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Joint ICTP-IAEA School of Nuclear Energy Management

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Nuclear non Proliferation an Overview

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Nuclear non Proliferation an Overview

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IAEA
International Atomic Energy Agency

Outline

- From 1939 to “atoms for peace”, 1953
- The creation of the IAEA, 1953 to 1957
- The NPT
- A difficult path
- Strengthening the System
- And now?

From 1939 to “atoms for peace”, 1953

Invention and use of the bomb

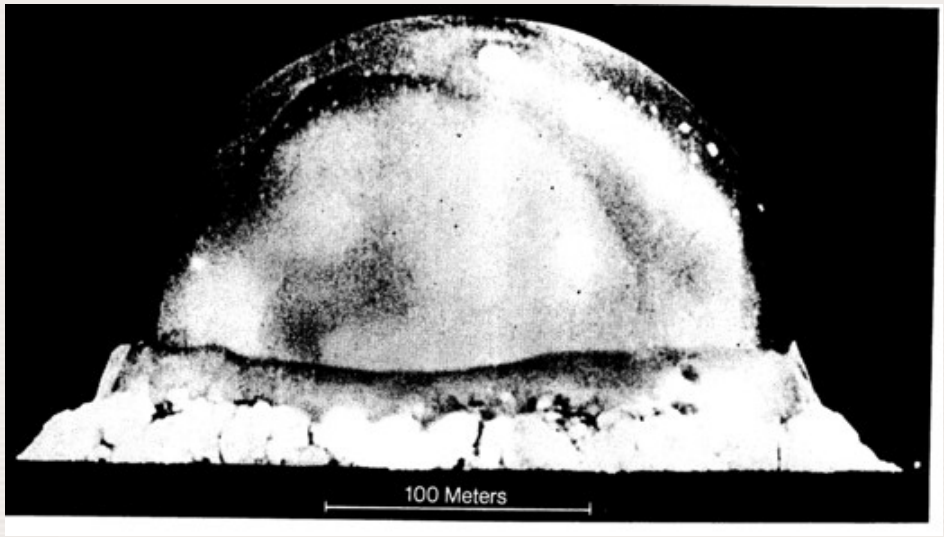
- Letter to President Roosevelt, 2 August 1939:
  - USA to arm before Germany did so.
  - Drafted by L. Szilard, E. Teller and A. Einstein

The Manhattan Project

- Started in 1942
- Secret project
- 120 000 persons
- 2 billions USD

Maj. Gen. Leslie R. Groves
Project Director

Dr. J. Robert Oppenheimer
Laboratory Director



Trinity test - the first nuclear explosion in "Jornada del Muerto", Alamogordo, New Mexico, 16 July 1945

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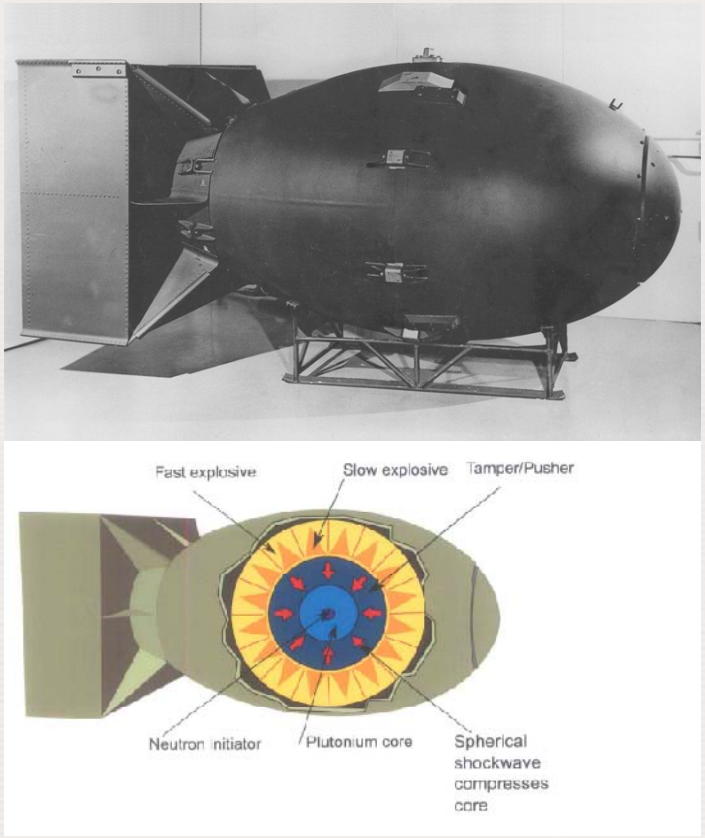
“Little Boy” and “Fat Man”

detonated in Hiroshima on 6th August 1945 (ca 15 ktons TNT)



detonated in Nagasaki on 9th August 1945 (ca 21 ktons TNT)

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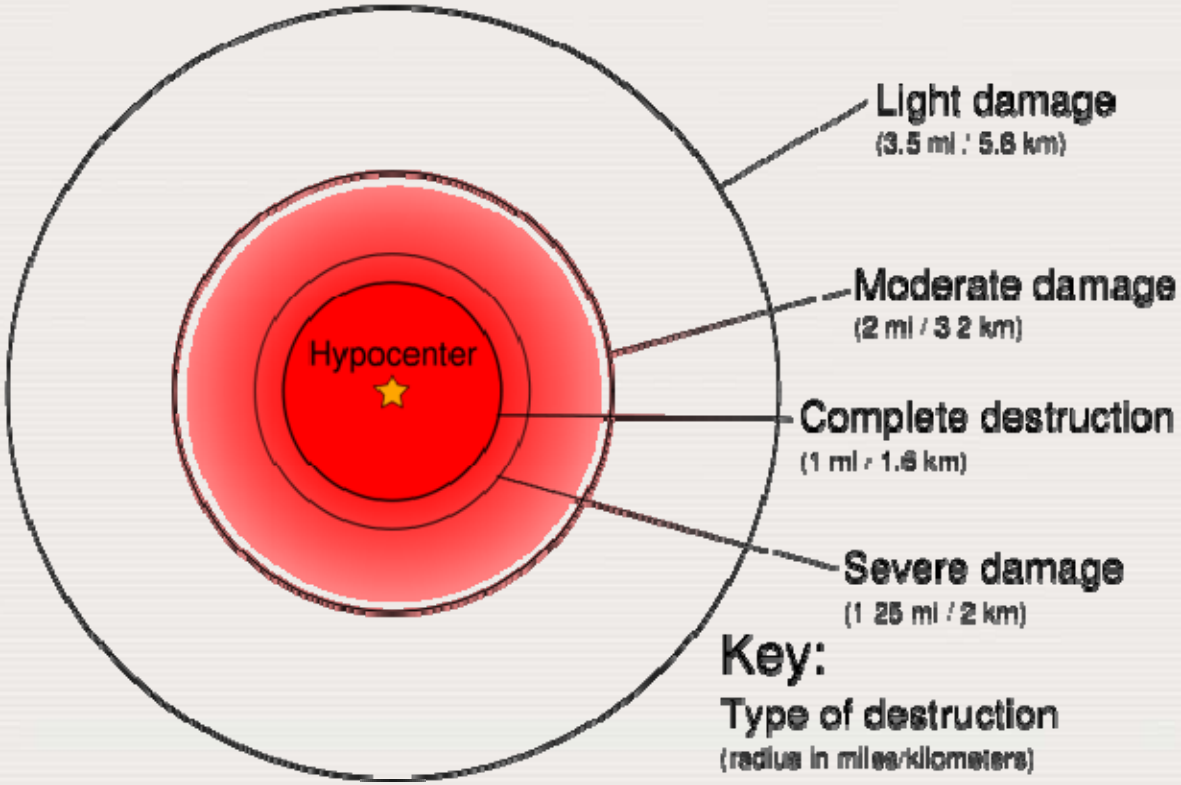
Effects of Nuclear Weapons

The energy released from a nuclear weapon can be divided into four basic categories:

- Blast—40-60% of total energy
- Thermal radiation—30-50% of total energy
- Ionizing radiation—5% of total energy
- Residual radiation—5-10% of total energy

Blast Effects



An estimate of the size of the damage caused by the Atomic bombings of Hiroshima and Nagasaki.

A modern hydrogen bomb would be tens of times more powerful and cause similar levels of damage at 2-5 times the distance.

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Blast effects

原爆投下直後のドーム／米国陸軍病理学研究所の返還資料・[財]広島市平和文化センター提供

Dome immediately after the A-bombing in 1945

Thermal Effects

On this victim of the atomic bombing of Hiroshima, the pattern of the kimono is clearly visible as burns on the skin.

When thermal radiation strikes an object, part will be reflected, part transmitted, and the rest absorbed. The fraction that is absorbed depends on the nature and color of the material. A thin material may transmit a lot. A light colored object may reflect much of the incident radiation and thus escape damage. The absorbed thermal radiation raises the temperature of the surface and results in scorching, charring, and burning of wood, paper, fabrics, etc. If the material is a poor thermal conductor, the heat is confined to the surface of the material.

At Hiroshima, "shadows" were burnt into the walls by the flash burn of the thermal radiation.

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Radiation Effects

- Central nervous system dysfunction
- Gastrointestinal damage
- Uncontrolled internal, gums and skin bleeding
- Massive infections – Death

Delayed radiation:

- Everything in the vicinity of the explosion becomes radioactive
- Hiroshima: “Black Rain” containing radioactive fallout poured down over a large area for about 7 hours, starting 45 minutes after the explosion
- 1/3 of original fissile material not destroyed
- Widespread contamination
- Increased risk of developing cancer for survivors

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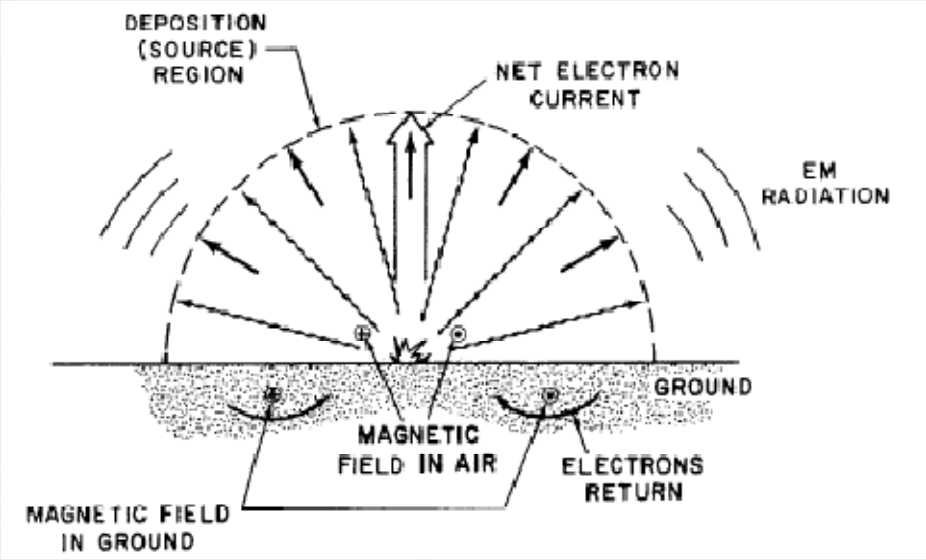
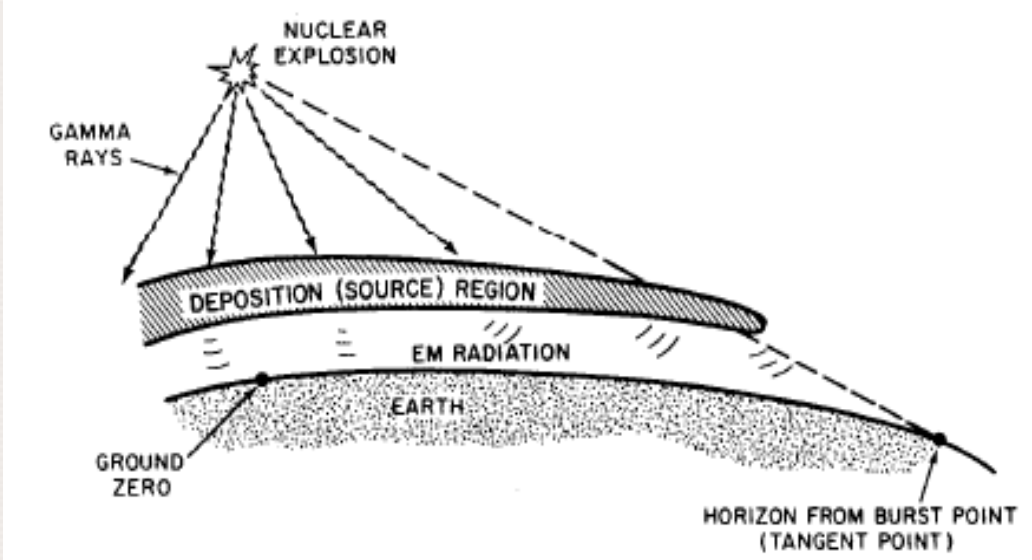
Electromagnetic Pulse





Deposition Region: ionized region created between gamma rays and air molecules and atoms

Electric field attains its maximum in about 10^{-8} seconds. It can be millions of time greater than in ordinary radio waves and can create a pulse of 12 000 amperes in a power line

1945-1953

1945	United States explodes nuclear bombs over Hiroshima and Nagasaki, Japan.	
1946		United Nations establishes UN Atomic Energy Commission. **Baruch Plan** - the United States would give up its nuclear weapon program after all other states had ceded their nuclear materials to international control. The Soviet Union opposed the plan as too advantageous to the United States and wanted the United States to turn over its nuclear weapons before other countries gave up their nuclear materials.
1949	USSR tests first nuclear weapon.	
1950	United States and USSR arms race begins.	
1952	United Kingdom tests first nuclear weapon	
1953		U.S. President Dwight Eisenhower established the **"Atoms for Peace"** program through which the United States concluded nuclear cooperation agreements with 40 friendly countries between 1956 and 1959. As a result, 26 states that accepted U.S. safeguards on U.S.-origin nuclear materials and equipment against military use of nuclear technology were provided with research reactors, nuclear training, and reactor fuel (fissionable material). The Soviet Union developed a similar program during this period to provide peaceful nuclear technology to nations in its orbit.

A first step towards Atoms for Peace
Eisenhower's Speech at the UN, 8 December 1953

- "An international Agency for Atomic Energy"
- Under the UN
- Responsible for Nuclear Material (NM)
- Promote peaceful applications of atomic energy.
- Verification of peaceful use of nuclear material

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1954-1961: IAEA was born

1954	Brazil begins long-term effort to develop nuclear weapons technology.	
1955	Argentina begins long-term nuclear research program retaining the option to develop nuclear weapons.	
1956		1956-1959 40 nations participate in Atoms for Peace program.
1957		The IAEA is established.
1958		EURATOM - Western European nuclear cooperation organization is established. 1958-61 UN Non-Proliferation Treaty proposal debate on stopping proliferation without tying it to stopping the arms race.
1960	France conducts first nuclear weapon test. At that time, several countries were actively researching nuclear technologies, including among others, Germany, Israel, India, Italy, Japan, Sweden, and Switzerland.	
1961		IAEA Information Circular 26 - first set of uniform safeguards for nuclear reactors is published. The treaty of Antarctica enters into force; prohibits nuclear testing or any military use of Antarctica.

The First General Conference of the IAEA 1st to 23rd October 1957

"Wiener Konzerthaus"

The Mandate: IAEA Statute (1957)

IAEA statute (Art III – A.5):

The Agency is authorized (…)

- to establish and administer safeguards designed to ensure that **special fissionable and other materials, services, equipment, facilities, and information** (…) are not used in such a way as to further any military purpose
- And to apply safeguards to **any of that State's activities in the field of atomic energy**
  - **At the request of the parties, to any bilateral or multilateral arrangement**
  - **At the request of a State**

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Relations With the United Nations

UN Headquarters in New York

Article XVI:

- Annual Report to the UN General Assembly
- Report to the Security Council

Result:

- Autonomous independent, science and technology-based, intergovernmental organization
- Within the UN System

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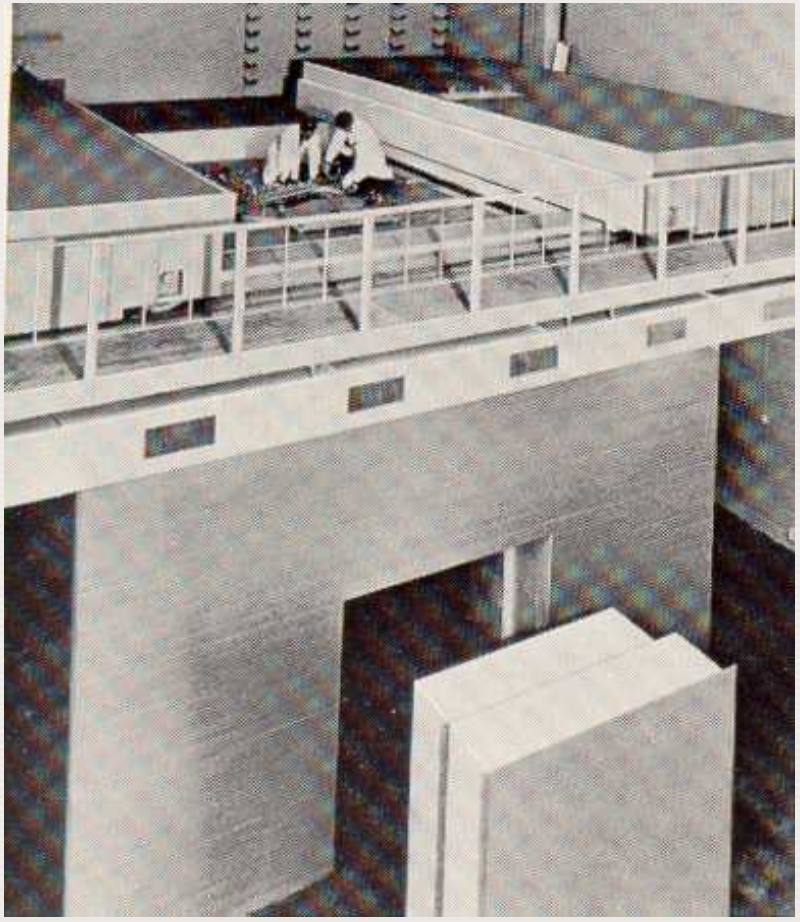
The first Safeguards Systems, 1961 and 1965/1968

The First Safeguards Systems

- The Agency's Safeguards System of January 1961: INFCIRC/26
- The first extensive Agency's Safeguards System of February 1965: INFCIRC/66
- INFCIRC/66 Rev 1 and 2 (1966 and 1968)

  Still applied for certain facilities in India, Israel and Pakistan

1962: The First Safeguards Inspection



Verification of design of a 3 MW(th) reactor in Norway

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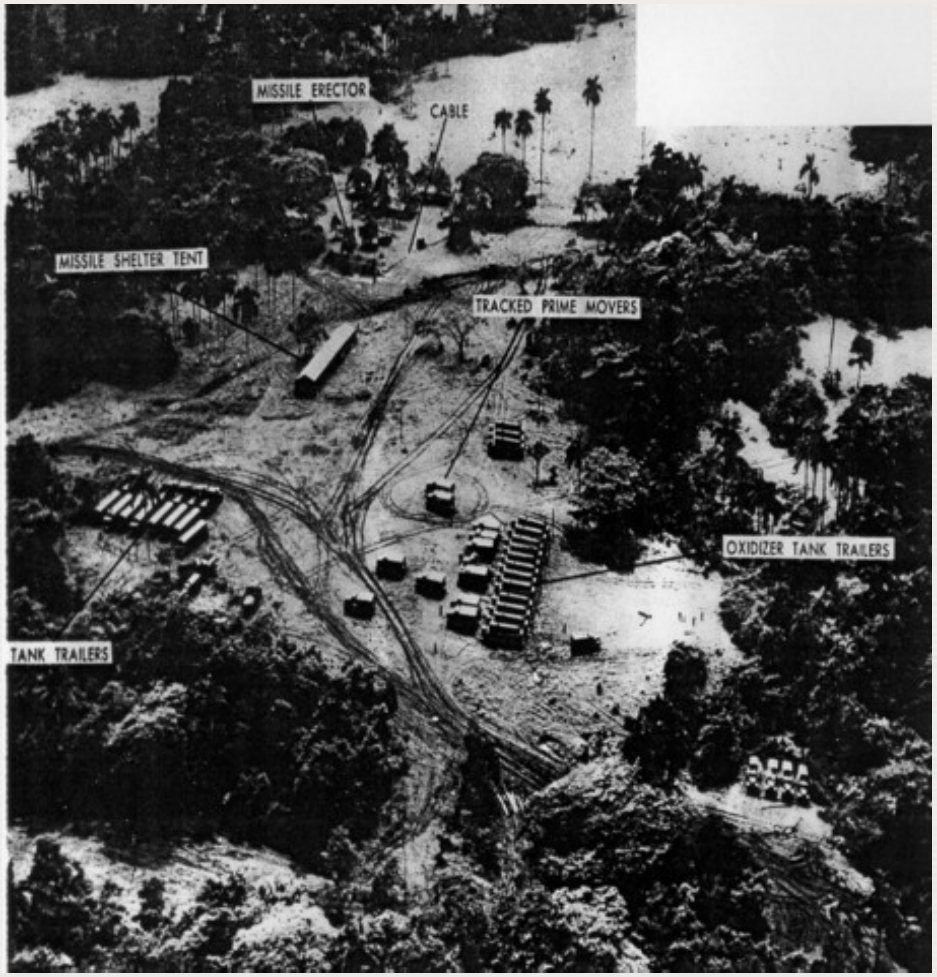
1962: CUBA


KASIMOV WITH IL-28 FUSELAGE CRATES ENROUTE TO CUBA
28 SEPTEMBER 1962
13


MISSILE ERECTOR
CABLE
MISSILE SHELTER TENT
TRACKED PRIME MOVERS
OXIDIZER TANK TRAILERS
TANK TRAILERS

1962-1970: Towards the NPT

1962	Cuban Missile Crisis brings world to brink of nuclear war.	United States, United Kingdom, and USSR sign Partial Test Ban Treaty (PTBT) prohibiting testing in atmosphere, underwater, and in outer space.
1964	China conducts first nuclear weapon test.	
1965		United Nations adopts Resolution 2028, the conceptual basis for the NPT. United States and USSR submit draft treaties to Eighteen-Nation Disarmament Committee (ENDC).
1967	Israel believed to acquire undeclared nuclear weapon capacity.	IAEA publishes broader safeguards document (INFCIRC/66/Rev.2) Latin American states conclude a regional nuclear-weapon-free zone treaty (Treaty of Tlatelolco). The Outer Space Treaty is signed, banning nuclear weapons in outer space.
1968		United States and USSR submit revised version of NPT to the Eighteen-Nation Disarmament Committee; United Nations endorses treaty. NPT opens for signature. United States and USSR promise not to use nuclear weapons against non-nuclear weapon state parties to the NPT (with limited exceptions).
1970	South Korea (not a party to the NPT) launches a secret nuclear weapons program.	NPT enters into force after three NPT nuclear weapons states (U.S., U.K., USSR) and forty non-nuclear weapons states ratify the treaty, bringing it into force.
1971		Zangger Committee is formed

NPT Treaty

- Safeguards to prevent diversion from peaceful uses
- Balanced obligations between NNWS and NWS
- Full access to peaceful uses of nuclear energy
- Security assurances

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Comprehensive Safeguards Agreements

- Negotiated at the Safeguards Committee (1970)
- Basis for negotiations: INFCIRC/153

Dr. Kurt Waldheim, Chairman of the Safeguards Committee

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A difficult path

1974	India (not a party to the NPT) detonates a nuclear device it claims to be a "peaceful nuclear explosive."	
1975	Taiwan (non-nuclear weapon state NPT party) pursues secret nuclear weapons program.	First NPT Review Conference meets. Nuclear Supplier group is created. Libya and West Germany join NPT. South Korea ends its nuclear weapon program under U.S. pressure and joins NPT.
1976	Taiwan ends nuclear weapons program.	Japan joins NPT.
1978		US Nuclear Non Proliferation Act is passed
1979	An event in the South Atlantic may have been an Israeli and/or South African nuclear test. South Africa (not a party to NPT) secretly constructs its first nuclear weapon.	
1980		Second NPT Review Conference meets.
1981	Israel destroys OSIRAQ reactor in Iraq, fearing Iraq would use reactor for a nuclear weapons program despite application of IAEA safeguards to the facility.	
1982	Iraq (NPT party) believed to accelerate clandestine nuclear weapons program in violation of NPT.	

A difficult path

1985	Romania secretly violates IAEA safeguards by producing small quantity of plutonium.	Third NPT Review Conference meets. North Korea ratifies NPT, but delays implementation of IAEA safeguards.
1989	Pakistan (not a party to NPT) believed to acquire undeclared nuclear weapons.	
1991	U.K. conducts its last nuclear test. Iraq defeated in Persian Gulf War; under UN Security Council Resolution 687, UN Special Commission (UNSCOM) inspections begin.	Republic of South Africa joins NPT as a non-nuclear weapon state after dismantling its arsenal of nuclear warheads. Argentina and Brazil formally renounce nuclear weapons and agree to mutual inspections under the Argentine-Brazil Agency for Accounting and Control (ABACC).
1992	New leadership in Romania exposes earlier clandestine plutonium separation and reiterates commitment to NPT. North Korea permits IAEA inspections under NPT, following a five-year delay. IAEA inspectors detect undeclared production of plutonium and seek further special inspections to determine the scale of undeclared nuclear activities, which North Korea refuses.	IAEA Action Team together with UNSCOM inspectors find evidence of secret Iraqi nuclear weapons program in violation of Iraq's obligations under NPT. China joins NPT as nuclear weapon state (NWS); France joins NPT (as NWS); Russia, as successor to USSR, joins NPT (as NWS).
1994	North Korea's refusal to allow special inspections leads to international crisis and threat of war; crisis defused when North Korea and U.S. sign "Agreed Framework" freezing apparent North Korean nuclear weapons program.	Kazakhstan and Ukraine join the NPT as NNWS, return all Soviet nuclear warheads to Russia by 1995 and 1996, respectively.

Strengthening the System

The Additional Protocol

- Negotiated at the “Committee 24”
  - (Open ended Committee appointed by the Board)
- Approved on 15 May 1997
- Additional legal authority
  - Information on the nature and location of all the nuclear activities and all the nuclear related activities
  - Physical access to relevant locations and not only to strategic points
- Signed by 123 states (as of **09 July 2009**)
  - In force for 91 states

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Resolution 1540, UN Security Council

- 28 April 2004: States to establish and enforce domestic controls to prevent proliferation of WMD
- UNSC Committee to follow up resolution and report to the UNSC
- IAEA to assist the UNSC Committee
- Legal background for the US Proliferation Security Initiative (2003)?

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1995: NPT extended indefinitely, but…

1995		Argentina joins NPT as a NNWS. **Fifth NPT Review and Extension Conference meets and extends NPT indefinitely.** Southeast Asian countries open regional nuclear-weapon-free zone treaty (Bangkok Treaty) for signature.
1996	U.S. intelligence estimates North Korea possesses one or two nuclear weapons in violation of its NPT commitments. China and France conduct their last nuclear tests.	The Pelindaba Treaty establishes an African NWFZ. The Comprehensive Nuclear Test-Ban Treaty (CTBT) is opened for signature.
1997		AP
1998	India and Pakistan conduct nuclear tests.	Brazil joins the NPT as a NNWS.
2002	In December, North Korea expels IAEA inspectors monitoring the country's nuclear facilities. IAEA claims it has no means of monitoring activities at DPRK facilities.	

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1995: NPT extended indefinitely, but…

2003	**Iran:** IAEA DG was informed by Iran of its uranium enrichment programme and of undeclared import of uranium in 1991. **Iraq:** On March 17, the Agency ceased its UNSC verification activities in Iraq and had found no evidence or plausible indications of the revival of a nuclear weapons programme in Iraq. **Libya**: On December 19, Libya announced its decision to "eliminate…material, equipment and programmes which lead to the production of internationally proscribed weapons". On December 20, Libya informed the Agency that it had been engaged for more than two decades in the development of an undeclared uranium enrichment capability. This included importing uranium feed material and conversion and centrifuge equipment and the construction of now dismantled pilot scale centrifuge facilities. Libya acknowledged having received documents related to nuclear weapon design in early 2002. These documents were sealed by the Agency and removed from Libya in January 2004	

An extremely difficult path

2004	On February 2, Pakistani nuclear scientist, Abdul Qadeer Khan acknowledges that he provided Iran, Libya, and North Korea with the necessary designs and technology to fabricate uranium enrichment equipment. Evidence of Iran's failure, inter alia, to report on enrichment activities in 1999 and 2002	On April 28, the United Nations Security Council adopts **Resolution 1540** on nonproliferation of weapons of mass destruction
2005	**Iran:** On August 1, Iran notifies the IAEA it has decided to resume uranium conversion activities at the Uranium Conversion Facility at Isfahan and removes IAEA seals On August 11, the IAEA BoG adopts a resolution calling Iran to reestablish full suspension of enrichment related activities and to reinstate IAEA seals. On September 24, the IAEA BoG adopts a resolution finding Iran in breach of non-compliance in the implementation of SG June: creation of a Special Committee on SG and Verification	The 2005 Nonproliferation Review Conference is held at UN Headquarters in New York May 2-27. **The Conference fails to reach any substantive agreement.** On October 6, the Norwegian Nobel Committee awards the IAEA and DG Mohamed El Baradei the 2005 Peace Prize.

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An extremely difficult path

2006	On October 9, DPRK announced that it had carried out an underground nuclear test On December 4, British Prime Minister Tony Blair presents a paper “The future of the UK’s Nuclear Deterrent” to retain Britain’s nuclear capacity.	On July 31, the United Nations Security Council (UNSC) adopted **resolution 1696** (2006), inter alia, demanding, that Iran suspend all enrichment-related and reprocessing activities, including research and development (R&D) to be verified by the Agency On September 8, the five Central Asian states signs a treaty establishing a Central Asia Nuclear Weapons-Free Zone (CANWFZ) in Semipalatinsk, Kazakhstan. The Security Council adopted **resolution 1718** (2006) in which it demanded, inter alia, that the DPRK return to IAEA safeguards On December 23, the UNSC unanimously adopts **resolution 1737** calling Iran to suspend all proliferation sensitive nuclear activities, including those related to uranium enrichment, plutonium reprocessing, and the development of nuclear weapons delivery systems.

An extremely difficult path

2007	**DPRK:** In March, pursuant to a request from the States in the Six-Party talks process and at the invitation of the DPRK, the Director General, along with a team of Agency experts, visited the DPRK. Following this visit, and subsequent expert level consultations, the Agency agreed with the DPRK on monitoring and verification arrangements related to the shutdown of the Yongbyon nuclear facility On November 4, the DPRK started the disablement of the Yongbyon nuclear facilities. **US/INDIA:** On July 27, US announced that it has reached agreement with India. **Syria:** September: destruction of a possible reactor in Syria by Israel	On 24 March, the United Nations Security Council adopted resolution 1747, in which it re-affirmed that "Iran shall without further delay take the steps required" by the BoG On April 3, Uzbekistan ratified the CANFWZ treaty. In June, the Chair of the Committee 25 presented a report (GOV/2007/27) on its conclusions to the Board of Governors and the Board took note of it.
2008	**DPRK:** the Agency continued implementing monitoring and verification measures related to the shutdown of four installations located at the Yongbyon nuclear facility and one in Taechon. These activities were partially discontinued from 22 September 2008 to 13 October 2008, at the request of the DPRK **Syria:** June: IAEA visits the Dair Alzour site in Syria. ES indicate “anthropogenic uranium”.	

An extremely difficult path

2009	March: UK proposed to reduce nuclear arsenal in disarmament deal **DPRK:** April: IAEA inspectors have been asked to leave the DPRK at the earliest possible time May 25: DPRK Nuclear test (?) **Myanmar** appears to be establishing nuclear facilities with help from North Korea and Russia, possibly with the intent of producing nuclear weapons, the *Sydney Morning Herald* reported	

Most significant tests

Date	Name	Yield	State	Significance
1945-07-16	*Trinity*	19	USA	First fission device test, first plutonium implosion detonation
1949-08-29	*RDS-1*	22	USSR	First fission weapon test by the USSR
1952-10-3	*Hurricane*	25	UK	First fission weapon test by the UK
1953-08-12	*Joe 4*	400	USSR	First fusion weapon test by the USSR (not "staged")
1954-03-01	*Castle Bravo*	15,000	USA	First dry fusion fuel "staged" thermonuclear weapon
1955-11-22	*RDS-37*	1,600	USSR	First "staged" thermonuclear weapon test by the USSR (deployable)
1957-11-08	*Grapple X*	1,800	UK	First (successful) "staged" thermonuclear weapon test by the UK
1960-02-13	*Gerboise Bleue*	70	France	First fission weapon test by France
1961-10-31	*Tsar Bomba*	50,000	USSR	Largest thermonuclear weapon ever tested
1964-10-16	*596*	22	PR China	First fission weapon test by the People's Republic of China
1967-06-17	*Test No. 6*	3,300	PR China	First "staged" thermonuclear weapon test by the People's Republic of China
1968-08-24	*Canopus*	2,600	France	First "staged" thermonuclear test by France
1974-05-18	*Smiling Buddha*	12	India	First fission nuclear explosive test by India
1998-05-11	*Pokhran-II*	45	India	First potential fusion/boosted and first deployable fission weapon test by India
1998-05-28	*Chagai-I*	40	Pakistan	First fission weapon test by Pakistan
2006-10-09		<1	DPRK	First fission device tested by North Korea; resulted as a fizzle ????
2009-05-25		?	DPRK	First successful fission device tested by North Korea ???

2005: Nobel Prize

Director General Mohamed ElBaradei addressing the media after the Nobel Committee's announcement

- The Nobel Committee announced on 7 October 2005 that Nobel Peace Prize for 2005 is to be shared, in two equal parts, between the **International Atomic Energy Agency (IAEA)** and its **Director General, Mohamed ElBaradei**
- Prize award ceremony took place in Oslo, Norway on 10 December 2005

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Towards A Safer World

Proposals of the former DG of the IAEA, Mr. El Baradei

- Limit the processing of weapon usable material in civilian nuclear programs
- Design nuclear-energy- systems avoiding materials that may be applied directly to making nuclear weapons
- Multi-lateral management and disposal of spent fuel and radioactive waste

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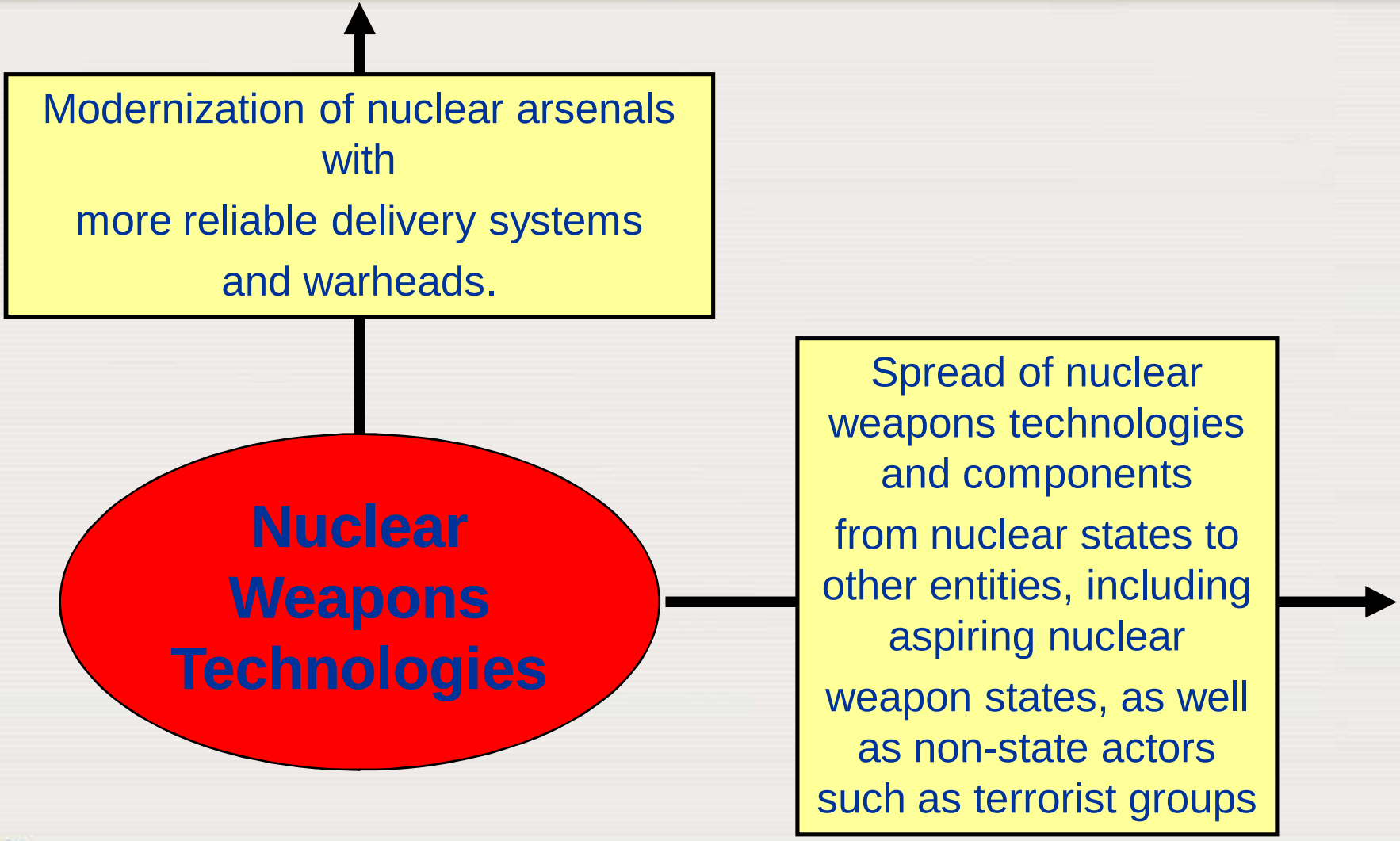
Where do we stand?

Time is running

Proliferation



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Nuclear-Weapons-Free Zones

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Main challenges

- ca. 159 000 SQ under Safeguards
- 1131 facilities under Safeguards or containing safeguarded material
- The “search for the MUF” in enrichment and reprocessing facilities
- The “Nuclear Renaissance”

Some questions….

- Will IAEA Safeguards be able keep Iran from using their nuclear programme to make bombs?
- What are the IAEA Inspectors' abilities to rummage out all of North Korea's nuclear activities?
- Will the Safeguards being proposed for India effectively prevent US and foreign nuclear cooperation from assisting New Delhi's nuclear weapons programme?

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Towards a New Nuclear age?

- Nuclear arms race in Middle East?
- Escalation of DPRK nuclear crisis?
- Proliferation spill over from the revival of nuclear power?
- Acquisition of (crude) nuclear weapons by terrorists?
- New nuclear confrontation (India/Pakistan; USA/Russia/China)?
- Renewed efforts to test and modernize existing nuclear weapons?

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Summary

The Non-Proliferation Regime:

- Genesis: “Atoms for Peace” speech
- Strengthened when NPT came in force, 1970 (INFCIRC 153)
- Challenged in international events (1974, 1981, 1987)
- Strengthened with the Additional Protocol (1991)
- Comprehensive Test Ban Treaty (CTBT)
- UNSC Resolution 1540

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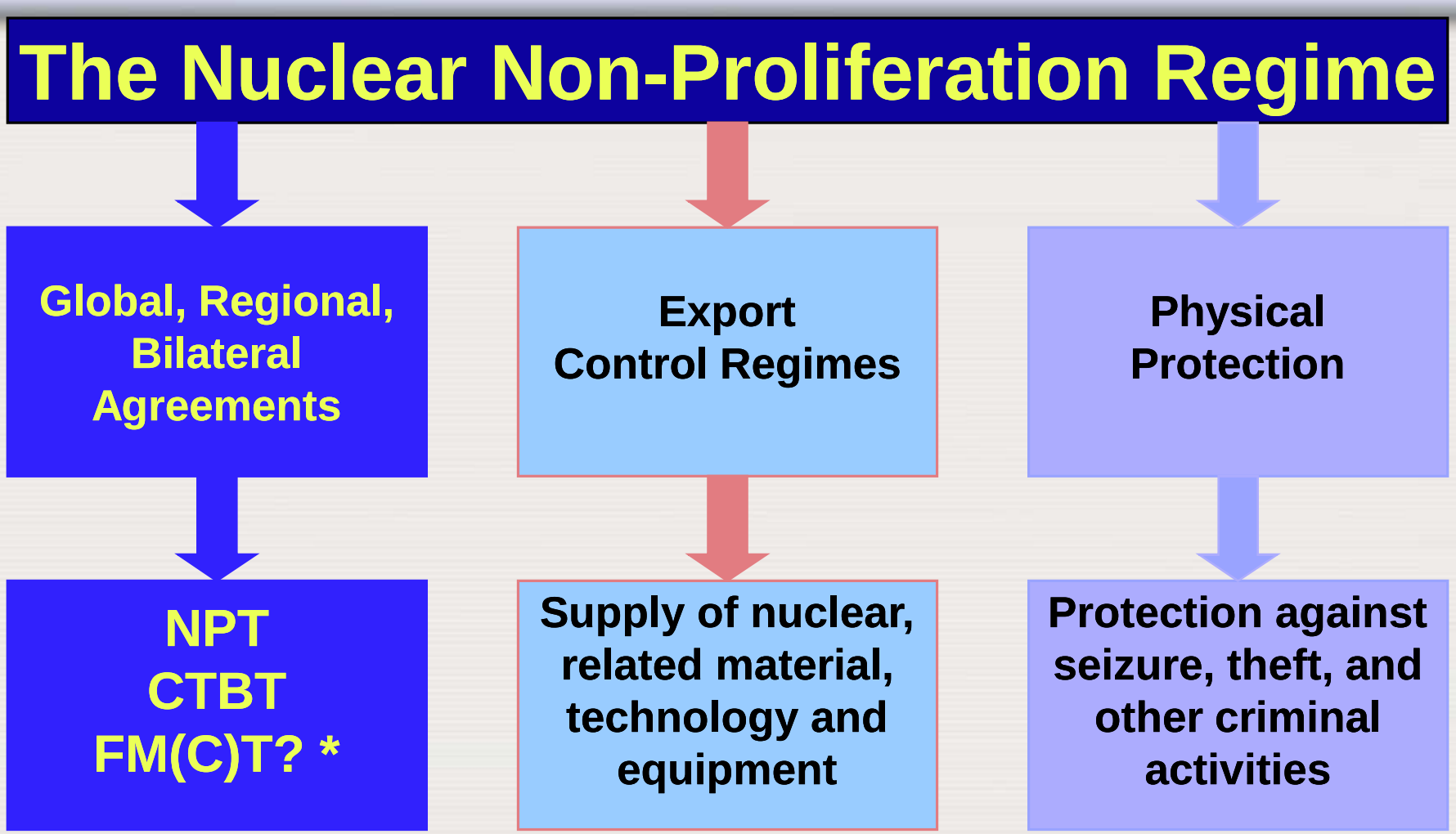
Summary (cont) + Finale



*FMCT: fissile material cutoff treaty

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