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An Overview of Nuclear Weapon Stockpile Lifetimes and Past Problems

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Background

The US nuclear weapons program has entered a new era in its history. The first 45 years of the program were characterized by continuous weapon development supported by underground nuclear testing and a large production capability. In the last 5 years there has been no new weapon development and there is none planned for the foreseeable future, no underground nuclear tests have been conducted since September 1991 and the production complex has significantly downsized in number of plants and personnel. In this new era some old questions must be faced which have not been seriously confronted in the past. One of these questions is 'How long can the weapons in the current stockpile be expected to last?'.

Weapon Stockpile Durations

Past history cannot provide a definitive answer to this question but it can provide some useful insights. In the past, weapon types (i.e., weapon Mk numbers) have remained in the stockpile a minimum of 2 (W66) and a maximum of 35 years (W33). The average (and median) duration has been around 20 years which coincidentally is the 'minimum design lifetime' referenced in weapon requirements documents for much of the current stockpile. However, the duration of a weapon type in the stockpile does not help in determining how long nuclear weapons last unless the reason for removal is understood. The W66 was removed from the stockpile because the US made a decision to eliminate its ABM defenses, not because the warhead was not functioning after 2 years in the stockpile. A review of the history of those weapon types retired to date reveals that most weapon retirement decisions are made due to several factors and that these factors are almost always driven by DoD and political considerations (e.g., delivery system retirement or complying with arms control treaties). Of the weapon types retired, history does not indicate any retirement decision based primarily on the fact that the weapon was aging and not performing adequately.

Trend of the Average Age of the Stockpile

In the past the US had the comfort of knowing that it had a large and diverse stockpile and that almost continually a new weapon type was in development to replace existing weapons. This continuous replacement strategy kept the stockpile relatively young and obviated the need to answer how long weapons really last. The average age of the stockpile gradually rose to 12 years old from 1945 to about 1980, remained between 12 and 13 years old in the 1980s and dropped to around 11 when President Bush initiated retirement of most of the US theater nuclear weapons in 1991. The average age is now greater than ever in history and is rising at the rate of approximately 1 year each year and with no new weapons planned to enter the stockpile, the average age will exceed 20 years old by 2004.

Weapon Problem: Method of Discovery

The finding above that weapon defectiveness has not led to weapon system retirement should not be taken to imply that there have been no design or aging problems in nuclear weapons. Quite to the contrary, there have been some significant problems. However, the DOE and DoD made committments and had the capability to correct those problems when they arose. Major changes to stockpile weapons have been undertaken including replacement of nuclear parts.

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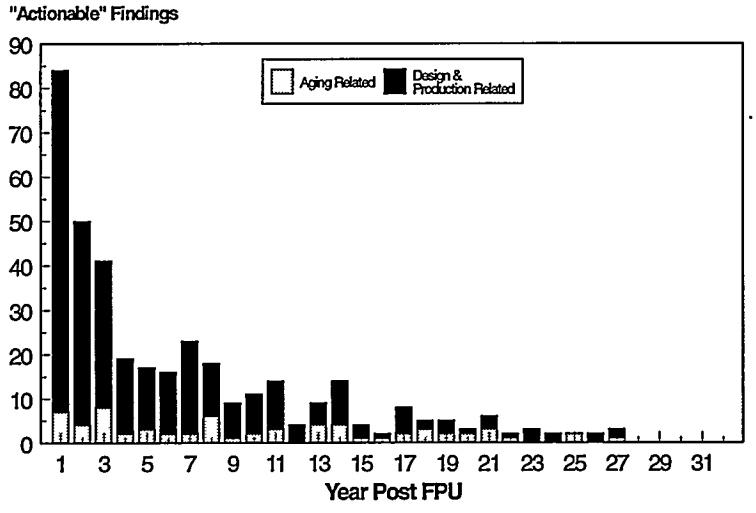
The majority (approximately 75%) of the problems affecting weapons in the stockpile have been discovered through the Stockpile Evaluation Program. Since its inception in 1958, over 13,900 individual weapons have been evaluated through this program. Field reports from the military account for about 10% of the findings and the remaining 15% have been found through various activities including research and development activities, retirement activities, underground nuclear tests, etc. Sandia maintains a database for the DOE of the findings (some are problems and some are anomalies that are recorded from testing but were determined not to be problems per se) related to nuclear weapons in the stockpile. This database contains 2,500 records and more than 40 fields of data for each record. These fields include such information as how the finding was discovered, the cause of the finding (design, production, field handling, aging), when the finding was discovered, any reliability impact associated with the finding, an indication of any action taken in response to the finding and a short description of the finding. Of the 2,500 records in the database, there are about 800 finding types and about 1,700 repeat occurrences of those types. Action (retrofit, production change, field handling change, test equipment change, reliability reduction, etc.) was taken in response to about 400 of the 800 finding types, indicating that these findings were more significant than the other 400 findings.

When Problems Are Discovered

Using this database, a plot (Figure 1) can be made of number of finding types (400) that resulted in some action for each year beyond First Production Unit (FPU). Although the findings data is arguably different from standard industry defect data, Figure 1 displays the characteristic front half of a 'bathtub' curve. Most findings are made early in a weapons stockpile lifetime. It is notable that the other side of the 'bathtub' curve does not appear in the data collected to date. Several comments are appropriate in this regards: first, the fact that changes are made to weapons when significant problems are discovered reduces the accumulation of defects later in a weapons lifetime; second, very few weapons have been evaluated 30 years beyond FPU (only 15 of the 13,900 weapons tested to date); and third, the weapons that remained in the stockpile 30 years

Figure 1. "Actionable" Findings Are Discovered Throughout A Warhead's Lifetime, But Most Are Found Early On



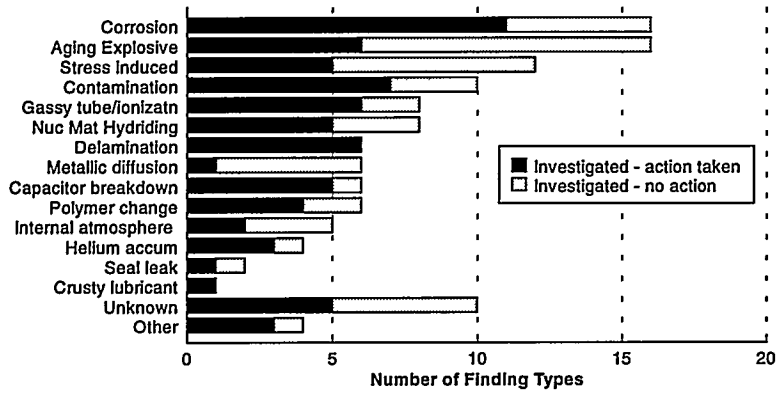
beyond FPU contained very different components compared to current weapons. Thus, there is significant uncertainty as to what the defect trend beyond about 25 years post FPU really is for the weapon types that are now in the stockpile.

Age-related Findings

Figure 1 separates age related findings from other types. Aging findings are defined as those findings that could not be detected by the production acceptance or new material testing conducted at the time of production and that require the passage of time to appear. Surprisingly, some aging findings appear in the first year post FPU. The data show a fairly constant rate of occurrence for the 72 age-related finding types for which some action was taken ("actionable" finding types).

Examination of all age-related findings types (119 finding types including both "actionable"finding types and those finding types which were investigated, but resulted in no action) reveals the following breakdown by component type: primaries - 19 (11 occurring to the HE), detonators - 14, electromechanical components - 14, neutron generators - 13, radars - 11, structural elements - 11, pressure sensitive switches (baroswitches) - 7, fire sets - 5, parachute deployment components - 5, secondaries - 5, use control components - 4, batteries - 3, gas transfer system - 3, switch tubes - 3, cables/connectors - 2. Figure 2 groups these finding types by the mechanism which produced the finding. These breakouts by component and mechanism can be useful when making resource allocations for study of aging issues among component and materials research groups.

Figure 2. Aging mechanism for 119 age-related findings



Conclusion

One of the conclusions that can be drawn from looking at the historical data from findings in stockpile nuclear weapons is that problems will continue to manifest themselves. Based on the historical data, 1 - 2 'actionable' findings can be anticipated to be discovered each year in the current stockpile. It is likely that an increasing percentage of these will be age-related findings due to the fact that no new weapons are entering the stockpile. At this time there are no data which indicate an end to the stockpile life of current weapon types. Research is needed to better quantify component lifetimes beyond 20 years of weapon service life. In addition, the nuclear weapons program must have the capability to understand the problems that arise and be able to assess whether changes are required as a result of those problems.