The DOE Phase X and 6.X Processes vs. the System Engineering V Process

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Outline

- Background and Context
- The Phase X, 6.X and DoD Acquisition Processes
- System Engineering V and NNSA Processes

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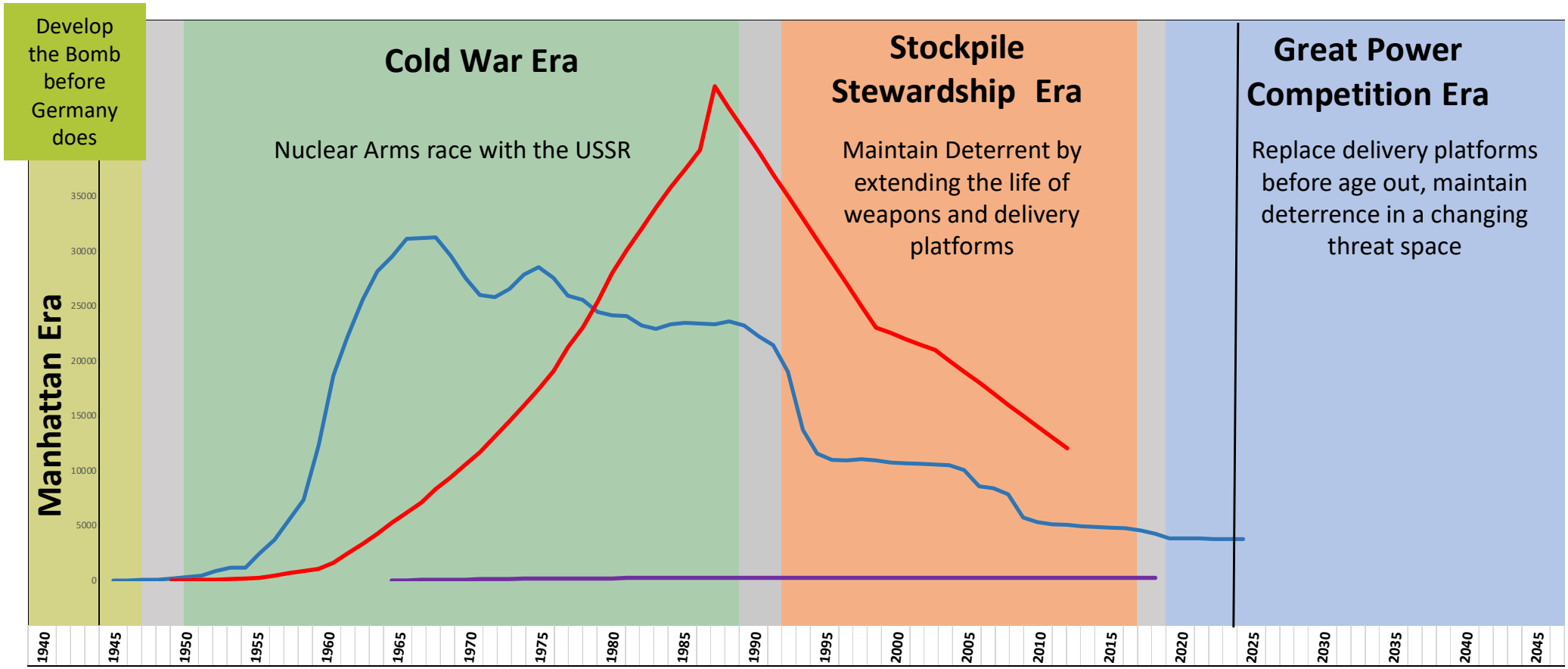
Background and Context

Nuclear Weapons Eras



The Size of the System

- Design, Testing and Production of Nuclear Weapons requires an extensive set of organizations
- Sites included national laboratories, material production, part production, assembly, testing and storage
- This map only shows the DOE side

The Size of the System

- The DoD NW infrastructure is also very large
  - Air Leg
    - Air Force Bases
    - Nuclear capable bombers
    - Nuclear capable multi role combat aircraft
    - Cruise Missiles
    - Testing Facilities
  - Land Leg
    - Air Force Bases
    - Control and Launch Facilities
    - Missiles
    - Aeroshells
  - Sea Leg
    - Navy Bases
    - Submarines
    - Missiles
    - Aeroshells
- All of these require Storage Transportation and Maintenance Facilities, Testing Facilities, Training Facilities, the NC3, and much more that all factor into the development process

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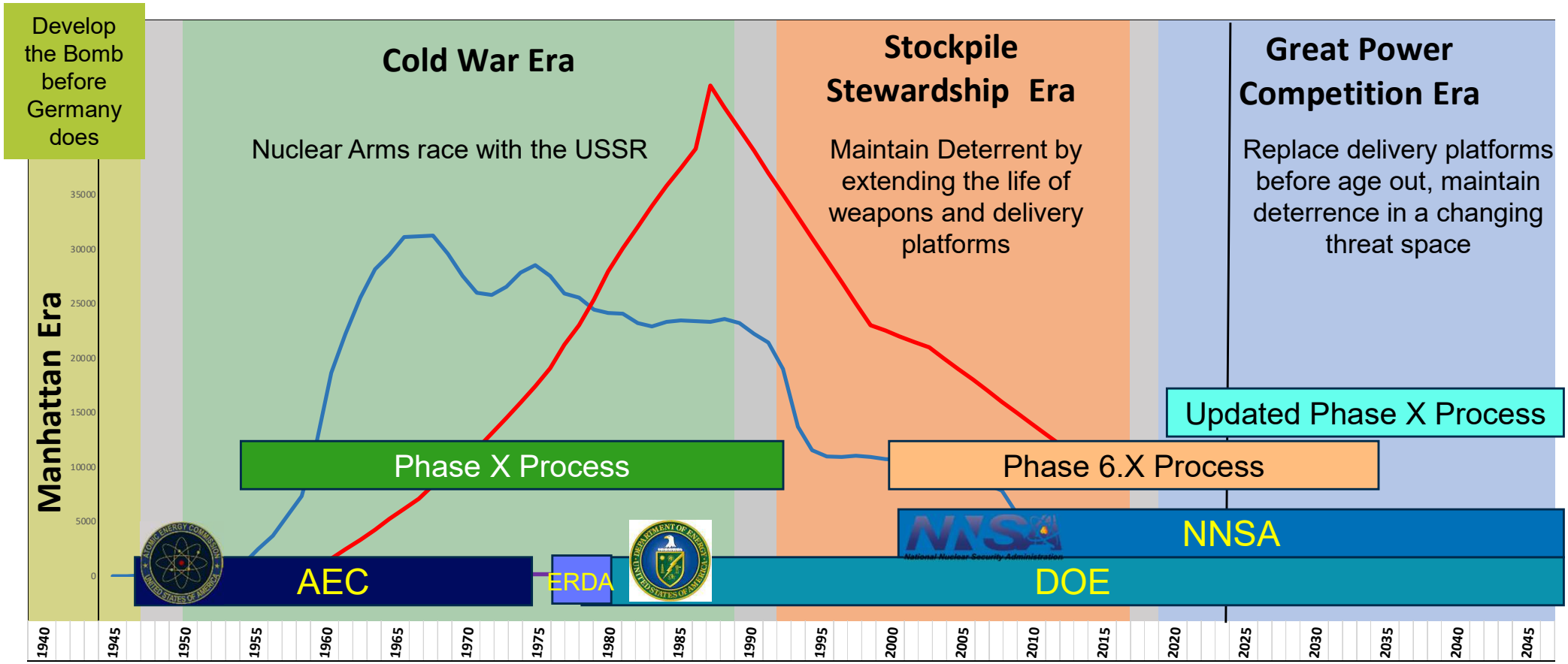
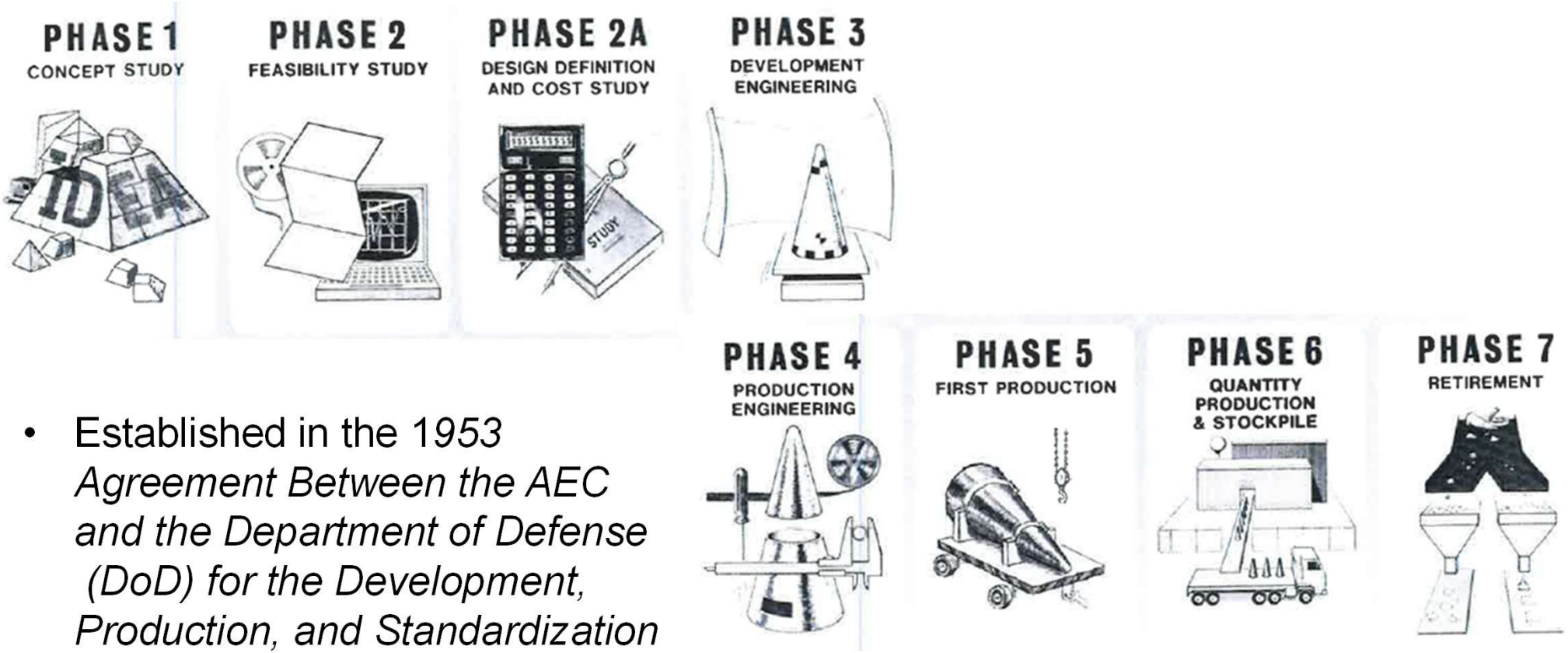
Phase X, 6.X & DoD Acquisition Processes

Nuclear Weapons Eras and the Phase X & 6.X



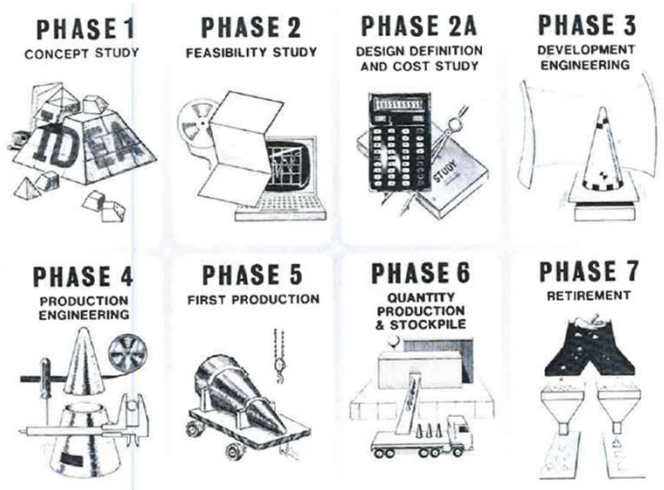
Cold War Phase X Process



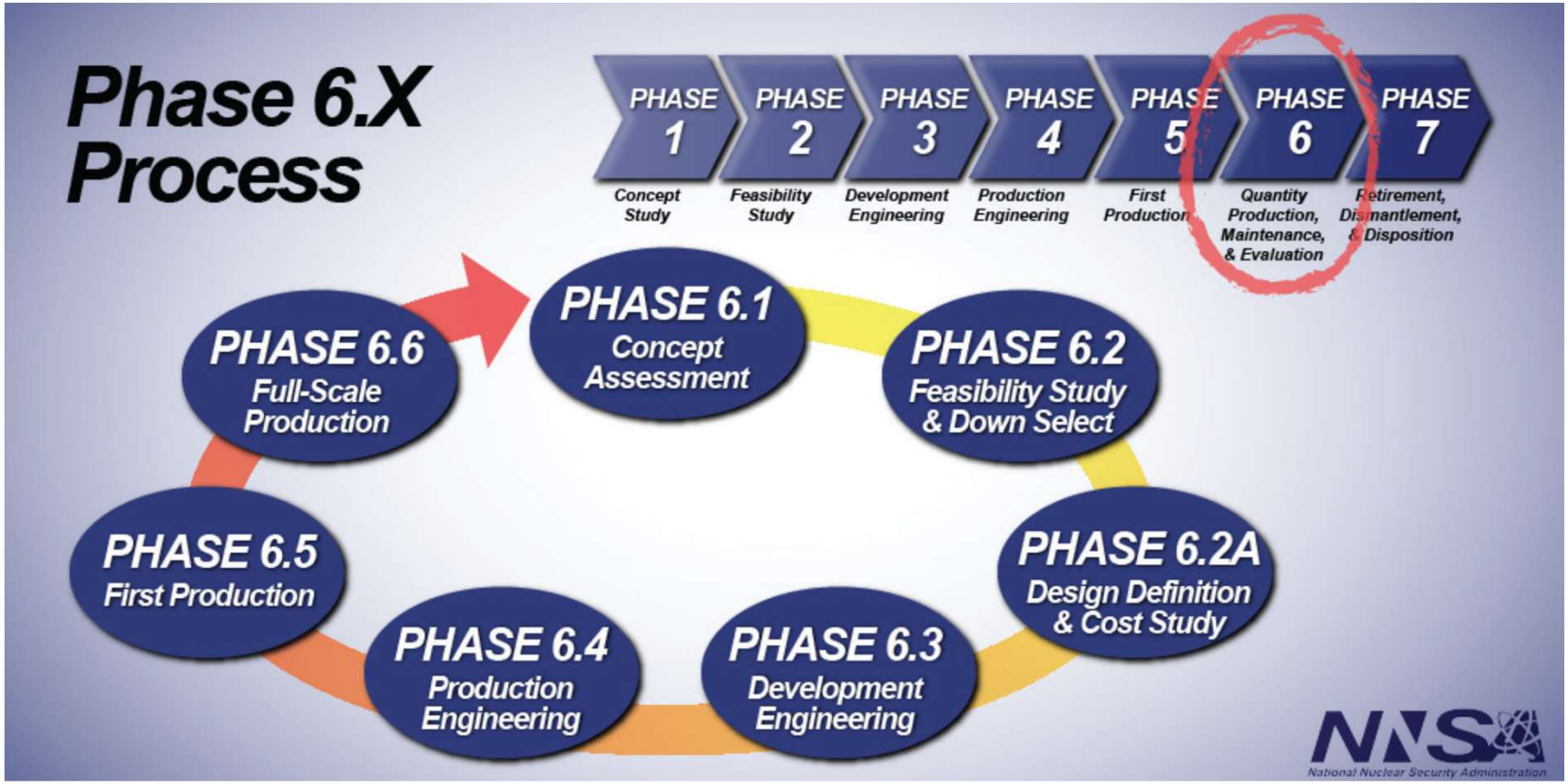
- Established in the *1953 Agreement Between the AEC and the Department of Defense (DoD) for the Development, Production, and Standardization of Atomic Weapons*.
- Also called the Joint DoD-DOE/NNSA Nuclear Weapons Life-Cycle Process
- Periodically supplemented in 1977 (ERDA), 1983 (DOE), and 1988 (NWC)
- Last used in the early 1990's
- Usually works in parallel with a DoD Acquisition process for the delivery Vehicle

Cold War Phase X Process

- The process could include:
  - A DoD service (Navy, Air Force, Army)
  - A DoD “air framer” contractor (Lockheed Martin, General Electric, etc.)
  - A DOE physics lab (Los Alamos National Lab (LANL) or Lawrence Livermore National Lab (LLNL))
  - Sandia National Laboratory (SNL)
  - A large number of Production Agencies and their suppliers across the entire country
- Phase 1 to Phase 5 timeframes varied but were roughly 2-5 years
- Weapon Lifetimes (Phase 6) averaged 3-5 years
- Dozens of Systems went through this process and only a subset saw the stockpile
- Production numbers were in the 10s of thousands



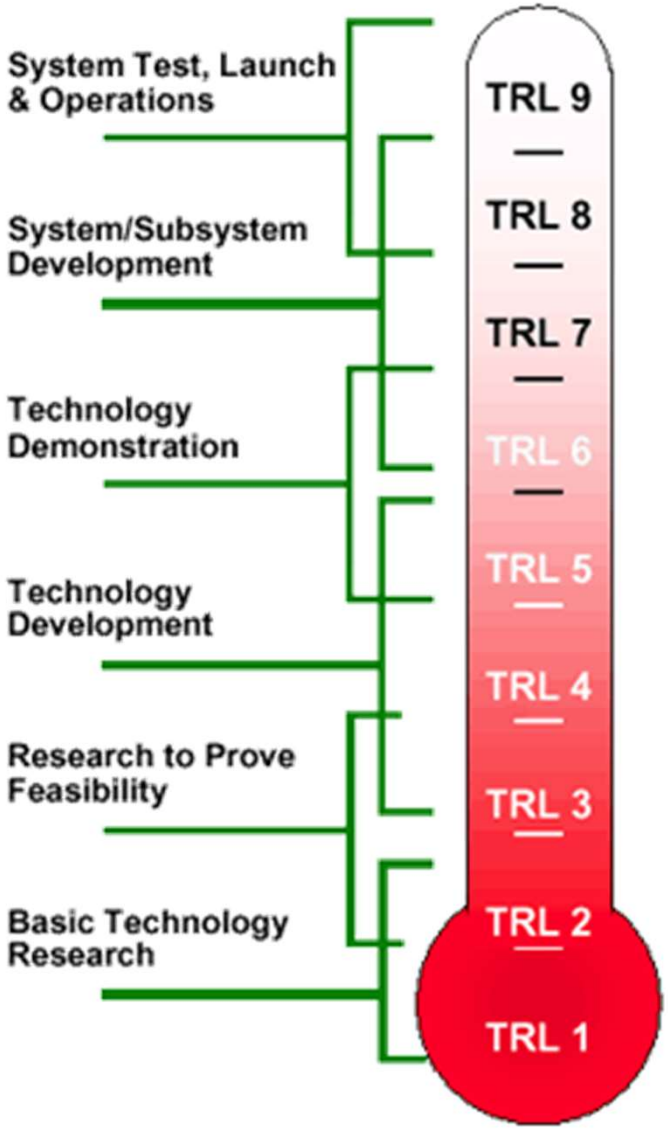
Stockpile Stewardship Phase 6.X Process



- Established in 1999 for Alterations (ALTS), Modifications (Mods) and Life Extension Programs (LEP's) of existing systems
- Procedural guidelines were released in 2000 and updated in 2015
- The process incorporated new elements like Product Realization Teams (PRT's), Technology and Manufacturing Readiness Levels (TRL's and MRL's), Nuclear Enterprise Assurance (NEA) among others.

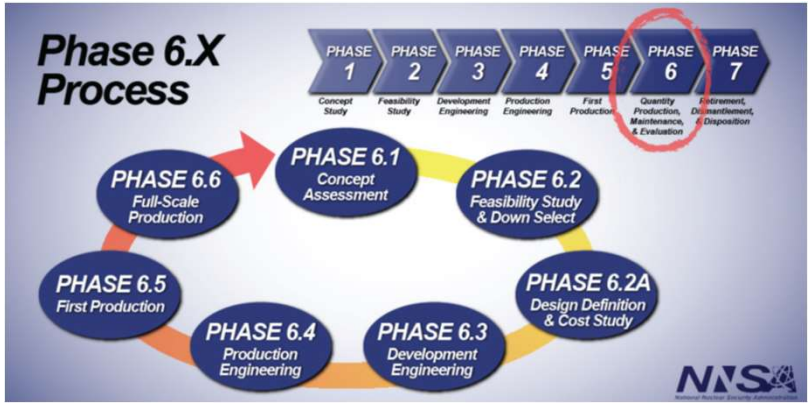
Technology and Manufacturing Readiness Levels

- Developed by NASA in the 70's
- Has been adopted by DoD and the European Space Agency (ESA) among others and is codified now in the ISO 16290:2013 standard
- DOE adopted them in 2011 with DOE G 413.3-4
- NNSA adopted them as well in 2016 with NAP 413.4
- They are being applied to the current Phase 6.X and X programs implementing Technology Realization Teams (TRT's) that assess the TRL and MRL levels against a standardized matrix.
- DoD is also using TRL and MRL levels



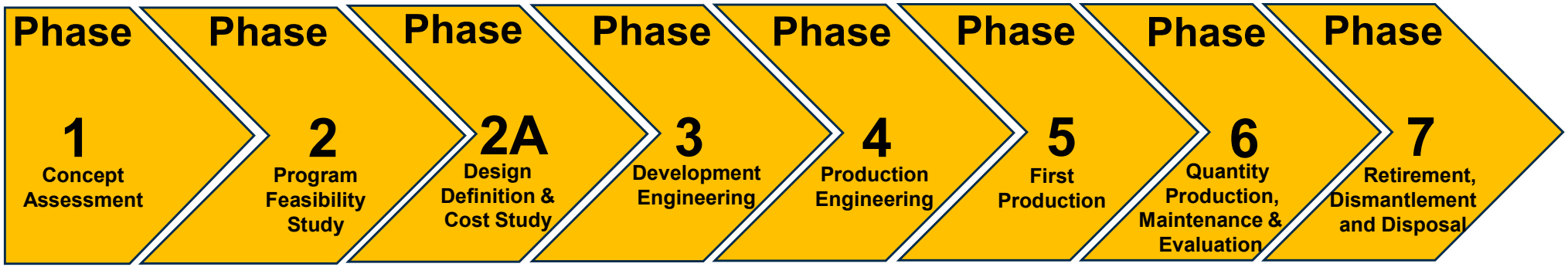
Stockpile Stewardship Phase 6.X Process

- The process can include:
  - A DoD service (Navy, Air Force, ~~Army~~)
  - A DoD "air framer" contractor (Lockheed Martin, General Electric, etc.)
  - A DOE physics lab (Los Alamos National Lab (LANL) or Lawrence Livermore National Lab (LLNL))
  - Sandia National Laboratory (SNL)
  - A smaller number of smaller Production Agencies and their suppliers across the entire country
- Phase 6.1 to Phase 6.5 timeframes varied but were roughly 8-10 years
- Weapon Lifetimes (Phase 6.6) are averaging 25 years
- Only a handful of Systems have gone through this process and some were cancelled
- Production numbers are in the hundreds



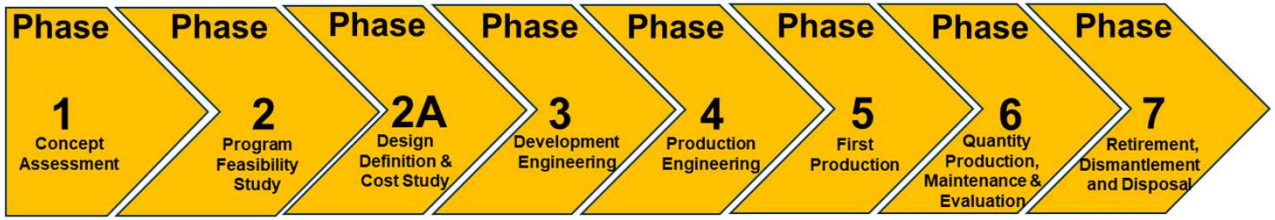
The Updated Phase X Process

- DoD, DOE and NWC Guidelines, Manuals, Directives and Instructions relating to the Phase X Process all started to be updated in 2018 and are still in progress in most cases
- W93 Phase 1 was successfully completed in 2022 and is now in phase 2
- The updated Process is a blend of the original Phase X process and the 6.X process
- Incorporates many of the elements added in to the 6.X process (PRT's, TRL & MRL Levels, NEA, etc.)



The Updated Phase X Process

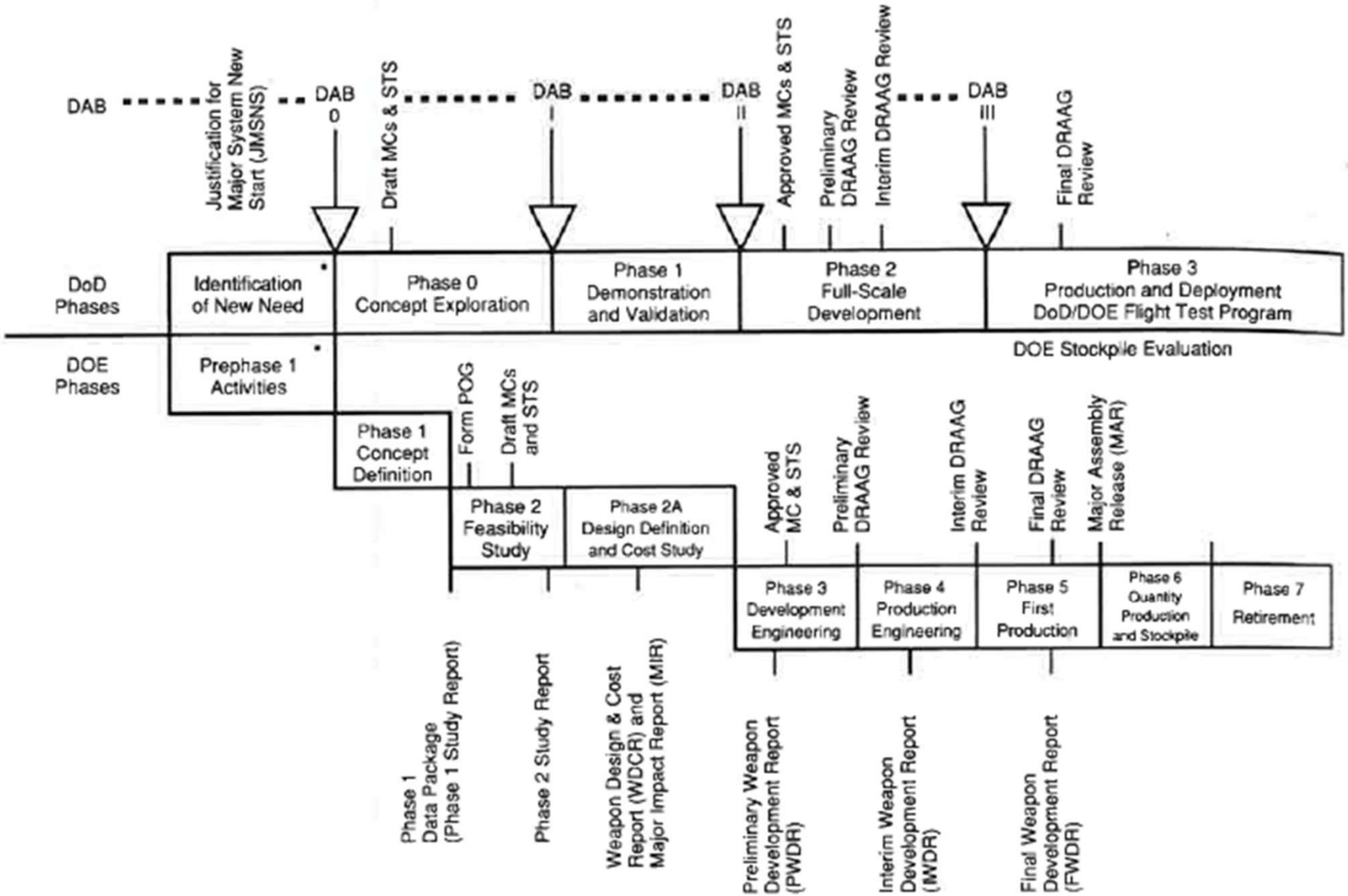
- The process might include:
  - A DoD service (Navy, Air Force, ~~Army~~)
  - A DoD "air framer" contractor (Lockheed Martin, General Electric, etc.)
  - A DOE physics lab (Los Alamos National Lab (LANL) or Lawrence Livermore National Lab (LLNL))
  - Sandia National Laboratory (SNL)
  - A smaller number of growing Production Agencies and their suppliers across the entire country
- Phase 1 to Phase 5 timeframes may still be 8-10 years
- Average Weapon Lifetimes (Phase 6) will probably stay at 25 years
- Only one System has started this process (W93)
- Production numbers will depend on what is deemed necessary to maintain deterrence in a changing geopolitical environment



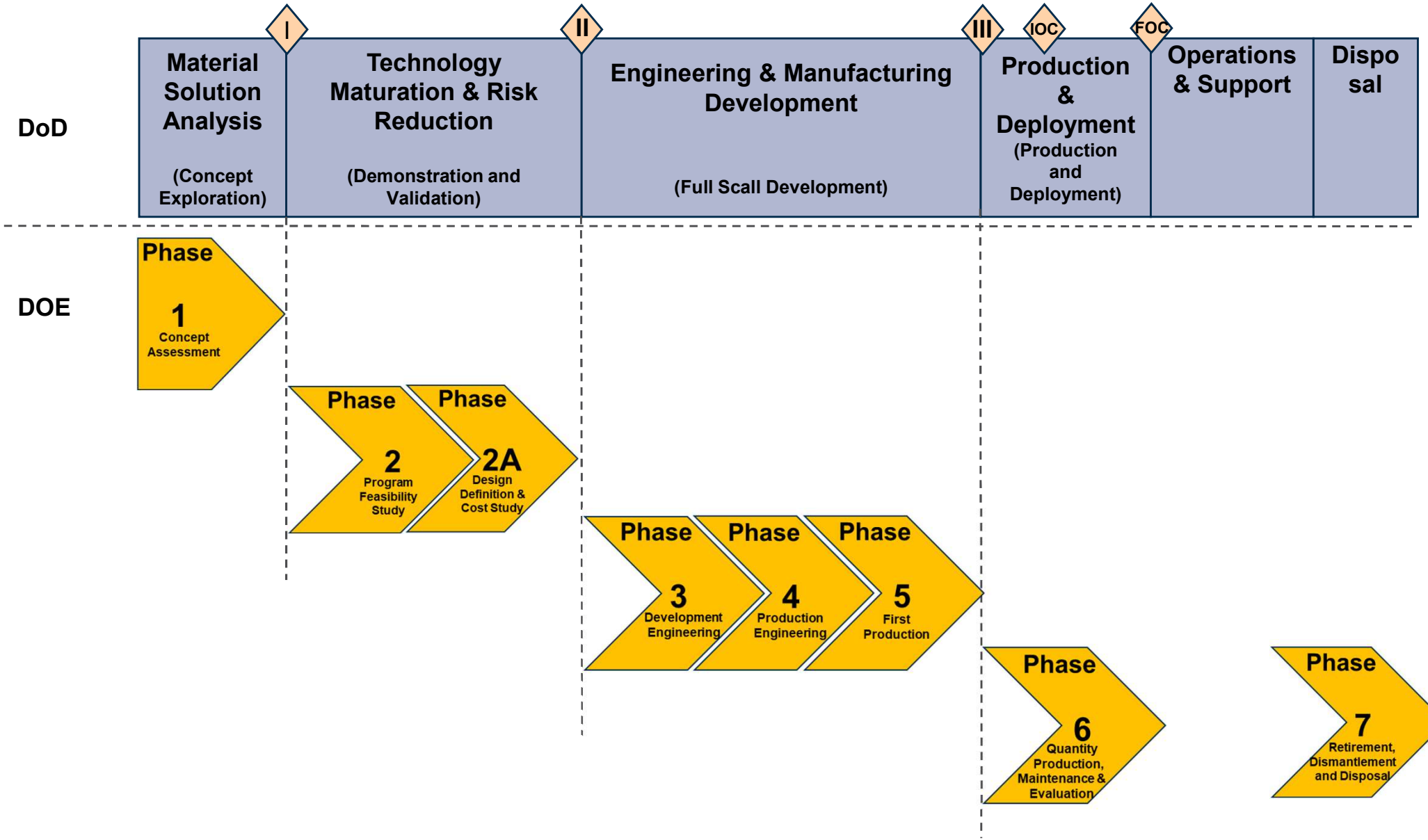
A few Acronyms you might see

- AoA – Analysis of Alternatives
- DRAAG – Design Review And Acceptance Group
- FOC – Full Operating Capability
- FWDR – Final Weapons Development Report
- IOC – Initial Operating Capability
- ICD – Initial Capability Definition (or Interface Compatibility Document in the DOE)
- MC – Military Characteristics
- NWC – Nuclear Weapons Council
- POG – Project Officers Group
- STS – Stockpile to Target Sequence
- WDCR – Weapon Design and Cost Report

Alignment to the DoD Acquisition Process in 1989



Alignment to the DoD Major Capability Acquisition Process (DoD 5030.55, 2001)



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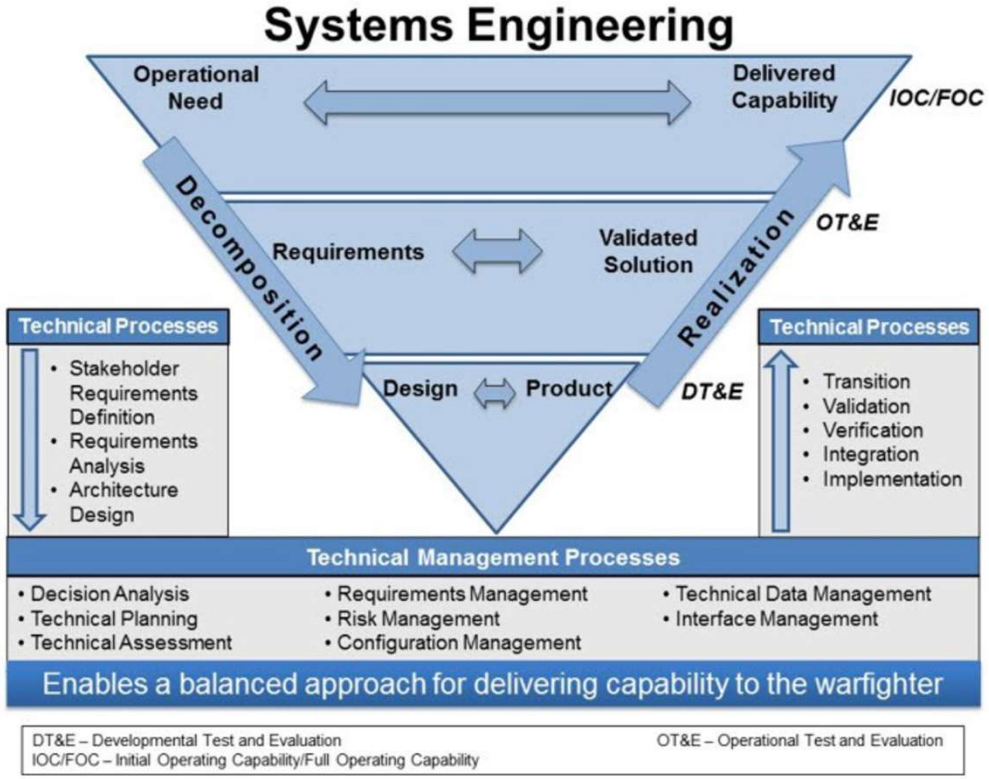
System Engineering V & NNSA processes

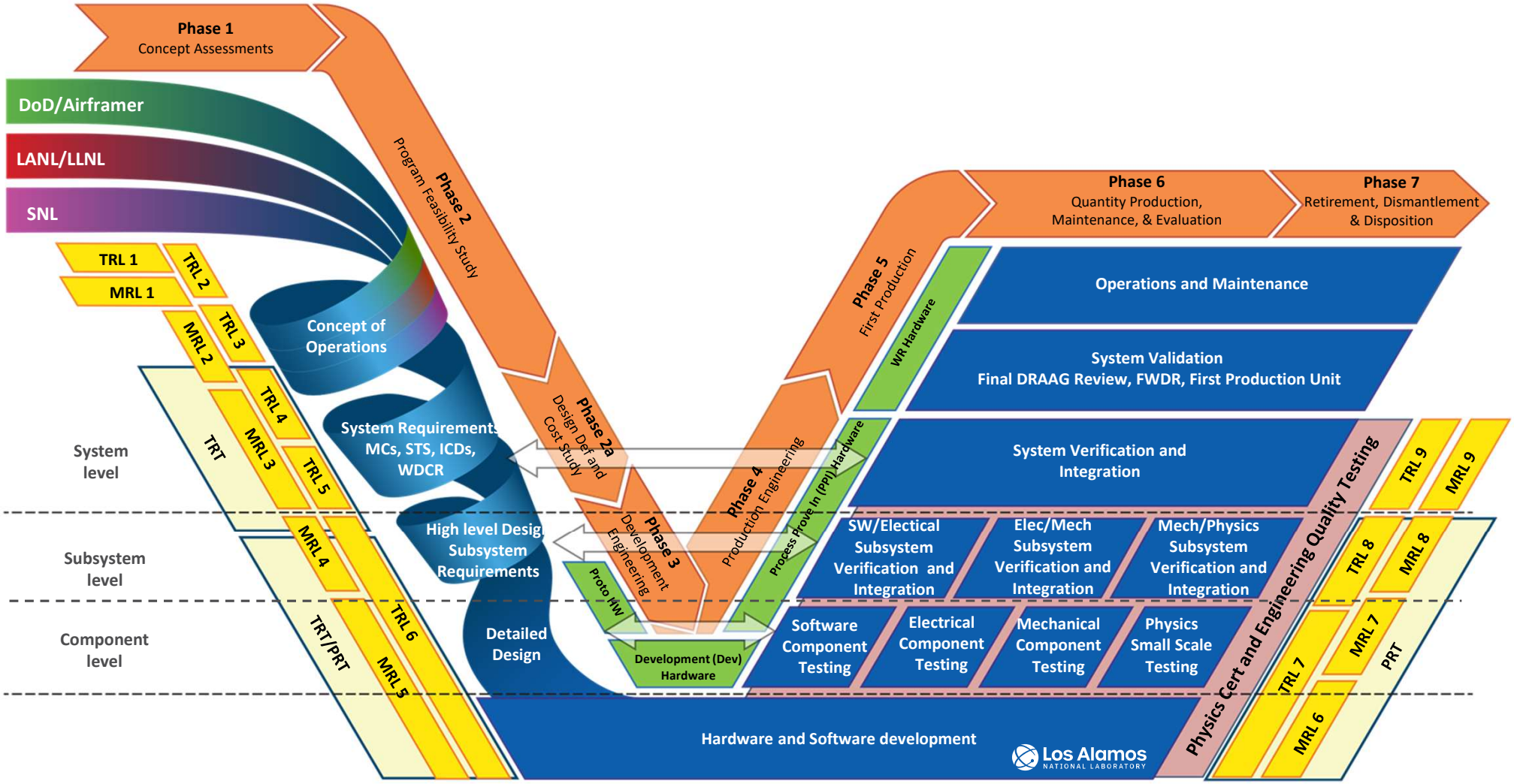
The System Engineering V

- First appeared in a proposal from Hughes in 1982
- There are many different versions and variations(V-Modell, W model, Morton Butterfly Model, etc), but the US model was documented in the 1991 NCOSE proceedings looking at satellite systems
- It is used around the world for large projects in many venues from project management to software development to defense programs
- The US Government standard V-model dates back about 20 years

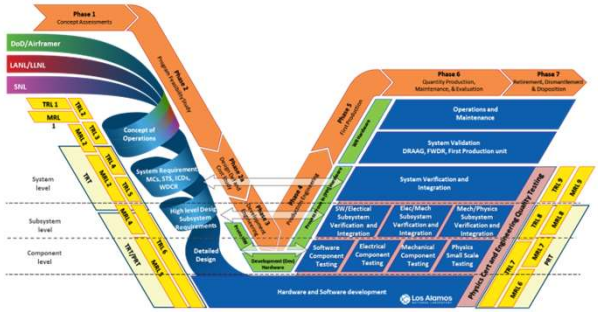


DoD OSDR&E Systems Engineering Guidebook, 2022

Overlaying the Phase X on the System Engineering V



Key Similarities and Differences

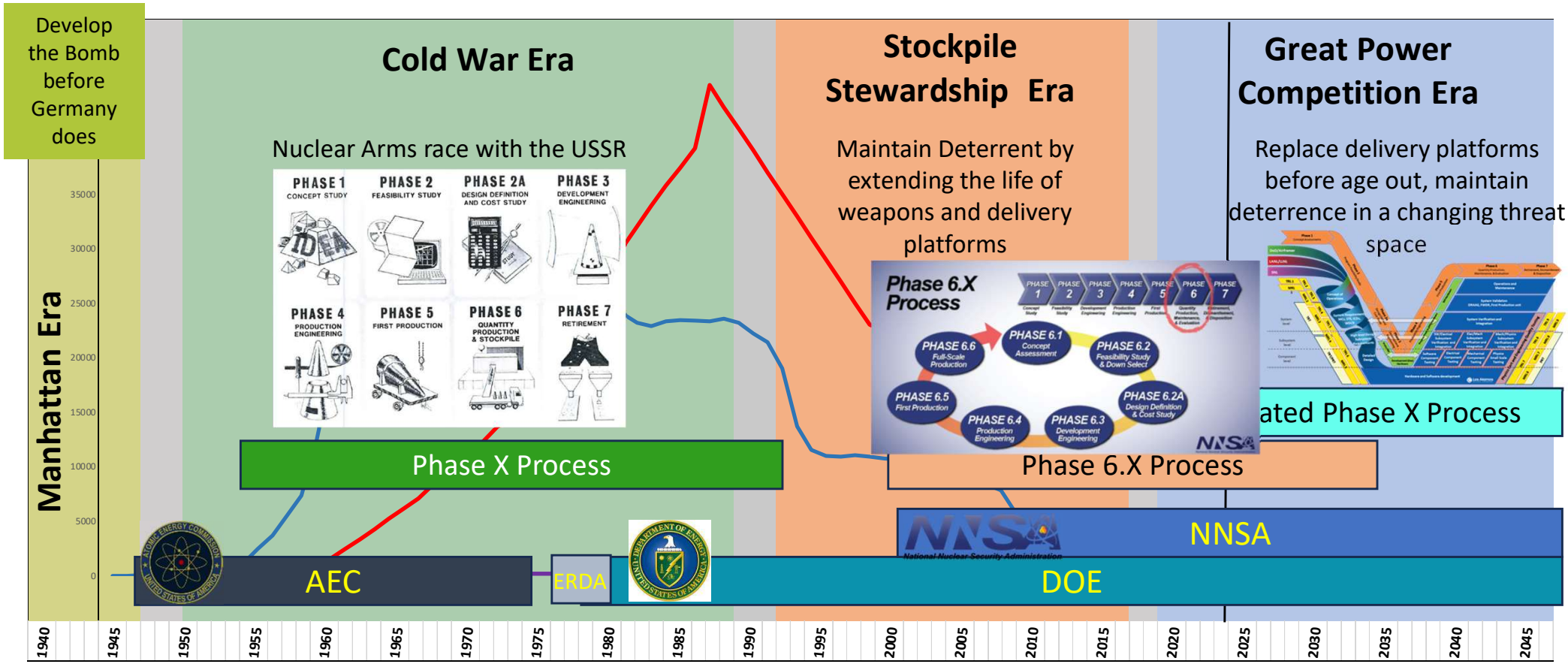


- The Joint DoD/DOE Weapon Development Process (Phase X/6.X) is very similar to the System Engineering V-Model especially at the high level.
  - They have nearly identical steps
  - They are both intended for large complex systems
  - Focus on Verification and Validation of system requirements

- The Phase X Process has many more details that further refine the process:
  - The process is linked to the DoD acquisition process
  - TRL/MRL Levels and where they must be at accomplished
  - The Phase 2A phase gate requiring a baseline design and cost analysis that goes to the Nuclear Weapons Council and Congress for approval and funding in order to proceed
  - The physics thread of the process from design to testing
  - Safety and Security aspects in every part of the DoD/DOE process where they usually play a smaller role with most systems.

Summary

- We are in a new Era with Nuclear Deterrence
- The Joint Development Process has evolved in the past and is doing so again
- There are many advantages to ensuring the Phase X Process aligns with the System V-model and standard system engineering processes



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Questions?

Sources

- THE NUCLEAR MATTERS HANDBOOK 2020
- Department of Defense Instruction Number 5030.55 2001
- ICOSE Systems Engineering Handbook INCOSE-TP-2003-002-03 2006
- Technology Readiness Assessment Guide DOE G 413.3-4A 2011
- Technology Readiness Assessments NAP 413.4 2016
- Systems Engineering Guidebook, Office of the Under Secretary of Defense for Research and Engineering (OSDR&E), 2022
- DoD Instruction 5000.02, Operation of the Adaptive Acquisition Framework, 2020

Abstract

The DOE used the Phase X development process to develop new weapon systems up until the early 90's when it stopped designing new systems. Up until recently they used a modified version of the Phase X process to complete Life Extension Programs called the Phase 6.X process. With the recent return to the Phase X process there are some interesting differences and similarities to the US System Engineering V Model. This talk will describe the two DOE processes and then show the differences and similarities to the US system Engineering V Model.