A Nuclear Weaponization Program

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Definitions

- A nuclear weaponization program involves a set of activities and facilities aimed at manufacturing and maintaining nuclear weapons. It does not include the manufacturing complex to make separated plutonium or highly enriched uranium, or “fissile material.”
- For the purposes of verification, such a program includes any nuclear weapons, partially assembled devices, components, and the means to manufacture and use nuclear weapons.

Definitions (cont.)

- A nuclear weaponization program also includes the means of making the nuclear weapons deliverable by carriers such as missiles, bombs, or glide bombs. For the purposes of dismantling a nuclear weaponization program, the means to produce any delivery systems are excluded from further consideration here.

Weaponization Program Overview

- The creation of a nuclear weaponization program requires commitment, resources, and time.
- A program needs to initially establish, at least roughly, its objectives, strategies, and policies.
- Based on progress in making nuclear explosive materials and delivery systems, a country may modify its program, seeking smaller or more sophisticated nuclear weapons.

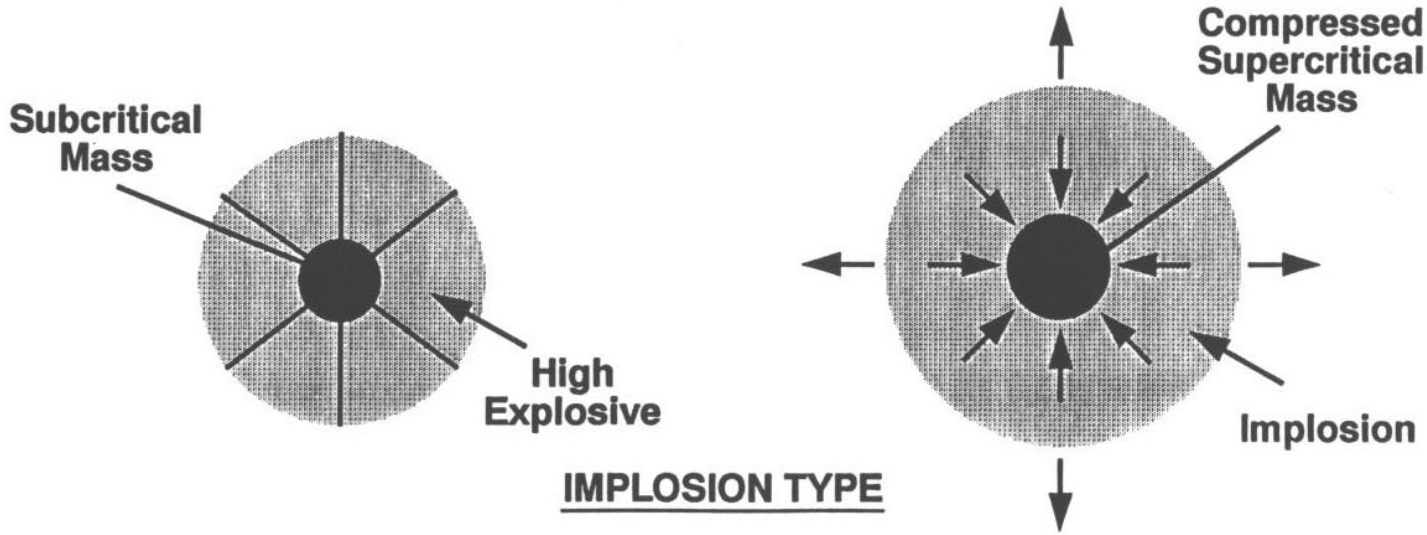
Program Objectives

- Before starting a nuclear weaponization program, decisions are required, including:
  - about the type of weapons that will be built;
  - the schedule for studying and building the first nuclear weapon;
  - the annual goal for nuclear weapons production;
  - the type of production technologies; and
  - the methods of acquiring the necessary items.

Types of Nuclear Weapons

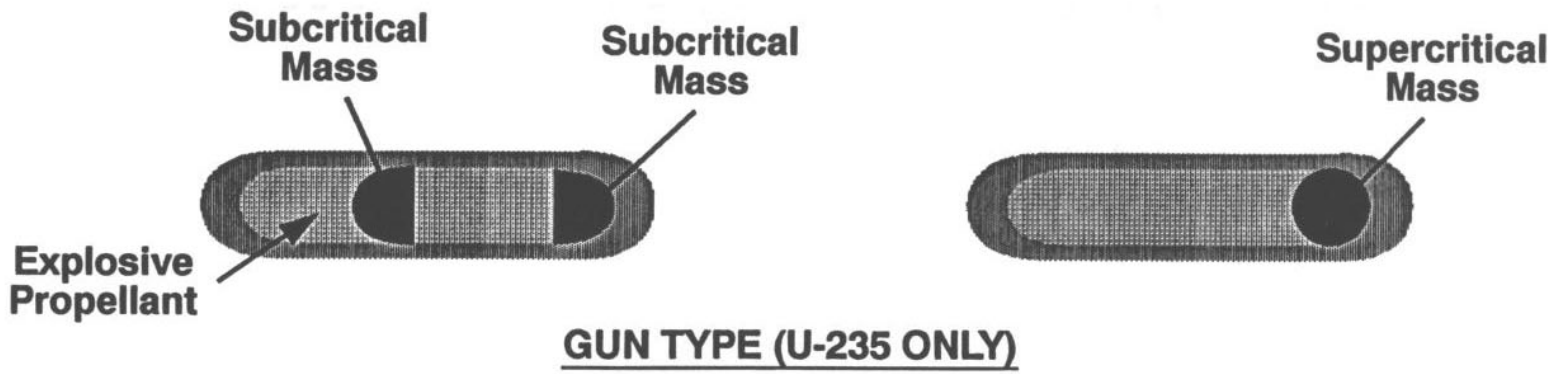
- Fission weapons: gun-type and implosion
- Boosted fission weapons
- Thermonuclear weapons

Fission Weapons – Implosion



Based on THE EFFECTS OF NUCLEAR WEAPONS, Glasstone and Dolan, 1977.

Fission Weapons – Gun-type



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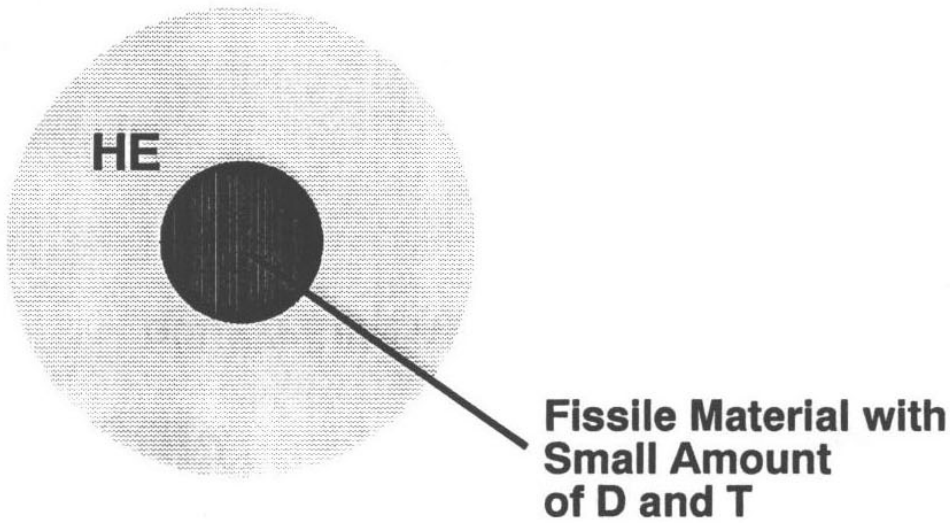
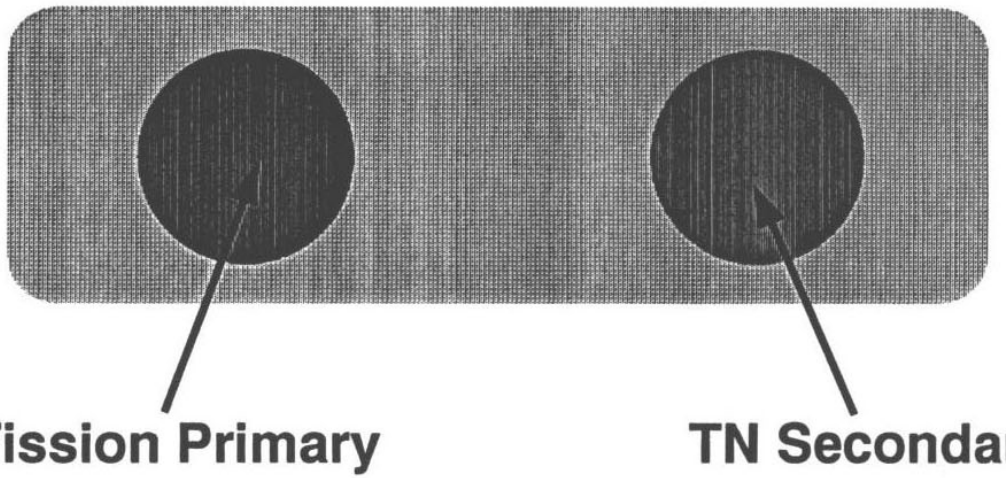
Boosted Fission Weapons



Fission → Heats D and T → Fusion Reactions
→ Increased Neutrons → Increased Fissions
Trivial TN Yield, Higher Fission Yield

Thermonuclear Weapons



"X-rays produced during the nuclear explosion of the primary transfer energy to compress and ignite the thermonuclear fuel contained in the secondary." (declassified 1979, The Progressive Case)

Illustrative Fission Weapon Program

- The following slides outline an illustrative program to make a solid-pack implosion-type fission nuclear weapon.
- The following discussion does not explicitly address gun-type nuclear weapons, which in general would have fewer tasks to accomplish. But this discussion is relevant to accomplishing a gun-type design.
- Boosted fission or thermonuclear weapons are not further considered here.

Strategies

- The program must determine the best method to acquire the industrial infrastructure to make implosion nuclear weapons.
- This program will require considerable secrecy, complicating its progress.
- Special consideration will need to be given to the foreign procurement of key items. Some items may have to be developed indigenously to reduce the chance of detection, which may take more time.

Initial Studies

- Review available literature to prepare basic ideas for a weaponization program
- Define research, development, testing, and production activities
- Identify indigenous capabilities useful for the program.

Basic Report

- A country may prepare a basic report on the overall description of the program, anticipated activities and facilities, timelines, cost, and personnel requirements.

Information in the Basic Report

- Theoretical and experimental physics, calculations, and computer codes;
- Chemistry of the preparation of explosives or propellants;
- Plans for experiments in preparing and using high explosives or propellants in the nuclear weapon;
- Plans for the testing of subsystems or mock-ups of a nuclear weapon or device;
- Chemistry of the preparation and purification of metallic uranium or plutonium.

Information in the Basic Report (cont.)

- Technical requirements for the preparation of materials, including melting and casting of metals, powders, and quality control of these activities.
- Plans for obtaining or manufacturing necessary electronics, including items to produce and supply energy, arming and fusing systems, and safety systems.

Management

- Making a reliable, deliverable fission nuclear weapon is a large undertaking.
- Personnel will likely number in the hundreds.
- A separate organization will be necessary that will plan and implement the program, administer and finance the program, and coordinate with other portions of the nuclear weapons program and the delivery systems programs.

Management (cont.)

- A senior group would need to be responsible for the final design of the nuclear weapon and the integration of all the components into a weapon.
- Such an organization would be expected initially to draw experts from an existing civil nuclear program, including specialists in radiochemistry, fuel fabrication, reactor physics, and solid state and nuclear physics.
- Such an organization would also need specialists in high explosives or propellants.

Essential Elements

- The program will need an extensive array of research, development, and testing activities.
- The program will also need manufacturing capabilities to make many of the components of nuclear weapons.

Basic Tasks in Developing an Implosion-Type Nuclear Weapon

- Theoretical Computation
- Experimentation
- Radiochemistry
- Uranium or plutonium metal production
- Engineering Services
- Non-nuclear component designs and construction
- Material experiments
- Material characteristics
- Metallurgical and powder technology

Design and Construction of Facilities

- A nuclear weapon program requires the design and construction of a variety of facilities, including research, development, and testing facilities, and a range of manufacturing sites.
- Many of the items used in these facilities may be imported from more developed countries.

Foreign Procurement

- Most nuclear weapons programs are highly secret and thus keep contacts with non-national bodies to a minimum.
- Although most countries can develop the necessary items indigenously, they have sought equipment, materials, and technology from foreign companies for their nuclear weapons programs.

Foreign Procurement (cont.)

- Countries have sought flash x-rays, streak cameras, high speed oscilloscopes, vacuum induction furnaces, isostatic presses, multi-axis CNC machine tools, and key materials.
- Countries have also sought information about nuclear weapons from both open sources and via other means.

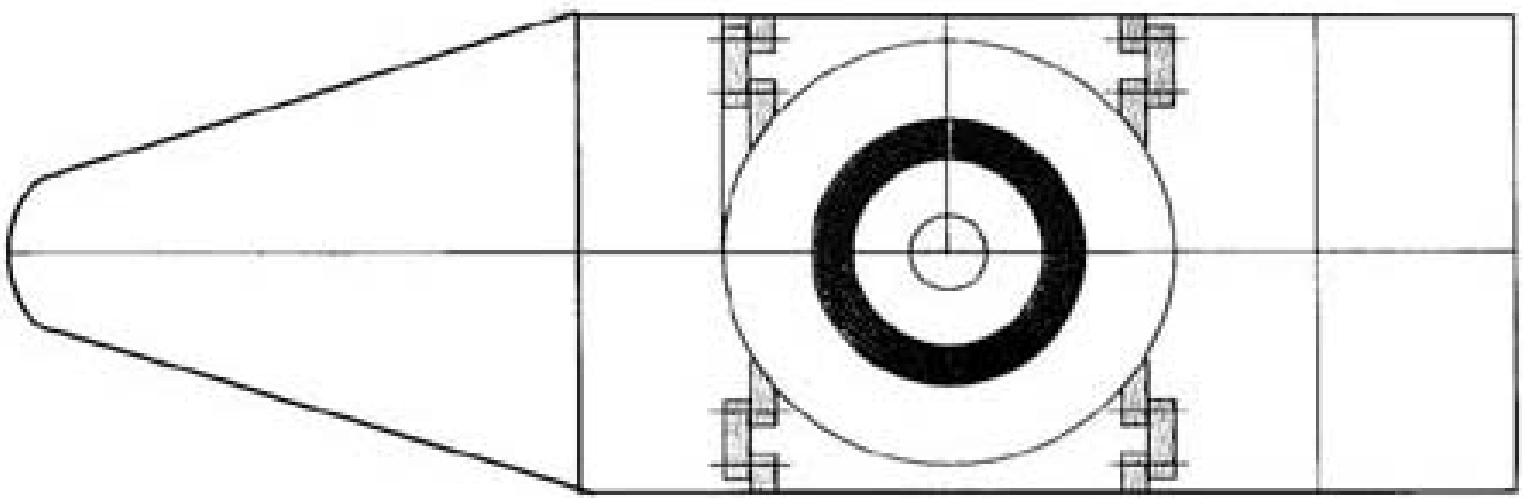
Timeline

- The time from start to the completion of a finished nuclear weapon is a few years, not including fissile material production.
- The tasks can be completed quicker if the country applies the necessary resources. On the other hand, the program can take considerably longer.
- Typically, the time needed to produce necessary quantities of fissile materials is considerably longer than that needed to build a fission weapon.

Mating to Delivery Systems

- Close coordination is required between the nuclear weapon program and the programs responsible for delivery systems.
- The overall weight and size of the nuclear weapon largely defines its delivery mode. Typically, a weapon needs to be less than a tonne to be carried by a ballistic missile.

Schematic of a Warhead for a Ballistic Missile



Assembly Facility

- A facility is needed to assemble nuclear weapons.
- A design could be a main hall with a central crane surrounded by a number of separated rooms and vaults to store the different components of the device.

Examples of Nuclear Weaponization Facilities

- Nuclear and non-nuclear component manufacturing sites
- High explosive test sites
- Nuclear weapon assembly facilities
- Nuclear weapon storage vaults
- Underground test sites

Underground Test Site

- An underground test site provides a means to demonstrate a nuclear device, verify its design, learn its yield, and improve understanding of nuclear weapons.
- A vertical shaft of about 1 meter in diameter and 300 meters deep is usually sufficient for a crude fission weapon.
- A horizontal tunnel can also be dug into a mountain.
- Containment of the explosion is straightforward.

Closing Thought

- Any strategy to verifiably dismantle a nuclear weapons program will need to take into account all the nuclear weaponization program elements discussed above.