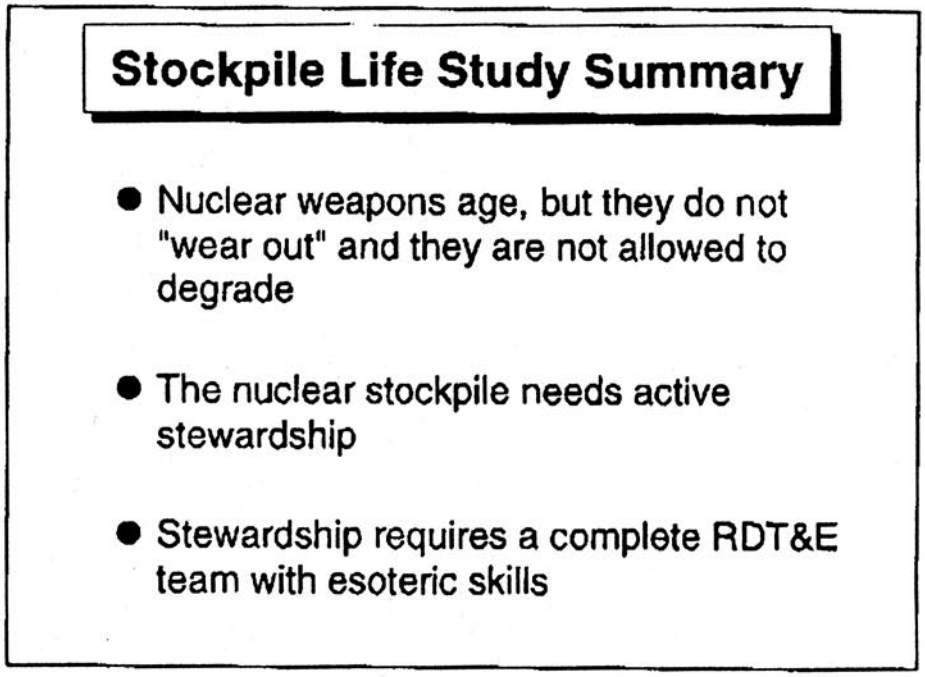
# A SUMMARY OF THE SNL STOCKPILE LIFE STUDY

We undertook this study to understand how long nuclear weapons last. We quickly learned that this is the wrong question. It is clear that, although nuclear weapons age, they do not wear out; they last as long as the nuclear weapons community (DoD and DOE) desires. In fact, we can find no example of a nuclear weapon retirement where age was ever a major factor in the retirement decision.




The more significant question is "what does it take to sustain a weapon while it is in the stockpile?" We redirected our study toward this question and what we learned can be summarized quite succinctly. The DOE labs have a role of active stewardship of the stockpile. On the order of 70,000 nuclear weapons have been produced and, in fact, full system tests have been conducted on approximately 20% of them. Failures, defects, and aging problems have been discovered, but these have been rare. In our study, we counted 257 "actionable" defect types. (An "actionable" defect is one which involves safety, reduces reliability, or resulted in remedial action.) Most of the problems have been discovered through our own test and evaluation program, not by the user. We have tried to manage this process so that there is minimal impact on the user. A survey of all the changes that have been made to stockpiled weapons and associated equipment indicates that about half of these changes were performed at the request of the user. These user requested changes were made to deal with circumstances and conditions that were not anticipated during the design phase; essentially new requirements. We examined the records of those systems in the stockpile which are expected to last beyond the year 2000. The number of defects and changes for these systems follow historical trends. Thus, a reasonable estimate for workload attributable to fixing defects and making other changes can be made. Finally, we examined what skills were required to handle the problems and new requirements as they arose. The defects were distributed over the broad range of components, subsystems and technical skills that make up nuclear weapons program.

We conclude that if there continues to be a requirement to maintain high readiness for the stockpile, stewardship of the stockpile will require a complete and functioning RDT&E team to deal quickly and promptly with problems as they occur. Maintaining competence in nuclear weapons and the supporting tech base sciences and testing will continue to be an important issue for Sandia.

December 1993

## Stockpile Life Study Summary

- Nuclear weapons age, but they do not "wear out" and they are not allowed to degrade
- The nuclear stockpile needs active stewardship
- Stewardship requires a complete RDT&E team with esoteric skills

## The Backdrop

- ⋆ A diminishing interest in nuclear weapons within the US government
- ⋆ No nuclear weapons are in production and there are no new programs on the horizon
- ⋆ The nuclear weapons production complex is in a state of transition
- ⋆ The underground nuclear test moratorium is likely here to stay
- ⋆ The DoD and the DOE are reducing the $ and personnel associated with nuclear weapons

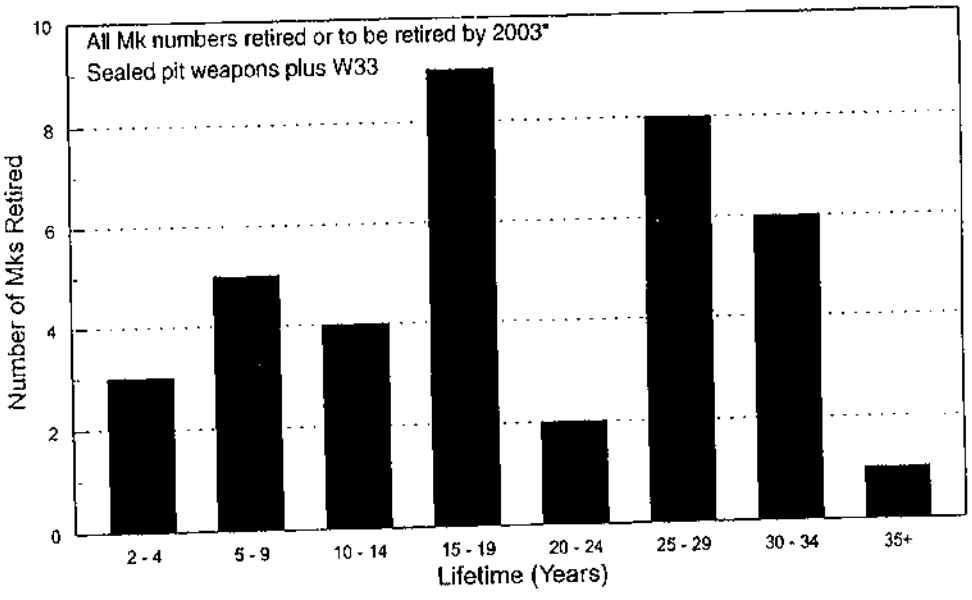
# Our Study Addresses Two Questions

How Long Do Nuclear Weapons Last?

and

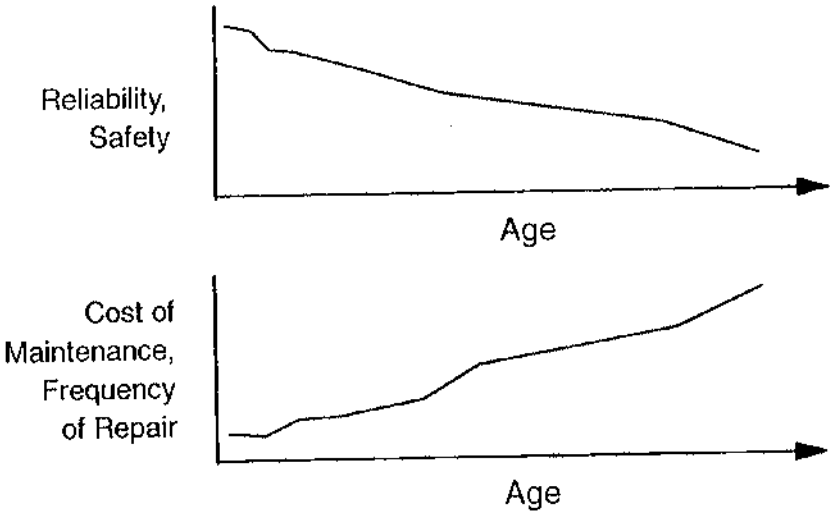
What Is Required To Keep Nuclear Weapons In The Stockpile?

## Mk Number Lifetime




* As projected by P&PD 94-0

## There are many perceived models of why we retire weapons

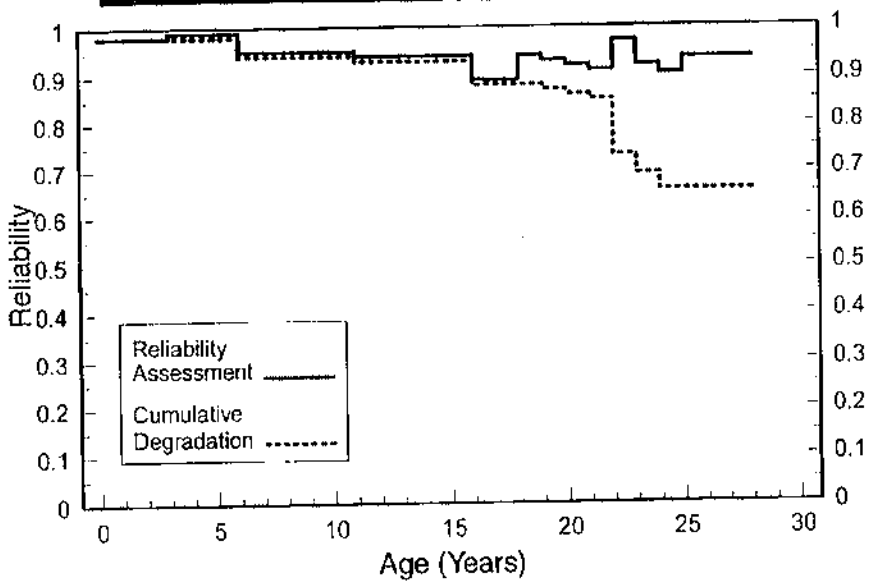



## The Role Of Underground Nuclear Testing In The Maintenance Of The Stockpile

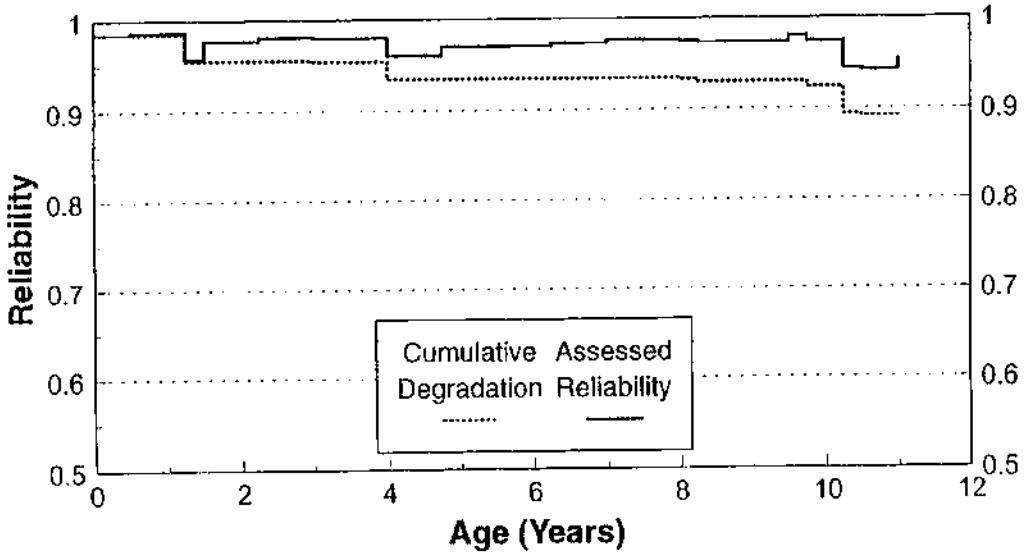
- The Stockpile Evaluation Program does not include underground nuclear testing

- Underground nuclear tests have been involved in 4 PCPs since 1970 (B61, W68, W79, W80)

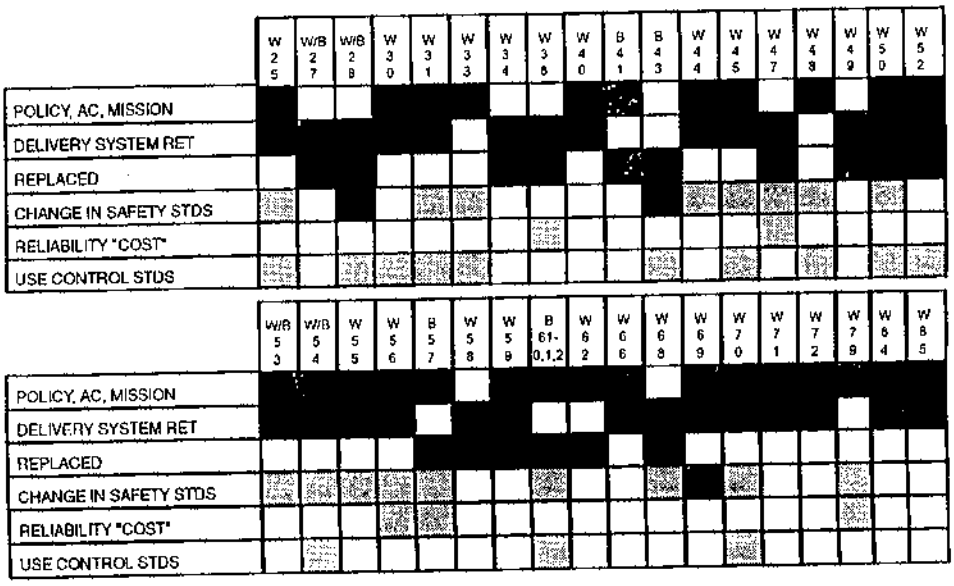
Example Reliability Assessment Profile and
Cumulative Assessed Reliability Degradation




**Example Reliability Assessment Profile and Cumulative Assessed Reliability Degradation**



## FACTORS AFFECTING WEAPON RETIREMENTS *




* *Missions, policy, standards, delivery systems, and state-of-technology change; however, nuclear weapons do not wear out.*

## Conclusions On Retirements: Policy And DoD Requirements Are The Drivers

- Requirements Drive Retirements
  - Usually a combination of factors in the retirement decision, but policy and DoD requirements predominate (mission elimated, replacement/retirement of delivery system)
  - Age of weapon is a consideration, but

    We can find no example where age is the sole or even primary factor in the retirement decision

## Weapon Histories Lead to a New Question

- "What is required to sustain a weapon while it is in the stockpile?"
  - The DOE has active programs to:

    Upgrade a weapon's surety

    Maintain a weapon's reliability

    Incorporate new operational features into a weapon

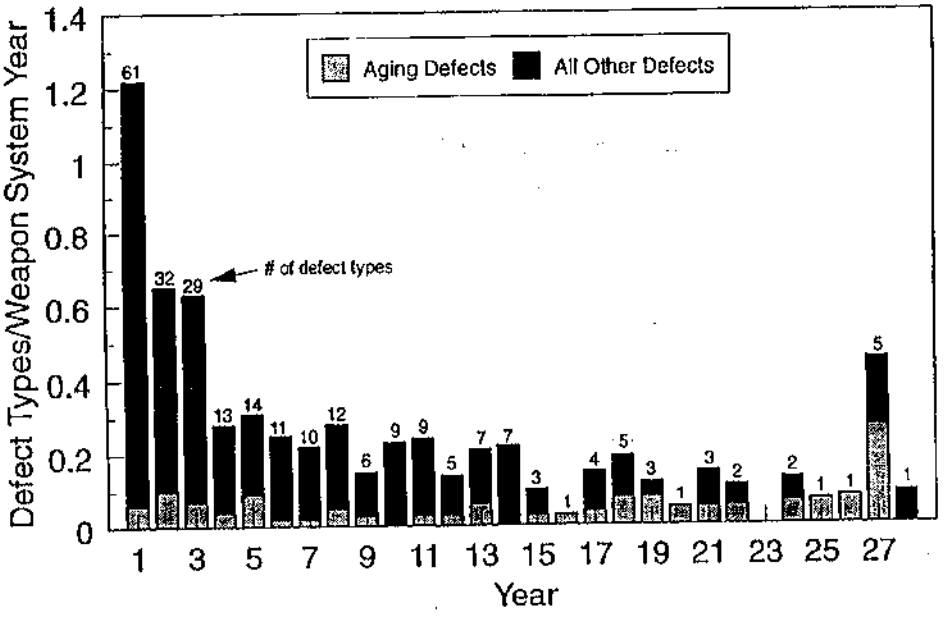
## Defects Have Been Relatively Rare

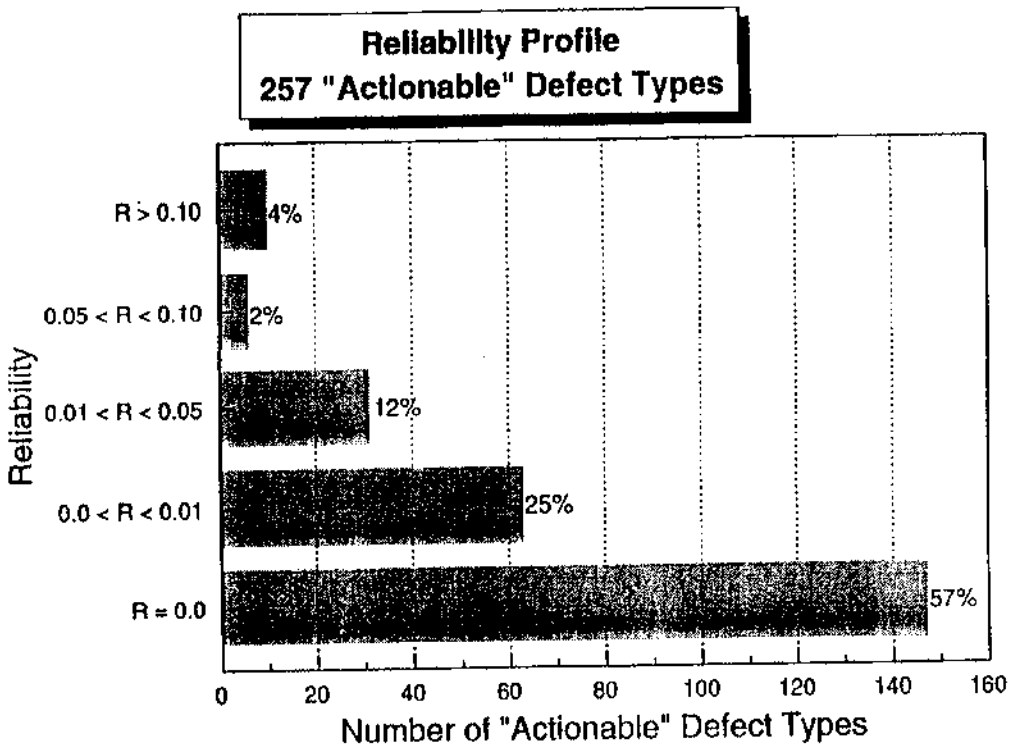
- Number of Stockpiled Weapons for which an Evaluation Program existed
  - ~70,000 Weapons
- The DOE has an extensive and evolving Test Program
  - ~13,500 Weapons have been tested
  - ~2,350 Defec ts noted including multiple occurrences
  - ~740 Defect types (1st occurrences)
- We have found 257 "Actionable" Defect Types
  - "Actionable" is herein defined as a defect type which impacts reliability or safety and/or for which some action is taken
  - 10 Defect types with reliability decrement of 0.10 or more
  - ~80% of these "Actionable" Defect Types were first discovered in the DOE Test Program

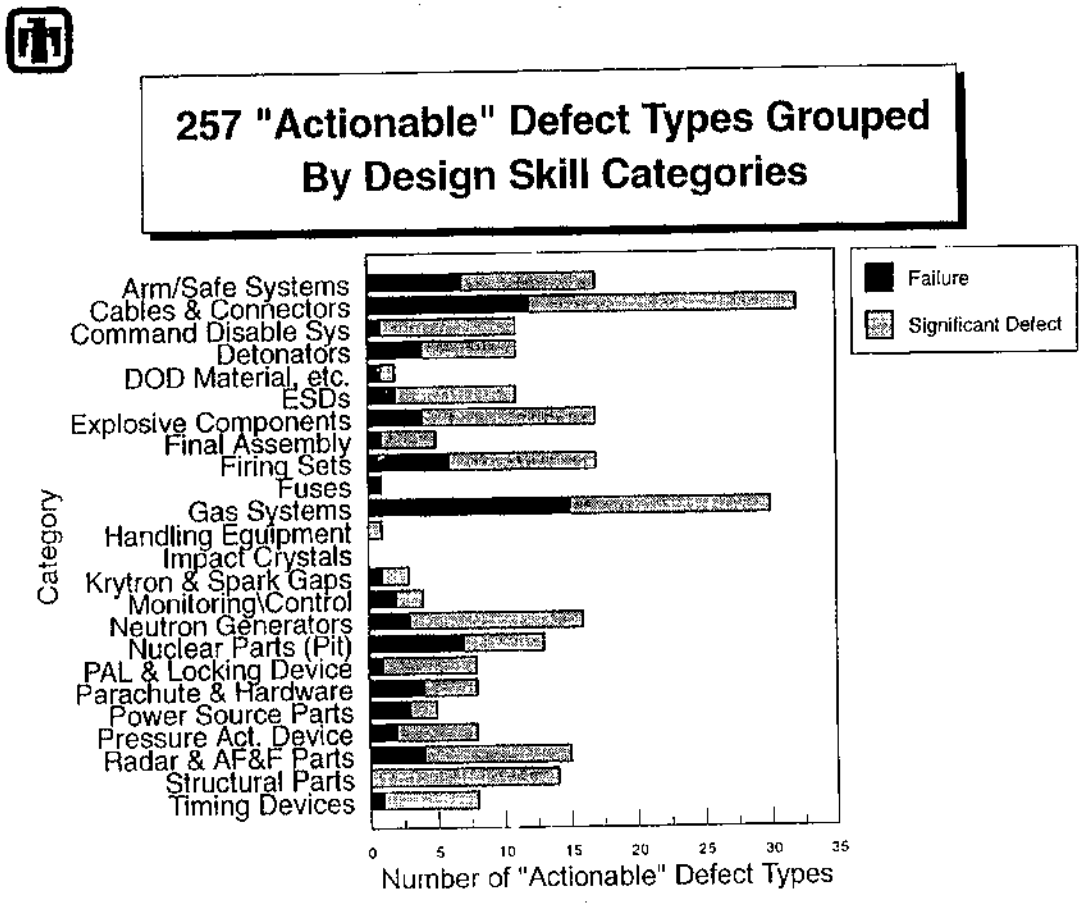
## Implications For The DOE Weapons Program

- Need A Complete RDT&E Team
  - Problems found and corrected in the stockpile cover the spectrum of nuclear weapon technical skill areas
  - If high readiness is a requirement for the future stockpile, expertise must be maintained in each of these skill areas
  - Plus, expertise in tech-base sciences, testing and production must be readily available

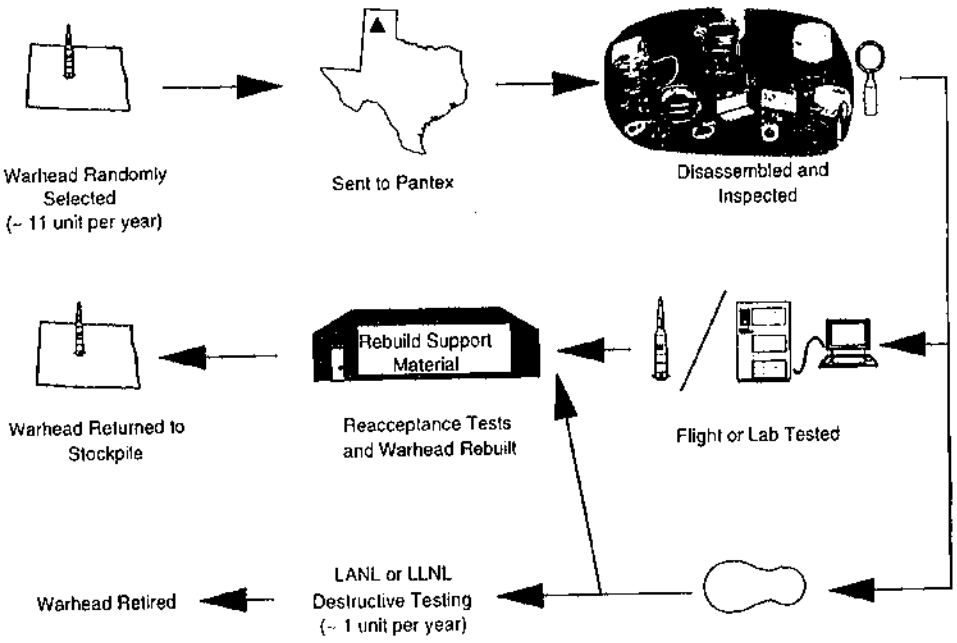
## Average "Actionable" Defect Types per Weapon-Year for Each Year Beyond FPU




Reliability Profile
257 "Actionable" Defect Types
R > 0.10
0.05 < R < 0.10
0.01 < R < 0.05
0.0 < R < 0.01
R = 0.0
Reliability
4%
2%
12%
25%
57%
0
20
40
60
80
100
120
140
160
Number of "Actionable" Defect Types

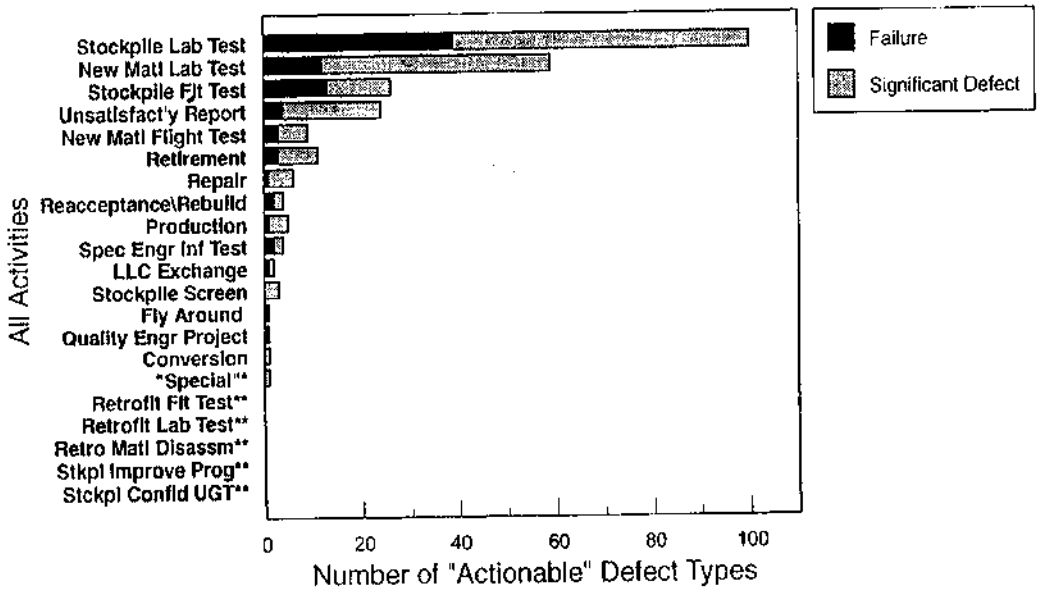

257 "Actionable" Defect Types Grouped
By Design Skill Categories
Failure
Significant Defect
Category
Arm/Safe Systems
Cables & Connectors
Command Disable Sys
Detonators
DOD Material, etc.
ESDs
Explosive Components
Final Assembly
Firing Sets
Fuses
Gas Systems
Handling Equipment
Impact Crystals
Krytron & Spark Gaps
Monitoring\Control
Neutron Generators
Nuclear Parts (Pit)
PAL & Locking Device
Parachute & Hardware
Power Source Parts
Pressure Act. Device
Radar & AF&F Parts
Structural Parts
Timing Devices
0
5
10
15
20
25
30
35
Number of "Actionable" Defect Types

# The Stockpile Evaluation Process



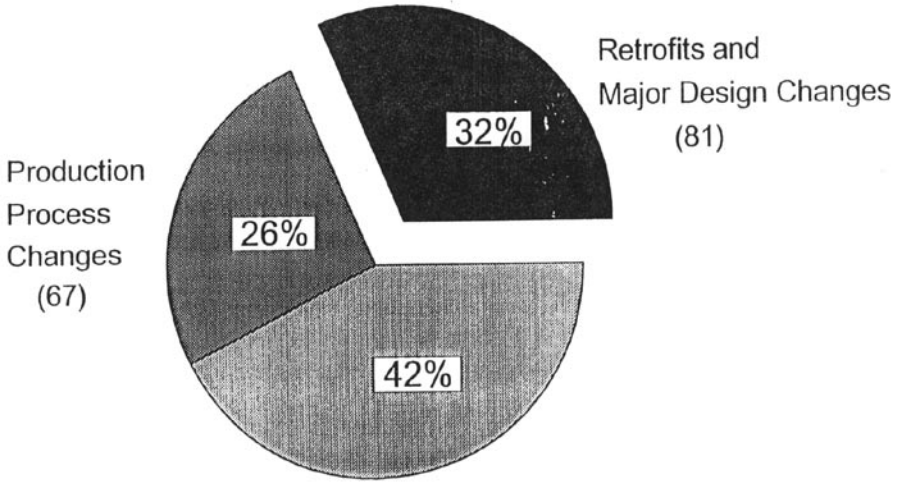

# Nuclear Weapon Defects

## Where The 257 "Actionable" Defect Types Were First Discovered



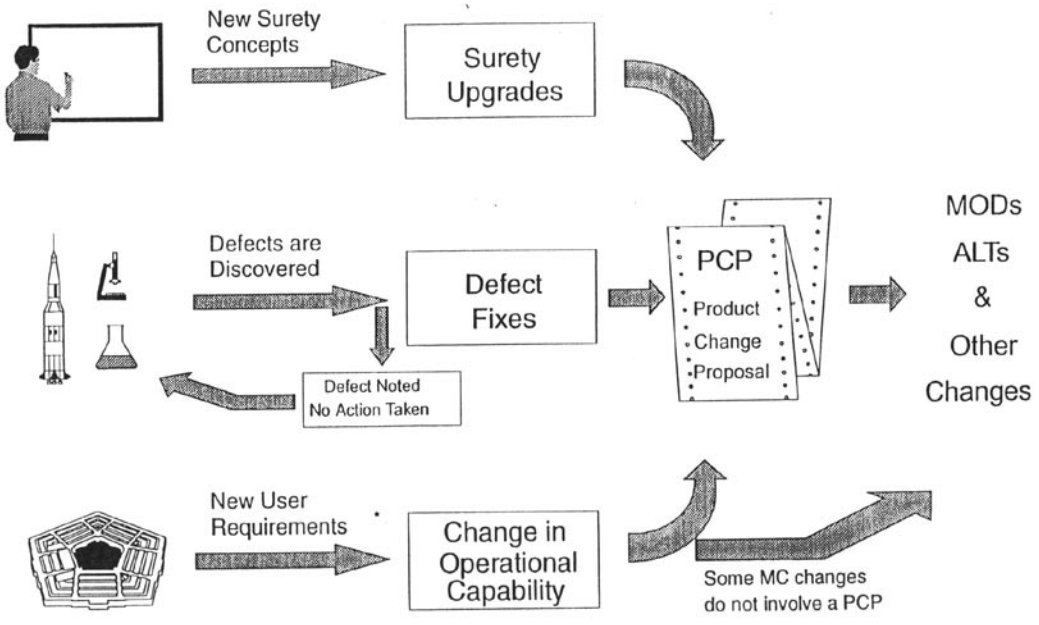

* Designation in the Historical Summary
** No "Actionable" Defect Types first discovered in these Activities

## One In Three "Actionable" Defect Types Has Been Corrected By A Retrofit or Major Design Change




No Physical Change Made (109)

## How Changes Are Made To Stockpiled Weapons



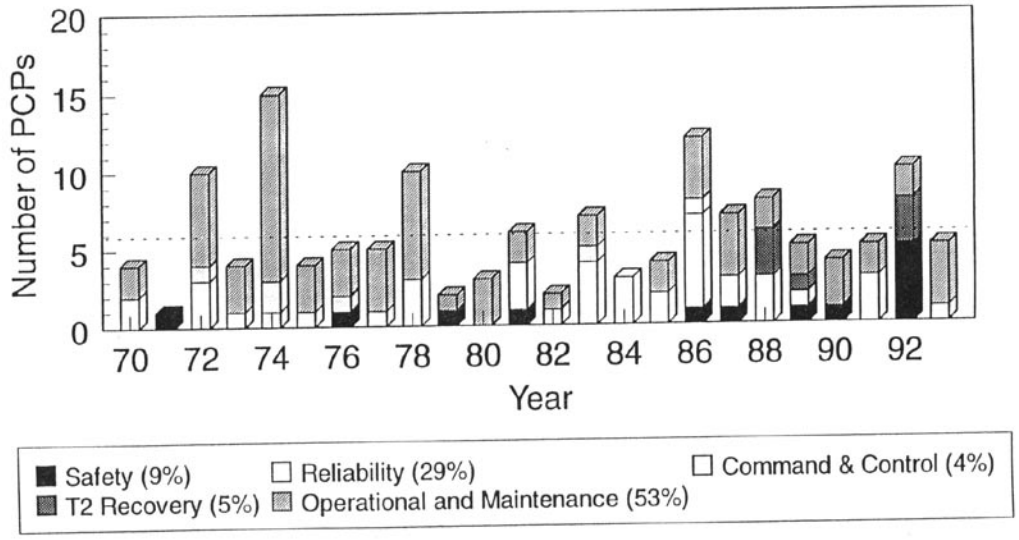

* New user requirements may result in new weapon development

# Product Change Proposal (PCP) Data

- PCPs initiate and authorize accountable changes to a WR weapon, its associated equipment and training units
- About 500 PCPs since the process began in 1957
- 141 PCPs since 1970 - "Modern" era
- 67 PCPs classified as major since 1970
- 4 PCPs involved UGT since 1970

## All "Modern Era" PCPs (1970 - 1993)

### 141 PCPs by Type of Change



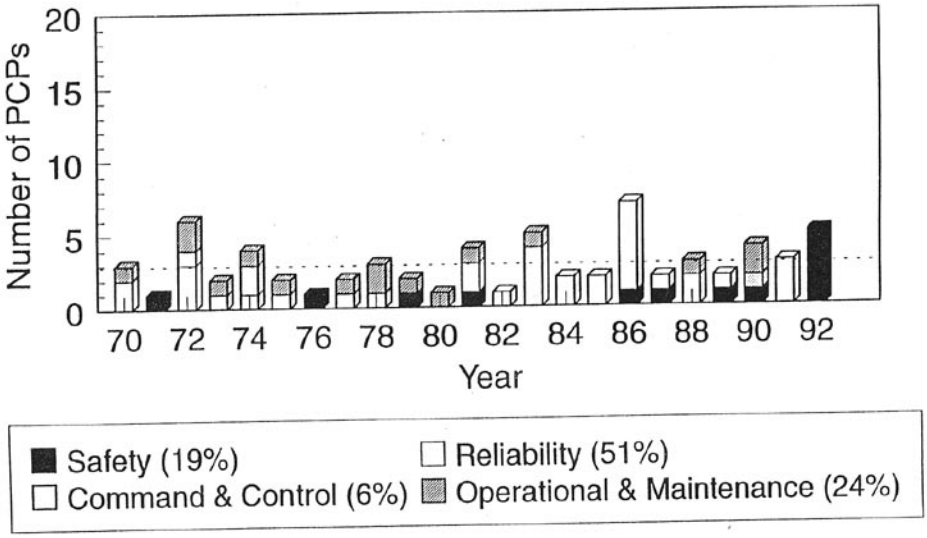
# What is a "major" PCP ?

## A Few Examples

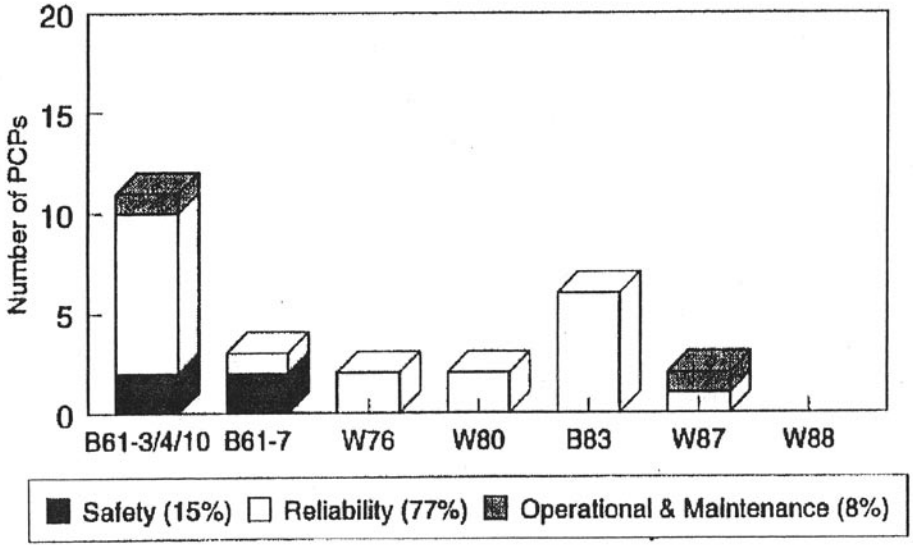
| PCP # | PCP Details | Assessment |
|---|---|---|
| 3-89 | Disable system for 1-point safety | Major |
| 4-89 | Replace gas transfer system | Major |
| 1-87 | Bomb Stockpile Improvement Program | Major |
| 5-77 | Change-out HE & Dets, NGs, & Nose | Major |
| 2-83, 1-82, 7-81 | Desensitize PAL System | Major |
| 1-70 | Inspect system for loose nuts | ??? |
| 1-75 | Change 2 amp to 1 amp fuzes in tester | Not Major |
| 3-76 | Modify instruction plate on tester | Not Major |
| 7-74 | Drill & tap 2 holes on H-gear | Not Major |
| 13-72 | Add foam & plastic to H-gear | Not Major |

# "Major" PCPs (1970 - 1993)

## 67 PCPs by Type of Change



## Stockpile Weapons in 2004
### "Major" (26) PCPs by Type of Change




## The Enduring Stockpile Tends to Follow Historical Trends for Defects and PCPs

| | Expected Average | Actual Average |
|---|---|---|
| Actionable Defect Types | 3 to 4 | 5.7 |
| Total PCPs | 5 to 6 | 5.6 |
| Major PCPs | 2 to 3 | 2.9 |

## Future Workload Issues

For the enduring stockpile (comprised of 7 systems), historical data suggest that:

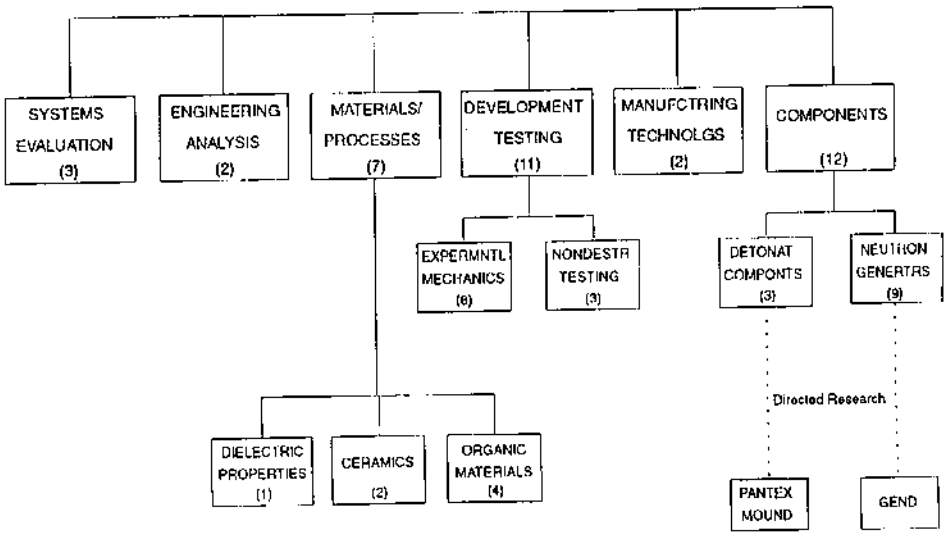
- 1 "actionable" defect will be discovered each year.
- About 2 PCPs will be approved each year - 1 of these will constitute a major change.

## Selected Case Study
### Mk21/W87 Neutron Generator Defect

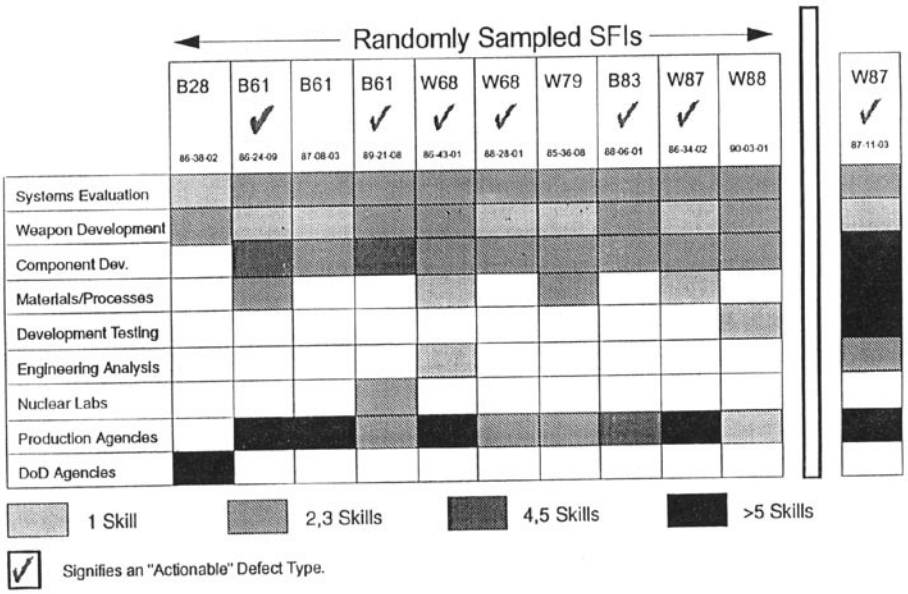
- High Voltage Breakdown in High Temperature Test
- Potential Impact on Many Weapon Systems
- Initial Action: Reduce High Temperature in the W87 STS & Investigate Failure Mechanism
- Final Resolution: Failure Mechanism Understood
  - Determined Existing Hardware Designs Were Acceptable (With W87 STS Temperature Change)
  - Designed New Explosive Timer for Future Applications

## Resolution of the W87 Neutron Generator HVB Problem Required 37 Key Technical Specialists Plus Support From Three Production Plants

() - Numbers in parentheses indicate number of key specialists in that technical area




## Tech Support for SFIs



## Conclusions On Changes: Defects Have Been Found/Changes Have Been Made

- Defects have occurred and fixes have been made, even for modern designs
  - Although more defects are found early in a weapon's life, defects have been found in weapons of all ages
  - Most defects are found by means of a formal test program and fixed (when necessary) through a formal process
- Changes to weapons have also been made to improve military operations and maintenance

## Future Will Be Different

- Fewer New Systems & Smaller Stockpile
- Underground Nuclear Test Moratorium/ Comprehensive Test Ban
- Production Complex Will Be Different
- Major Policy Changes?