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Total Pages 650

February 16, 1998

INTEC

sandia national laboratories

DEPARTMENT OF ENERGY DECLASSIFICATION REVIEW	
1ST REVIEW DATE: <u>6-18-78</u>	DETERMINATION (CIRCLE NUMBER(S))
AUTHORITY: <input type="checkbox"/> AOC <input type="checkbox"/> ADG <input type="checkbox"/> ADD	<input checked="" type="radio"/> 1 CLASSIFICATION RETAINED
NAME: <u>DICK CRANE</u>	<input type="radio"/> 2 CLASSIFICATION CHANGED TO: _____
2ND REVIEW DATE: <u>7-26-99</u>	<input type="radio"/> 3 CONTAINS NO DOE CLASSIFIED INFO
AUTHORITY: <u>ADD</u>	<input type="radio"/> 4 COORDINATE WITH: <u>DD</u>
NAME: <u>Philip Ulbr</u>	<input type="radio"/> 5 CLASSIFICATION CANCELLED
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Survey of Weapon Development and Technology (WR708) (U)

~~Restricted Data~~

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~~Classified By: John C. Hogan~~

~~Title/Org: Manager, DP Knowledge Integration & Ed, 5507, 8/22/97~~

~~Derived From: CG-1, 5/01/84~~

~~TCG-1, 04/86~~

~~TCG-BTS-1, 10/84~~

~~TCG-SAFF-1, 1/86~~

~~TCG-UC-2, 10/93~~

~~CRITICAL NUCLEAR WEAPON DESIGN INFORMATION - DOD DIRECTIVE 5210.2, 1985~~

~~NUCLEAR WEAPON DATA~~

~~SIGMA 1 & 2~~

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Corporate Training & Development

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SURVEY OF WEAPONS DEVELOPMENT AND TECHNOLOGY

WR708

SESSION I

- COURSE OVERVIEW
- WEAPON COMPLEX & DEVELOPMENT PROCESS

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SURVEY OF WEAPONS DEVELOPMENT AND TECHNOLOGY WR708

<u>Day</u>	<u>Time</u>	<u>Session</u>	<u>Title</u>	<u>Instructor</u>
Monday	8:00 - 12:00	1	Course Overview - Introduction	Hogan
		2	Physics - Explosion Theory	Hogan
	1:00 - 4:00	2	Physics - Explosion Theory (cont)	Hogan
		3	Nuclear Effects	Hogan
Tuesday	8:00 - 12:00	4	High Explosives - Detonators	Hogan
		5	Fission	Hogan
	1:00 - 4:00	5	Fission (cont)	Hogan
		6	Thermonuclear	Hogan
Wednesday	8:00 - 12:00	6	Thermonuclear (cont)	Hogan
		7	Safety	Layne
	1:00 - 3:00	7	Safety (cont)	Layne
		8	Use Control - Access Control	Layne
		9	Weapons Systems	Rogulich
Thursday	8:00 - 9:00	10	Dismantlement	Hogan
	9:00 - 11:00	11	Arming, Firing and Initiation	Curtis
	11:00 - 12:00	12	Nuclear Testing	Hogan
	1:00 - 4:00	13	Transfer Systems	Robinson
		14	Fuzing	Hartwig
		15	Arms Control	Layne
Friday	8:00 - 9:00	15	Arms Controls (cont)	Layne
	9:00 - 10:00	16	Non-Proliferation/Counter Proliferation	Taylor
	10:00 - 11:00	17	Stockpile Matters	Layne
	11:00 - 11:15		Summary	Hogan
	12:00 - 3:30	18	Nuclear Weapons Musuem Tour	Hogan

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WR708 - Course Objectives

What We hope you learn

- The nuclear physics principles
- Nuclear weapons engineering implementation
- Depth and breath of the nuclear weapons program
- Principles of nuclear surety
- Surety as implemented in the enduring stockpile weapons
- Operation of the enduring stockpile weapons
- Similarities/differences of the weapons
- The evolution of nuclear stockpile over the last 50 years
- The principle drivers of the nuclear stockpile over the last 50 years
- Nuclear weapons subsystem components and their evolution

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Course Themes

- Stockpile surety
- Stewardship
- Historical teaching approach
- Extensive use of hardware
- Survey of almost all aspects of nuclear weapons

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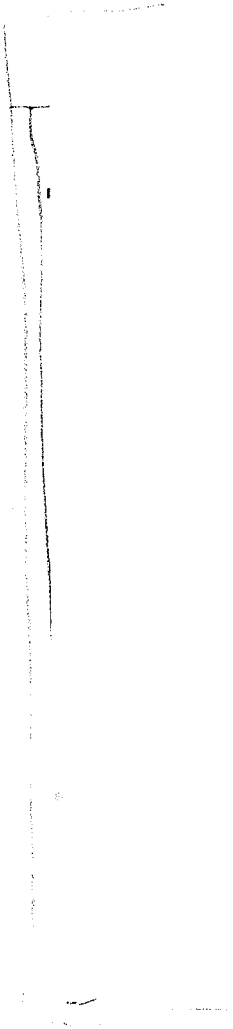
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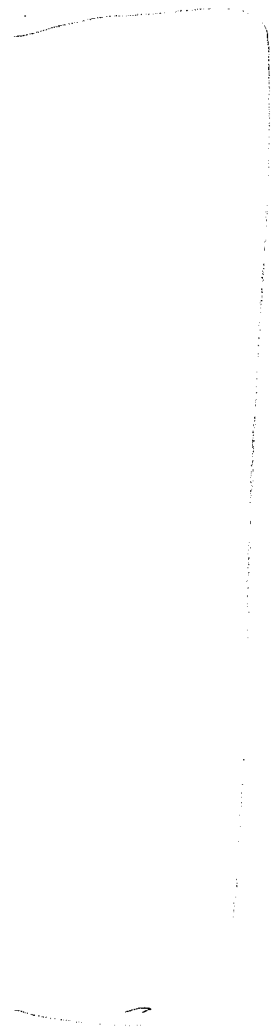


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OVERVIEW (Continued)

- There have been weapon system, aircraft and missile trades which have over the last 50 years driven the nuclear weapons community to design smaller, lighter, yet higher-yield weapons.
- A systems engineering approach is required when viewing nuclear weapons.
- Arms control is a major driver for weapons reduction.
- History and early weapon development is extremely important to the understanding of third world proliferation.

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Nuclear Weapons Development Drivers

- Nuclear surety
- Service Requirements/weapon system interfaces
 - less manpower intensive
 - less weight and volume
- National security strategy/policy
 - United States
 - CINC's
 - NATO
- Arms control
 - limit technology
 - limit growth
 - eliminate categories
 - reduce numbers

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National Security Strategy: Deterrence

<u>Decade</u>	<u>Implementation</u>
1950	Massive Retaliation
1960	Flexible Response
1970	Flexible Response
1980	Flexible Response
1990	Last Resort

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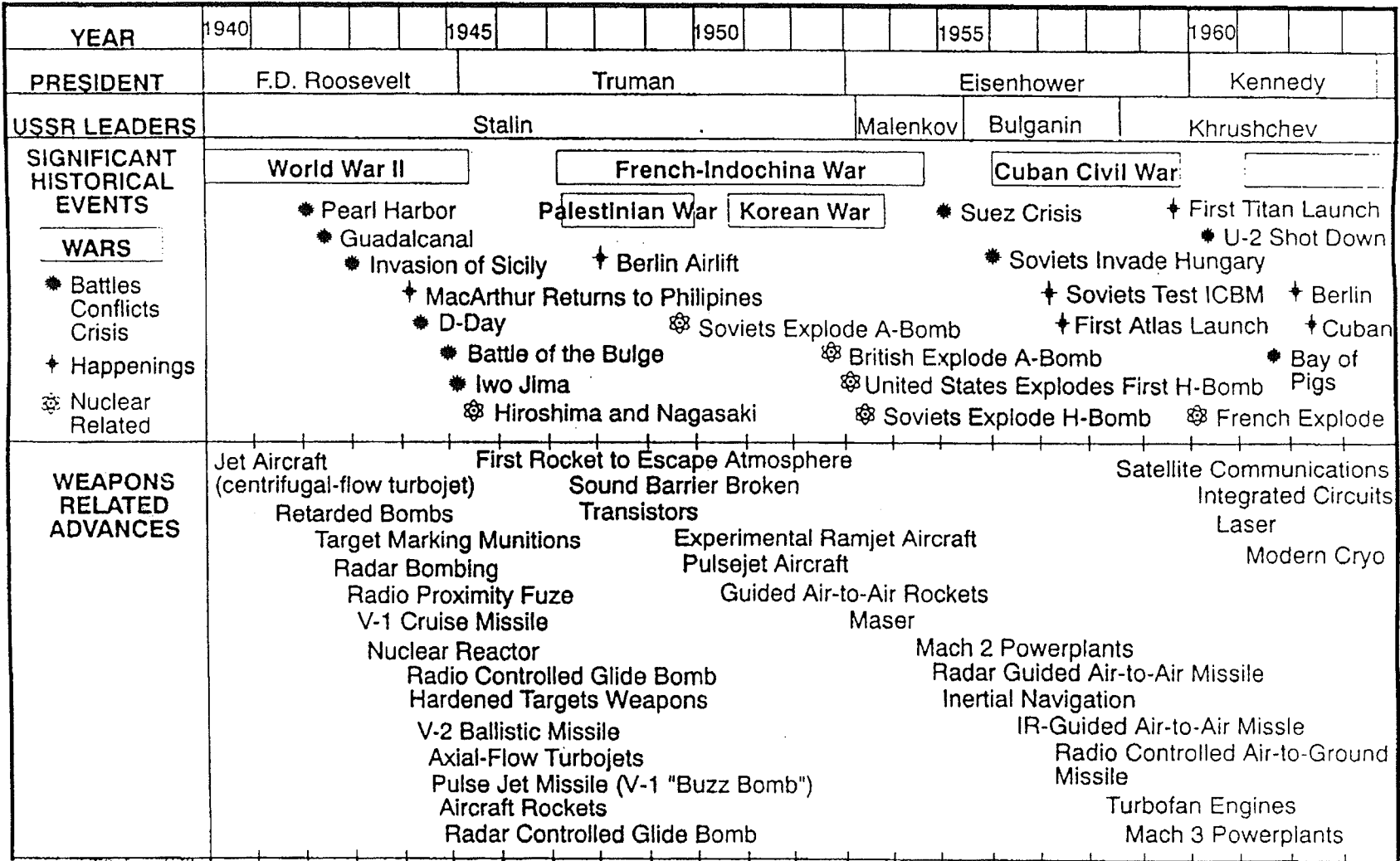
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SIGNIFICANT HISTORICAL EVENTS RELATIVE TO NUCLEAR WEAPONS

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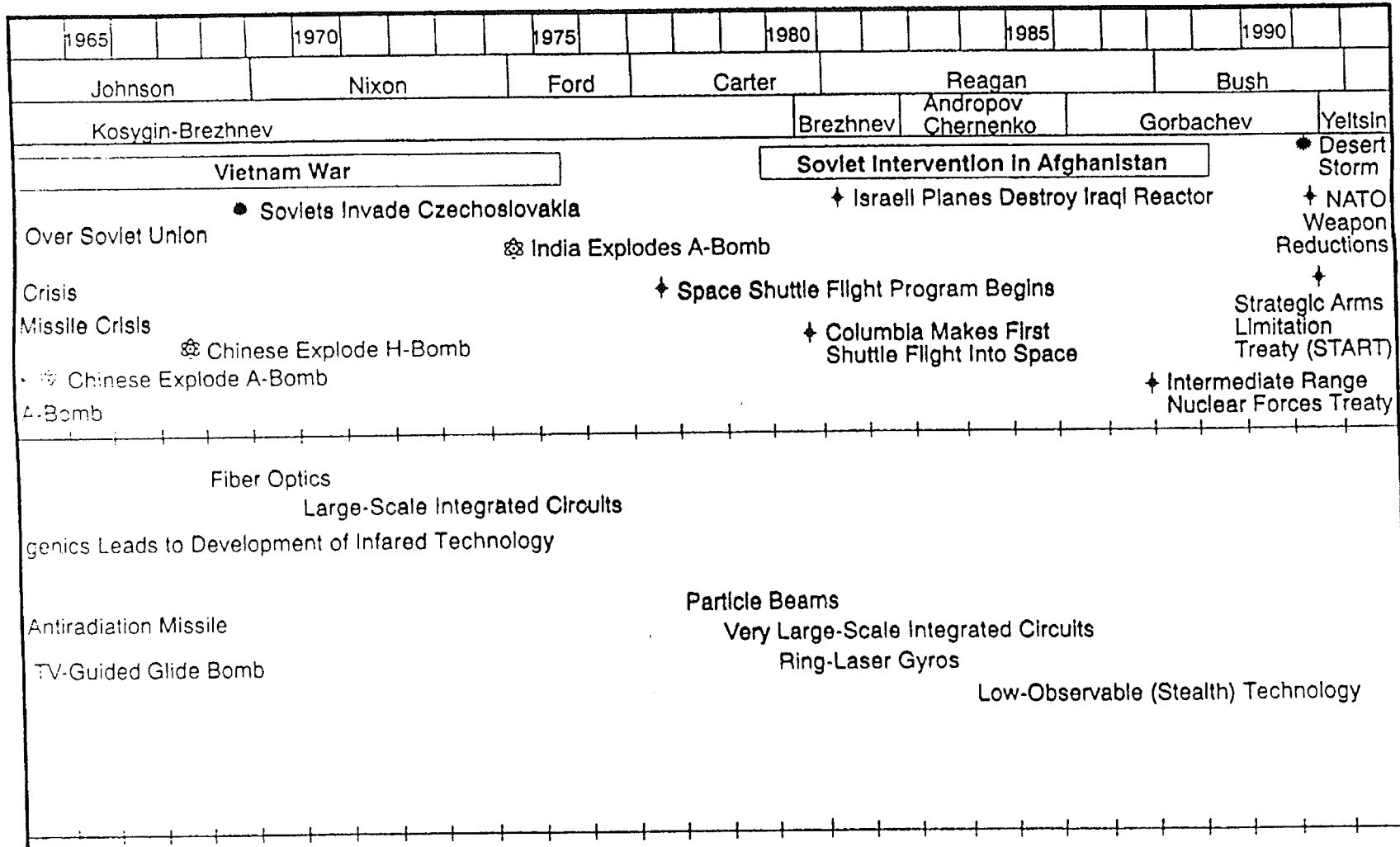


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SIGNIFICANT HISTORICAL EVENTS RELATIVE TO NUCLEAR WEAPONS

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Strategy, Arms Control, and Weapon Systems Technology Drive Stockpile Requirements

Strategy	Threat	Tech.	Size/Wt.	Yield	Arms Control	Number
1950 Massive retaliation	Global	A/C & missiles inaccurate	Large	Very high	Very limited talks	Growing
1960 Flexible response	Global Theater	A/C & missiles improve	Decrease	Decrease	Limited talks	Growing
1970 Flexible response	Global Theater	A/C & missiles improve accuracy	Decrease even more	Tactical needed lower yields	SALT ABM limitations	Decline
1980 Flexible response	Global Theater	A/C & missiles very accurate	Large decrease	Continued decrease	Mutual elimination & reduce	Decline more
1990 Last resort	Theater Global	A/C & missiles very accurate	Remain small	Remain same	Large cuts mutual elimination/unilateral	Large reduction

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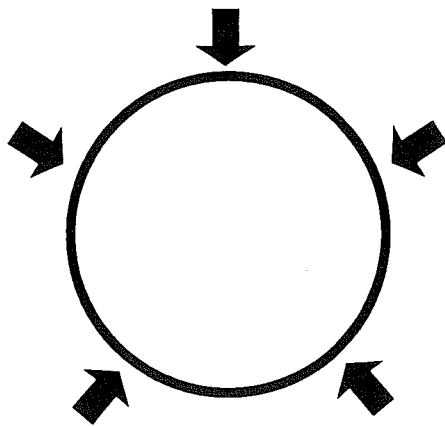
SELECTED HARDWARE ORIENTATION

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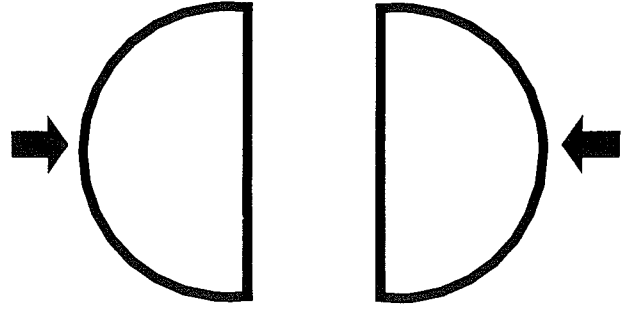
Fission Primaries

IMPLOSION



Critical Mass Achieved with Compression from HE

GUN TYPE



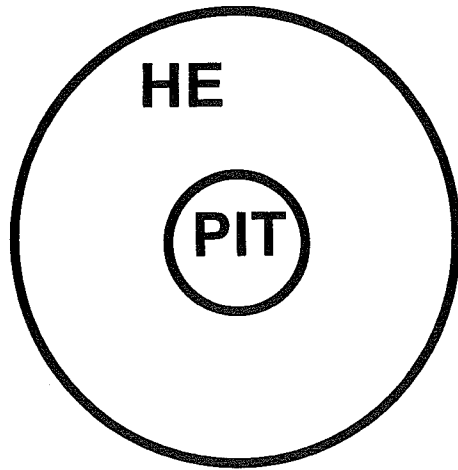
Critical Mass Achieved with "Lots of Special Nuclear Material"

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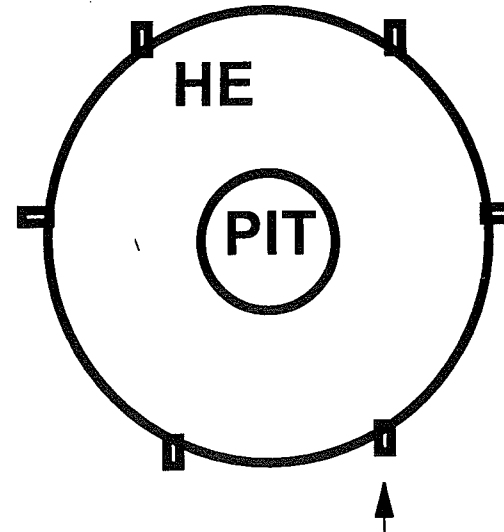
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Fission Primary



Detonators Required to Fire the HE



Original Detonators Large

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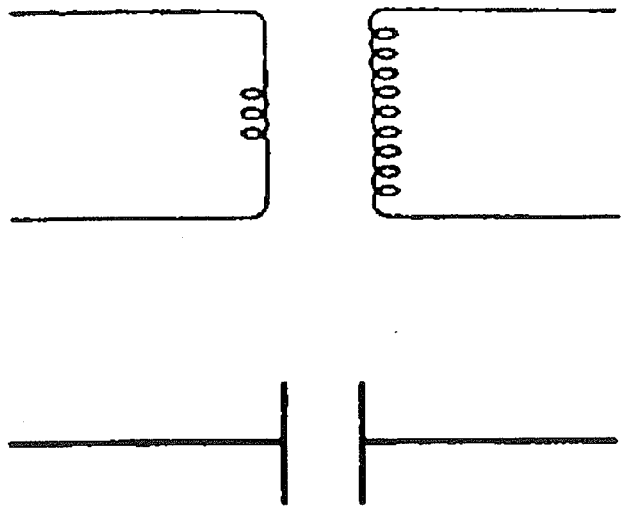
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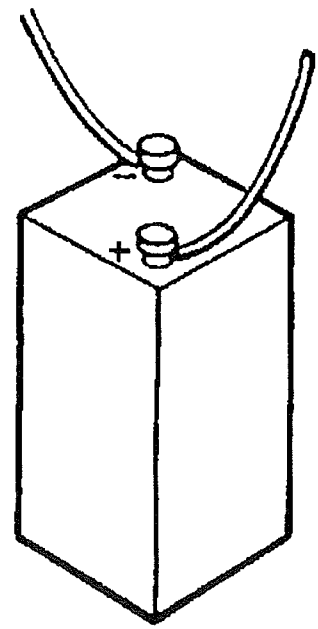
Basic Electronics Needed to Fire the Detonations

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FIRE SET
Evolved from Large to Compact



POWER SOURCES
Originally Lead Acid (car battery style)
Evolved to Thermal Batteries

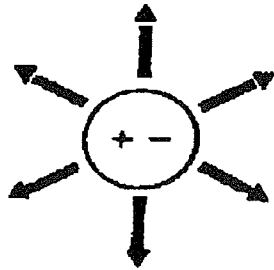
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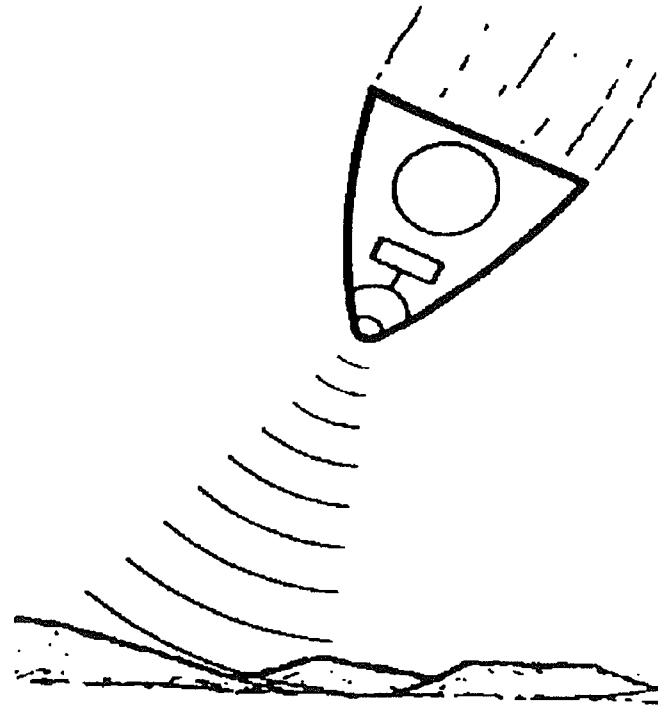
Additional Elements Required for Detonation

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Neutron Source



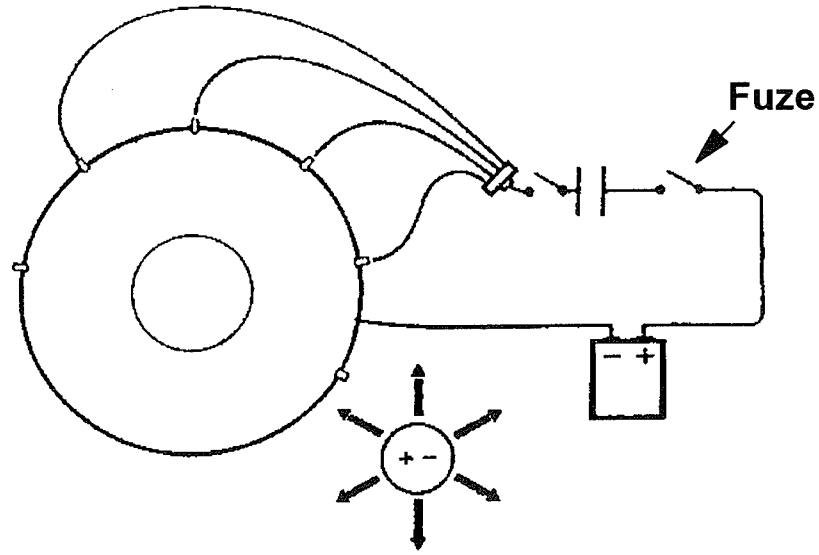
Fuzes

- Height of Burst
- Impact

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Basic Elements of a Nuclear Weapon



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GAS BOOSTING

- INITIAL FISSION RAISES BOOST GAS TO FUSION TEMPERATURES
- D.T REACTIONS RELEASE A FLOOD OF HIGH ENERGY NEUTRONS FOR FISSIONING OF O_y AND/OR Pu

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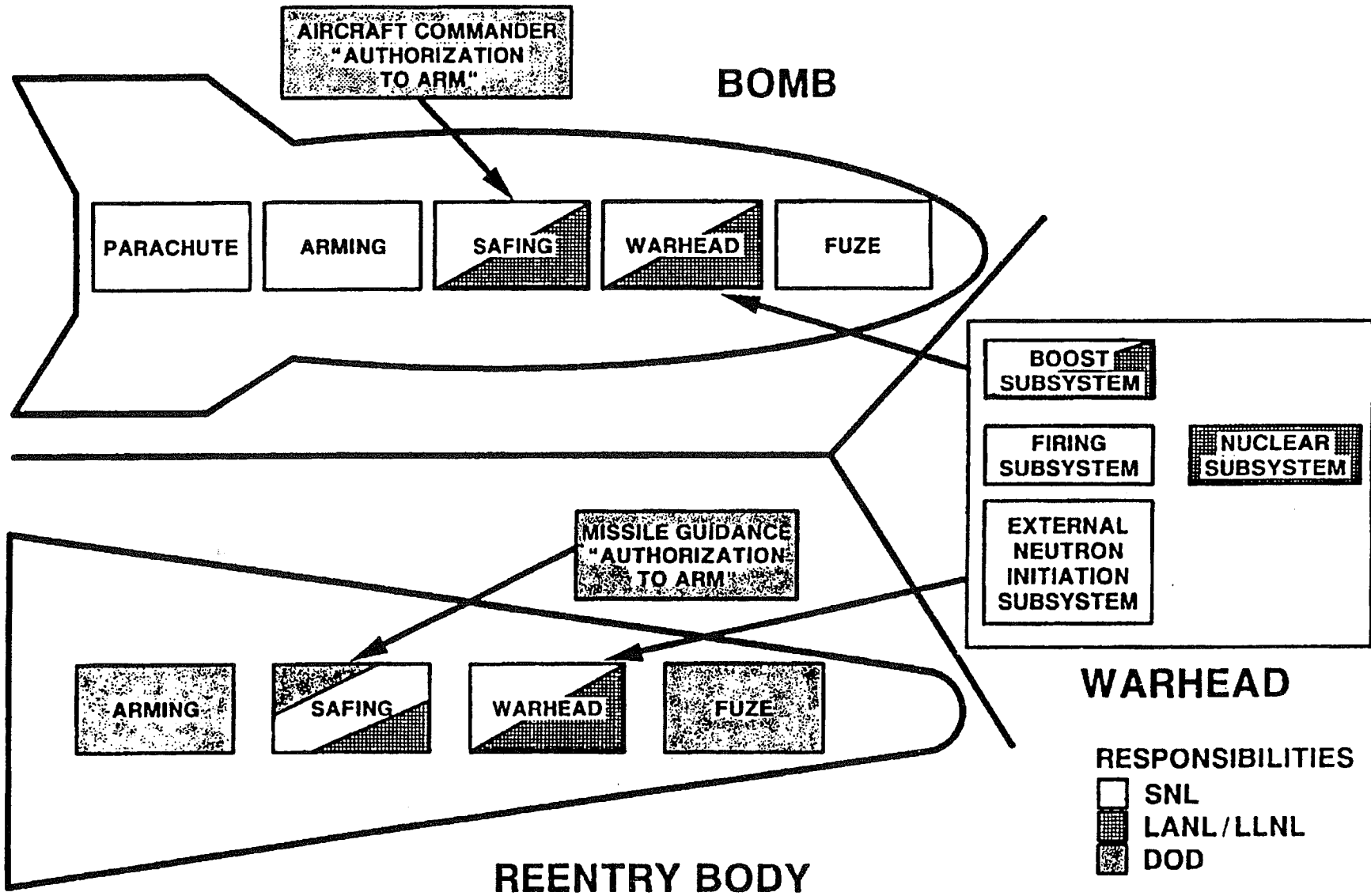
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DIVISION OF RESPONSIBILITIES

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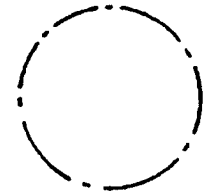


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TERMINOLOGY

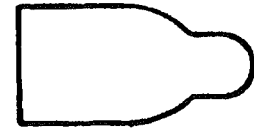
NUCLEAR PACKAGE
PHYSICS PACKAGE

➤ PRIMARY/SECONDARY
(Includes High Explosive)



NUCLEAR WARHEAD

➤ NUCLEAR PACKAGE &
WEAPON ELECTRICAL
SYSTEM & PLUMBING



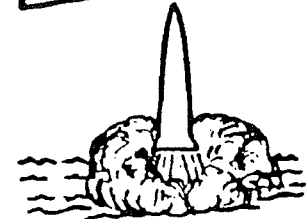
NUCLEAR WEAPON

➤ NUCLEAR WARHEAD &
ARMING & FUZING &
AERODYNAMIC CASE,
ALSO REENTRY VEHICLE



NUCLEAR WEAPON SYSTEM

➤ NUCLEAR WEAPON & DoD
DELIVERY SYSTEM



- THE TERM NUCLEAR DEVICE USUALLY IMPLIES A TEST WARHEAD BUT IS SOMETIMES USED IN A PLACE OF EITHER NUCLEAR PACKAGE OR WARHEAD

- THE ARMY USED THE TERM NUCLEAR WARHEAD SECTION TO INCLUDE WARHEAD + AK + BALLISTIC BASE

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WEAPON PROGRAM OBLIGATIONS

STOCKPILE MANAGEMENT:

MAINTENANCE OF THE NATIONAL STOCKPILE OF NUCLEAR WEAPONS IN A SAFE, SECURE, RELIABLE, READY CONDITION

WEAPONIZATION:

DEVELOP AND PRODUCE NUCLEAR WEAPONS FOR STOCKPILE AS JOINTLY AGREED TO BY DOD & DOE AND AS AUTHORIZED BY THE PRESIDENT

WEAPON TECHNOLOGY:

PURSUE TECHNOLOGY IN THE SCIENCE & ENGINEERING OF NUCLEAR WEAPONS SO THAT OUR UNDERSTANDING & ABILITY TO DEVELOP IS SECOND TO NONE

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As the nuclear weapons systems integrator for the DOE, Sandia has responsibility for:

- Fire set development--neutron generator, batteries, capacitors, etc.
- Electrical & mechanical interface compatibility
- Electrical detonation safety
- Use control & use control equipment
- Handling and ancillary equipment
- Stockpile surveillance (reliability)--testing & evaluation
- Military training & manuals
- Field support
- Weapon systems (including DoD hardware) independent evaluations
- DOE & DoD security facility upgrade
- Safe secure trailers (total life cycle) & DOE courier training
- Neutron generator production

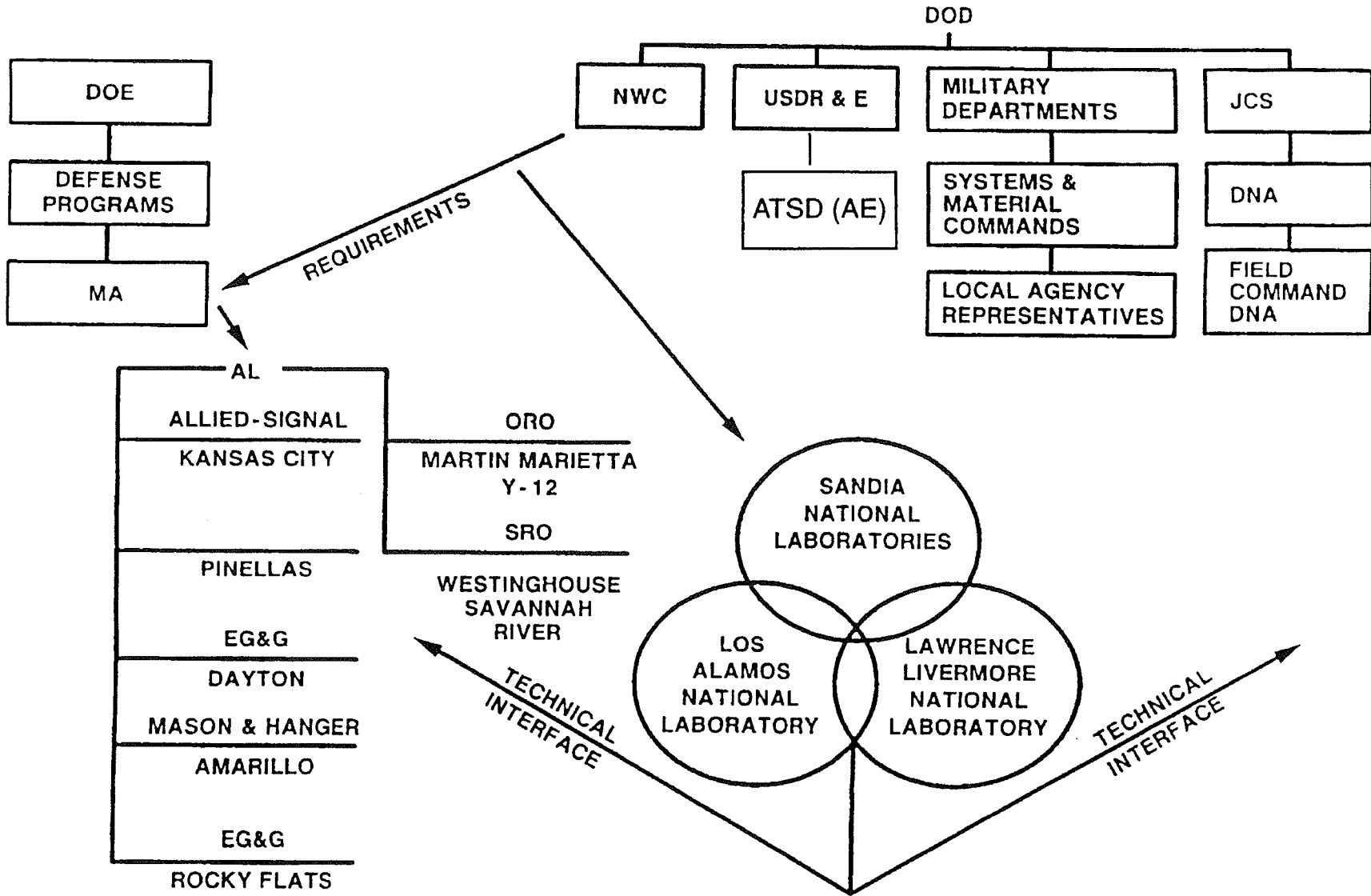
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SANDIA-DOE / DOD INTERFACES WEAPON PROGRAM



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Rocky Flats Golden, Colorado -Historical Context-

Contractor: EG&G

Principal Missions: Fabrication of beryllium,
plutonium on uranium alloy;
Plutonium recovery and
research;
Fabrication of pressure
vessels

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Kansas City Plant Kansas City, Missouri

Contractor: Allied-Signal

Principal Missions: Fabrication and assembly of electrical, electronic, electro-mechanical, precision mechanical, rubber and plastic components;
Heavy machining

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Y-12 Plant

Oak Ridge, Tennessee

Contractor: Martin Marietta

Principal Missions: Fabrication of test and
stockpile secondary
assemblies;
Fabrication and research in
uranium;
Machining

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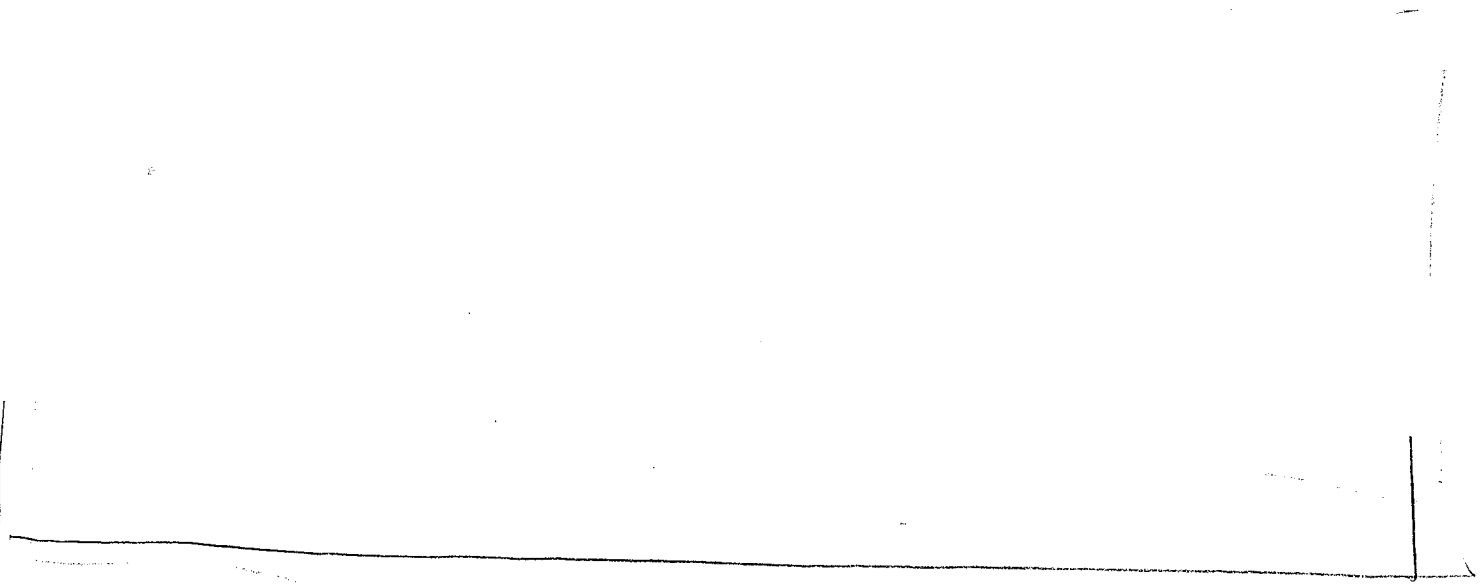
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Pinellas Plant

St. Petersburg, Florida

Contractor: Martin Marietta speciality components, inc.

Principal Missions: Neutron generators, thermal batteries, Radioisotopic Thermoelectric Generator (RTGs), lightning arrestor connectors, capacitors, neutron detectors

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Savannah River Plant Aiken, South Carolina

Contractor: Westinghouse

Principal Missions: Production of tritium and
plutonium;
Fill reservoirs with tritium

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Pantex Plant Amarillo, Texas

Contractor: Mason and Hanger

**Principal Missions: Fabricate high explosive system;
Final assembly, disassembly and retirement of weapons**

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Historical Pressure on Nuclear Designs

		PEACETIME EMPHASIS	WARTIME EMPHASIS
IMPROVE		SAFETY SECURITY CONTROL	SURVIVABILITY DELIVERABILITY EFFECTIVENESS FLEXIBILITY BATTLE MANAGEMENT
REDUCE		MAINTENANCE MOVEMENT TRAINING	REACTION TIME OPERATIONAL CONSTRAINTS COLLATERAL DAMAGE

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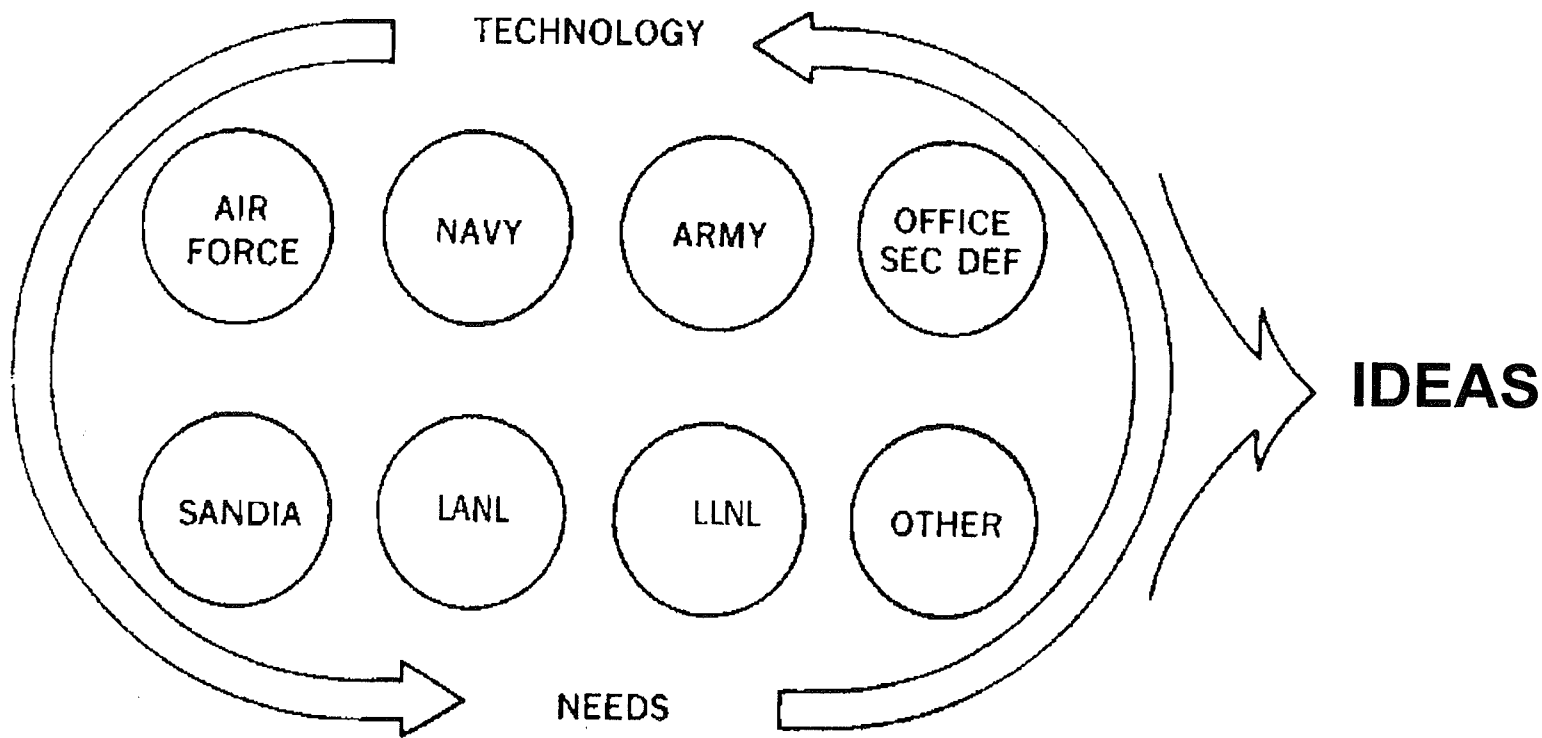
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PHASE 1 CONCEPT FORMULATION

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Phase 1 - Weapon Conception

DOE

Continuing studies by DOE agencies. Studies may be informal and independent from DoD or may be conducted jointly with DoD. May result in the focusing of sufficient DoD interest in a modification of a present weapon or in the development of a new type weapon to warrant formal study.

DoD

Continuing studies by DoD agencies. May be independent of the DOE or may be conducted jointly with DOE. Sufficient attention may become focused on an item to warrant a formal program study. DoD requests DOE to make a program study on a new idea for a weapon or component or may initiate its own study.

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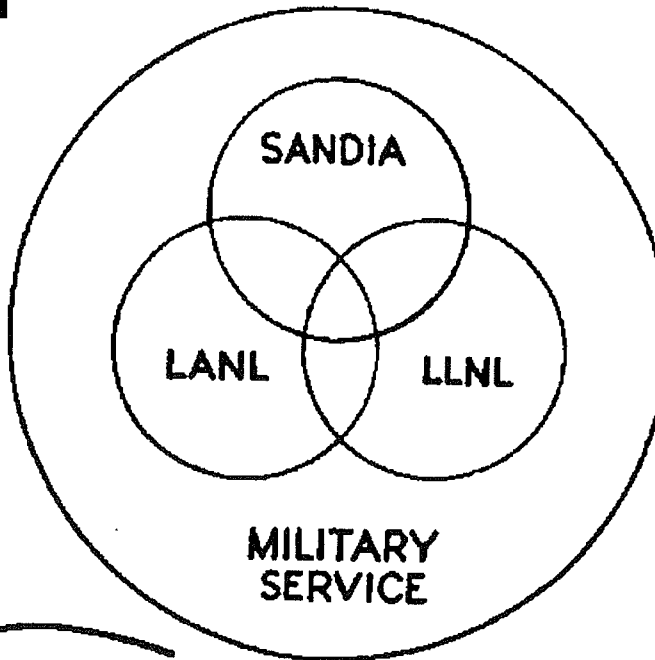
PHASE 2 FEASIBILITY

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IDEAS



DESIGN ALTERNATIVES
MAJOR IMPACT
REPORT



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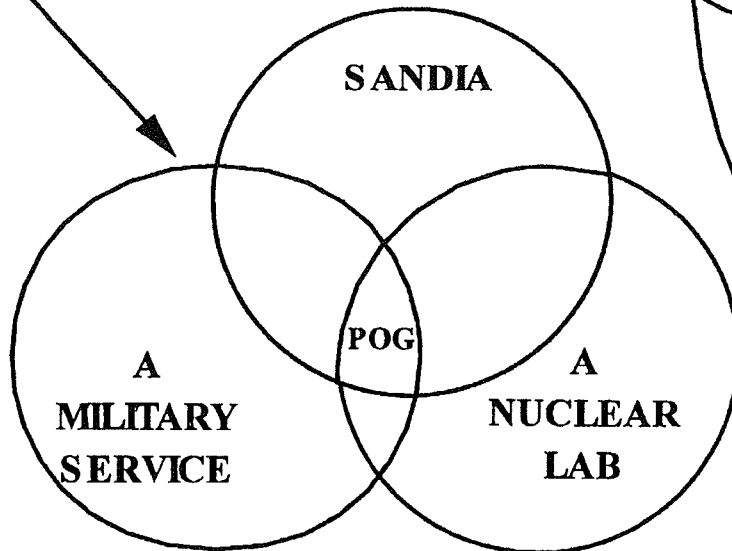
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Phase 2A VALIDATION (Φ2A)

- SELECT BASELINE DESIGN & LAB
- SCHEDULE
- WEAPON DESIGN & COST REPORT (WDCR)

DESIGN TEAM SELECTION

DESIGN ALTERNATIVES



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Phase 2A - Design Definition and Cost Studies

A DOE design team will normally be selected and a Project Officer Group will be formed. The POG will conduct trade-off studies to identify baseline design(s) which best balances resources and requirements. Review and revise draft MCs and STs. Establish tentative development and production schedule and division of responsibilities. A Weapon Design and Cost Report will be prepared.

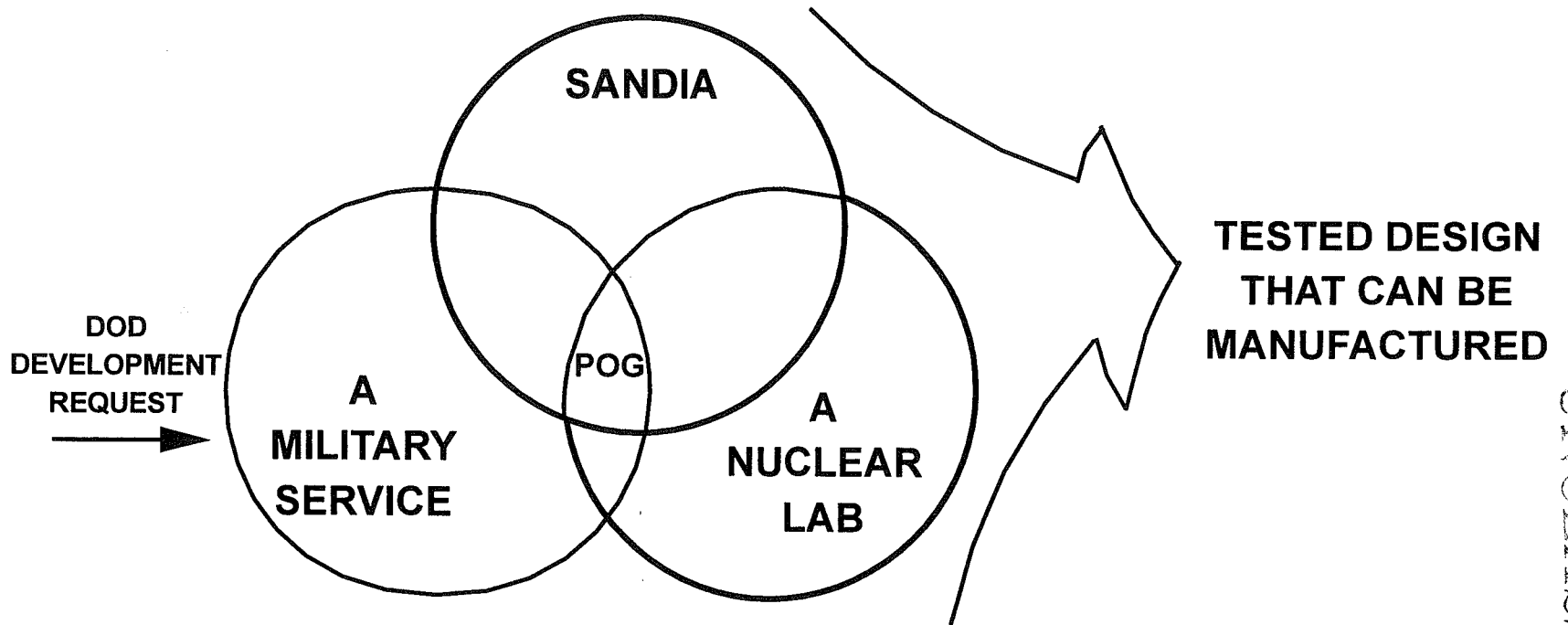
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Phase 3 ENGINEERING DEVELOPMENT (O3)



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Phase 3 - Development Engineering

DOE

Launches a development program based on required military characteristics. Produces prototypes for DOE and DoD evaluation.

Provides development specifications to DoD as they become available.

Determines the developmental design release date and submits a final report on the development design to the DoD.

DoD

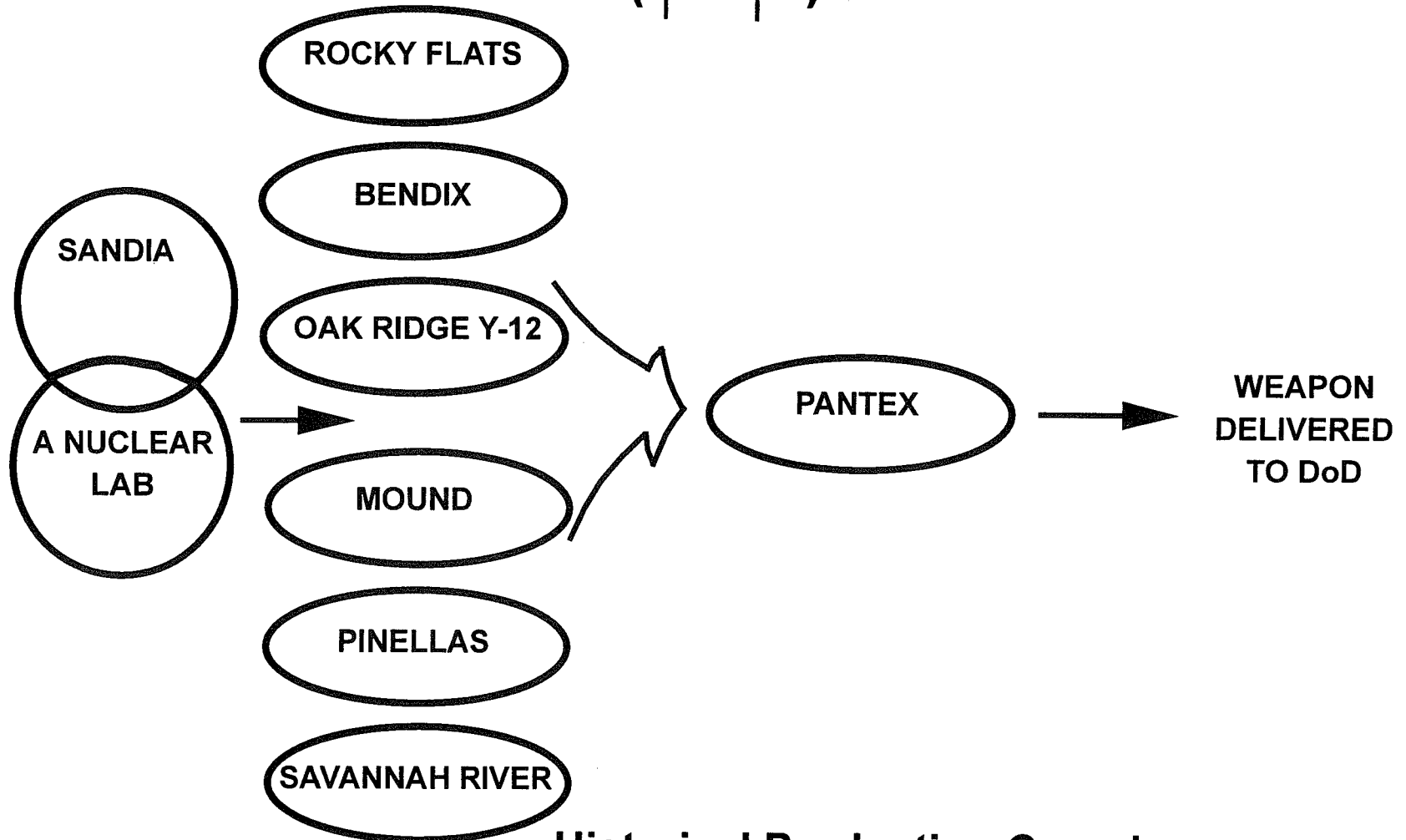
Maintains liaison with DOE field agencies and conducts independent evaluation of prototypes as considered necessary.

Studies the development specifications of the weapon design and gives appropriate guidance to the DOE.

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Phase 4-6 PRODUCTION (Φ4-Φ6)



- Historical Production Complex
- Reconfiguration Will Impact

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Phase 4 - Production Engineering

DOE

Proceeds with production engineering of weapon, tooling, and layout of manufacturing facilities, without waiting for formal comments of DoD on the developmental design. Such guidance is integrated when received. Further prototype evaluation is performed during this phase.

Prepares product specifications for production release and furnishes these specifications to the DoD for review.

DoD

Reviews product specification.

Maintains liaison with appropriate DOE agencies on product design changes and specifications and gives appropriate guidance to DOE.

Continues evaluation of prototypes as considered necessary.

Phase 5 - First Production

DOE

Initiates manufacture of weapons according to product specifications by production tools, without waiting for DoD's comments on product specifications. DOE performs own evaluation and on basis of preliminary evaluation releases weapons to DoD for testing, training, and other purposes. Makes final evaluation and approves weapon model as suitable for standardization.

DoD

Completes operational suitability tests and makes independent evaluation of production type weapons. If weapon as designed, produced, and approved by DOE is satisfactory, approves the weapon as standard.

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Phase 6 - Quantity Production and Stockpile

DOE

Brings various production facilities up to full production pursuant to DoD requirements. Maintains production, inspection and quality control programs to ensure that each article produced meets specifications.

Maintains quality assurance and functional surveillance programs to ensure the continued quality of weapons in stockpile, in accordance with current agreements with respect to stockpile operations. These programs and the data obtained thereof will be made available to the DoD.

DoD

Maintains liaison with DOE agencies at production facilities. Continues appraisal of weapon performance.

Maintains liaison with DOE to review performance and technical advances in anticipation of modernization changes.

Reviews DOE's quality assurance and functional surveillance programs and results and submits appropriate comments and recommendations to the DOE. Maintains functional surveillance program in accordance with current agreements with respect to stockpile operations.

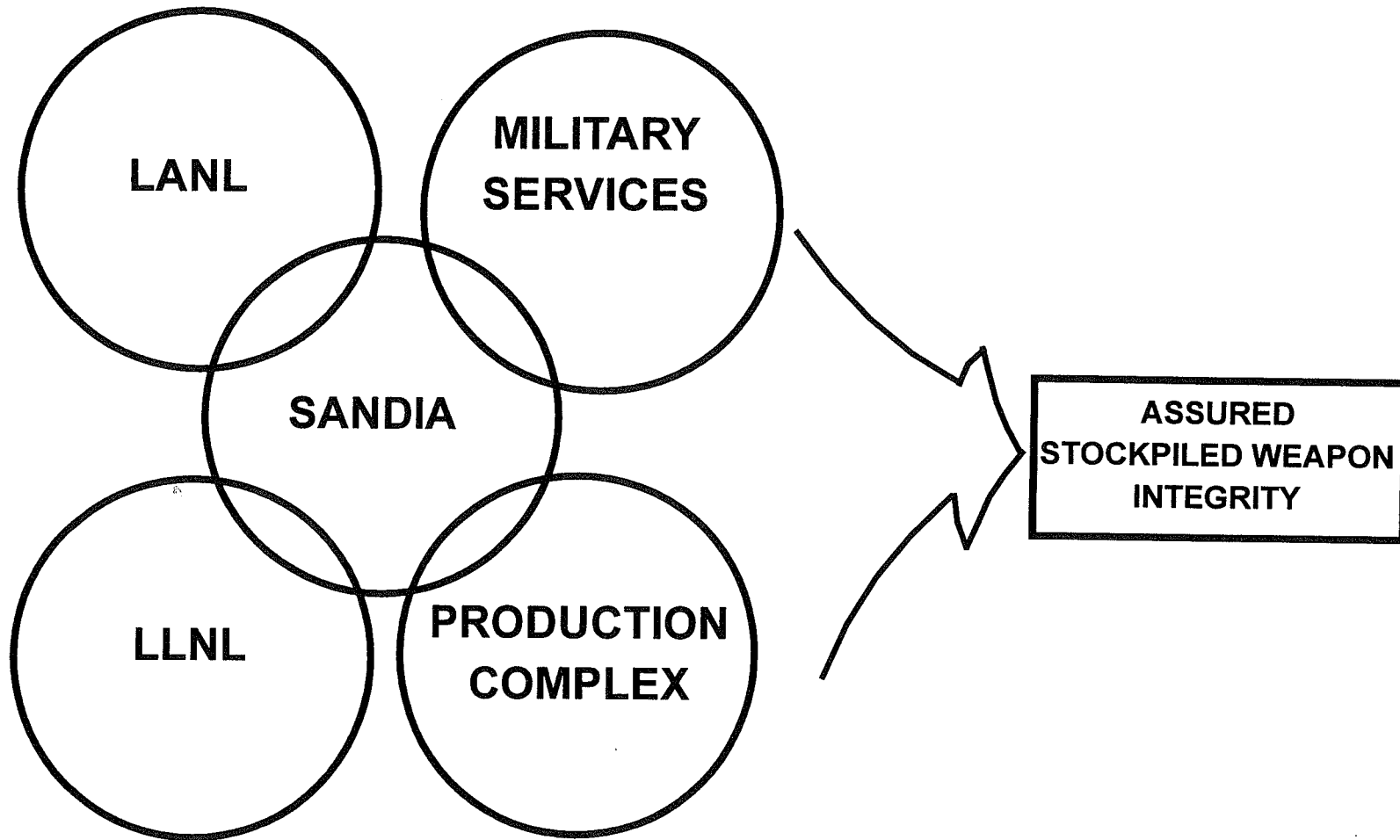
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Phase 6 STOCKPILE SURVEILLANCE (Φ6)



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Nuclear Weapon Life Cycle

(The following pages are for reference. Not all of the material will be presented during the briefing)

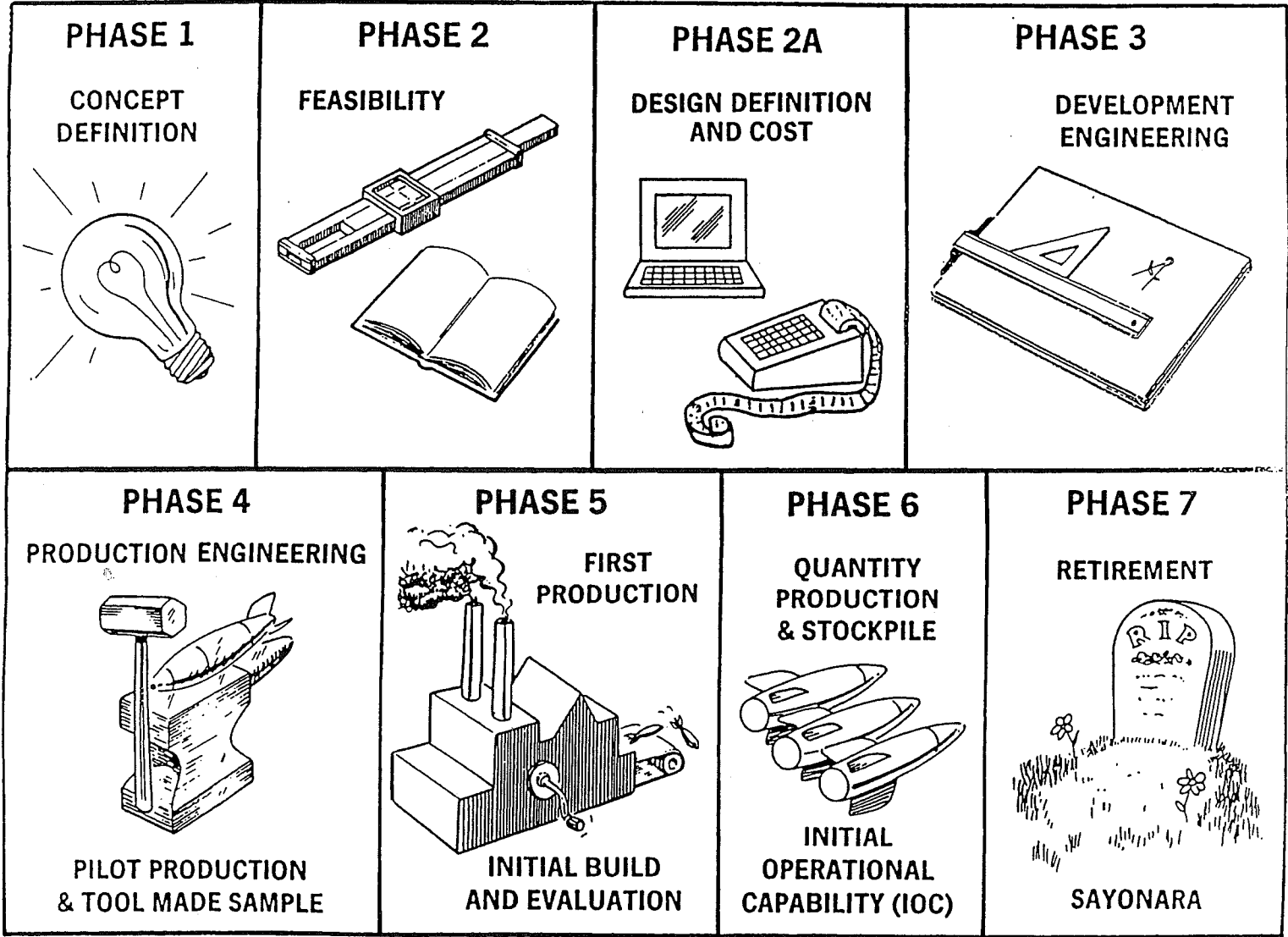
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WEAPON DEVELOPMENT



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Phase 1 -- Concept Definition

- Initiation:** Informal agreement between participants to undertake study
- Purpose:** Study a Service requirement or DOE technological breakthrough/innovation for weapon application
- Organization:** Joint DoD/DOE Study Group with appropriate working groups. (Note: it can be a DOE or DoD-only study group.) Working Groups: Surety, Requirements Analysis, Mission Analysis, Design, and Systems Engineering
- Warhead**
- Deliverables:** Phase 1 Study Report [In some cases: Draft Military Characteristics (MCs) & Draft Stockpile-to-Target Sequence (STS)]

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Phase 1 Activities

Military Characteristics

Warhead performance requirements

Warhead physical characteristics

Requirements for nuclear safety

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Phase 1 Activities

Stockpile-to-Target Sequence

Logistical employment concepts

Operational employment concepts

Normal & abnormal environments applicable to MC safety requirements

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