUF), and to evaluate causes of MUF. (NOTE: Nuclear material accounting does not include procedures for physical protection of nuclear material or activities.)

Nuclear Material Subject to (IAEA) Safeguards (in the United States)

The **U.S.-IAEA Safeguards Agreement**, in Article 3(b), states: “The **source** or **special fissionable material** subject to **safeguards** under this Agreement shall be that material in those facilities which have been identified by the Agency at any given time.” (See also **identified U.S. facilities**.)

Nuclear Nonproliferation Treaty (NPT)

A multilateral treaty designed to prevent the spread of **nuclear weapons** to **non-nuclear weapon states**. The treaty opened for signature on July 1, 1968 and entered into force on March 5, 1970. In May 1995 the States Parties agreed to extend the life-span of the treaty to remain in force indefinitely and unconditionally.

Nuclear Power Plant

Any device or assembly that converts **nuclear energy** into useful power. In a nuclear electricity generating plant, heat produced by a **reactor** is used to produce steam to drive a turbine that in turn drives a generator.

Nuclear Proliferation

The spread of **nuclear weapons**-related components or technology to countries that are not currently nuclear capable.

Nuclear Radiation

Particle and electromagnetic **radiation** emitted from atomic nuclei in various nuclear processes. The important **radiation**, from a **nuclear weapons** effects standpoint, are **alpha** and **beta particles**, **gamma rays**, and **neutrons**. (See **electromagnetic pulse**.)

Nuclear Reactor

A device in which nuclear **fission** may be sustained and controlled in a self-supporting nuclear reaction. The varieties are many, but all incorporate certain features, including **fissionable material** or fuel, a moderating material (unless the reactor is operated on **fast neutrons**), a **reflector** to conserve escaping **neutrons**, provisions of removal of heat, measuring and controlling instruments, and protective devices. The reactor is the heart of a **nuclear power plant**.

Nuclear Regulatory Commission (NRC)

An independent federal agency responsible for the licensing and regulation of commercial users of **nuclear materials** in the United States.

Nuclear Risk Reduction Center (NRRC)

A special communications office, one of which was established by the United States in the Department of State in Washington, DC, and one was established by the Soviet Union in the Ministry of Defense in Moscow, under a September 15, 1987 agreement aimed at facilitating bilateral communications in order to reduce the risk of nuclear war occurring as the result of a misinterpretation, miscalculation, or accident. The two NRRC offices became operational on April 1, 1988 and continue to provide a direct, reliable, high-speed channel for communications between the United States and Russia. Over time the NRRC offices also became responsible for communications with other arms control treaty partners and with arms control treaty-implementation organizations. NRRC communications regularly include notifications of **on-site inspections** or overflights, as well as the data and other information exchanged under a wide range of arms control treaties, agreements, and confidence-building measures.

Nuclear Suppliers Group (NSG)

A voluntary effort by 46 nuclear supplier states, including China, Russia, and the United States, to maintain nuclear guidelines and a trigger list for controlling exports of **nuclear material** and nuclear-related equipment and technologies to **non-nuclear weapon states**. The aim is to ensure these exports are used for civilian purposes protected by **IAEA safeguards** and are not used for the development of **nuclear weapons**.

Nuclear Treaty Manager

Designated by the U.S. Under Secretary of Defense for Acquisition, Technology and Logistics USD(AT&L) to oversee implementation and compliance for each existing and prospective arms control agreement covered in DoDI 2060 (including the U.S.-IAEA AP).

Nuclear Waste

The radioactive byproducts formed by **fission** and other nuclear processes in a **reactor**. Most nuclear waste is initially contained in spent fuel. If this material is reprocessed, new categories of waste result. (See also **high-level waste** and **low-level waste**.)

Nuclear Weapon(s)

A collective term for both **fission** and **fusion** weapons. (See also **atomic weapon**, **gun-type nuclear weapon**, and **implosion weapon**.)

Nuclear Weapon Deficiency

A situation or condition that degrades, or could degrade, nuclear safety but is not serious enough to be a nuclear weapon accident or **nuclear weapon incident**. (See **DULL SWORD**.)

Nuclear Weapon Incident

An unexpected event involving a **nuclear weapon**, **facility**, or component resulting in any of the following, but not constituting a nuclear weapon(s) accident: a) an increase in the possibility of explosion or radioactive contamination; b) errors committed in the assembly, testing, loading, or transportation of equipment, and/or the malfunctioning of equipment and material, which could lead to an unintentional operation of all or part of the weapon arming and/or firing sequence, or which could lead to a substantial change in **yield**, or increased dud probability; and c) any act of God, unfavorable environment, or condition resulting in damage to a weapon, **facility**, or component.

Nuclear Weapon State(s) (NWS)

As defined by the **Nuclear Nonproliferation Treaty (NPT)** in Article IX, paragraph 3, "... a nuclear-weapon state is one which has manufactured and exploded a **nuclear weapon** or nuclear explosive device prior to 1 January 1967." Five states meet this definition: China, France, Russia, United Kingdom, and United States. Other States Parties to the NPT are **non-nuclear weapon states (NNWS)**.

Nucleus

The small, central, positively charged region of an atom that carries the atom's nuclei. Except for the nucleus of ordinary (light) hydrogen, which has a single **proton**, all atomic nuclei contain both protons and **neutrons**. The number of protons determines the total positive charge, or **atomic number**. This is the same for all the atomic nuclei of a given chemical element. The total number of neutrons and protons is called the mass number.

Objective of IAEA Safeguards in the United States

The [U.S.-IAEA Safeguards Agreement](#), in Article 28, states: “The objective of the safeguards procedures set forth in the Agreement is the timely detection of withdrawal, other than in accordance with the terms of this Agreement, of **significant quantities of nuclear material** from activities in facilities while such material is being safeguarded...” Article 29 of the Agreement further states: “For the purposes of achieving...[that] objective... , material **accountancy** shall be used as a safeguards measure of fundamental importance, with **containment** and **surveillance** as important complementary measures.”

Open Skies Airplane

As defined by [New START](#), an airplane performing an observation flight in accordance with the [Open Skies Treaty](#) that is simultaneously used for transporting an **inspection team** to or from a **point of entry** on the territory of the **inspected State Party**.

Oralloy, Oak Ridge Alloy

A highly enriched uranium metal, typically 93.5% U^{235} , oralloy is used in U.S. **nuclear weapons**. (See also [tuballoy](#).)

Parent

A **radionuclide** that upon **radioactive decay** or disintegration yields a specific nuclide (the **daughter**).

Peaceful Nuclear Explosions (PNE)

The use of nuclear explosions for civil engineering or construction projects. There is no practical difference between a PNE and the explosion of a **nuclear weapon**.

Peaceful Nuclear Explosions Treaty (PNET)

Treaty signed by the United States and the Soviet Union on May 28, 1976, which entered into force on December 11, 1990. The PNET established a ceiling of 150 **kilotons** on peaceful nuclear explosions, equal to that established in the [Threshold Test-Ban Treaty](#), and provides for verification by **national technical means**, information exchange, and access to the test site.

Pellet

See [fuel pellet](#).

Permissive Action Link (PAL)

A device included in or attached to a **nuclear weapon** system to preclude arming and/or launching until the insertion of a prescribed discrete code or combination.

Period of Inspection Activities

For an **on-site inspection** or **exhibition**, the period of time from the completion of pre-inspection procedures until the commencement of post-inspection procedures.

Photon

Used to describe electromagnetic radiation such as x-rays or **gamma rays** as particles rather than as waves, i.e., gamma-ray photons. Photons have no mass and travel at the speed of light.

Physical Inventory

Per the **U.S.-IAEA Safeguards Agreement**, Article 90, paragraph P, “the sum of all the measured or derived estimates of batch quantities of **nuclear material** on hand at a given time within a **material balance area**, obtained in accordance with specified procedures.”

Physical Protection (material safeguards)

Physical controls employed to prevent the theft or diversion of **nuclear material**, or sabotage. It may include such elements as guards, fences, and vaults but not material accounting. (See also **safeguards, domestic**.)

Pit

The components of a nuclear warhead located within the inner boundary of the high explosive assembly, but not including **safing** materials.

Plasma Separation Process (PSP)

This **isotope separation** process is similar to **gas centrifuge** separation except that it uses a plasma instead of a gas.

Plutonium

A radioactive element which occurs only in trace amounts in nature, with **atomic number** 94 and symbol Pu. As produced by irradiating uranium fuels, plutonium contains varying percentages of the isotopes 238, 239, 240, 241, and 242. Plutonium is considered as **special fissionable material** and as **direct-use material**.

Plutonium-239 (Pu²³⁹)

A **fissile isotope** produced by neutron capture in U²³⁸; it is used in the **core** of **nuclear weapons** and can be used for reactor fuel.

Plutonium-240 (Pu²⁴⁰)

A **fissile isotope** whose presence complicates the construction of nuclear explosives because of its high rate of spontaneous **fission**, which, in significant concentration, results in unpredictability of the **yield**. It is produced in reactors when a Pu²³⁹ **atom** absorbs a **neutron** instead of fissioning.

Plutonium Production Reactor Agreement (PPRA)

An agreement that entered into force on September 23, 1997 and prohibits the resumption of operations at specific U.S. and Russian **plutonium** production reactors that have been shut down.

Plutonium, Reactor-Grade

Plutonium which has a high Pu²⁴⁰ content, generally in the range of 15-25%. It could be used to make explosives, but with either a lower **yield** or uncertainty of yield, compared to **weapons-grade plutonium** with a comparatively low content of Pu²⁴⁰.

Plutonium Recycle

A fuel cycle in which **plutonium** produced in a **reactor** is separated from **spent fuel** and introduced into fresh reactor fuel for reuse. (See the nuclear fuel cycle diagrams on pages 116-117.)

Plutonium Uranium Extraction (PUREX)

One of the solvent extraction processes that may be employed in processing irradiated **nuclear reactor** fuel for the separation of **uranium** and **plutonium** from **fission** products.

Plutonium, Weapons-Grade

The **plutonium** presently used in weapons applications, commonly considered to contain not more than 6.5% Pu²⁴⁰.

Pool Reactor

A **reactor** in which the **fuel elements** are suspended in a pool of water that serves as the **reflector**, **moderator**, and **coolant**. Popularly called a “swimming pool reactor,” it is used for research and training, not for electrical generation.

Positron

The positively charged form of the **electron** or **beta particle**. Certain radionuclides such as C^{13} and N^{13} (carbon-13 and nitrogen-13) decay by positron emission. The attraction between an **electron** and a positron results in an annihilation reaction that destroys both particles, yielding a gamma-ray **photon** with an energy of 0.512 MeV.

Power Reactor

A **reactor** designed to produce heat or electricity, as distinguished from reactors used primarily for research or for producing radiation or materials for explosives.

Preinitiation, “Fizzle”

The initiation of the fission **chain reaction** in the **fissile material** of a **nuclear weapon** at any time before the designed or the maximum compression or degree of assembly is attained.

Pre-Inspection Restrictions (PIR)

Under **New START**, restrictions placed on the inspected Party to ensure that the status and location of **strategic offensive arms** present at the **inspection site** does not change from the time the site is designated until the **inspection team** arrives at the site and pre-inspection procedures are completed or, in some cases, the inspection team arrives at the item designated for inspection. (See also **Item of Inspection**.)

Pressure Vessel

A strong-walled container housing the **core** of most types of **power reactors**. It usually also contains the **moderator**, neutron **reflector**, thermal shield, and **control rods**.

Pressurized-Water Reactor (PWR)

A **light water power reactor** in which the heat is transferred from the **core** to a heat exchanger (steam generator) by water kept under high pressure to achieve high temperature without boiling. The steam generator, in turn, drives the turbine which produces electricity. The PWR is the most widely used **reactor** in nuclear power programs around the world.

Primary Stage

The **fission** trigger or first stage of a multistage **thermonuclear weapon** or device.

Produce

As defined by **New START**, the term means to build, construct, or manufacture in any quantity, and includes serial production as well as one-of-a-kind manufacturing.

Production Facility:

As defined by **New START**:

- (a) For **intercontinental ballistic missiles (ICBMs)** or **submarine-launched ballistic missiles (SLBMs)** concerned with **New START**, a **facility** at which:
 - (i) ICBMs or SLBMs that are maintained, stored, and transported as assembled missiles in their launch canisters, are assembled, including the joining of all **stages** of such missiles and the loading of such missiles into **launch canisters**.
 - (ii) ICBMs or SLBMs that are maintained, stored, and transported as assembled missiles without launch canisters, are assembled, including the joining of two or more stages.
 - (iii) First stages of ICBMs or SLBMs that are maintained, stored, and transported in stages are assembled.
- (b) For ballistic missile submarines, a facility at which construction of ballistic missile submarines is performed.
- (c) For **mobile launchers of ICBMs**, a facility at which the erector-launcher mechanism of a mobile launcher of ICBMs is mounted on the self-propelled device.
- (d) For **heavy bombers**, a facility at which assembly of a complete heavy bomber airframe is performed.

Production Reactor

A **reactor** designed primarily for large-scale production of **weapons-grade plutonium** and other materials for explosives.

Proton

An elementary nuclear particle with a positive electric charge located in the **nucleus** of an **atom**.

Prototype

For **intercontinental ballistic missiles (ICBMs)** or **submarine-launched ballistic missiles (SLBMs)** subject to **New START**, an ICBM or SLBM of a new type, no more than 20 missiles of which have been **launched**, and no launchers of missiles of which have been deployed.

PUREX

See [Plutonium Uranium Extraction](#).

Radiation Detection Equipment (RDE)

With regard to [New START](#), radiation detection equipment (RDE) may be used to demonstrate to the inspecting Party that an object declared by a member of the [in-country escort](#) to be a nonnuclear object, is, in fact, nonnuclear. RDE is designed to detect the presence, or confirm the absence, of radioactive materials. RDE accomplishes this task by counting the number of [neutrons](#) emitted from decaying [uranium](#) and [plutonium](#). Formerly, RDE was also used under the first START treaty and the [Intermediate-Range Nuclear Forces \(INF\) Treaty](#).

Radiation, Nuclear

Particles ([alpha](#), [beta](#), [neutrons](#)) or [photons](#) ([gamma](#)) emitted from the [nucleus](#) of unstable radioactive [atoms](#) as a result of [radioactive decay](#).

Radioactive Decay

The process in which a radioactive nucleus emits [radiation](#) and changes to a different [isotope](#) or element. A number of different particles can be emitted by decay. The most typical are [alpha](#) and [beta particles](#).

Radioactive Isotopes, Radioisotopes

[Isotopes](#) of an element that have an unstable number of [neutrons](#) and [protons](#) in the [nucleus](#). Radioactive isotopes are commonly used in science, industry, and medicine. The nucleus eventually converts to a more stable number through a number of [radioactive decay](#) processes.

Radioactivity

The spontaneous emission of [radiation](#), generally [alpha](#) or [beta particles](#), often accompanied by [gamma rays](#), from the [nucleus](#) of an unstable [isotope](#). Also, the rate at which radioactive material emits radiation. Measured in units of becquerels or disintegrations per second.

Radionuclide Stations

Used by the [International Monitoring System](#) (80 worldwide supported by 16 radionuclide laboratories) to measure the atmosphere for radioactive particles (40 also measure noble gas) as a means of detecting nuclear explosions and verifying compliance with the [Comprehensive Nuclear Test-Ban Treaty](#).

Range

As defined by **New START**:

- (a) For an **air-launched cruise missile (ALCM)**, the maximum distance that can be flown by an ALCM of that type in its standard design mode flying until fuel exhaustion, determined by projecting its flight path onto the Earth's sphere from the launch point to the point of impact.
- (b) For a **ballistic missile**, the maximum distance determined by projecting the flight trajectory onto the Earth's sphere from the launch point of a missile of that type to the point of impact of a **reentry vehicle**.
- (c) For an aircraft, the maximum distance that can be flown, without refueling, by an aircraft of that type when carrying an ordnance load of 7500 kilograms, with a full fuel load in the internal and external fuel tanks and a flight profile optimized to ensure minimum fuel consumption per kilometer, taking into account the distance covered during climb and descent. The fuel remaining in the fuel tanks after landing shall be no more than five percent of the maximum capacity of the fuel tanks.

Reactor

See **nuclear reactor**.

Reactor Control Rod

See **control rod**.

Reactor-Grade Plutonium

See **plutonium, reactor-grade**.

Reentry Vehicle (RV)

As defined in **New START**, that part of the **front section** that can survive reentry through the dense layers of the Earth's atmosphere and that is designed for delivering a weapon to a target or for testing such a delivery.

Reflector (in reactor operations)

A layer of material immediately surrounding a reactor **core** which scatters back or deflects into the core many **neutrons** that would otherwise escape. Common reflector materials are graphite, beryllium, and **natural uranium**.

Repair Facility:

As defined by **New START**:

- (a) For **intercontinental ballistic missiles (ICBMs)** or **submarine-launched ballistic missiles (SLBMs)**, a specified facility, outside an **intercontinental ballistic missile base** or a **submarine base**, for the repair or maintenance of ICBMs or SLBMs
- (b) For **mobile launchers of intercontinental ballistic missiles**, a specified facility, outside an ICBM base, for the repair or maintenance of mobile launchers of ICBMs.
- (c) For **heavy bombers**, a specified facility, outside an **air base**, for the repair or maintenance of heavy bombers.

Reprocessing

Chemical treatment of spent reactor fuel to separate **plutonium** and possibly **uranium** from the unwanted radioactive waste byproducts and from each other. (The United States does not currently reprocess spent reactor fuel.)

Research Reactor

A **nuclear reactor** designed primarily to supply **neutrons** for experimental purposes. It may also be used for training, materials testing, and production of **radioactive isotopes**.

Restricted Data

All data concerning: 1) design, manufacturer, or utilization of **atomic weapons**; 2) the production of **special nuclear material**; or 3) the use of special nuclear material in the production of **nuclear energy**. Does not include data declassified or removed from the "Restricted Data" category pursuant to section 142 of the Atomic Energy Act of 1954, as amended. "Restricted Data" is specifically exempted from all provisions of Executive Order 12958.

Restricted-Access Site

Measure under the **Comprehensive Nuclear Test-Ban Treaty** to protect sensitive installations and locations and to prevent disclosure of confidential information not related to the purpose of the inspection. Each such site shall be no larger than 4 square kilometers. No more than 50 square kilometers of restricted-access sites may be designated. If more than one restricted-access site is declared, each such site shall be separated from any other such site by a minimum distance of 20 meters. Each restricted-access site shall have clearly defined and accessible boundaries. No inspection activities may take place within a restricted-access site.

Rocket Motor Case

As defined by **New START**, the case that remains after the solid propellant is removed from the solid rocket motor.

Routine IAEA Inspections

The **U.S.-IAEA Safeguards Agreement**, in Article 70, states: “The Agency may make routine inspections in order to: a) verify that [inventory and **material balance area**] reports submitted [by the United States are] consistent with [accounting and operating] records kept pursuant to [this Agreement]; b) verify the location, identity, quantity, and composition of all **nuclear material subject to safeguards** under this Agreement; and c) verify information on the possible causes of **material unaccounted for, shipper/receiver differences**, and uncertainties in the **book inventory**.” (See also **complementary access visit or inspection, managed access, and U.S.-IAEA Additional Protocol**.)

Safeguards

Under the **Nuclear Nonproliferation Treaty**, the **verification** measures implemented by the **IAEA** to ensure **nuclear material** is being used for peaceful purposes and is not diverted for use in developing **nuclear weapons** or other nuclear explosive devices.

Safeguards, Domestic

Measures employed by a nation to prevent or detect the diversion of **nuclear material** and to protect against the sabotage of **facilities**.

Safeguards, International

Measures implemented by the **IAEA** to detect and deter the diversion of **nuclear material** from uses permitted by law or treaty, to give timely indication of possible diversion or credible assurance that no diversion has occurred, and to verify the declared operation of the **facility**.

Safeguards, Transparency, and Irreversibility (STI)

Introduced by the United States after the January 1994 Summit Meeting with the Russian Federation to build confidence and promote stability in the two nations’ mutual security relationship. Six key elements include: 1) an agreement for cooperation; 2) a stockpile data exchange agreement; 3) **mutual reciprocal inspection (MRI)** methods for **plutonium**; 4) MRI methods for highly enriched **uranium**; 5) spot check methods to confirm declarations; and 6) methods to ensure chain of custody to enhance confidence that the excess **nuclear weapons** are dismantled and resulting excess **fissile material** is not reused in the production of new weapons.

Safing

As applied to weapons and ammunition, the changing from a state of readiness for initiation to a safe condition that prevents an unauthorized firing.

Secondary Stage in Weapons

The physics of a **thermonuclear device** that includes the high explosives assembly, **safing**, **fuzing**, and firing materials.

Seismic Stations

Used by the **International Monitoring System** (50 primary and 120 auxiliary worldwide) to monitor shockwaves in the Earth as a means of detecting a nuclear explosion and verifying compliance with the **Comprehensive Nuclear Test-Ban Treaty**.

Selected U.S. Facilities

See **identified U.S. facilities**.

Self-Contained Dispensing Mechanism

With regard to **New START**, a device that separates from the final **stage** of a missile together with the **front section** and that independently targets and releases the **reentry vehicle** or reentry vehicles and penetration aids.

Separative Work Unit (SWU)

See **SWU**.

Sequential Inspection

A **New START** inspection, conducted at **facilities** associated with the same **point of entry**, by an **inspection team** that has not departed the territory of the inspected Party following the completion of the previous inspection.

Shielding

Any material or obstruction designed to absorb radiation and protect personnel from its effects. Large thicknesses of dense materials are necessary for shielding against **gamma radiation**. Lead, for example, can act as shielding for gamma rays.

Shipper/Receiver Difference

Per the **U.S.-IAEA Safeguards Agreement**, Article 90, paragraph Q, "the difference between the quantity of **nuclear material** in a **batch** as stated by the shipping **material balance area** and as measured at the receiving material balance area."

Significant Quantity (SQ)

The approximate quantity of **nuclear material** in respect of which, taking into account any conversion process involved, the possibility of manufacturing a nuclear explosive device cannot be excluded. The **IAEA** currently uses the following values for significant quantities of nuclear material:

Direct-use nuclear material:	
Pu ^a	8 kg
U-233	8 kg
U (U-235 = 20%)	25 kg
Indirect-use nuclear material:	
U (U-235 < 20%) ^b	75 kg
Th	20 t

^a For **plutonium** containing less than 80% Pu²³⁸

^b Including **natural** and **depleted uranium**

Note: Significant quantities should not be confused with **critical masses**; the former take into account unavoidable losses of **conversion** and manufacturing processes.

Silo Launcher of Intercontinental Ballistic Missile

As defined by **New START**, an **intercontinental ballistic missile launcher** in a silo structure located in the ground.

Silo Training Launcher

As defined by **New START**, a full- scale **silo launcher of intercontinental ballistic missile launcher** specified for training purposes.

Site

The **U.S.-IAEA Additional Protocol**, in Article 18, paragraph B, states: "That area delimited by the United States in the relevant design information for a **facility**, including a **closed-down facility**, and in the relevant information on a **location outside facilities** where **nuclear material** is customarily used, including a **closed-down location outside facilities** where nuclear material was customarily used (this is limited to locations with **hot cells** or where activities related to **conversion**, **enrichment**, **fuel fabrication** or **reprocessing** were carried out). It shall also include all installations, co-located with the facility or location, for the provision or use of essential services, including: hot cells for processing irradiated materials not containing nuclear material; installations for the treatment, storage and

disposal of **waste**; and buildings associated with specified activities identified by the United States under [Annex I of the **U.S.-IAEA Additional Protocol**.]"

Soft-Site Launcher

As defined by **New START**, any land-based fixed launcher of **intercontinental ballistic missiles** or **submarine-launched ballistic missiles** other than a **silos launcher**.

Solid-Fueled Intercontinental Ballistic Missile

With regard to **New START**, an **intercontinental ballistic missile** for which all **stages** are equipped with **solid rocket motors**.

Solid-Fueled Submarine-Launched Ballistic Missile

With regard to **New START**, a **submarine-launched ballistic missile** for which all **stages** are equipped with **solid rocket motors**.

Solid Rocket Motor (SRM)

Under **New START**, that part of the **stage** that consists of the case filled with solid propellant.

Source Material

The Statute of the **IAEA**, in Article XX, paragraph 3, defines source material as: "**uranium** containing the mixture of **isotopes** occurring in nature; uranium depleted in the isotope of 235; **thorium**; any of the foregoing in the form of metal, alloy, chemical compound, or concentrate; any other material containing one or more of the foregoing in such concentration as the Board of Governors shall from time to time determine." (See also **nuclear material**.) As defined under the U.S. Atomic Energy Act (of 1954), ores containing **uranium** or **thorium**.

Space Launch Facility

As defined by **New START**, a specified **facility** from which objects are delivered into the upper atmosphere or space using **intercontinental ballistic missiles** or **submarine-launched ballistic missiles**.

Special Fissionable Material

The Statute of the **IAEA**, in Article XX, paragraph 1, defines special fissionable material as: "**Pu²³⁹**, **U²³³**; **uranium** enriched in the isotopes 235 or 233; any material containing one or more of the foregoing; and such other **fissionable material** as the Board of Governors shall from time to time determine; but the term 'special fissionable material' does not include source material." (See also **nuclear material**.)

Special IAEA Inspections

The [U.S.-IAEA Safeguards Agreement](#), in Article 71, states: “Subject to the [consultation] procedures laid down in [the U.S.-IAEA Safeguards Agreement], the Agency [the IAEA] may make special inspections: a) in order to verify the information contained in special reports submitted [by the United States], in accordance with [this Agreement, of any unusual incident or circumstance involving possible loss of [nuclear material subject to safeguards](#)]; or b) if the Agency considers that information made available by the United States, including explanations from the United States and information obtained from routine inspections, is not adequate for the Agency to fulfill its responsibilities under this Agreement. An inspection shall be deemed to be special when it is either additional to the routine inspection effort provided for in [this Agreement], or involves access to information or locations in addition to the access specified in [this Agreement] for *ad hoc* and [routine inspections](#), or both.” (See also [complementary access visit or inspection](#), [managed access](#), and [U.S.-IAEA Additional Protocol](#).)

Special Nuclear Material (SNM)

As defined under the U.S. Atomic Energy Act of 1954, SNM is [plutonium](#) and [uranium](#) enriched in the isotope U^{233} or the isotope U^{235} . SNM does not include [source material](#) such as [natural uranium](#) or [thorium](#). (See also [special fissionable material](#).)

Spent Fuel

[Fuel elements](#) removed from a [reactor](#) usually because reactor operation has become less efficient, due to consumption of [fissile material](#) and build-up of [fission products](#) in the fuel.

Spent Fuel Casks

The specially designed shipping containers for spent fuel assemblies. (See also [cask](#) and [transportation cask](#).)

Spent Fuel Storage Pools

Water-filled pools constructed as part of a [nuclear power plant](#) complex for discharged [fuel elements](#), or pools away from [reactors](#) where [spent fuel](#) may be stored awaiting further disposition.

Stable Isotope

An [isotope](#) that does not undergo [radioactive decay](#).

Stage

As defined by **New START**, for **intercontinental ballistic missiles** or **submarine-launched ballistic missiles**, a section of a missile that is equipped with a propulsion unit, with the exception of the self-contained dispensing mechanism.

Storage Facility:

With regard to **New START**:

- (a) For **intercontinental ballistic missiles (ICBMs)** or **submarine-launched ballistic missiles (SLBMs)**, a specified facility, outside an **intercontinental ballistic missile base**, a **submarine base**, a **test range**, or a **space launch facility**, for the storage of ICBMs or SLBMs.
- (b) For **mobile launchers of intercontinental ballistic missiles**, a specified facility, outside an ICBM base, a test range, or a space launch facility, for the storage of mobile launchers of ICBMs.
- (c) For **heavy bombers**, a specified facility, outside an **air base**, for the storage of heavy bombers.

Strategic Arms Reduction Treaty (START)

Treaty signed by the United States and Soviet Union on July 31, 1991, which entered into force on December 5, 1994. The treaty remained in force for 15 years and expired on December 5, 2009. Under START, the United States and Russia each reduced their deployed strategic **nuclear weapon** delivery systems (ballistic missiles and **heavy bombers**) to 1,600, eliminated the launchers associated with eliminated missiles, and reduced warheads (attributed to deployed ballistic missiles and deployed heavy bombers) to 6,000. Ukraine, Belarus and Kazakhstan eliminated all of the strategic nuclear weapon delivery systems deployed on their territories either by destroying them or transferring them to Russia. These weapon reductions were successfully achieved prior to the 2001 treaty deadline. During the life-span of the treaty, the United States conducted a total of 659 inspections and Russia conducted 481. The United States also conducted portal monitoring activities at Votkinsk, Russia

Strategic Offensive Arms (SOA)

With regard to **New START**, the items the Parties declare to be subject to the treaty including **intercontinental ballistic missiles**, **intercontinental ballistic missile launchers**, **submarine-launched ballistic missiles**, **submarine-launched ballistic missile launchers**, and **heavy bombers equipped for nuclear armaments**.

Strategic Offensive Reductions Treaty (SORT or Moscow Treaty)

Treaty between the United States and Russia which was in force from June 1, 2003 until it was superseded by **New START** on February 5, 2011. Under SORT, the United States and Russia were each obligated to reduce their operationally deployed strategic nuclear warheads to between 1,700–2,200 by December 31, 2012.

Strategic Point

Per the **U.S.-IAEA Safeguards Agreement**, Article 90, paragraph 5, a location selected during examination of **design information** where the information necessary and sufficient for the implementation of safeguards measures is obtained and verified; a strategic point may include any location where key measurements related to material balance **accountancy** are made and where **containment** and **surveillance** measures are executed.

Subcritical

An insufficient quantity of fissile fuel to sustain a fission **chain reaction**.

Submarine Base

As defined by **New START**, a **facility** at which **ballistic missile** submarines, as well as submarines that had been previously equipped with **submarine-launched ballistic missile (SLBM) launchers** but after conversion are incapable of launching SLBMs, are based, and at which shore-based support for such submarines, which may include the assembly, loading, maintenance, and storage of SLBMs, is provided.

Submarine-Launched Ballistic Missile (SLBM)

As defined in **New START**, a **ballistic missile** with a range in excess of 600 kilometers of a type, any one of which has been contained in or launched from a submarine.

Submarine-Launched Ballistic Missile Launcher

As defined in **New START**, a device intended or used to contain, prepare for **launch**, and launch a **submarine-launched ballistic missile**.

Submarine-Launched Ballistic Missile Loading Facility

As defined in **New START**, a shore-based **facility**, outside a **submarine base**, where **submarine-launched ballistic missiles** are loaded onto or unloaded from **ballistic missile** submarines.

Subsidiary Arrangement

A document containing a set of technical and administrative procedures designed primarily to implement the **safeguards** procedures laid down in safeguards agreements between a member state and the **IAEA**, the focus is on matters such as design review, records requirements, reporting requirements, and inspections. The document also includes **facility attachments**, which contain specific procedures for each [selected U.S.] **facility**. Subsidiary Arrangements enter into force no later than 90 days after either the state or the IAEA communicates the need for negotiating such an arrangement. The United States negotiated a Subsidiary Arrangement on **managed access**, specifying the purposes for which the United States intends to manage access and types of measures it intends to employ.

Supercritical, Supercriticality

The net production of **neutrons** is more than needed to maintain **criticality**. Supercriticality is the basic requirement for a **nuclear weapon**.

Surveillance

The collection of information through inspector and/or instrumental observation aimed at the **monitoring** of the movement of **nuclear material** and the detection of interference with **containment** and tampering with **IAEA** safeguard devices, samples, and data. The most important surveillance instruments are automatic optical devices and monitors. Surveillance may also be used for observing various operations or obtaining relevant operational data. IAEA **safeguards** inspectors may carry out surveillance assignments continuously or periodically at **strategic points**.

SWU

A unit of measure of the amount of work required to increase the abundance of U^{235} in **uranium**; i.e., to enrich uranium.

Tails, Tailings

The depleted stream of an enrichment plant or stage after the enriched product is removed, expressed as percent of U^{235} content. The term also applies to the depleted stream from **uranium milling**.

Tamper

A heavy, dense material surrounding the **fissionable materials** in a **nuclear weapon**, for the purpose of holding the supercriticality assembly together longer by its inertia, and also for the purpose of reflecting neutrons, thus increasing the fission rate of the active material. **Uranium**, tungsten, and beryllium can be used as tampers in nuclear weapons.

Telemetric Information

As defined in **New START**, information that originates on board a missile during its initial motion and subsequent flight that is broadcast.

Test Heavy Bomber

As defined in **New START**, a **heavy bomber** equipped for **nuclear armaments** designated exclusively for testing and based at a **heavy bomber flight test center**.

Test Launcher

As defined in **New START**, an **intercontinental ballistic missile launcher** or a **submarine-launched ballistic missile launcher** located within a **test range**.

Test Range

As defined in **New START**, a designated land area, other than an **intercontinental ballistic missile base**, from which **launches** of **intercontinental ballistic missiles** or **submarine-launched ballistic missiles** are conducted.

Thermal Neutron

A **neutron** with a velocity comparable to the random motion of **atoms** in materials. The typical energy of a thermal neutron in a material at room temperature is 0.025 eV. Thermal neutrons are produced from **fast neutrons** by slowing them down in a **moderator**.

Thermonuclear Weapon

A **nuclear weapon**—also referred to as a hydrogen bomb—in which the main contribution to the explosive energy results from **fusion** of light nuclei, such as **deuterium** and **tritium**. The high temperatures required for such fusion reactions are obtained by means of an initial **fission** explosion.

Thorium

A radioactive element with atomic number 90 and symbol Th. Naturally occurring thorium consists only of the **fertile isotope** 232. Through **transmutation** it becomes the fissionable U^{233} , which is **special fissionable material** and relevant to **safeguards**.

Thorium-232 (Th²³²)

A **fertile** naturally occurring **isotope** from which the **fissile isotope**, U^{233} , can be bred.

Threshold Test-Ban Treaty (TTBT)

Treaty signed by the United States and the Soviet Union on July 3, 1974, which entered into force on December 11, 1990. The TTBT established a nuclear “threshold” by prohibiting tests having a yield exceeding 150 kilotons (equivalent to 150,000 tons of TNT).

Training Facility (TF)

Under **New START**, a specified **facility**, outside an **intercontinental ballistic missile (ICBM) base** or a **submarine base**, at which personnel are trained to use, operate, or maintain ICBMs or **submarine-launched ballistic missiles** and their **launchers**.

Training Launcher (TL)

Under **New START**, a **silo training launcher** or a mobile training launcher.

Training Model of a Missile (TMOM)

Full-scale, inert model of an **intercontinental ballistic missile (ICBM)** or **submarine-launched ballistic missile (SLBM)** not capable of being **launched**, and differs from an ICBM or SLBM on the basis of external and functional differences that are visible during **inspection activities**.

Transit

As defined in **New START**, the one-way movement from one **facility** to another facility of:

- (a) A **non-deployed intercontinental ballistic missile**;
- (b) A **non-deployed submarine-launched ballistic missile**; or
- (c) A **non-deployed mobile launcher of intercontinental ballistic missiles**.

Transmutation

The **conversion** of one nuclide into another through one or more nuclear reactions; more specifically, the conversion of an **isotope** of one element into an isotope of another element through one or more nuclear reactions; for example, U^{238} is converted into **plutonium** by neutron capture followed by the emission of two **beta particles**.

Transparency

Exchange of information, access to facilities, and cooperative arrangements undertaken to provide ready observation and verification of defense or other activities.

Transportation (Shipping) Cask

Specially developed structures designed to confine radioactive material (containment), block radiation (shielding), and avoid fission (critical safety). The casks must pass various tests (drop, thermal, and immersion) before they can be certified by the Department of Energy as acceptable for transport.

Transuranic Elements

Elements with an atomic number greater than uranium (atomic number 92) are called transuranic elements, including neptunium, plutonium, americium, and curium.

Tritium (H³)

A naturally occurring, colorless, radioactive gaseous isotope of hydrogen used in thermonuclear weapons, and as a radioactive tracer in chemical, biochemical and biological research. Produced commercially from Li⁶ (lithium-6) by slow neutron bombardment in nuclear reactors.

Tuballoy (TU)

A term of British origin for uranium metal containing U²³⁸ and U²³⁵ in natural proportions, therefore, the term is considered ambiguous and its use is discouraged. This term is sometimes applied to depleted uranium. (See uranium.)

Type One Inspections

Under New START, on-site inspections conducted at intercontinental ballistic missile bases, submarine bases, and air bases to confirm the accuracy of declared data on the numbers and types of deployed and non-deployed strategic offensive arms subject to the treaty; the number of warheads located on deployed intercontinental ballistic missiles and deployed submarine-launched ballistic missiles; and the number of nuclear armaments located on deployed heavy bombers. Each Party may conduct up to ten Type One inspections per year.

Type Two Inspections

Under New START, on-site inspections conducted to confirm the accuracy of declared data on the numbers, types, and technical characteristics of non-deployed strategic offensive arms subject to the treaty. Locations subject to Type Two inspections include intercontinental ballistic missile (ICBM) loading facilities or submarine-launched ballistic missile (SLBM) loading facilities; storage facilities for ICBMs, SLBMs, and mobile launchers of intercontinental ballistic missiles; test ranges; and training facilities. Type Two inspections may also be conducted to confirm that strategic

offensive arms have been converted or eliminated, and to inspect formerly declared facilities to confirm that such facilities are not being used for purposes inconsistent with the treaty. Each Party may conduct up to eight Type Two inspections per year. (See also Conversion or Elimination Facility and Exhibition.)

Unique Identifier (UID)

With regard to New START, a non-repeating alpha-numeric number that has been applied by the inspected Party to an intercontinental ballistic missile, a submarine-launched ballistic missile, or a heavy bomber.

Unstable Isotope

A radioactive isotope.

Uranium

A radioactive element with the atomic number 92 and, as found in natural ores, an atomic weight of approximately 238. The two principal natural isotopes are U^{235} (0.7% of natural uranium), which is fissile, and U^{238} (99.3% of natural uranium), which is fissionable by fast neutrons and is fertile. Natural uranium also includes a minute amount of U^{234} . (See also high enriched uranium and low enriched uranium.)

Uranium-233

An isotope of uranium which is produced by transmutation of Th^{232} and which is considered as special fissionable material and as direct-use material. (See also thorium.)

Uranium-235 (U^{235})

The only naturally occurring fissionable isotope. Natural uranium contains 0.71% U^{235} . Light-water reactors use uranium containing about 3% U^{235} . High enriched uranium, containing 20% or more U^{235} , can be used to make nuclear explosives.

Uranium-238 (U^{238})

A fertile material from which Pu^{239} can be bred. Natural uranium is composed of approximately 99.3% U^{238} .

Uranium Conversion

The process in which concentrated uranium is converted to a highly purified gas, uranium hexafluoride, for subsequent enrichment. (See the nuclear fuel cycle diagrams on pages 116-117.)

Uranium Dioxide (UO₂), Brown Oxide

Purified uranium compound. The form in which natural uranium is used in heavy water-moderated reactors. Also, the form of uranium produced by the removal of fluorine from enriched uranium hexafluoride (UF₆) for use in fabrication of fuel elements for power reactors.

Uranium Fuel Fabrication Facility

A facility that (1) manufactures reactor fuel containing uranium for any of the following: (i) preparation of fuel materials; (ii) formation of fuel materials into desired shapes; (iii) application of protective cladding; (iv) recovery of scrap material; and (v) storage associated with such operations; or (2) conducts research and development activities.

Uranium Hexafluoride (UF₆)

A volatile compound of uranium and fluorine. UF₆ is a solid at atmospheric pressure and room temperature, but can be transformed into a gas by moderate heating. UF₆ gas (alone, or in combination with hydrogen or helium) is a feedstock in uranium enrichment processes and is sometimes produced as an intermediate product in the process of purifying yellowcake to produce uranium dioxide (UO₂).

Uranium Milling

See milling.

Uranium Mine and Ore Processing (Concentration) Plant

Installations respectively for mining uranium ore and for refining (concentrating) it to produce U₃O₈ (yellowcake).

Uranium Oxide

The generic name for a group of uranium compounds that includes uranium dioxide (UO₂, brown cycle), uranium trioxide (UO₃, orange oxide), uranium-uranium oxide (U₃O₈, black cycle), and uranium peroxide (UO₄·2H₂O).

U.S.-IAEA Additional Protocol (INFCIRC 288/Add.1)

The Agreement between the United States and the IAEA which entered into force on January 6, 2009. The U.S.-IAEA Additional Protocol is a follow-on agreement to the current U.S.-IAEA Safeguards Agreement (INFCIRC/288). The purpose of the U.S. Additional Protocol is primarily to assist the IAEA with developing the procedures, tools, and techniques it needs to detect undeclared nuclear activities, materials, and weapons programs in non-nuclear weapon states party to the Nuclear

Nonproliferation Treaty. The Additional Protocol increases IAEA inspectors' access to information, facilities, and locations including **nuclear fuel cycle-related activities** not involving **nuclear material**. It also increases the inspectors' rights to conduct more types of inspection activities and to use new types of detection equipment.

The unique provisions contained in the U.S.-IAEA Additional Protocol include the right to invoke the **National Security Exclusion (NSE)** and to **manage access**. The NSE allows the United States to continue its longstanding policy of exempting from declaration, or access, all activities, locations, and information with direct national security significance.

U.S.-IAEA Safeguards Agreement (INFCIRC/288)

The Agreement between the United States and the **IAEA**, which entered into force on December 9, 1980, permitting **safeguards** to be applied on all U.S. nuclear facilities, excluding only those with direct national security significance. The Agreement requires the United States to submit a list of eligible facilities to the IAEA. The United States volunteered more than 270 commercial and government nuclear facilities. The IAEA may then identify or "select" any or all of these eligible facilities for the application of safeguards. For each selected **facility**, the United States and the IAEA develop a separate **facility attachment**.

The IAEA uses the same procedures in **nuclear weapon states**, such as the United States, that it uses in similar facilities in **non-nuclear weapon states** party to the **Nuclear Nonproliferation Treaty**. This Agreement is also known as the Voluntary Offer Agreement.

Variant:

As defined in **New START**:

- (a) For **heavy bombers**, a classification declared by the inspected Party of airplanes of one type and one category that are distinguishable from other airplanes of the same type and the same category.
- (b) For **intercontinental ballistic missiles (ICBMs)** or **submarine-launched ballistic missiles**, a classification declared by the inspected Party of ICBMs of one type or SLBMs of one type that are distinguishable from other ICBMs or SLBMs of the same type.

Venting

The escape through the surface to the atmosphere of gases or radioactive products from a subsurface high explosive or nuclear detonation. (See also [radioactive decay](#) and [radioactive isotopes](#).)

Version

As defined in [New START](#), for [mobile launchers of intercontinental ballistic missiles \(ICBMs\)](#) of a type, a classification declared by the inspected Party based on external or functional differences from other such items.

Vessel

The external structure of a [reactor](#) within which the [nuclear fuel](#), [moderator](#), and [coolant](#) are located.

Visit

The [IAEA](#) defines this term as: “The presence of [IAEA](#) inspectors at a nuclear [facility](#) for purposes other than a [safeguards](#) inspection, such as a discussion of the [facility attachment](#) or of administrative matters in connection with the inspection regime, or . . . verification of the [design information](#) of the facility.”

Vitrification

The solidification process in which [high-level](#) (radioactive) [waste](#) is melted with a mixture of sand and reground fuzing materials (a frit) to form glass for ease of handling and storage.

Voluntary Offer

The announcement by President Johnson on December 2, 1967, that the United States would permit the [IAEA](#) to “apply its [safeguards](#) to all nuclear activities in the United States – excluding only those with direct national security significance.” President Johnson made it clear that the United States would not ask other States Parties to the [Nuclear Nonproliferation Treaty](#) to accept safeguards the United States was unwilling to accept. The Voluntary Offer subsequently led to ratification of the [U.S.-IAEA Safeguards Agreement](#) – also known as the [Voluntary Offer Agreement](#).

Voluntary Offer Agreement

See [U.S.-IAEA Safeguards Agreement](#).

Waste, Radioactive

See [nuclear waste](#).

Warhead (nuclear)

That part of a missile which contains the nuclear or thermonuclear system (explosive material and detonator) intended to inflict damage. As defined by **New START**, a unit of account used for counting toward the 1,550 aggregate limit as applied to **deployed intercontinental ballistic missiles**, **deployed submarine-launched ballistic missiles**, and **deployed heavy bombers**.

Warhead Section (WHS)

A completely assembled warhead including appropriate skin sections and related components.

Weapon Component

Any operational, experimental, or research-related part, subsection, design, or material used in the manufacture or utilization of a **nuclear weapon**, nuclear explosive device, or a nuclear weapons test assembly.

Weapon Debris (nuclear)

The residue of a **nuclear weapon** after it has exploded or burned; that is, the materials used for the casing, and other components of the weapon, plus unexpended **plutonium** or **uranium**, together with **fission** products, if any.

Weapon-Delivery Vehicle

As defined in **New START**, for **ballistic missiles** and **cruise missiles** that apply to a missile of a type, any one of which has been **launched** or flight-tested, or deployed to carry or be used as a weapon, that is, as any mechanism or any device that, when directed against any target, is designed to damage or destroy it.

Weapon Retirement

The process by which **nuclear weapons** are determined to be obsolete or unnecessary for national defense. A retired weapon or weapon system is no longer in an active status or deliverable, but may still be a fully functioning nuclear device.

Weapon System

Collective term for the nuclear assembly and non-nuclear components, systems, and subsystems that compose a **nuclear weapon**.

Weaponization Programs

The process involved in creating a **nuclear weapon**. This includes research and development laboratories with the human resources, technical skills, and equipment; specialized materials; production equipment; test facilities; and **delivery systems**.

Weapons-Grade Material

Nuclear material considered most suitable for a **nuclear weapon**. It usually connotes **uranium** enriched to above 90% U^{235} or **plutonium** with greater than about 90% Pu^{239} . Weapons can be fabricated from lower grade material.

Weapons-Grade Plutonium

See **plutonium, weapons-grade**.

Wide-Area Environmental Sampling

The **U.S.-IAEA Additional Protocol**, in Article 18, paragraph G, states: "The collection of environmental samples (e.g., air, water, vegetation, soil, smears) at a set of locations specified by the Agency [the **IAEA**] for the purpose of assisting the Agency to draw conclusions about the absence of undeclared **nuclear material** or nuclear activities over a wide area." (See also **complementary access visit or inspection, managed access**, and **U.S.-IAEA Additional Protocol**.)

Wipe Sample

A sample made for the purpose of determining the presence of removable radioactive contamination on a surface. It is done by wiping, with slight pressure, a piece of soft filter paper over a representative type of surface area. It is also known as a "swipe or smear" sample.

Yellowcake

A product of the **uranium** ore **milling** process that contains about 80% **uranium oxide** (U_3O_8). In preparation for uranium **enrichment**, the **yellowcake** is converted to **uranium hexafluoride** gas (UF_6). In the preparation of **natural uranium** power reactor fuel, yellowcake is processed into purified **uranium dioxide**.

Yield

The total energy released in a nuclear explosion. It is usually expressed in equivalent tons of TNT; i.e., the quantity of TNT required to produce a corresponding amount of energy.

Zangger Committee

Also known as the Nuclear Nonproliferation Treaty Exporters Committee, the Zangger Committee developed the Zangger List, which identifies non-nuclear materials or specialized equipment, the export of which would “trigger” the application of **safeguards** by the **IAEA** on the **nuclear materials** produced, processed, or used.

Zircalloy

An alloy consisting of zirconium and small amounts of other metals (Sn, Fe, Cr, Ni). Zircalloy tubes are used as **cladding** for **fuel rods** in a **nuclear reactor**.

93 + 2 Program

A commonly used name for the Strengthened **Safeguards** Program; refers to the year (1993) when the **IAEA** began work on this plan of action, and to the goal of presenting the plan 2 years later at the 1995 **Nuclear Nonproliferation Treaty** Review Conference.

PART III

Part III contains a brief tutorial on nuclear fundamentals. This section describes several basic concepts related to nuclear physics terminology and describes the nuclear fuel cycle. These concepts are illustrated with color graphics. A Periodic Table and a cross-referenced list of elements are also included (see pullout side A and pages 118-119).

NUCLEAR FUNDAMENTALS

All matter is composed of atoms. Some materials (e.g., pure copper or pure iron) are composed of a single atom while many others (e.g., water) are composed of combinations of atoms (hydrogen and oxygen make up water). Atoms, in turn, are composed of two parts: the nucleus and an electron cloud. The electron cloud surrounds the nucleus, thereby comprising the outer surface of the atom.

The nucleus, at the center of the atom, is exceedingly small, but contains almost all the weight of the atom. The nucleus is made up of two primary particles: protons and neutrons. The proton has a positive charge while the neutron has no charge; that is, it is neutral.

An atom is called “stable” when the number of protons in the nucleus equals the number of electrons surrounding the nucleus. Since electrons have negative charges, this results in a net charge of zero for the atom. Figure 1 depicts a lithium atom, composed of three protons, four neutrons, and three electrons.

Lithium Atom

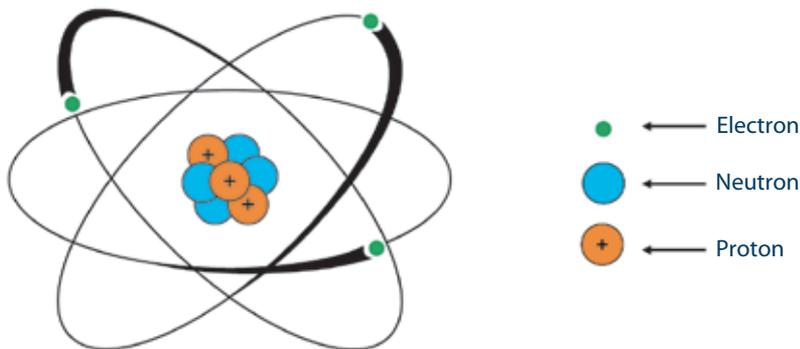


Figure 1

Isotopes

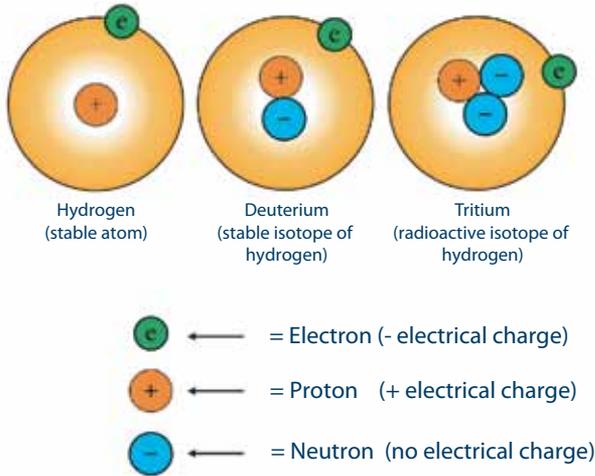


Figure 2

The chemical properties of an atom in a stable atom are determined by the electrons surrounding the nucleus. The number of protons in a stable atom is always equal to the number of electrons, but the number of neutrons may vary. If different atoms have the same number of protons and electrons, they will be the same element and have similar chemical properties. But the atom's weight will vary with the number of neutrons.

Nuclei with the same number of protons and electrons, but different numbers of neutrons, are called isotopes of an element. The isotopic number, or mass number, is the sum of the number of neutrons and the number of protons. For example, the most common isotope of uranium contains 92 protons and 146 neutrons for an isotopic number of 238. This may be written "uranium-238," " ${}^{238}\text{U}$," or " U^{238} ," with U being the chemical symbol for uranium. (This glossary utilizes the third convention.)

The simplest group of isotopes is one associated with the element hydrogen (Figure 2). Almost all hydrogen consists of an atom containing only one proton and a matching single electron. This isotope of hydrogen (containing no neutrons) is written as H-1 or H^1 (sometimes referred to as protium). If one neutron is added to the nucleus (still just one proton and one circling electron) the isotope becomes H^2 (referred to as deuterium). Both of these isotopes of hydrogen are stable and do not undergo radioactive decay.

If one additional neutron is added to the nucleus of a deuterium atom (now two neutrons, one proton, and the circling electron), the isotope H^3 (tritium) is produced. Tritium is an unstable isotope and undergoes radioactive decay to reach a stable state. Isotopes of an element have similar chemical properties, but usually have very different physical properties. For example, some isotopes are stable (like ordinary hydrogen and deuterium) and do not change with time, while others are radioactive and release energy or particles in order to attain a more stable state.

Radioactive isotopes may decay by several different modes. Principal decay modes are shown in Figure 3. In the first mode (gamma decay), a gamma particle (or high-energy x-ray) is emitted from the radioactive isotope. This decay mode releases energy and may result in a stable product. The other decay modes shown change the original nucleus, thereby changing either the atom's element type, its isotope number, or both. In the case of beta decay, one of the neutrons changes into a proton, releasing a beta particle (similar to a highly energetic electron) from the nucleus.

Radioactive Decay

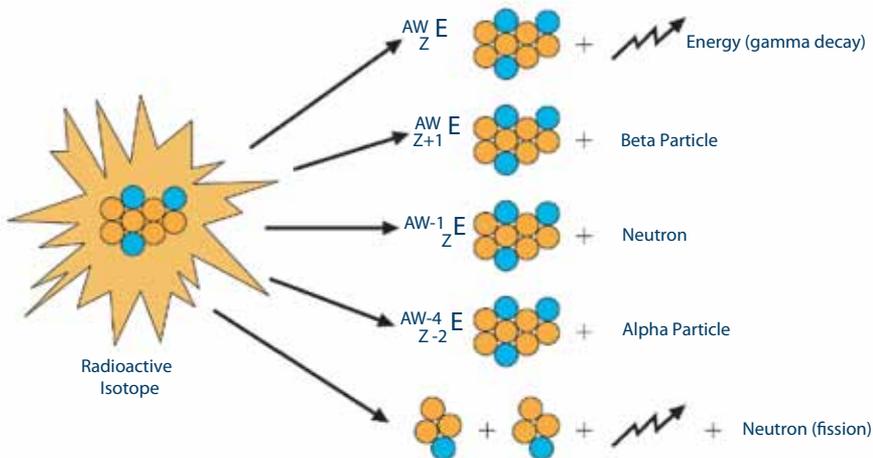


Figure 3: Different isotopes may decay by one or more means.

As a result of such decay, the atom will have gained one additional proton, causing the atom to change from one element into another. If uranium undergoes a beta decay, for example, it becomes neptunium, (see Figure 3).

In the case of neutron decay, the element remains the same, but the isotopic number is reduced by one. Isotopes which undergo neutron decay are fairly rare, but they can be an important source of neutrons. The availability of neutrons is an important aspect in creating plutonium, as will be seen later.

Alpha decay is a common radioactive decay mode, especially for radioactive isotopes with high isotopic numbers, such as plutonium. An alpha particle resembles the nucleus of a helium-4 atom (two protons and two neutrons). When protons are emitted from the decaying nucleus, the atom changes from one element into another. For example, when Pu^{239} decays by emitting an alpha particle, the atom changes into U^{235} (note the mass reduction of four; the sum of the two neutrons and two protons in the lost alpha particle).

The most dramatic change to an atom occurs when it fissions; that is, the original nucleus splits into two or more large fragments, with the possible release of neutrons, as well. While some nuclei may spontaneously fission, this event is most likely to occur when certain nuclei absorb a neutron. Such neutron-induced fission will be discussed later.

Radioactive decay is best described by the term, "half-life." Since radioactive decay is a random, statistical occurrence, it is impossible to predict exactly which nucleus will decay by a given time. It is possible, however, to predict the time when half of the nuclei of a large number of radioactive atoms of the same type will have decayed. This is referred to as the "half-life" of the atom, indicating that, after one half-life, one-half of the nuclei will have decayed (Figure 4). After a second half-life, half of those remaining will have decayed, leaving one-quarter of the original sample remaining, and so on. The half-lives of atoms are a function of the characteristics of the original nuclei and range from very small fractions of a second to billions of years.

Half-Life

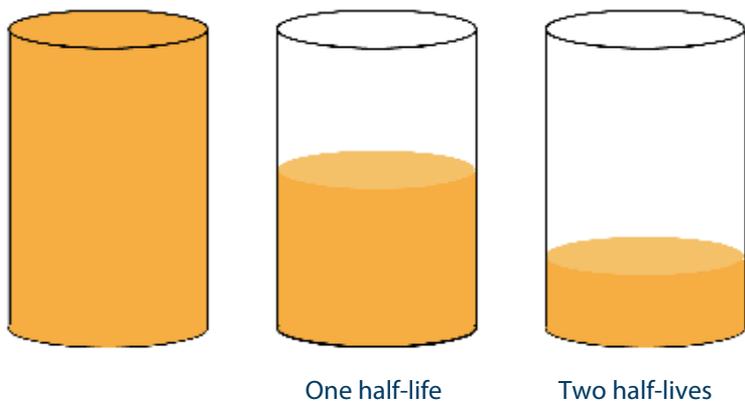


Figure 4: Half-lives vary from very small fractions of a second to billions of years.

It is important to note that when a nucleus with a large mass, or high isotopic number, is split into two parts, the combined weight of those parts is slightly less than the weight of the original nucleus (Figure 5). The lost weight is converted into energy in accordance with the equation, $E=mc^2$ (where E is energy, m is the mass difference, and c^2 is the speed of light multiplied by itself).

Atomic Weight

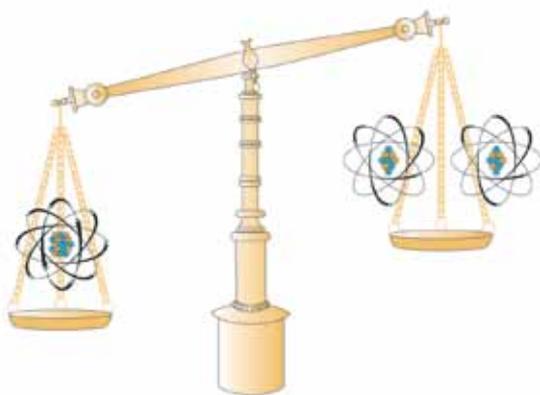


Figure 5: When an atom is “split”, the parts weigh less than the original.

The release of energy and particles resulting from fission is fundamental to both nuclear reactors and nuclear weapons. Fission will typically occur when a fissile nuclide (an isotope which can fission by absorption of any kind of neutron) absorbs a neutron. The result is a release of energy and, usually, two or three additional neutrons (Figure 6). The two parts resulting from the split of the original nuclide are called fission fragments or fission particles and are often radioactive. Typical examples are I^{129} , I^{131} , Cs^{137} , and Sr^{90} (iodine-129, iodine-131, cesium-137, and strontium-90).

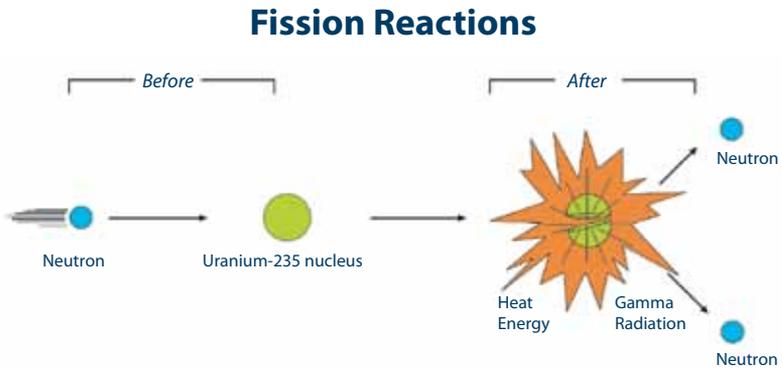


Figure 6: Fission reactions are fundamental to both nuclear reactors and nuclear weapons.

The neutrons released during fission can cause additional nuclei to fission, releasing still more energy and producing even more neutrons in the next generation (Figure 7). These neutrons can cause still more fissions, releasing more energy, and producing still more neutrons in the following generation, creating a self-sustaining chain reaction. In a nuclear weapon, this rapid expansion of the fission process occurs through perhaps 60 or more generations in a small fraction of a second, resulting in a very rapid release of a large amount of energy—an explosion.

Increasing Fission Rate

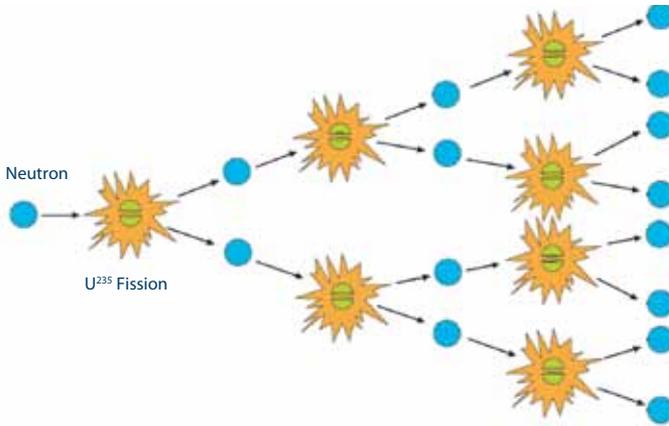


Figure 7: This reaction is "supercritical."

If the neutrons released from nuclei undergoing fission are absorbed in other nuclei which don't fission, or if the neutrons escape (i.e., leak out of) the area containing the fissile material, the chain reaction stops and no further energy is released (Figure 8).

Decreasing Fission Rate

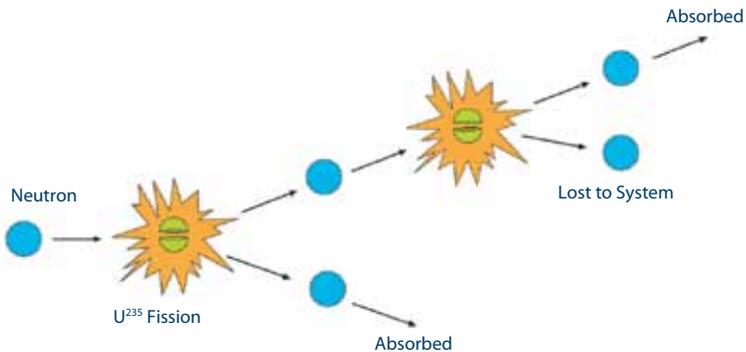


Figure 8: This reaction is "subcritical."

In a nuclear reactor, the desired process is for one neutron from each fission event to cause just one additional nuclei to fission, while the other neutrons released either escape or are absorbed without causing fissions. In such a case, the chain reaction proceeds steadily at a constant rate (Figure 9).

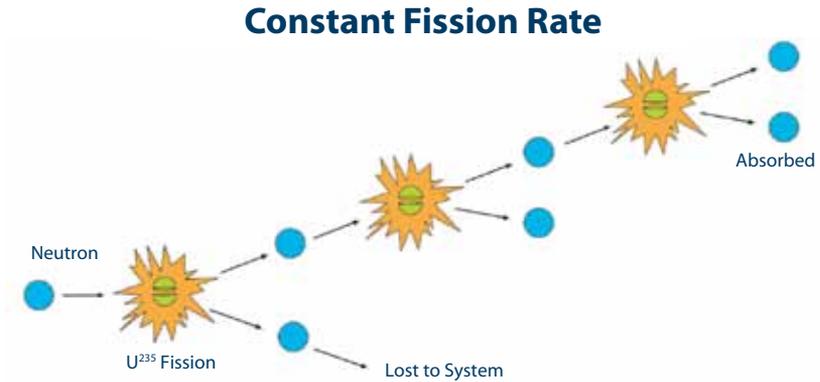


Figure 9: This reaction is “critical.”

If one kilogram of uranium or plutonium were to be completely fissioned, a large amount of energy would be released. If all of that energy were released at a constant rate, over one day, in a nuclear reactor, it could be used to produce 20,000,000 kilowatt hours of electricity, or enough to light a city the size of Washington, DC during that day. To obtain the same amount of energy from burning coal, a total of 2,500 tons of coal (2.5 million times more weight) would need to be consumed.

If one kilogram of uranium or plutonium were completely fissioned in a few millionths of a second, as in a nuclear explosive device, the equivalent of 17,000 tons of high explosive energy would be released. That is about the amount of energy released by each of the nuclear weapons dropped on Japan near the end of World War II.



Very few isotopes are capable of fissioning in a way that a chain reaction will occur. The only naturally occurring isotope which can do so is U235. Natural uranium, as it is mined from the ground, consists almost entirely of U238 (99.3% of the uranium); only 0.7% is the fissionable U235. To achieve the rapid chain reaction necessary for an explosion, the U235 content must be at least 20%, although the United States typically uses uranium “enriched” to 90% U235 or more in its weapons.

Special technologies must be used to enrich uranium. Nuclear reactors can be designed to operate with natural uranium fuel, although those used at U.S. power plants and those common in most other countries are designed to use uranium only slightly enriched in the U235 isotope.

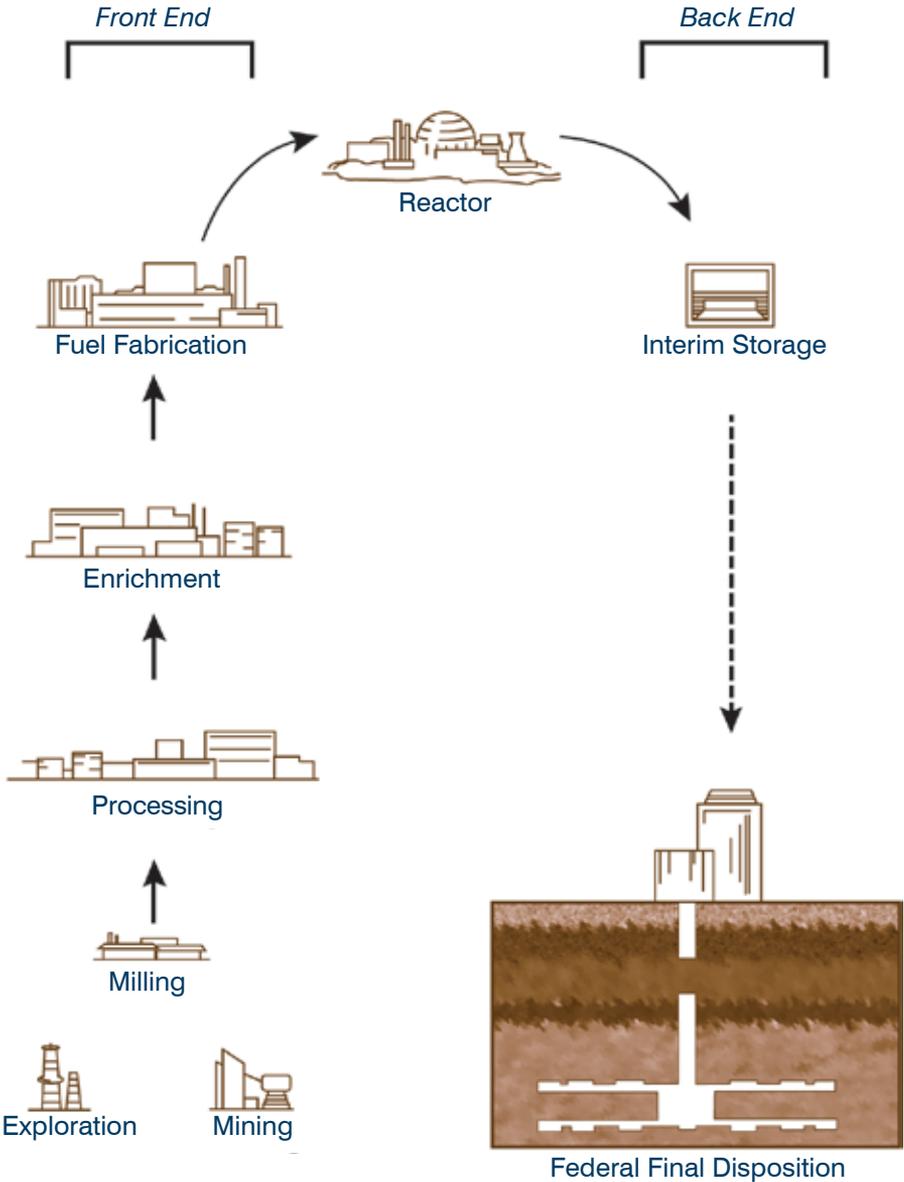
CREATION OF PLUTONIUM

Both types of reactors produce plutonium, which is fissionable. Unlike uranium, plutonium only exists in nature in trace quantities and is predominantly a man-made element. It is created through a process called transmutation, in which uranium is turned into plutonium. If an atom of U^{238} absorbs a neutron, it becomes U^{239} . U^{239} is unstable and undergoes radioactive beta decay to become Np^{239} . Np^{239} is also radioactive and it undergoes radioactive beta decay to become Pu^{239} . Thus, by absorbing a neutron, U^{238} , the most abundant (and non-fissionable) isotope of uranium, can change into a new element, plutonium, which is fissionable.

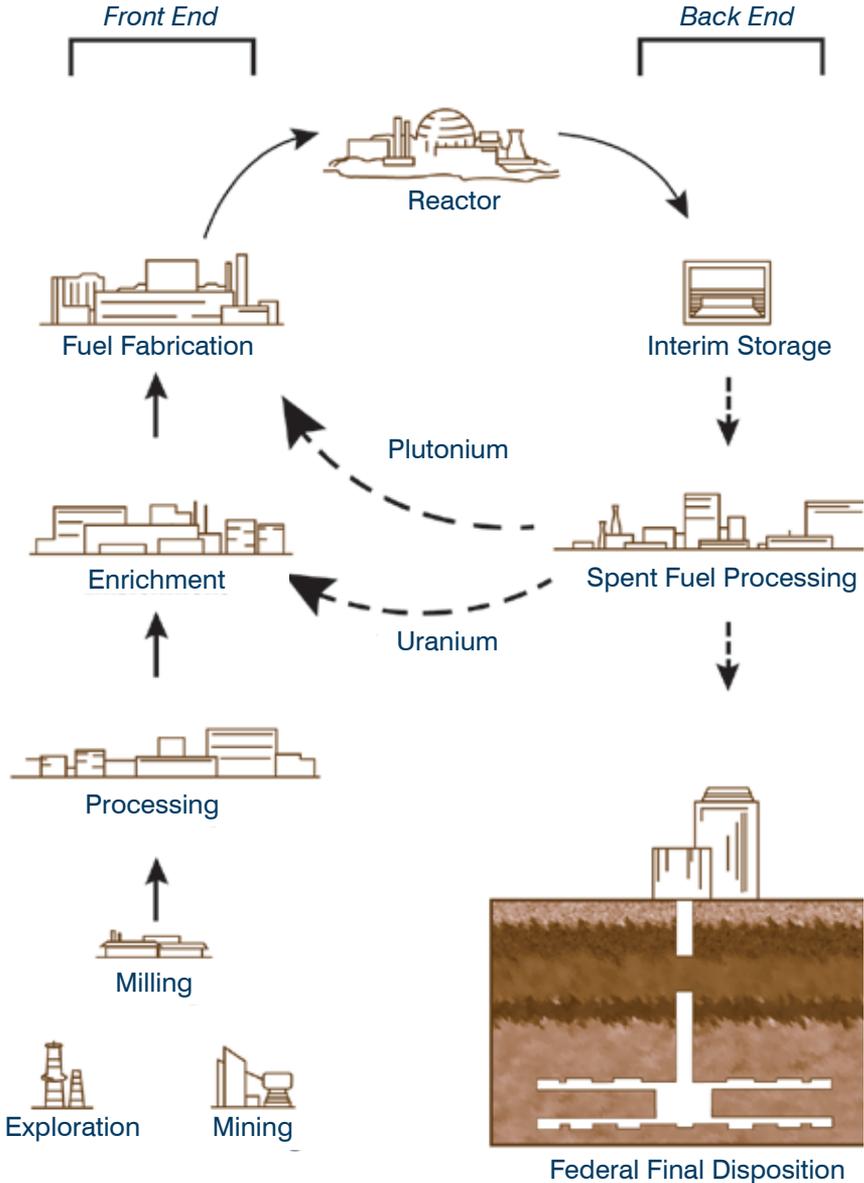
The creation of plutonium requires a source of neutrons, one of which must be absorbed by uranium to become one atom of plutonium. Recall that maintaining a controlled nuclear chain reaction in a reactor requires that the excess neutrons produced during fissioning of U^{235} nuclei be absorbed or allowed to escape. If the excess neutrons are absorbed in U^{238} , two benefits occur, a constant fission rate would be sustained and plutonium would be created. Thus, nuclear reactors are a sort of "Philosophers' Stone," the legendary substance which alchemists attempted to find to turn a base metal, such as lead, into gold. A reactor turns the "base metal" uranium into the "gold" of plutonium.

For the plutonium atoms to be of use in a weapon, they must be separated from the remaining uranium and the radioactive fission products which result from the chain reaction. Such a separation process is carried out in a chemical separations plant, also referred to as a reprocessing plant. Thus, the plutonium atoms are actually created in the nuclear reactor, but in order to be useable, they are separated through reprocessing. Both reactors and reprocessing facilities are thus necessary to obtain plutonium for use in nuclear weapons or other explosive devices.

ONCE-THROUGH NUCLEAR FUEL CYCLE FOR NATURAL URANIUM REACTORS



CLOSED NUCLEAR FUEL CYCLE FULL RECYCLE OF PLUTONIUM AND URANIUM



ALPHABETICAL LIST OF ELEMENTS, SYMBOLS AND ATOMIC NUMBERS

actinium	Ac	89	dysprosium	Dy	66
aluminum	Al	13	einsteinium	Es	99
americium	Am	95	erbium	Er	68
antimony	Sb	51	europium	Eu	63
argon	Ar	18	fermium	Fm	100
arsenic	As	33	fluorine	F	9
astatine	At	85	francium	Fr	87
barium	Ba	56	gadolinium	Gd	64
berkelium	Bk	97	gallium	Ga	31
beryllium	Be	4	germanium	Ge	32
bismuth	Bi	83	gold	Au	79
boron	B	5	hafnium	Hf	72
bromine	Br	35	helium	He	2
cadmium	Cd	48	holmium	Ho	67
calcium	Ca	20	hydrogen	H	1
californium	Cf	98	indium	In	49
carbon	C	6	iodine	I	53
cerium	Ce	58	iridium	Ir	77
cesium	Cs	55	iron	Fe	26
chlorine	Cl	17	krypton	Kr	36
chromium	Cr	24	lanthanum	La	57
cobalt	Co	27	lawrencium	Lr	103
copper	Cu	29	lead	Pb	82
curium	Cm	96	lithium	Li	3
dubnium	Db	105	lutetium	Lu	71

magnesium	Mg	12	ruthenium	Ru	44
magnanese	Mn	25	rutherfordium	Rf	104
mendelevium	Md	101	samarium	Sm	62
mercury	Hg	80	scandium	Sc	21
molybdenum	Mo	42	selenium	Se	34
neodymium	Nd	60	silicon	Si	14
neon	Ne	10	silver	Ag	47
neptunium	Np	93	sodium	Na	11
nickle	Ni	28	strontium	Sr	38
niobium	Nb	41	sulfur	S	16
nitrogen	N	7	tantalum	Ta	73
nobelium	No	102	technetium	Tc	43
osmium	Os	76	tellurium	Te	52
oxygen	O	8	terbium	Tb	65
palladium	Pd	46	thallium	Tl	81
phosphorus	P	15	thorium	Th	90
platinum	Pt	78	thulium	Tm	69
plutonium	Pu	94	tin	Sn	50
polonium	Po	84	titanium	Ti	22
potassium	K	19	tungsten	W	74
praseodymium	Pr	59	uranium	U	92
promethium	Pm	61	vanadium	V	23
protactinium	Pa	91	xenon	Xe	54
radium	Ra	88	ytterbium	Yb	70
radon	Rn	86	yttrium	Y	39
rhenium	Re	75	zinc	Zn	30
rhodium	Rh	45	zirconium	Zr	40
rubidium	Rb	37			

Periodic Table

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
IA 1A																	VIIIA 8A
1 H 1.008	IIA 2A											IIIA 3A	IVA 4A	VA 5A	VIA 6A	VIIA 7A	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31	IIIB 3B	IVB 4B	VB 5B	VIB 6B	VIIB 7B	VIII 8			IB 1B	IIB 2B	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.47	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.5	81 Tl 204.4	82 Pb 207.2	83 Bi 208.9	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 ---	111 ---	112 ---	113 ---	114 ---	115 ---	116 ---	117 ---	118 ---

Side A

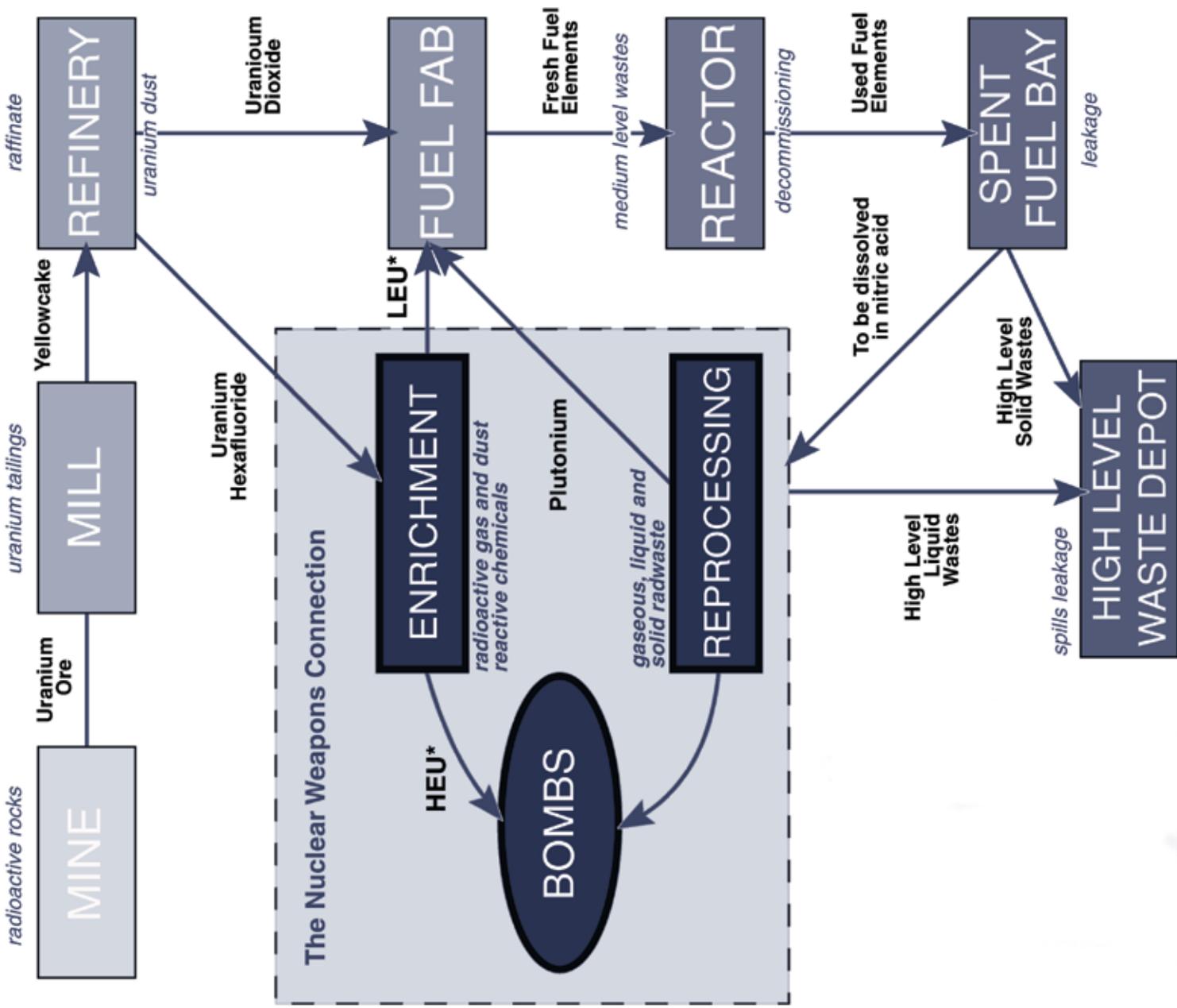
Lanthadine Series

Actinide Series

58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (147)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
90 Th 232.0	91 Pa (231)	92 U (238)	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (249)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

- Alkali Metals
- Alkaline Earth Metals
- Transition Metals
- Other Metals
- Non-Metals
- Noble Gases
- Unidentified Elements

Nuclear Fuel Chain with Nuclear Weapons Connection



*LEU = Low Enriched Uranium, usually about 3 percent U²³⁵

*HEU = High Enriched Uranium, usually over 90 percent U²³⁵



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NOTES

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