

# Nuclear Weapon Accident--Definition

## DOD Directive 5100.52

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An unexpected event involving nuclear weapons or nuclear components that results in any of the following:

- (1) Accidental or unauthorized launching, firing, or use by U.S. forces or U.S. supported allied forces of a nuclear capable weapon system.
- (2) An accidental, unauthorized, or unexplained nuclear detonation.
- (3) Non-nuclear detonation or burning of a nuclear weapon or nuclear component.
- (4) Radioactive contamination.
- (5) Jettisoning of a nuclear weapon or nuclear component.
- (6) Public hazard, actual or perceived.

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**Accidents (mainly air-delivered systems) eventually led to reexamination of the premature nuclear yield criteria and to the present nuclear detonation safety design criteria.**

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## Need for a Safety Process

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- As the deployment dates for sealed pit weapons approached, the Armed Forces Special Weapons Project (AFSWP) and the Services became uncomfortable with their lack of knowledge and understanding of weapon safety designs.
- 1957, AFSWP convened a safety Board to examine the sealed pit weapon systems becoming available.
- Between 1957 and 1960, the Air Force convened joint safety study groups as weapons entered the stockpile.
- A formal, Joint DoD/DOE Nuclear Weapons System Safety process was established in 1960.

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# DoD/DOE Nuclear Weapon Safety Process

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- **Joint Safety Study of Each Weapon System and Operational Concept**
  - **Determine if Weapon System Meets the 4 Qualitative Standards**
  - **Develop Operation Safety Rules**

and

- **Ensure Maximum Safety Consistent with Operational Requirements**

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## 1968 -- DoD/DOE Agree on Premature Nuclear Detonation Design Safety Criteria

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- The probability of a premature nuclear detonation due to component malfunctions, in the absence of any input signals except for specified (e.g. monitoring and control), shall not exceed.

(1) For normal storage and operational environments described in the STS, 1 in  $10^9$  per weapon lifetime.

(2) For the abnormal environments described in the STS, 1 in  $10^6$  per weapon exposure or accident.

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# 1968 -- DoD/DOE Agree on One-Point Detonation Design Safety Criteria

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## One Point Safety

- a. In the event of a detonation initiated at any one point in the high explosion system, the probability of achieving a nuclear yield greater than four pounds TNT equivalent shall not exceed one in one million.
- b. One-point safety shall be inherent in the nuclear design, that is, it shall be obtained without the use of a nuclear safing device.

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## Four Pounds

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**“The four pounds TNT equivalent evolved from a U.S. Navy requirement based upon personnel exposure in the engine room of an aircraft carrier resulting from a small nuclear yield occurring on the flight deck 50 feet above the engine room (Ref. 5). A study concluded that a detonation giving a nuclear contribution equivalent to 44 pounds of TNT would result in a 50% sickness dose (SD<sub>50</sub>) of 200 neutron rad to personnel in the engine room. To be conservative, a reliability factor of 10 was applied and the result rounded to four pounds. Another study, conducted in 1967 by the U.S. Army Nuclear Defense Laboratory, concluded that 8.5 pounds TNT equivalent would produce 200 neutron rad at 50 feet. This figure had a reliability factor of two applied and the result rounded to four pounds, also.”**

**Reference: “One-Point Safety,” Defense Science, LANL, March-April 1983**

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# Conclusion of Stockpile Study

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***New approach to nuclear  
weapon safety needed***

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# Safety Goals for Abnormal Environments

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- Assured, predictable, safe response of the warhead electrical system
- Maintain predictable, safe response until intended use
- Minimize safety critical components and dependence on knowing accident scenario

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# Modern Nuclear Safety -- The 4 I's

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- **Isolation**
  - Barriers
  - Stronglink switches
- **Incompatibility**
  - Unique signals
- **Inoperability**
  - Co-location of stronglinks and weaklinks
- **Independence of safety subsystems**

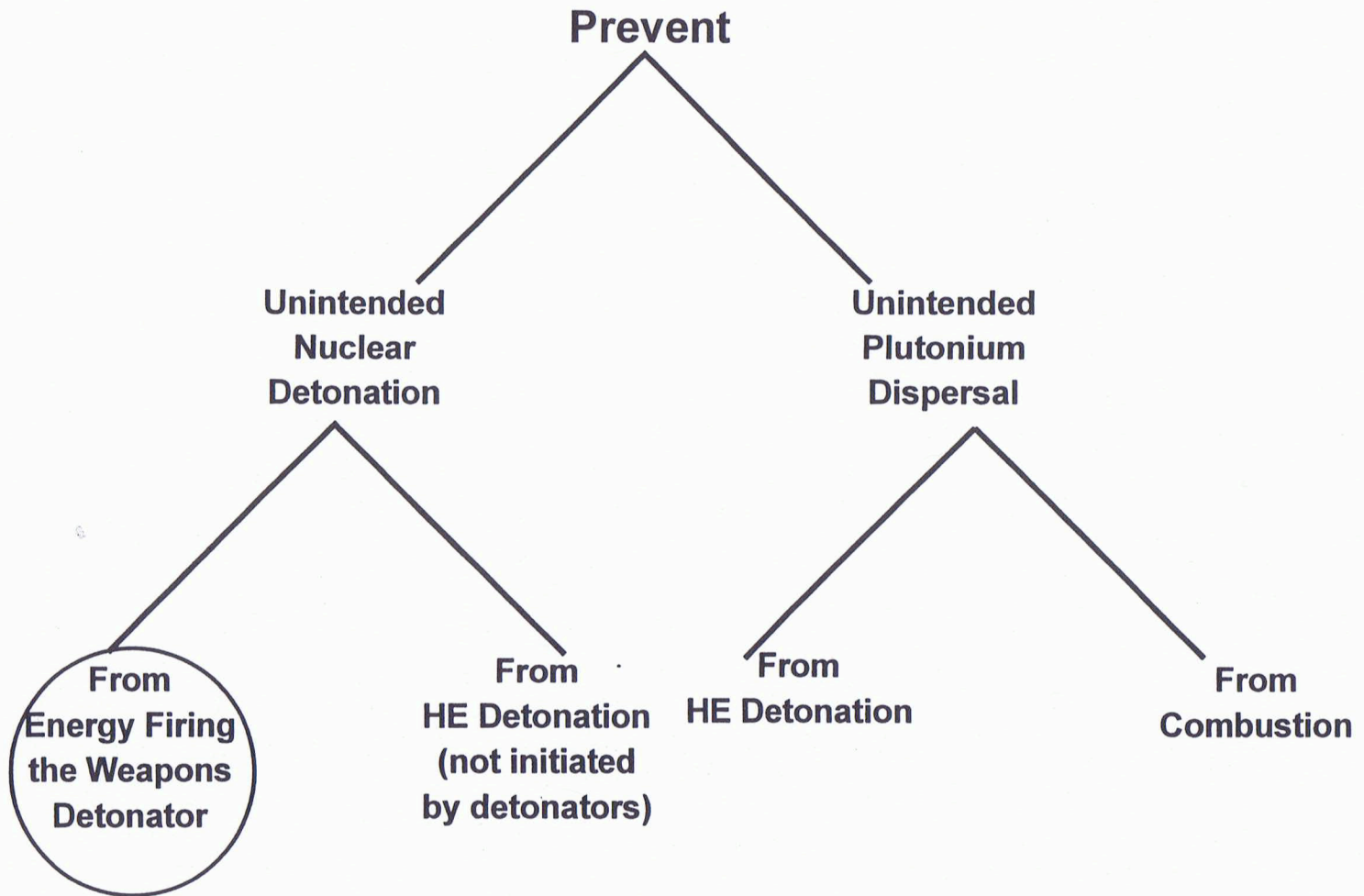
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MORE SPECIFICALLY THE SAFETY GOALS ARE TO



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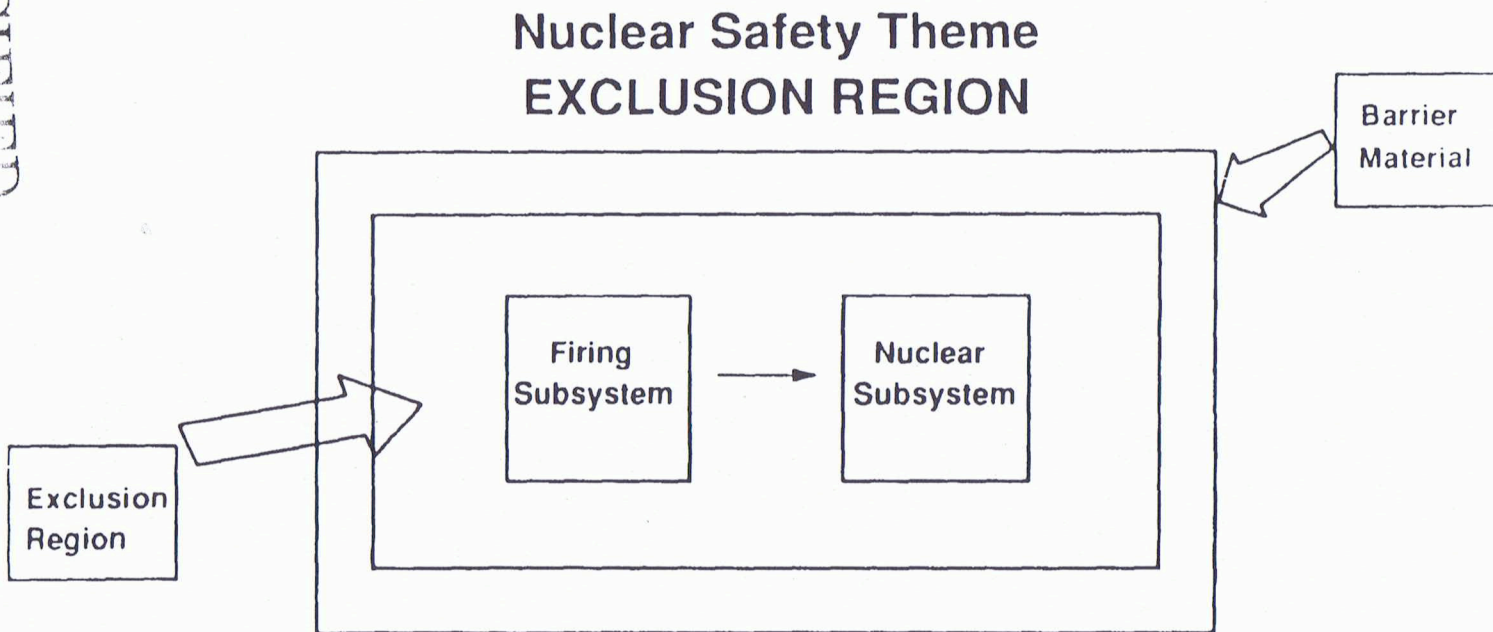
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# MODERN SAFETY DESIGN PHILOSOPHY

Co-locate detonation-essential components and protect them from abnormal environments by an exclusion region



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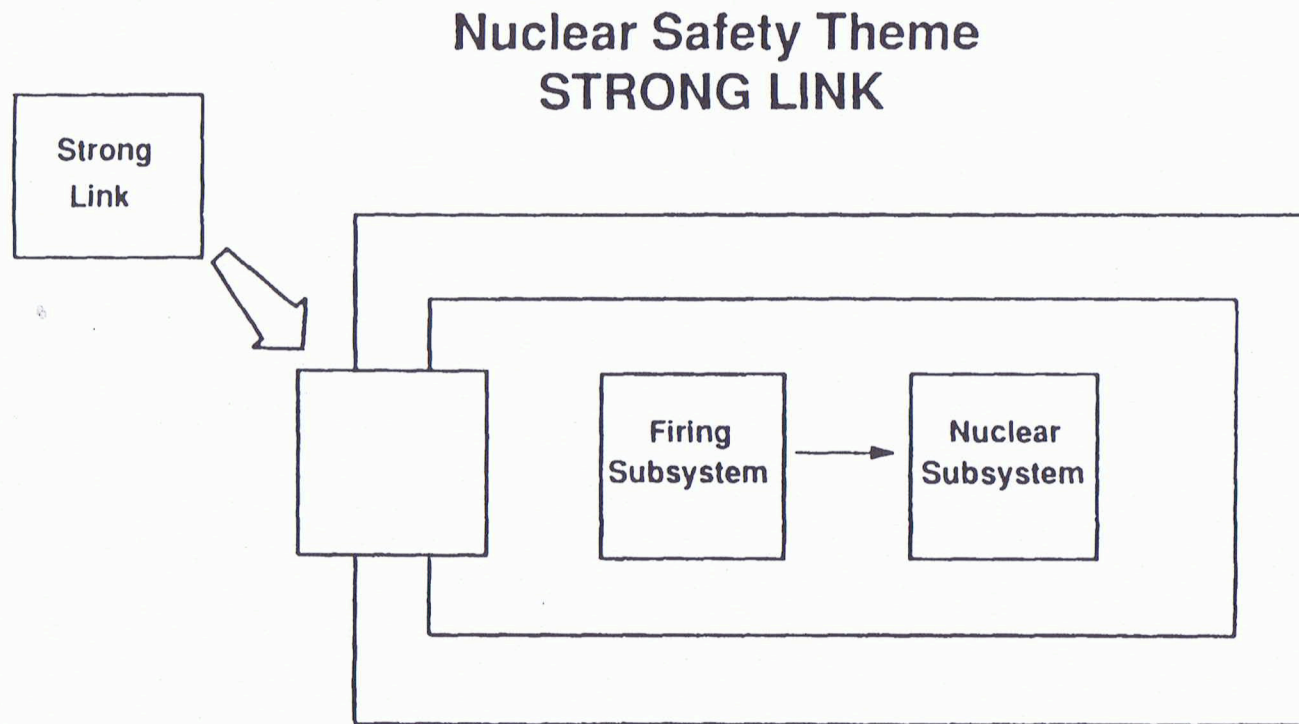
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## MODERN SAFETY DESIGN PHILOSOPHY (cont)

Allow energy/signals into the exclusion region only through a strong link



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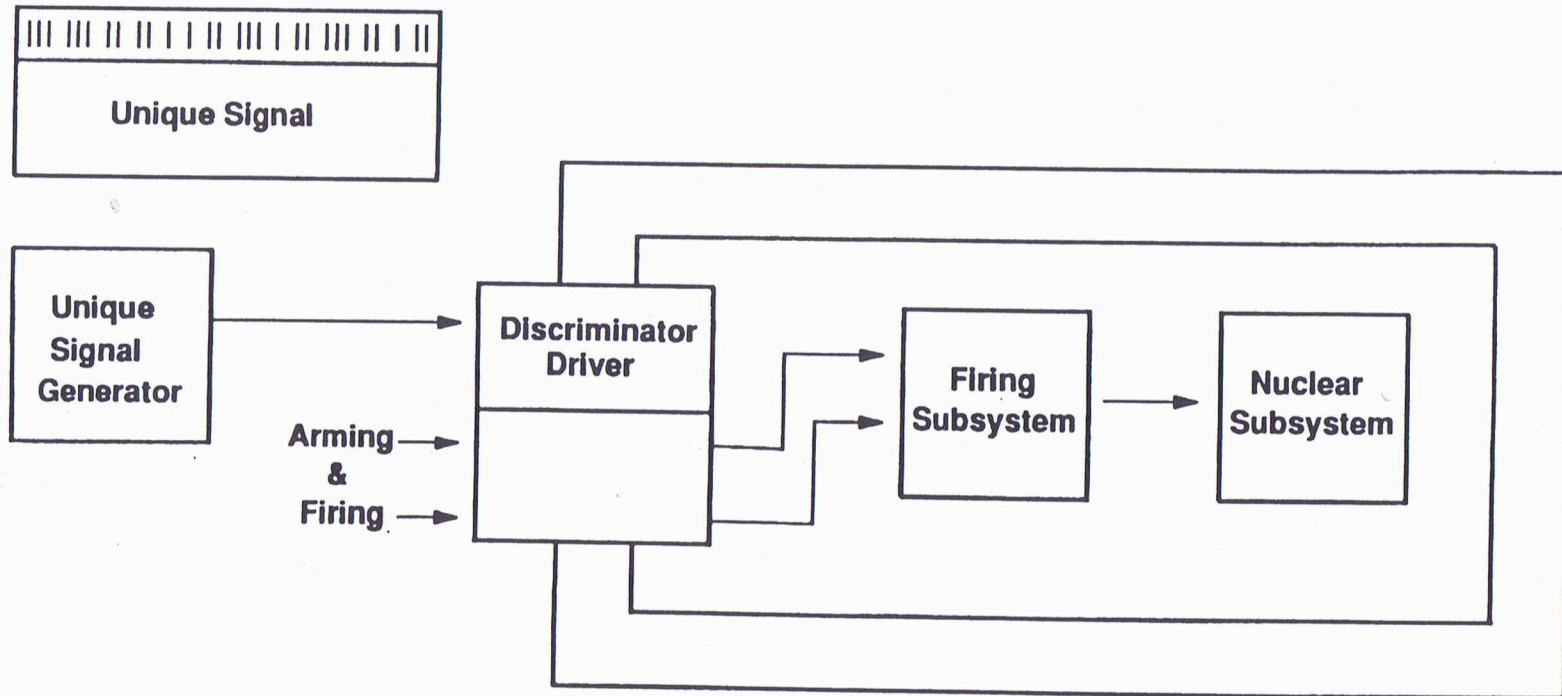
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# MODERN SAFETY DESIGN PHILOSOPHY (cont)

Control the strong link(s) with a unique signal  
not duplicated elsewhere in the system

## Nuclear Safety Theme UNIQUE SIGNALS



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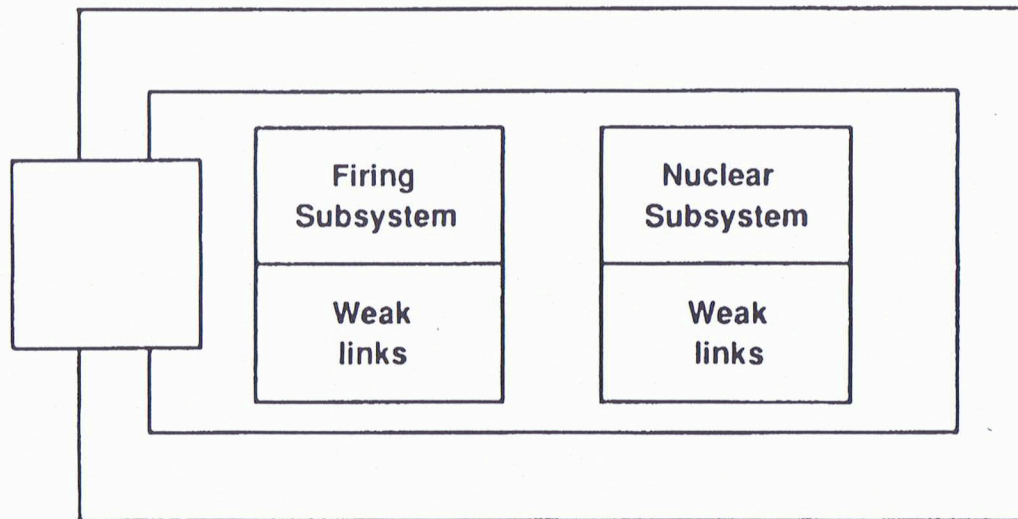
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## MODERN SAFETY DESIGN PHILOSOPHY (cont)

Finally, to address credible but catastrophically severe environments, co-locate *weak link* detonation-essential components which will predictably become inoperable prior to the barrier or strong links losing their integrity.

### Nuclear Safety Theme WEAK LINKS



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*BECAUSE THE REQUIREMENT  
(LESS THAN ONE-IN-A-MILLION)  
IS QUITE STRINGENT*

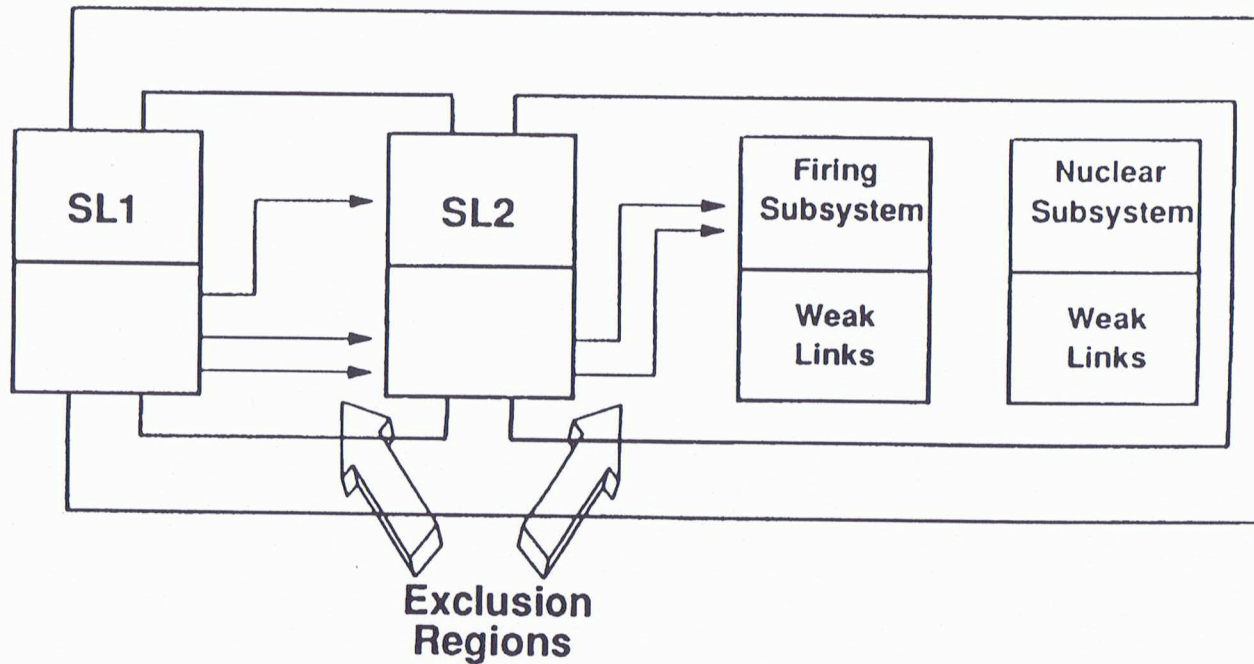
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**Nuclear Safety Theme  
TWO SAFETY SUBSYSTEMS ARE USED**

(PREARM)  
Human  
Intent  
Unique Signal

Environmental  
Unique Signal  
(PREARM)

Arming  
&  
Firing



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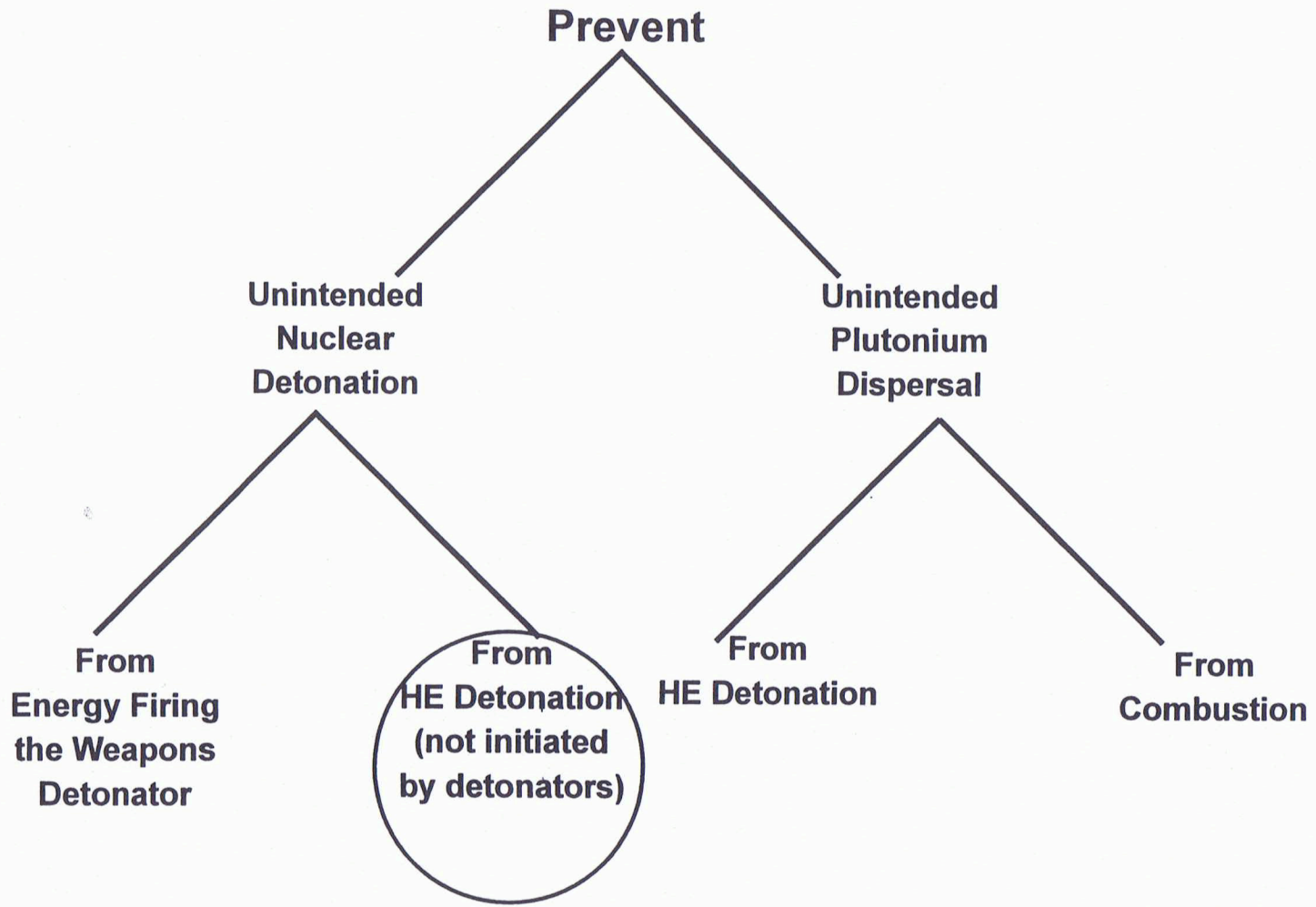
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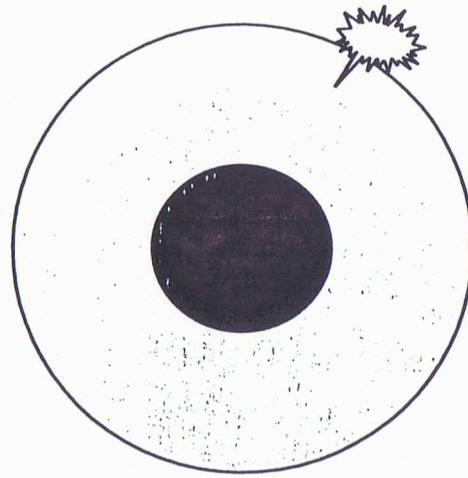
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# ONE POINT SAFETY



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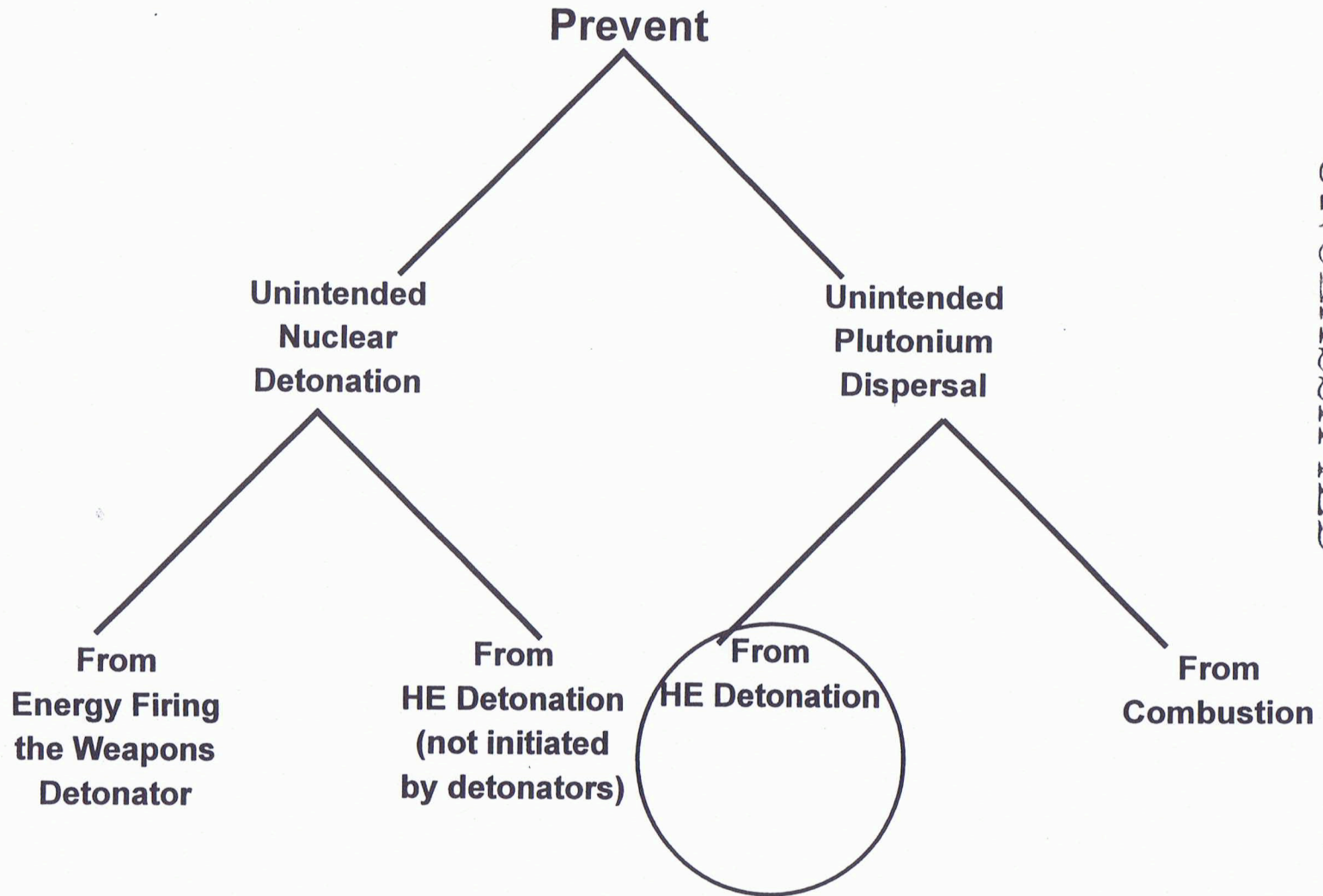
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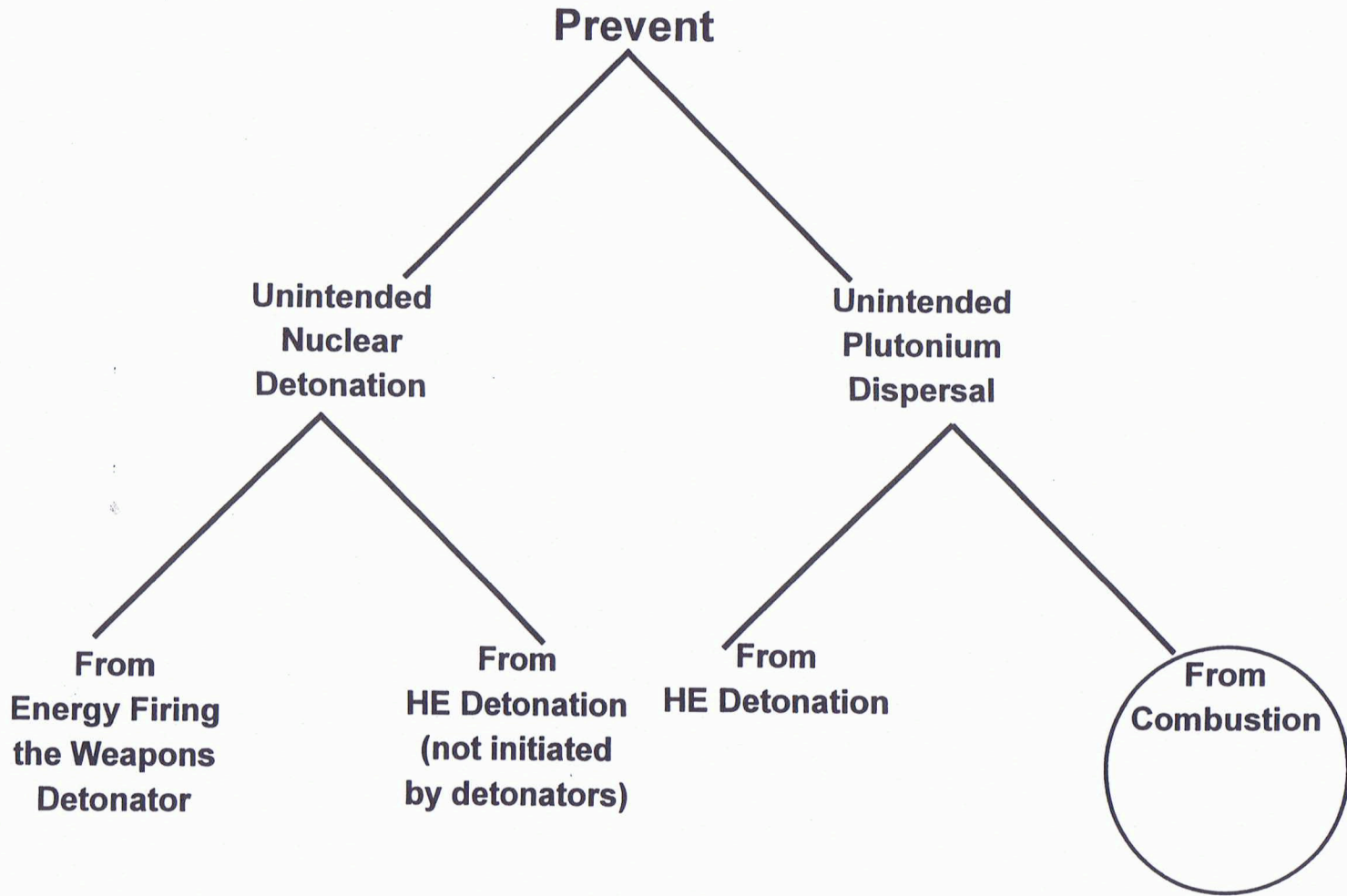
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# **SURVEY OF WEAPONS DEVELOPMENT AND TECHNOLOGY**

**WR708**

**SESSION VIII**

- **PROTECTION OF NUCLEAR WEAPONS**
  - **ACCESS CONTROL MEASURES**
  - **USE CONTROL MEASURES**

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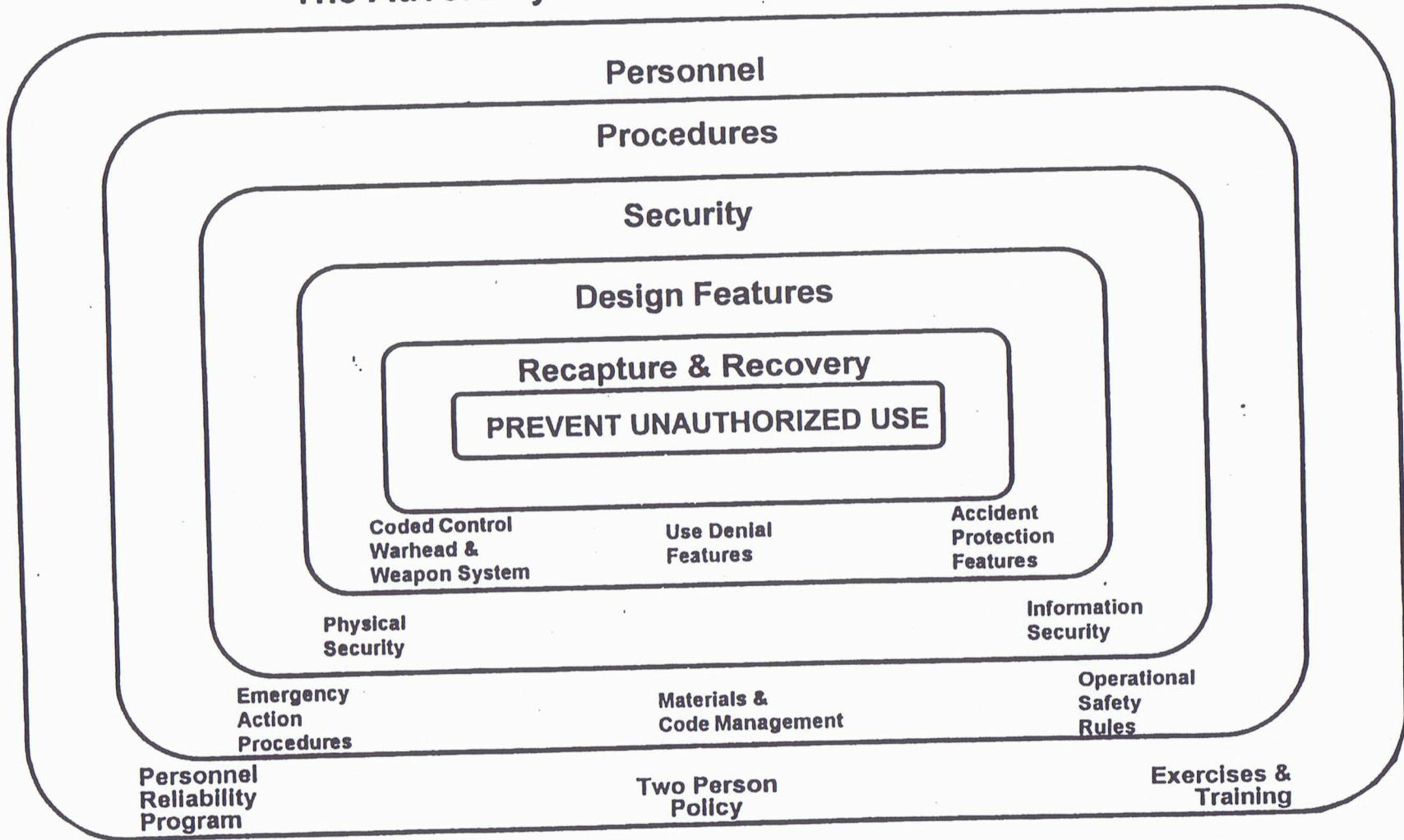
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# Layered Positive Measures to Assure Against Unauthorized Use

The Adversary: Humans or Accidents



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## **THE NUCLEAR WEAPONS ACCESS CONTROL AND USE CONTROL PROGRAMS TRY TO:**

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- **Prevent unauthorized access to a nuclear weapon**
- **Prevent loss of custody of a nuclear weapon**
- **Prevent an intended (but unauthorized) nuclear explosion**
- **Prevent an intended (but unauthorized) dispersion of SNM**

**AND...**

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**{ ACCESS CONTROL**

**NUCLEAR WEAPON  
USE CONTROL**

**AVOID  
NUCLEAR DETONATION**

**AVOID  
RADIOACTIVE MATERIAL DISPERSAL**

**REVERSIBLE  
PAL**

**IRREVERSIBLE  
DISABLEMENT**

**INTERNAL MEANS  
IHE**

**EXTERNAL MEANS  
ARMORED  
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ACCESS CONTROL (TO THE WEAPON) IS ANALOGOUS TO ACCIDENT PREVENTION - IF NO UNAUTHORIZED ACCESS (ACCIDENT) OCCURS, THERE IS LESS POTENTIAL FOR A PROBLEM.

HOWEVER, USE CONTROL FEATURES STILL ASSUME SOME LEVEL OF ACCESS CONTROL EXISTS OR CAN BE REESTABLISHED.

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## ***ENVIRONMENTAL SENSING DEVICES (ESDs)***

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**An open switch in the prearming circuits.**

**It is closed after sensing an environment experienced by the weapon system when enroute to the target.**

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# ***INTENDED USE AND NON-INTENDED USE MODE OPERATION***

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- **Intended Use Mode**

- **Use of the warhead, weapon and weapon system as designed to operate when used against a target.**

- **Non-Intended Use Mode**

- **Detonation “in place”; operation of weapon/weapon system in other than intended use mode.**

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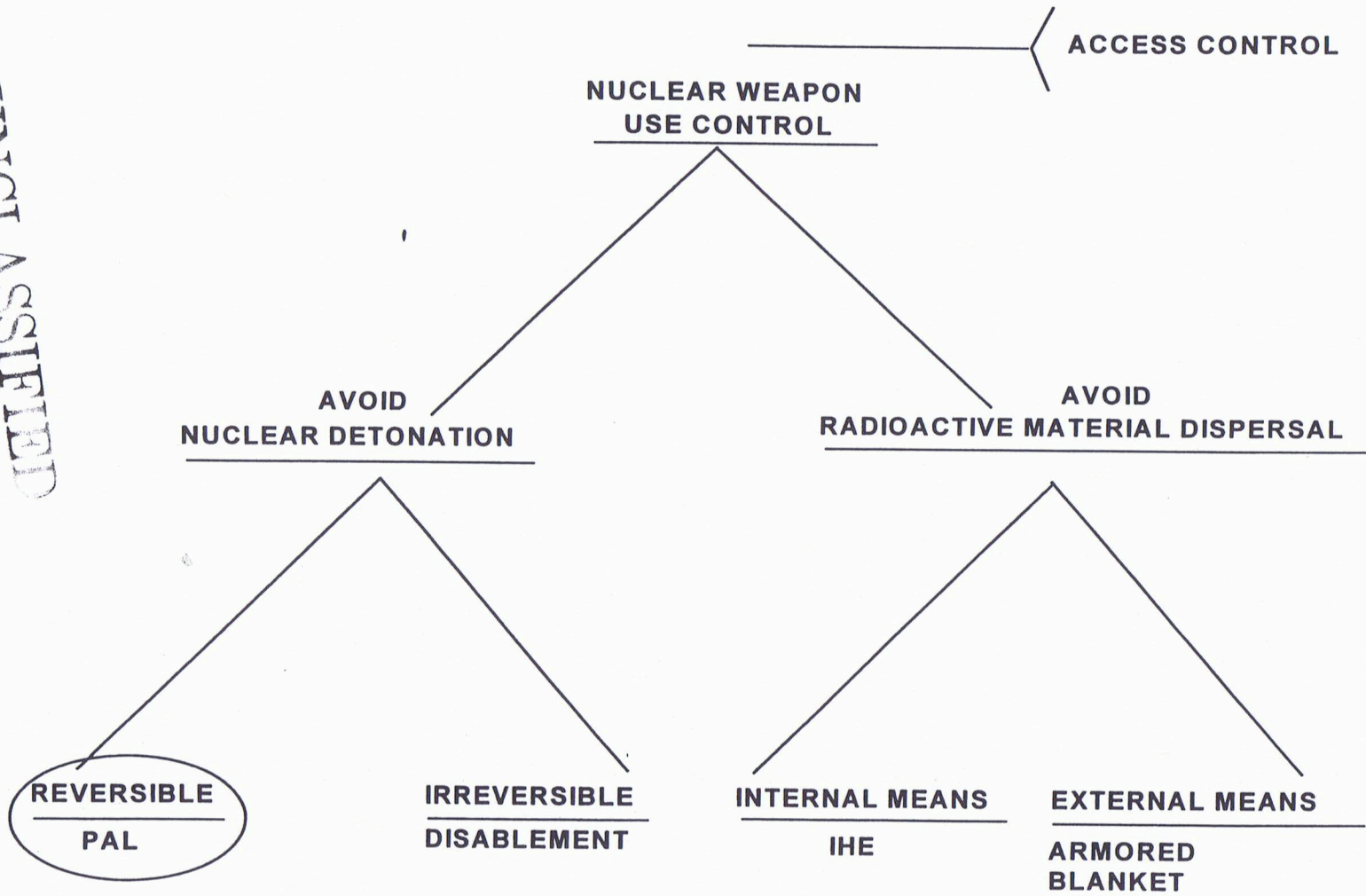


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# PAL (Permissive Action Link)

A code controlled switch which interrupts the warhead's arming circuit

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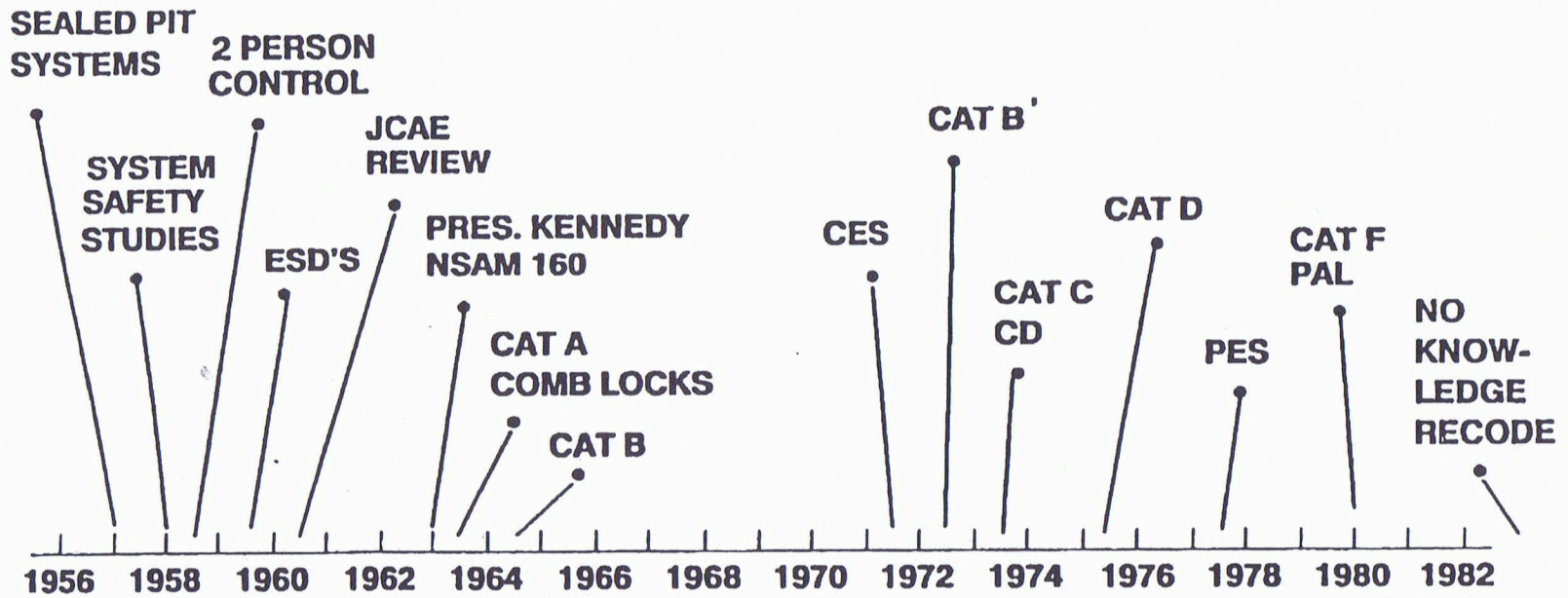
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# EVOLUTION OF NUCLEAR WEAPON USE CONTROL

PAL



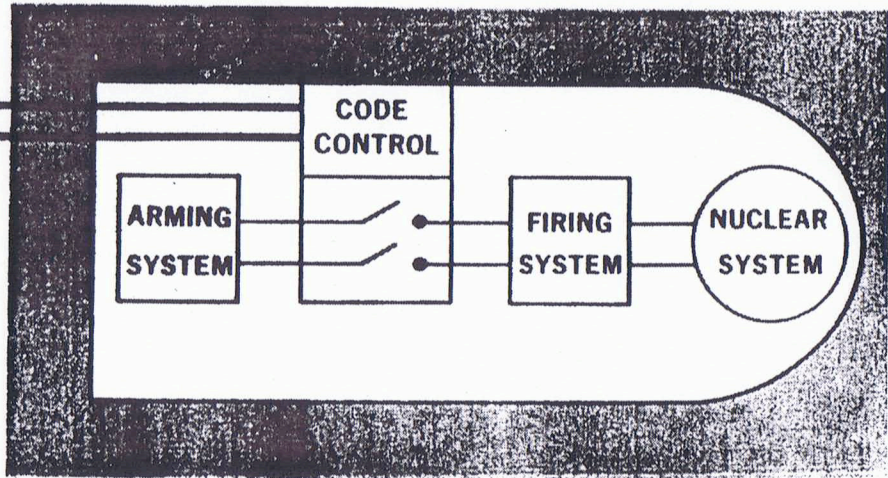
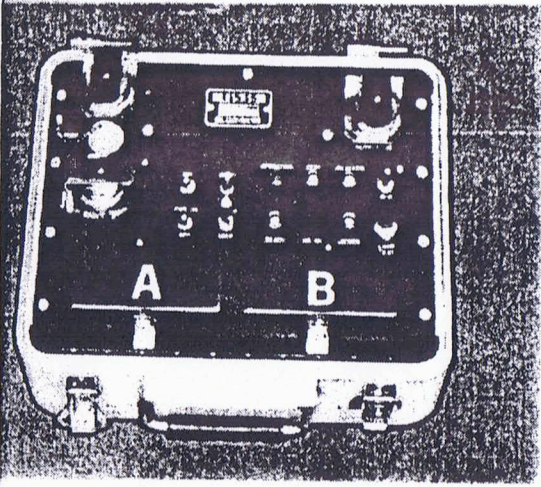
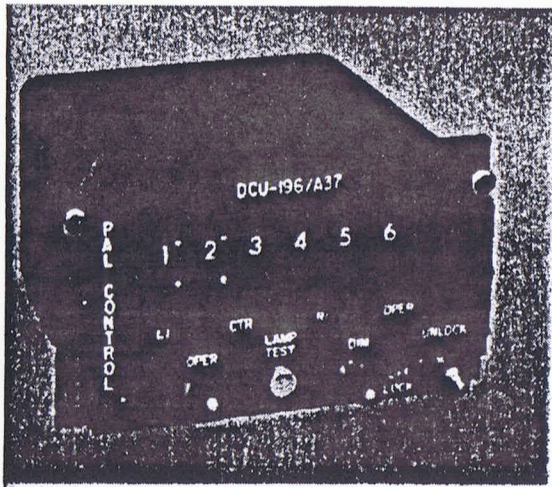
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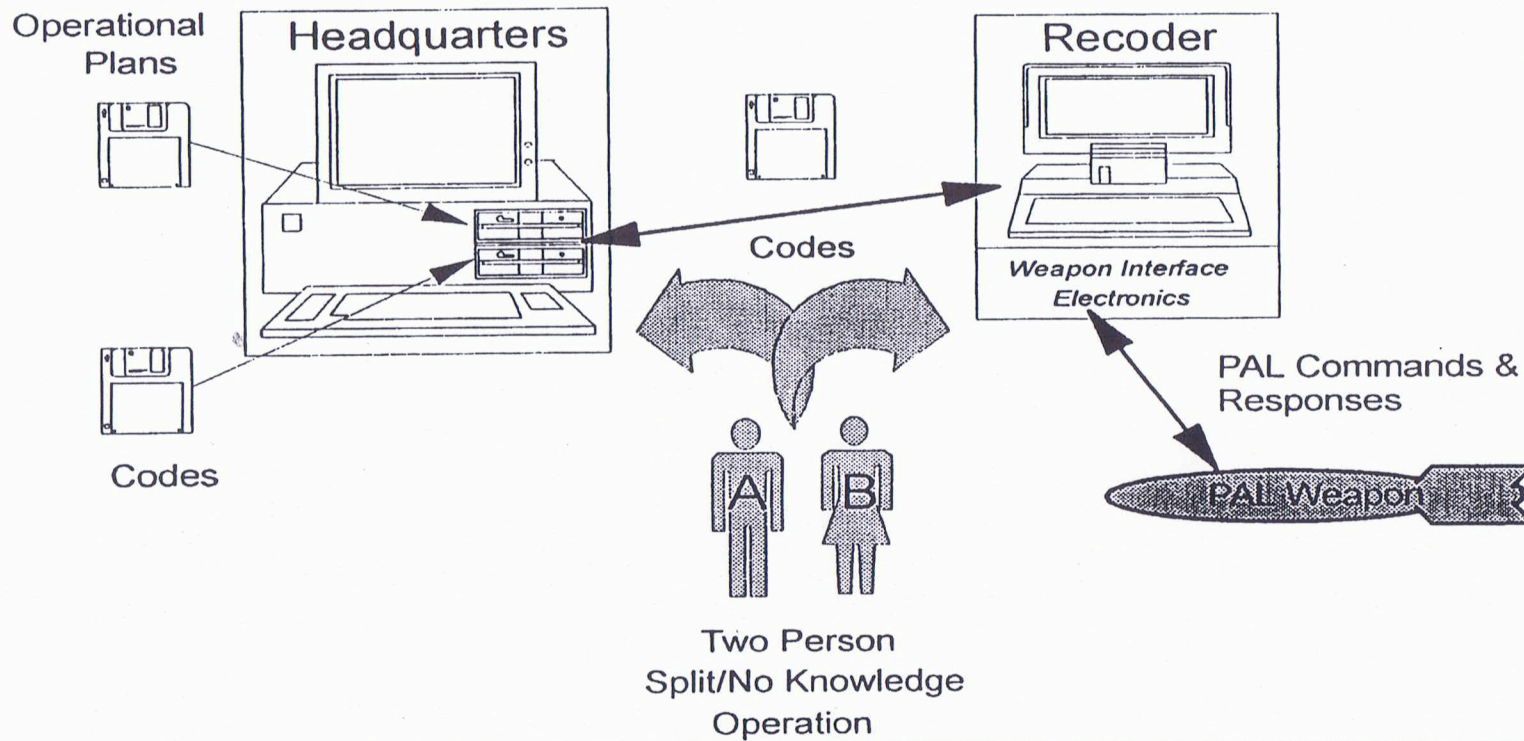
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**PERMISSIVE ACTION LINK**

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# PAL Code Management



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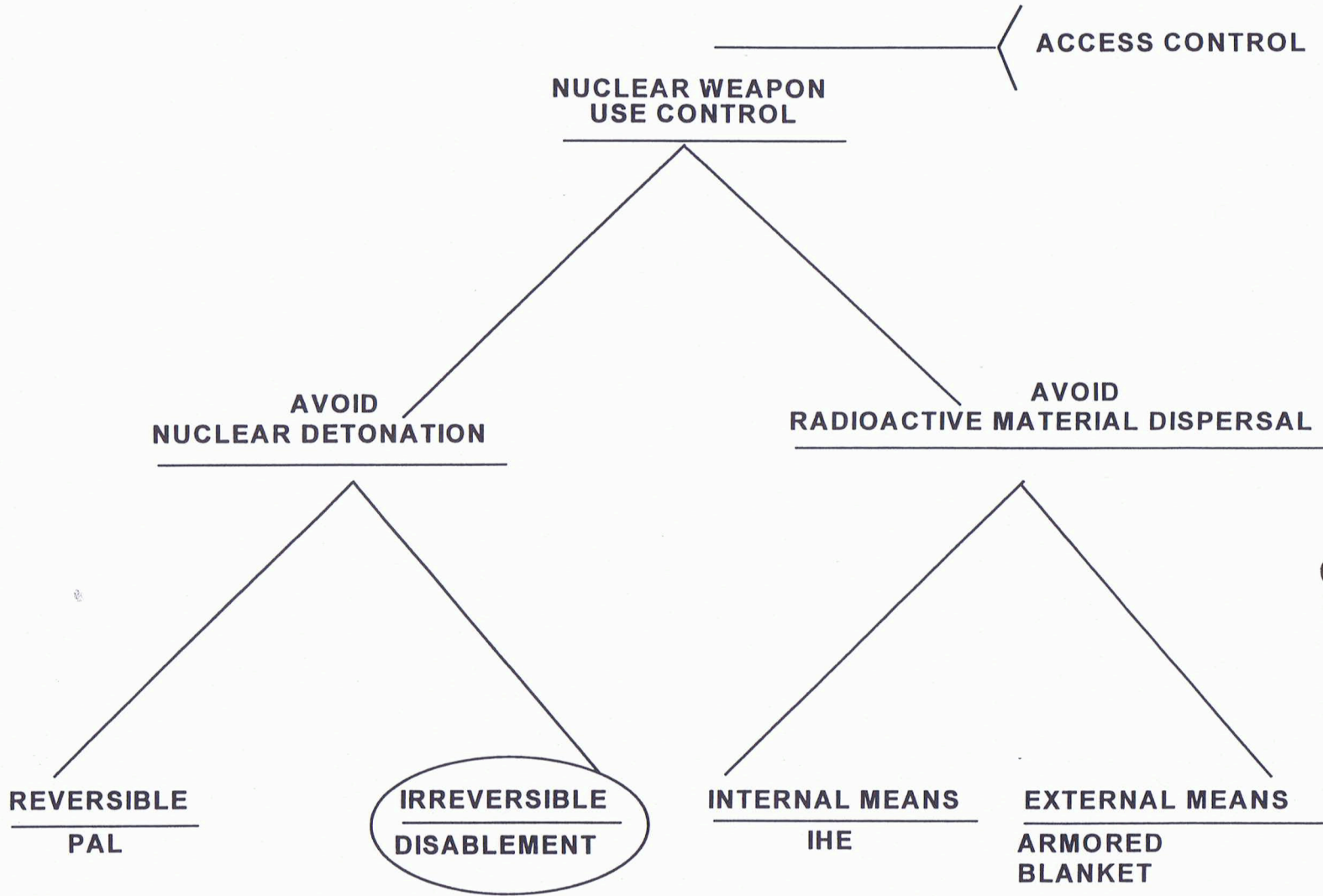
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## *DISABLEMENT*

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- When initiated, disables certain key nuclear detonation-essential components.
- Non-violent outside the weapon case.

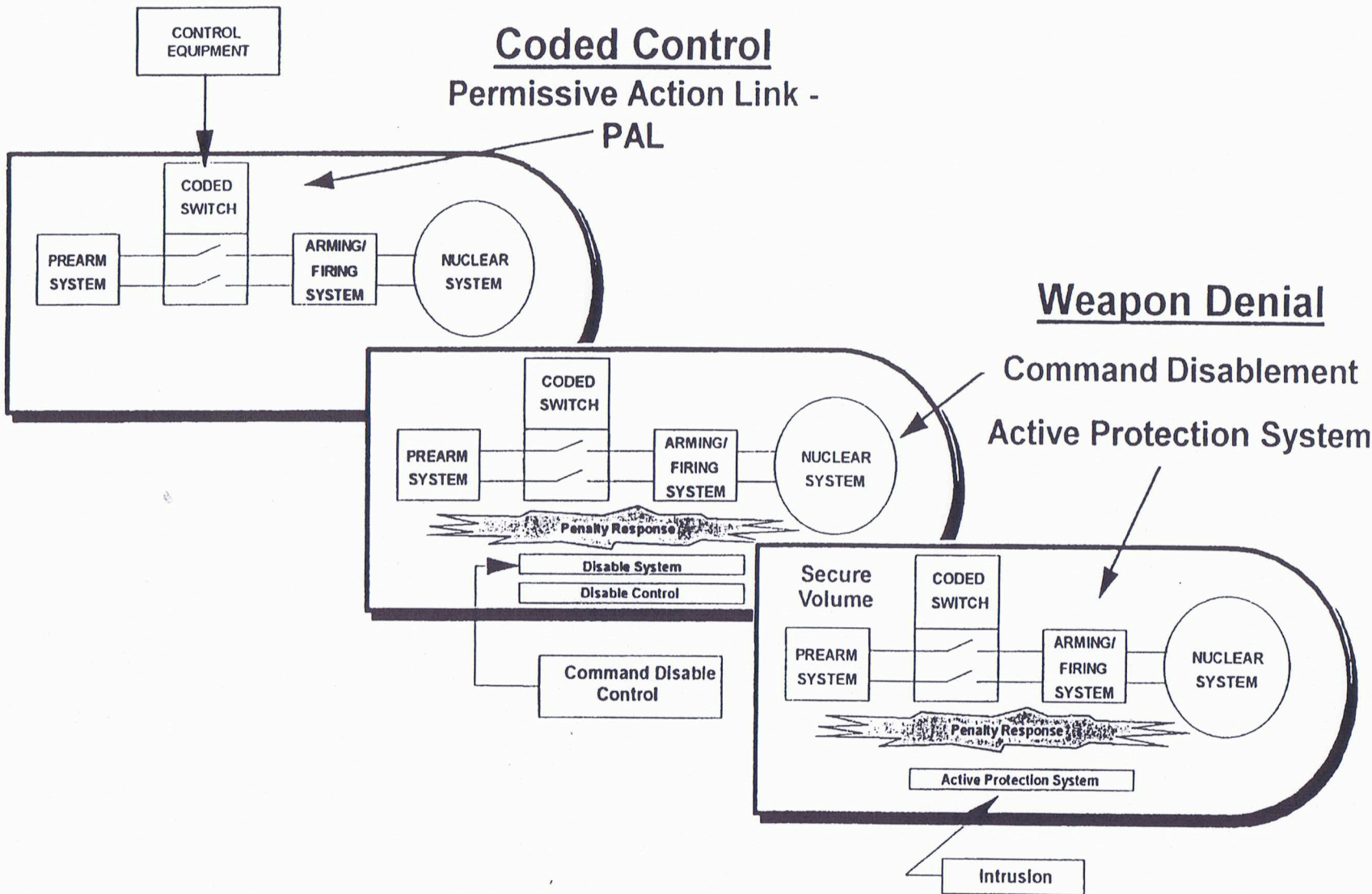
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# Warhead Use Control



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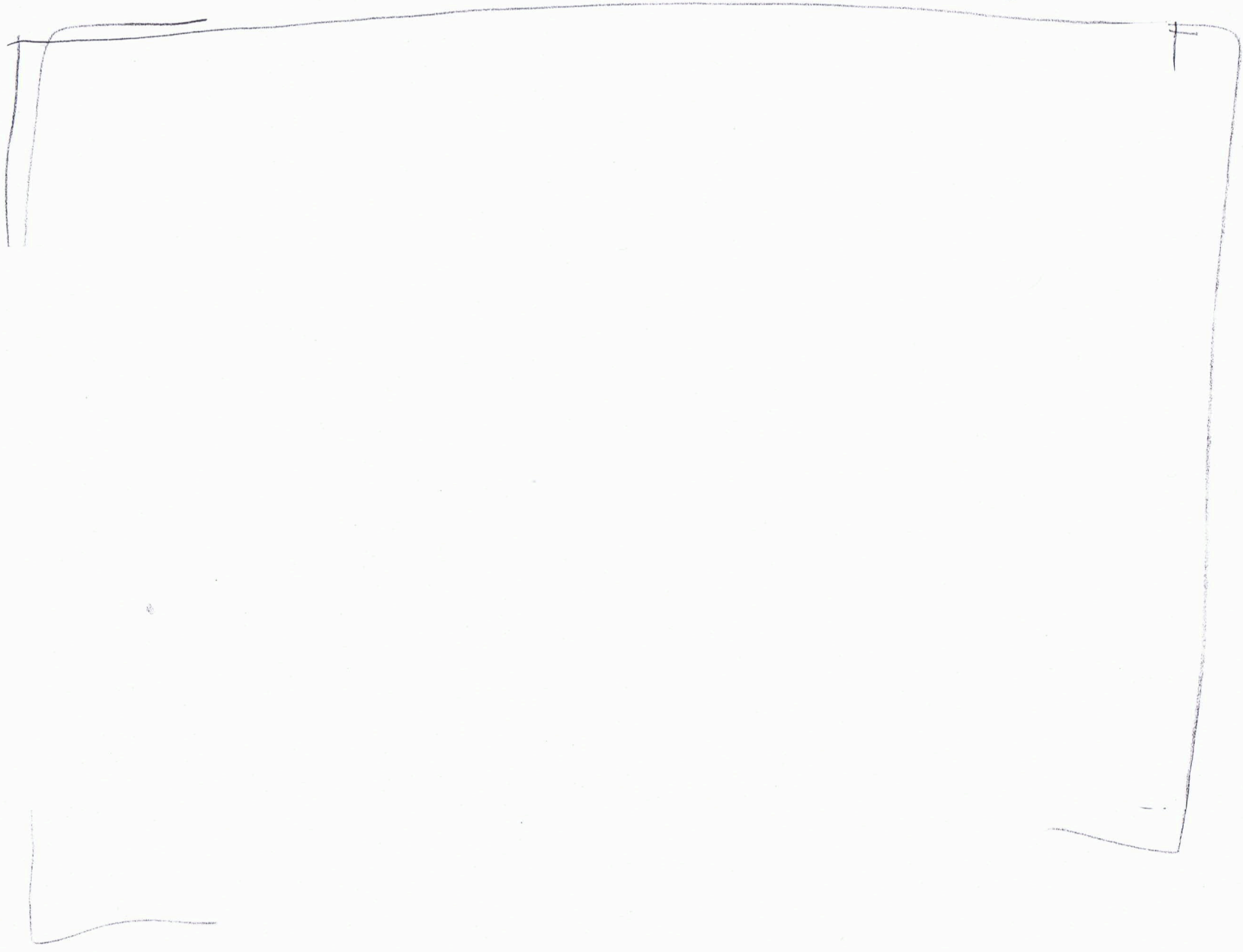
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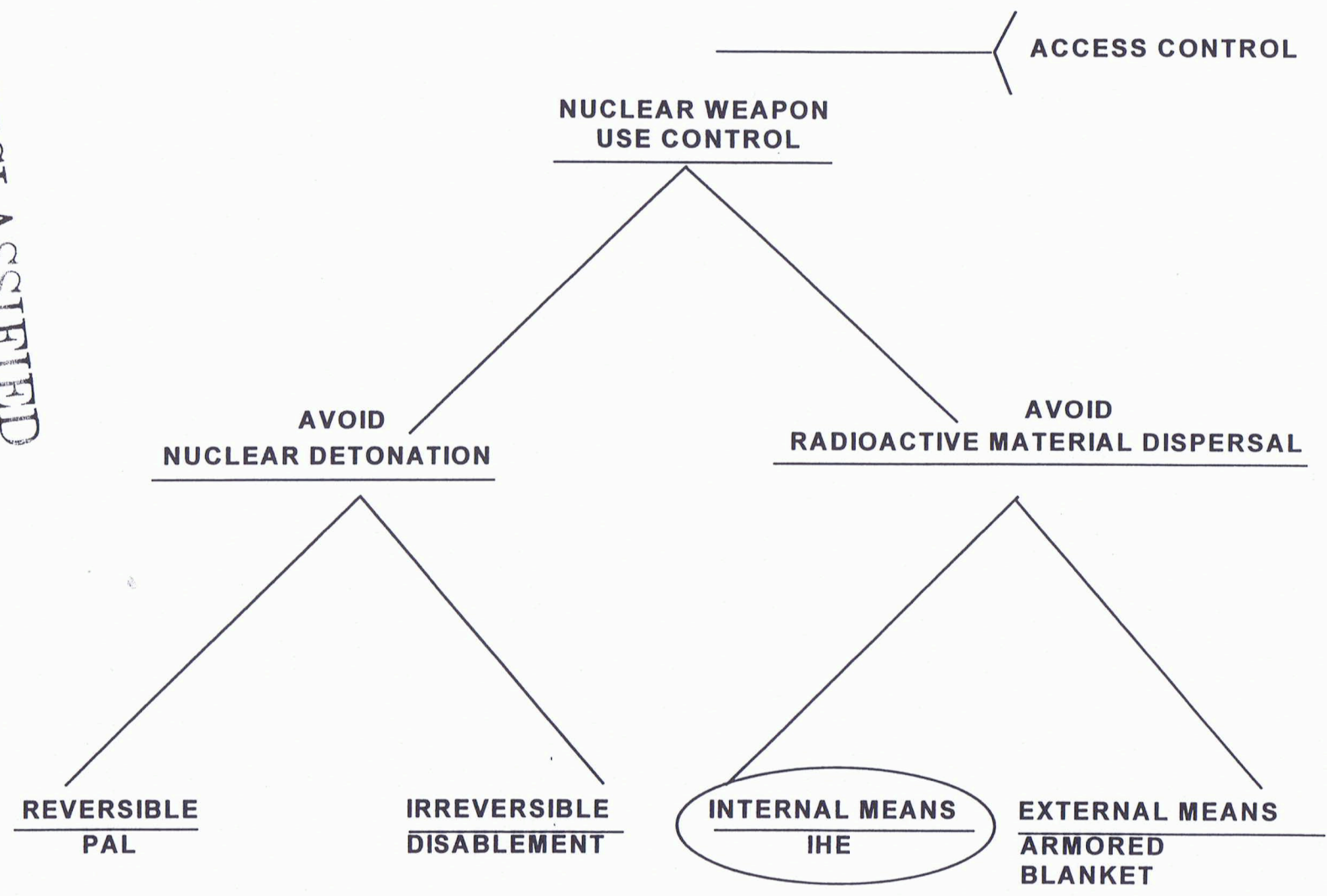
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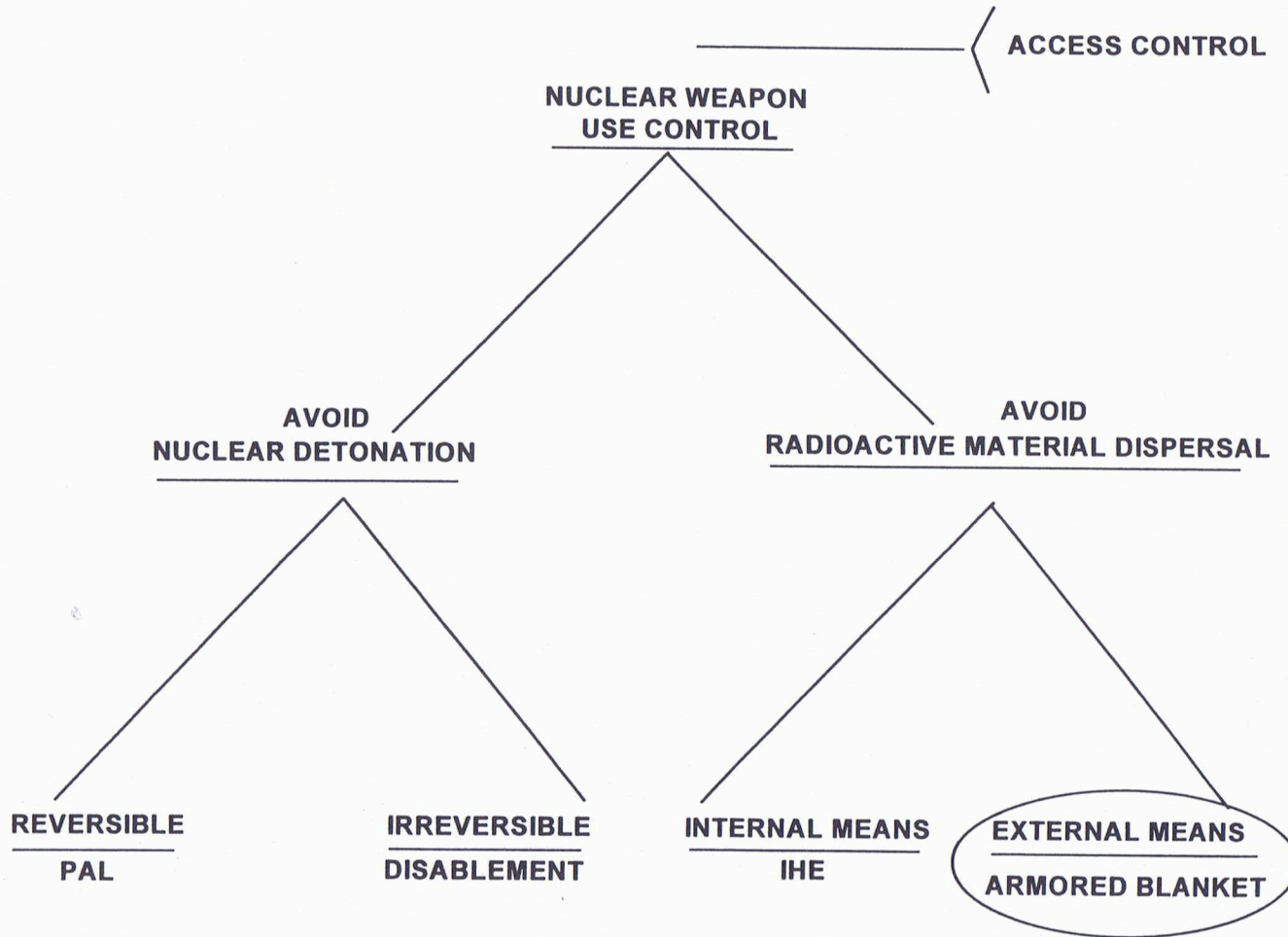


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