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Interim Development Report for the B61-6,8 Bombs (U)

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Sandia National Laboratories, Albuquerque
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Prepared by
Sandia National Laboratories
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for the United States Department of Energy
under Contract DE-AC04-76DP00789

Classified by D. N. Bray, Supervisor, B61-6,7,8/W61 Division 5111, March 3, 1989.

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Interim Development Report for the B61-6,8 Bombs (U)

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Albuquerque, NM, 87185
and
Los Alamos National Laboratory
Los Alamos, NM 87545

Abstract (U)

This report describes the B61-6,8 bombs in development as a part of the Stockpile Improvement Program. The bomb design, its ancillary and support equipment, and the planned test and evaluation program are presented.

Classified by D.N. Bray, Supervisor, B61-6,7,8/W61 Division 5111, March 3, 1989.

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Foreward

The B61-6,8 bombs will result from a factory retrofit of the B61-0,2,and 5 bombs. This retrofit is being conducted as part of the B61 Stockpile Improvement Program (SIP). The goal of the B61 SIP is to upgrade B61s in stockpile by incorporating modern design features of safety, use control, and improved operational flexibility. References 1–9 trace the stockpile reviews identifying the shortcomings of the stockpile and the recommendations for a selective retirement/retrofit program. Each of these references is reproduced in Appendix A of the B61-7 Weapon Development Report[10] and summarized in the foreward of that document. The mechanical and electrical design of the B61-6,8 is very similar to the B61-7, an ongoing retrofit of the B61-1 scheduled to be completed in September 1990.

The SIP does not follow the normal nuclear weapon path of authorizations and approvals. No 01 through 03 activities occur. The first authorization occurred with the release of the Nuclear Weapons Production and Planning Directive (P&PD) issued by the Director of Military Applications in March 1987 scheduling the production of the B61-6,8. Phase 4 authorization was granted by DOE/AL November 1987. Since stockpile assets are required for the B61-6,8 production, a Product Change Proposal was coordinated through Field Command, DNA defining the effect of the retrofit. The PCP for the B61-6 was approved in April 1988.

At this time, the DOE/DoD coordinated draft Military Characteristics for the B61-6,8 await NWCSC approval. The Interim Design Review and Acceptance Group (DRAAG) is tentatively scheduled for May 1989.

Summary

The B61-6,8 is a factory retrofit of the B61-0,2,5, utilizing an IHE nuclear primary and enhanced electrical safety components. Use control, command disable, and improved operational flexibility features are also included. The B61-6,8 was designed to be compatible with all aircraft now approved for B61 carriage. Compatibility will only be demonstrated for those Navy aircraft listed in the MCs: A-4, A-6, A-7, F/A-18, and A-12 (when available). No known problems exist.

The B61-6,8 will be fielded to be compatible with aircraft employing AMACs without Intent Unique Signal (IUQS) generators through the employment of the MC3025 Signal Selector. The MC3025 will be removed from all bombs on or before 1 January, 2000. Only aircraft with IUQS-capable AMACs will be compatible after this time.

Significant design features of the B61-6,8 are as follows:

Physical:

Length	3597 mm (141.6 in.)
Diameter	338 mm (13.3 in.)
Weight	350 kg (770 lb)

Yields:

[redacted]

DOD/DOE b(3)

Delivery Options:

- Freefall Airburst (FFA)
- Freefall Groundburst (FFG)
- Retarded Airburst (REA)
- Retarded Groundburst, Laydown (REG)

Aircraft Delivery Constraints:

Certified to maximum aircraft capabilities

[redacted]

DOD/DOE b(3)

Safety:

- Use of IHE for primary explosive
- Primary is inherently one-point safe
- Enhanced electrical safety to meet modern nuclear safety standards

Use Control:

[redacted]

DOD b(3)

Limited Life Components:

[redacted]

DOD/DOE b(3)

Intrinsic Radiation:

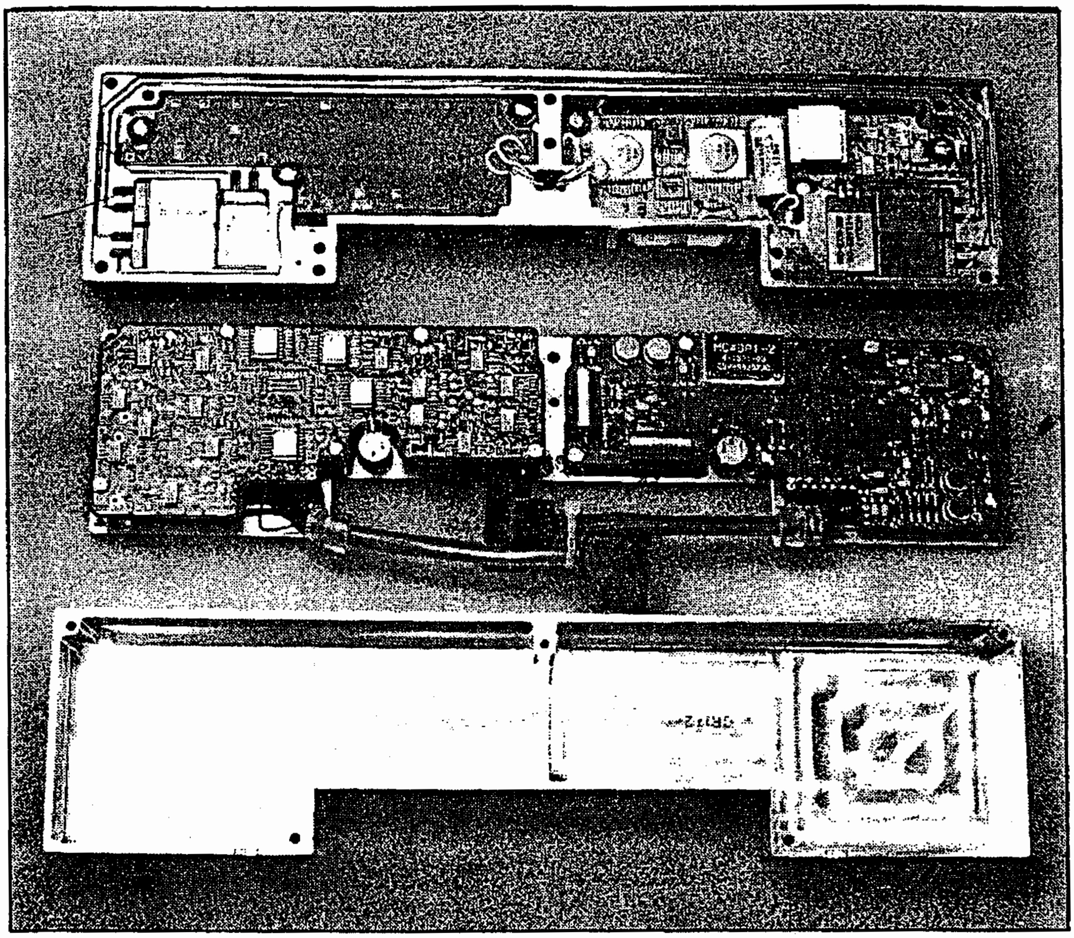
[redacted]

DOD b(3)

MC4137 TSSG

The "intent-enabled" design of the MC4137 requires the MC4137 TSSG electronics to "store" the IUQS signal which enables (operates) the MC2969 Intent Strong Link Switch in the firing set during the prearming of the bomb before aircraft release. Until the MC2969 arming sequence is complete, the TUQS signal is not "stored" in the MC4137 electronics. Without the information content of the IUQS signal, the MC4137 cannot formulate the TUQS signal. The strong link/weak-link design and packaging of earlier B61 TSSGs is also retained. Additionally, the new MC4137 "intent-enabled" TSSG is philosophically improved over the earlier TSSGs designed for the B61. Discussion of the nuclear detonation safety of the two TSSG designs appears in Chapter 4.

Figure 18. MC4137 TSSG, Intent-enabled



During prearm of the bomb, the MC4137 TSSG will store the IUQS code in "volatile" memory; without power the code will not be retained. The design of the MC4137 will assure that the IUQS is retained for a minimum of 7 seconds of power loss. If all arming power and monitor power is lost for longer than 7 seconds, the MC4137 will interrupt the arm monitor line to the AMAC. On Navy System I aircraft (A-7E and F/A-18), this will result in both the "arm" light and the "safe" light being illuminated when power returns. On the FSA aircraft (A-4M, A-6E,G), the "disagreement" light will illuminate. A power dropout long enough to cause this condition will require the pilot to retransmit the IUQS to "rearm" the TSSG. Power dropouts of shorter duration will not affect the AMAC indications or cause additional pilot workload. The use of "volatile" memory for IUQS retention is a desirable nuclear safety design feature.

Although the B61-6,8 MCs only require compatibility with Navy strike aircraft, the MC4137 TSSG will be designed to be compatible with all aircraft approved for carriage of any B61. Additionally, all aircraft listed in the B90 MCs will be tested for compatibility during development. Demonstration of aircraft compatibility and subsequent incorporation in the B61 ACCD will be restricted to those listed in the MCs.

Whereas the MC4175 TSSG uses two identical, nonconductive assemblies to provide outputs to the two MC2935 Trajectory Strong Link Switches in the firing set, both channels of the MC4137 are packaged in a single conductive enclosure (Figure 18). The materials selected are 304 stainless steel for exclusion region protection and 6061 aluminum for the cover. The single housing is designed to maintain mechanical integrity of the housing, rolamites, and exclusion area electronics in abnormal environments. Isolation of all signals from the case is required.

The top assembly in Figure 18 is the exclusion region containing the rolamites, weak-link ROM, and the circuitry necessary to communicate the ROM pattern through the rolamite contacts to the microprocessor. The circuit board is ceramic. The circuit boards in the middle of figure 18 are identical, with surface mount components on one side (left) and leaded, "through-hole" components on the other. This circuitry is mounted to the steel top of the exclusion region and

d. Safe Separation Time (SST) Selection - Two independent SSTs, TA and TB are set on the preflight controller. Some AMACs can select between TA or TB. The ICU is designed to store and use this information.

After bomb release, the MC4140 is without power until the rise of the weapon system pulse batteries. [redacted] The remaining function of the ICU is to perform the timing and "gate" pulse battery power to initiate the spin rocket or gas generator. After the "deploy" function, the ICU tasks are complete and "shutdown" is commanded.

DoE/DoD b(3)

MC4136 Preflight Controller

[redacted] The preflight controller also houses the DE1002 Coded Device and MC3246A Thermal Battery (identical to the MC3246[26] in the B61-7 except lithium-silicon/iron disulfide (Li(Si)/FeS$_2$) electrochemical system is used) for command disable, the J1 connector for PAL operations or interconnecting with the MC4142 Strike Enable Plug, and the PAL voltage regulator. The command disablement and PAL components are described in Chapter 6. The preflight controller is mounted to the preflight bomb subassembly case.

DoE/DoD b(3)

The switch markings and function associated with each switch position are as follows:

TA and TB - For non-laydown deliveries, two independent aircraft safe escape times (TA and TB) are selected. The selection of each requires the manipulation of two digital switches, one for the tens data (1-10) and one for units data (0-9). The maximum safe escape time for the B61 is 69 seconds; therefore, the 7, 8, 9, and 10 switch positions of the tens switch are shorted to the 6 switch deck. Thus, 109 becomes 69, 77 becomes 67, etc. No provision is made to prevent TB settings shorter than TA or vice versa. The selection of the appropriated safe escape time is made from the aircraft during bomb prearm.

Delivery - 2 position; RE, FF
RE - retarded
FF - freefall

Aircraft with FSA AMACs like the Navy A-6E can not override this switch. Arm position selections on the AMAC are limited to AIR and GROUND. System 1 AMACs like the Navy A-7 and A-18 can override this switch; all four delivery options are selectable from the cockpit.

[redacted]

Delay - 3 position; G, H, J

G — 0.3 second deployment delay
H — 0.6 second deployment delay
J — 1.6 second deployment delay

Additionally, positions G and H provide short laydown delay (30 seconds) and position J provides long laydown delay (80 seconds) for aircraft safe escape from laydown deliveries. Discussions at the B61 POM and the B61 Environmental Sugroup have recently addressed the use of "J" by Navy aircraft. Future B61 ACCDs may restrict the use of longer delay times than compatibility tests and analyses have shown to be sufficient to provide separation. No settings longer than the "minimum" times now specified in the ACCD will be approved.

[redacted]

3. System Operation

General

Preflight operations and arming, fuzing, and firing events for the four bomb delivery options are discussed in this chapter. A simplified functional block diagram (Figure 34) and pictorial event sequences for each bomb delivery option (Figures 35-38) are included. Those procedures and electrical system operations that are common to each delivery option are presented below.

Before takeoff, the appropriate switch settings are made on the MC4136 Preflight Controller as described in Chapter 2. At this time, the PAL could be unlocked through the J1 connector of the MC4136 with ground equipment (Chapter 6) or after takeoff if the aircraft is equipped with a PAL-capable AMAC. Complete bomb prearming cannot be accomplished until the PAL is unlocked (i.e., enabled). The MC4142 Strike Enable Plug would be installed. If the aircraft does not contain an IUQS-capable AMAC, the MC3025 Signal Selector must be rotated to the OVERRIDE position.

The bomb may now be prearmed before release by rotating the AMAC selector switch to the desired option position. On FSA/B AMACs, this selector switch provides two positions: air or ground. Retard or freefall is obtained by the delivery switch position on the preflight controller. On System I AMACs like the A-7E and F/A-18, the AMAC has four positions corresponding to the four delivery options: FFA, FFG, REA, and REG. With this capability, the RE/FF Delivery Switch on the MC4136 PFC is overridden.

The F/A-18 AMAC generates a unique train of pulses (IUQS) to drive the MC2969 Intent Stronglink Switch to the closed (enabled) position. Without the AMAC-produced IUQS, the MC2969 will be enabled by the MC3025 Signal

[redacted]

Figure 34. B61-6,8 Functional Block Diagram

Doe b(3)

DOE
b(3)

DOE
b(3)

Figure 35. Event Sequence, Freefall Airburst

At safe separation time plus 1.5 seconds, programmer fire circuitry is enabled. Once this occurs, any subsequent radar fire signal will result in the programmer providing closure of the main battery to firing set (A3), causing X-unit discharge which initiates the neutron generator timing circuitry and fires the nuclear primary detonators.

If backup fuzing is selected, at SST plus 1.5 seconds the programmer will also accept impact crystal signals as valid fire signals. If neither radar nor crystal signal is received, the programmer will provide A3 at 120 seconds (design life of the main batteries). If backup fuzing is not desired, the programmer will not deliver A3 if impact crystal signal is received. Contact preclude is not guaranteed. If the bomb impacts the ground with a charged firing set, the X-unit may be triggered by the impact (bypassing the programmer), even if backup were not desired.

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Figure 36. Event Sequence, Freefall Groundburst

Freefall Groundburst (FFG) Delivery

Upon initiation of the spin rocket, the bomb spins to a minimum roll rate of about 3 revolutions per second within about 1 second (Figure 36). The canted fins will sustain the roll rate. This roll rate closes the radial inertial switches (rolamites). At 3 seconds after release, the programmer "gates" main battery power to the MC4175 or MC4137 TSSG to drive the MC2935 Trajectory Stronglink Switch in the firing set.

The aircraft-selected safe separation time (SST) has been previously communicated by the ICU to the programmer.

[redacted]

b(3)

[redacted]

(b)(3)

At safe separation time minus 3 seconds, the programmer connects main battery power to the transverter oscillator in the firing set (A1). At safe separation time, similar programmer circuitry connects main battery power to the firing set transverter (A2). With these two inputs, each electronic transverter can charge the 2.0-µF firing set X-unit capacitor and the 0.6-µF neutron generator capacitors to approximately 3300 V and 2400 V, respectively, in less than 1.2 seconds.

At safe separation time plus 1.5 seconds, programmer fire circuitry is enabled. Once this occurs, the subsequent crystal fire signal will result in the programmer providing closure of the main battery to the firing set (A3), causing X-unit discharge which initiates the neutron generator timing circuitry and fires the nuclear primary detonators.

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[redacted]

Do
b(3

Figure 37. Event Sequence, Retarded Airburst

Retarded Airburst (REA) Delivery

Firing the gas generator into the volume enclosed by the telescoping tubes starts the parachute deployment process (Figure 37). The deceleration produced by the deployed parachute closes the longitudinal nonlatching inertial switch (rolamite). The design of the rolamite guarantees a closure time greater than the maximum required (0.734 seconds) for the MC4175 or MC4137 TSSG to enable the MC2935 Trajectory Stronglink Switch in the firing set.

The aircraft-selected safe separation time (SST) has been previously communicated by the ICU to the programmer. At 7 seconds before SST, the programmer "gates" main battery power to the radar and at 4 seconds before SST, the programmer activates circuitry to communicate height of burst selection to the radar.

[redacted]

DOE/DOD
b(3)

[redacted]

DOE
DOD
b(3)

At safe separation time minus 3 seconds, the programmer connects main battery power to the transverter oscillator in the firing set (A1). At safe separation time, similar programmer circuitry connects main battery power to the firing set transverter (A2). With these two inputs, each electronic transverter can charge the 2.0-µF firing set X-unit capacitor and the 0.6-µF neutron generator capacitors to approximately 3300 V and 2400 V, respectively, in less than 1.2 seconds.

If backup fuzing is selected, at SST plus 1.5 seconds the programmer will accept either a radar fire or impact crystal signal as a valid fire signal. Activation of the impact crystal at parachute-retarded terminal velocities (80 fps) will not be reliable in all terrain. If neither radar nor crystal signal is received, the programmer will provide A3 at 120 seconds (design life of the main battery).

[redacted]

DOE/DOD (b)(3)

Figure 38. Event Sequence, Retarded Groundburst (Laydown)

Retarded Groundburst (REG) or Laydown Delivery

Firing the gas generator into the volume enclosed by the telescoping tubes starts the parachute deployment process (Figure 38). The deceleration produced by the deployed parachute closes the longitudinal nonlatching inertial switch (rolamite). The design of the rolamite guarantees a closure time greater than the maximum required (0.734 seconds) for the MC4175 or MC4137 TSSG to enable the MC2935 Trajectory Stronglink Switch in the firing set.

For the laydown delivery mode, the safe separation times selected on the preflight controller do not apply. Aircraft safe escape maneuvers are instead constrained by the laydown delay time, which is 30 seconds or 80 seconds. Selection of G or H deploy time results in a 30-second delay, whereas J provides an 80-second delay. As discussed earlier, selection of J may be restricted in the B61 ACCD except for aircraft requiring that time to ensure safe escape.

[redacted]

b(3)

[redacted]

DOE/DOD b(3)

At safe separation time minus 3 seconds, the programmer connects main battery power to the transverter oscillator in the firing set (A1). At safe separation time, similar programmer circuitry connects main battery power to the firing set transverter (A2). With these two inputs, each electronic transverter can charge the 2.0-µF firing set X-unit capacitor and the 0.6-µF neutron generator capacitors to approximately 3300 V and 2400 V, respectively, in less than 1.2 seconds.

At safe separation time plus 1.5 seconds, the programmer will provide closure of the main battery to firing set (A3), causing X-unit discharge which initiates the neutron generator timing circuitry and fires the nuclear primary detonators.

[redacted]

As shown in Figure 39, the sealed covers of Region 1 of the firing set are not on the same surface as the covers for Regions 2 and 3. This allows hot and possibly conductive gases generated in Region 1 by an abnormal environment to escape without compromising the barriers between Region 1 and Regions 2 or 3.

[redacted]

DOE
b(3)

The firing set housing and detonator cable cover is fabricated from fiberglass-reinforced, compression-molded MXB-71. MXB-71 is fire-resistant with excellent dielectric strength properties for temperatures up to 500°C. The openings in the barriers for the functional stronglink switch contacts and necessary openings into Regions 2 and 3 for test or reset of the MC2935s are sealed with high-temperature silicone. The metal mounting screws for the stronglink switches are through the container wall and are similarly closed from the exterior of the firing set by plugs of MXB-71 sealed with the same silicone.

To assure protection of the firing set exclusion regions by the stronglink switches, the contact assembly of each switch is constructed of metal and ceramic parts. The free volume is minimized to avoid bridging between input and output contacts by unintended conductive paths during abnormal thermal and crush environments. The switch housings are made of high-strength stainless steel to resist deformation in crush environments. The MC2969 and MC2935 can each withstand at least 1600 V dc at temperatures up to 400°C. Both switches contain discriminator mechanisms that, upon receiving an incorrect input signal, lock the switch in the open position. The MC2969 is resettable, requiring a pulse of correct length and amplitude to return the discriminator mechanism to its initial state. To be reset, the MC2935 requires both a manual release and a specific electrical signal input. Because physical access to the firing set is required, this procedure can only be done at a DOE manufacturing facility.

MC Requirements

Normal Environments

The B61-6,8 military characteristics state:

"The probability (per bomb lifetime) of a premature nuclear detonation for the normal environments described in the STS shall not exceed:

1. Prior to prearm (which includes application of the arming power and the unique intent enabling stimulus) and prior to release from the aircraft and in the absence of the trajectory stimulus, 1×10^{-9}.
2. After prearm and prior to release from the aircraft, and in the absence of trajectory stimulus, 1×10^{-6}.
3. After prearm and after release from the aircraft, and in the absence of the trajectory stimulus, 1×10^{-3}.

The probability (per occurrence) of a nuclear detonation in the normal release envelope after receipt of the trajectory stimulus shall not exceed:

1. Prior to expiration of the safe separation time, 1×10^{-3}.
2. After expiration of the safe separation time and prior to the intended detonation, 1×10^{-2}."

Abnormal Environments

The military characteristics for the B61-6,8 state:

"The probability (per occurrence) of a nuclear detonation of a bomb for individual or credible combinations of abnormal environments specified in the STS shall not exceed:

1. In the absence of any unique intent and trajectory stimuli, 1×10^{-6}.
2. After receipt of the unique intent and in the absence of the trajectory stimulus, 1×10^{-3}.
3. Placing the normal/override switch in the override position shall be considered intent enabling stimulus."

Safety Subsystems

Fault tree analysis techniques are useful for defining and evaluating the nuclear safety design of the bomb system. Figures 40 through 43 are abbreviated examples of fault trees. These figures illustrate the three safety subsystems incorporated in the B61-6,8 to meet nuclear detonation safety requirements in normal and abnormal environments. Both DOE (Sandia, Los Alamos, and production agencies) and DoD requirements are addressed.

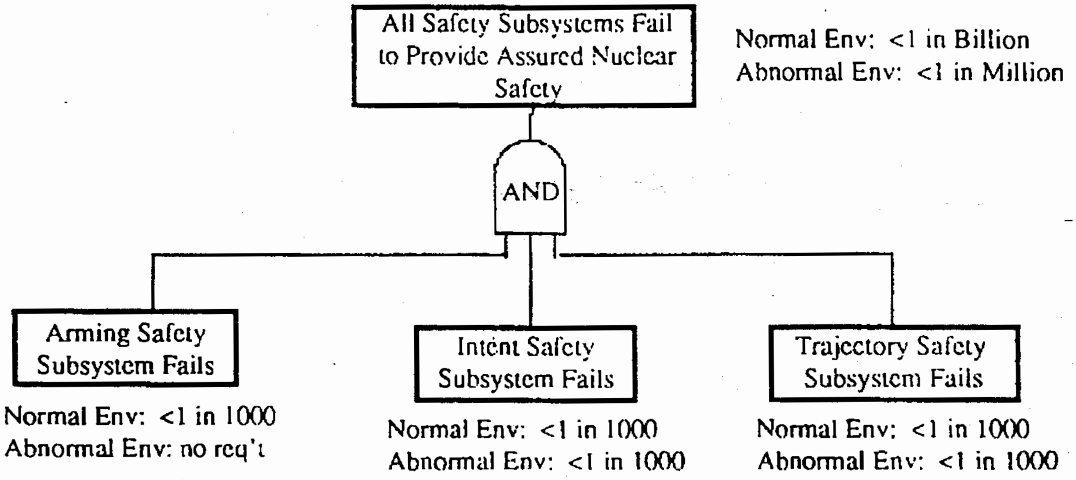

Figure 40. Fault Tree, Loss of Electrical System Safety

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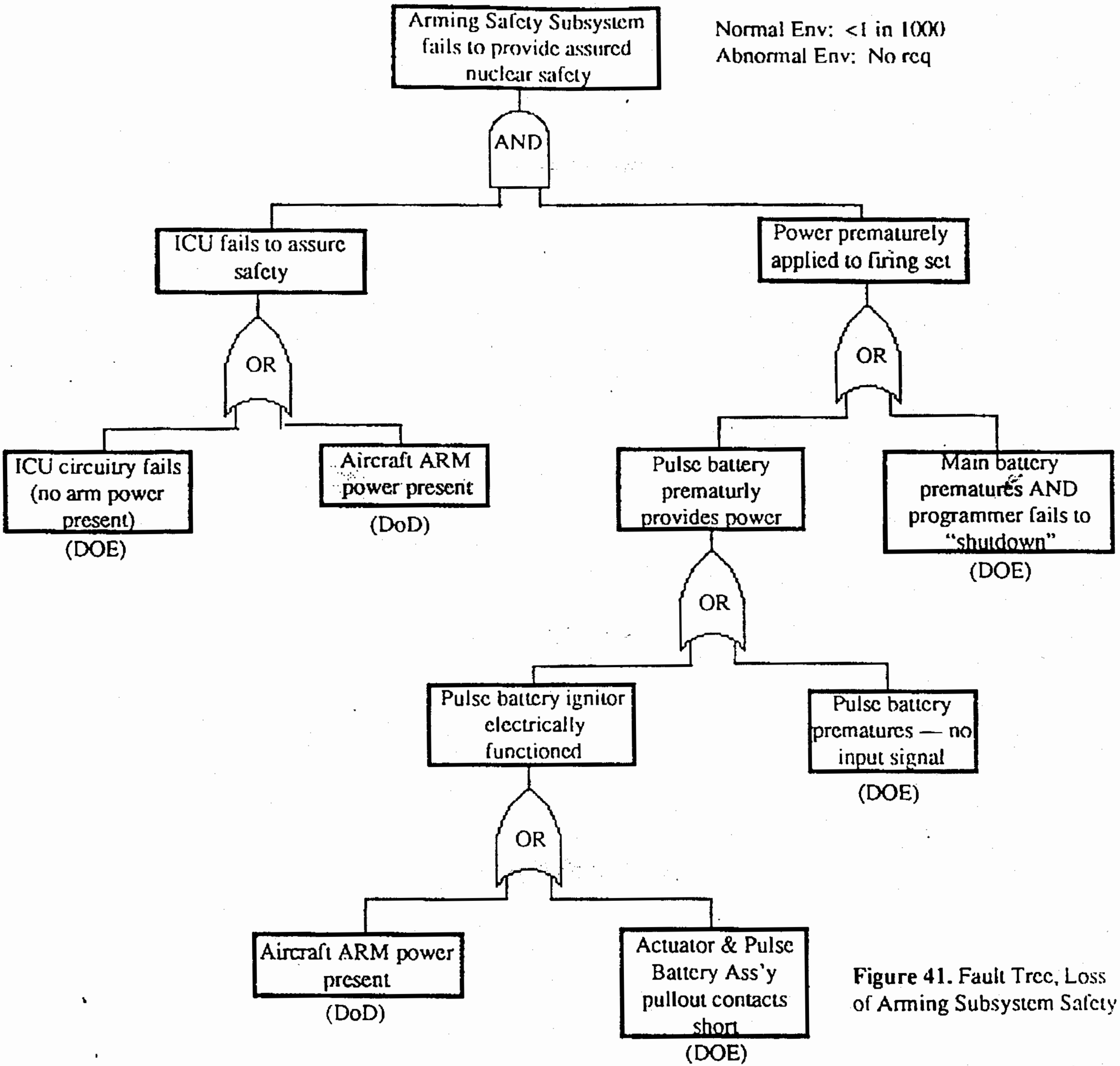

Figure 41. Fault Tree, Loss of Arming Subsystem Safety

Arming Safety Subsystem

The arming subsystem, when combined with the intent and trajectory subsystems, provides the additional 1×10^{-3} nuclear detonation safety to achieve the MC requirements in normal environments. No abnormal-environment nuclear detonation safety requirements are placed on this subsystem. This subsystem prevents the application of normal environment aircraft and bomb electrical system signals to critical circuits. Electrical signals at the bomb umbilical and preflight controller connectors are restricted to prescribed PAL or stronglink monitor signals from the aircraft or T-gear.

The component assemblies included in the arming subsystem are the MC2213(A) Actuator and Pulse Battery Assembly, the MC2238A/B Pulse Batteries, the MC3656 Main Batteries, MC4138 Programmer, and the MC4140 ICU. The delivery option selection circuitry and the ICU software provide positive control of the output of the pulse batteries. Premature actuation of a pulse battery will result in system "shutdown" without the required aircraft delivery option voltage being present. Premature of the main battery will similarly result in system "shutdown" by the programmer. Both premature actuation of the pulse battery and aircraft prearm power must occur for the ICU and programmer to function in the intended use mode. For the arming safety subsystem, the DoD must insure that prearm de-power is not applied to the umbilical connector. The DOE will insure the components involved meet the design requirements.

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Intent Safety Subsystem

As shown in figure 42, both the DoD and DOE must meet requirements for the Intent Safety Subsystem to provide assured nuclear detonation safety. The DOE must assure that the MC2969 ISLS in the firing set meets the isolation requirements and is only enabled upon the application of the IUQS. The DoD must assure that the IUQS signal is not generated prematurely due either to inadvertent or inappropriate human action or hardware malfunction of the IUQS generator in the AMAC. Both DOE and DoD must meet these requirements in the event of an abnormal environment.

If the MC3025 Signal Selector is in the OVERRIDE position, there are no requirements of the intent safety subsystem to provide protection in an abnormal environment. With the selector in OVERRIDE, the bomb will meet only a 1×10^{-3} probability of a nuclear detonation in an abnormal environment. Additionally, 1×10^{-3} probability of a nuclear detonation can only be met in the "absence of the trajectory stimulus."

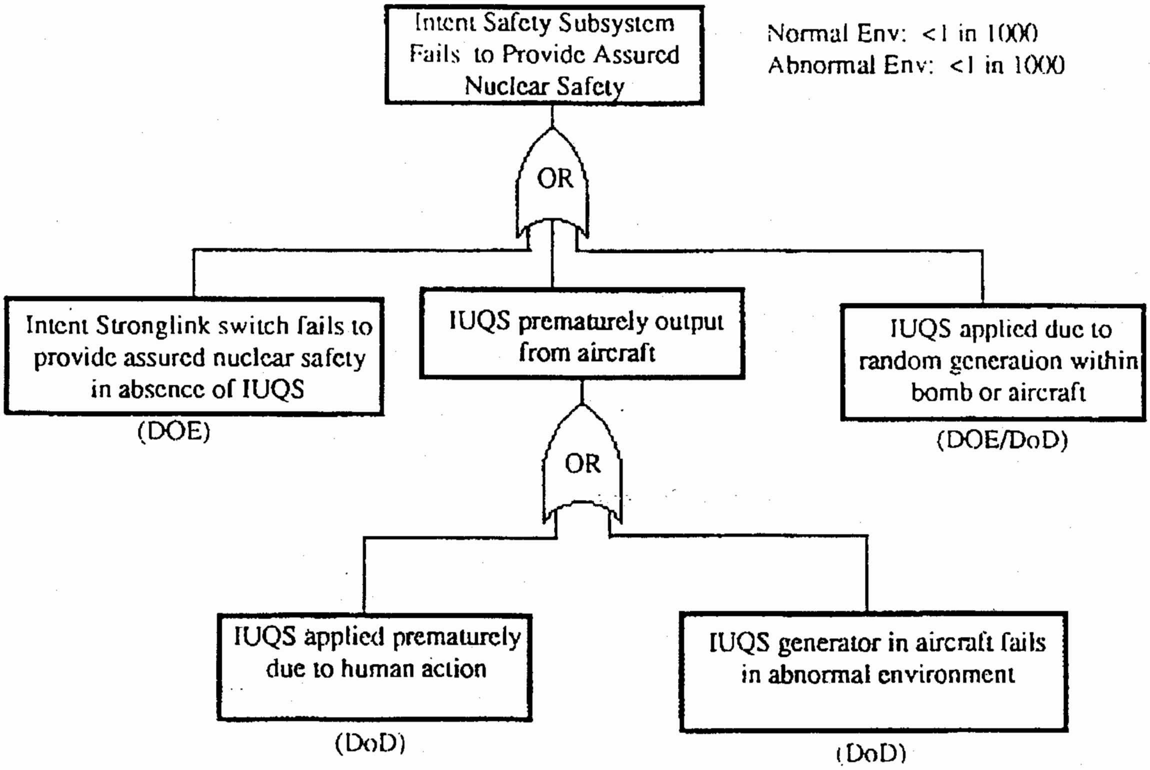

Figure 42. Fault Tree, Loss of Intent Subsystem Safety

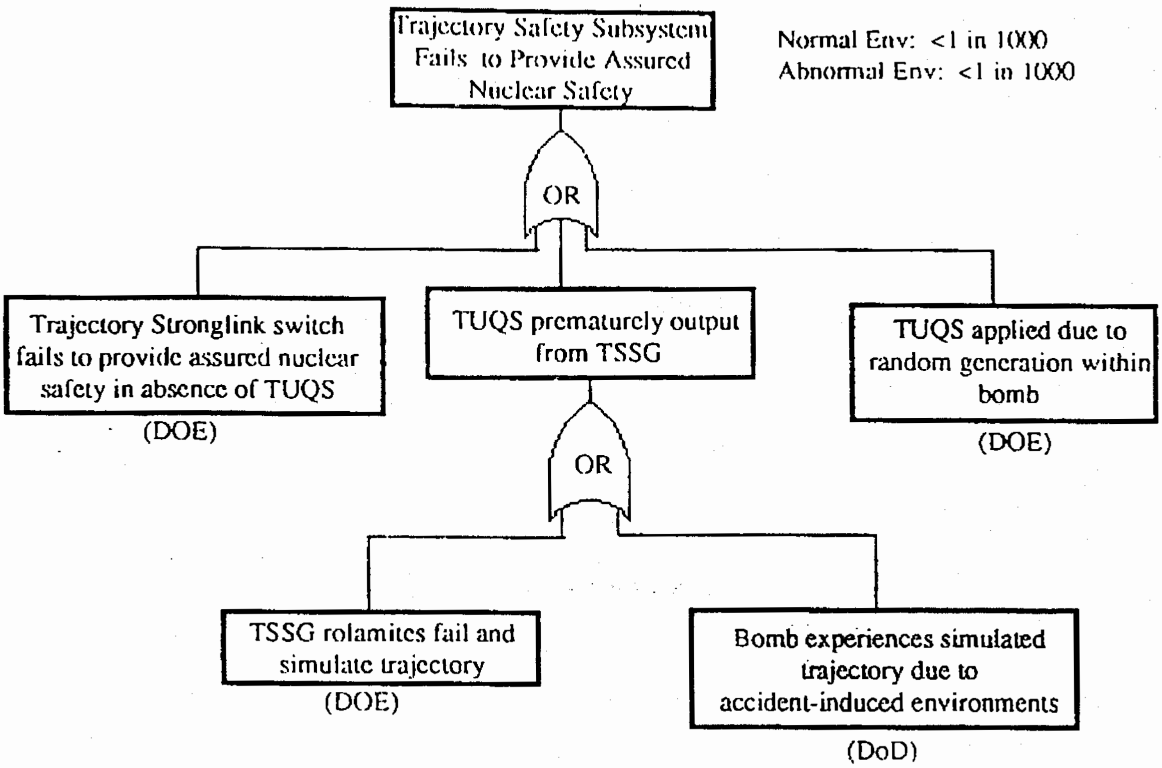

Figure 43. Fault Tree, Loss of Trajectory Subsystem Safety

Trajectory Safety Subsystem

Of the three nuclear safety subsystems, arming, intent, and trajectory, only the trajectory safety subsystem is composed entirely of DOE hardware. The DoD responsibility is to assure that no accidental simulation of the "intended use" environment (retardation or spin) occurs. Major components within this safety subsystem are the MC4175 TSSG or the MC4137 TSSG and the MC2935 Trajectory Strong-Link Switch in the firing set. The MC4175 TSSG is identical to the MC3640 TSSG (B61-7) except for a connector change and will support B61-6 production for the first six months until the MC4137 TSSG is available.

MC4175

The MC4175 TSSG is a second-generation design of trajectory sensing devices incorporated into B61 bombs to enable (close) the MC2935. In the mid-70's, the MC2948 TSSG was designed for first use in the B61-5 and was later used on the B61-3,4. Both the MC2948 TSSG and MC4175 TSSG use "stronglink/weak-link" design philosophy to achieve nuclear safety in abnormal environments. The normally open, acceleration-sensing rolamite switches (stronglinks) interrupt electrical power from the TSSG electronics that generate the trajectory unique signal (TUQS). The application of power through the inertial rolamite switches to the electronics will produce the TUQS to drive the MC2935. Thus the design theme requires that the TSSG rolamite switches (stronglinks) be capable of surviving, without shorting, higher levels of shock or temperatures produced by an accident environment than the TUQS-producing electronics/ceramic circuit board (weak-link). Failure of the stronglinks in severe environments is acceptable, but only if the weak-link also fails irreversibly.

Figure 44 is a simplified block diagram of the trajectory safety subsystem with the MC4175 TSSG which illustrates the electrical connection for both the parachute retarded and spin-stabilized freefall delivery modes of the bomb. Functional contacts of the MC2969 Intent Strong-Link Switch are required to be closed before the TUQS can drive the MC2935. Both the intent and trajectory safety subsystems are designed to meet a goal of 10^{-3} given an abnormal environment; each is considered to be independent and no contribution to the trajectory safety subsystem because of the interruption of the MC2935 drive lines by the MC2969 is assumed. In the spin-stabilized bomb delivery mode, one radially oriented rolamite switch in each of the two TSSGs must close before the series circuit is closed between the bomb power source and the TUQS-producing electronics. The two MC4175 TSSGs are mounted opposed to each other equidistance from the

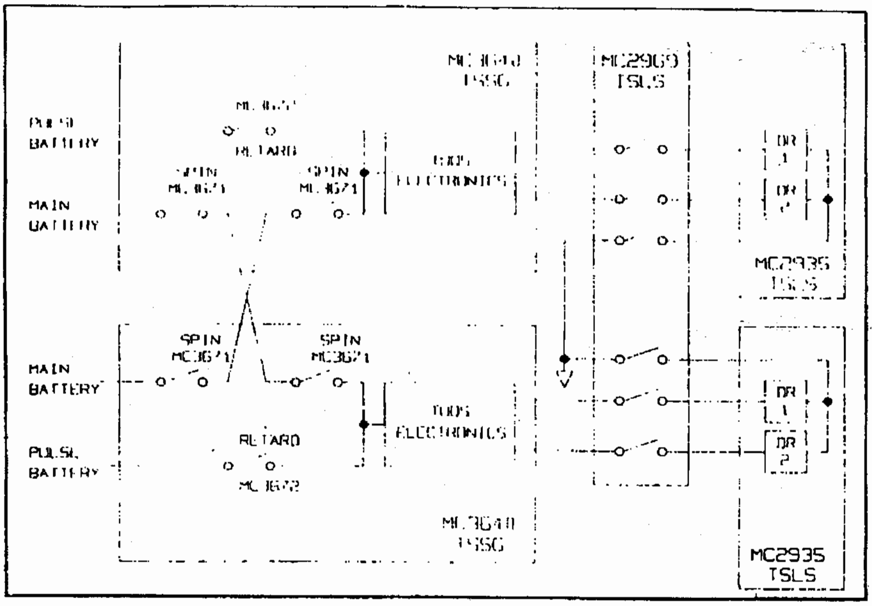

Figure 44. Block Diagram, Trajectory Safety Subsystem with MC4175 TSSG

bomb's longitudinal center line so that a radial acceleration or deceleration may cause both of the radially-mounted rolamites in one TSSG to close, but the spin rolamites in the opposite TSSG will remain reset. Spinning of the bomb is required to close all four spin rolamites.

Numerous shock tests of the MC3671 (spin) and the MC3672 (retard) rolamites have revealed the MC3671 to be most susceptible to shock: 4000g, 1ms when the direction of the shock causes the rollers to travel from the reset end (resting end) to the actuate end. The heavier rollers of the MC3671 travel to the actuate end with sufficient velocity/energy to separate the end cap from the case. In all other directions the MC3671 is 6000g's or greater, as is the MC3672 in all directions, including the actuate direction.

By design, the ceramic printed wiring board for the TUQS electronics is the weak -link for the MC4175 TSSG in the shock environment. The two-sided bonding of the DAP rolamites to the mica housing of the MC4175 TSSG insures minimum failure levels of approximately 6000g's. Whereas shocks perpendicular to the ceramic board result in breakage at as low as 330g, shocks in the plane of the board do not result in predictable failures (fracture). Abnormal environment testing of the ceramic boards have shown boards to survive ~7000g's in the plane of the board (undesirable since the stronglink rolamites can fail at lower levels). However in no system test nor component-level testing of complete MC3640 TSSGs for the B61-7 did there exist an "unsafe" condition. Some abnormal environment tests have resulted in damaged rolamites and/or lack of adhesion to the exclusion region barrier and an undamaged circuit board, but none exhibited a short circuit that could transmit power to the electronics. With the actuate contacts on one end of the rolamite, bypass requires the band or roller to remain at the actuate end. None of the damaged rolamites exhibited a potential for that condition.

Two polycarbonate capacitors, essential components for the generation of the TUQS, are used as the thermal weak-link. Both the DAP rolamite and the glass-bonded mica housing of the MC4175 TSSG retain excellent electrical insulative properties to the structural limit of the materials in high thermal environments. With a repeatable and irreversible failure temperature of 350° to 400°F, the polycarbonate capacitors will fail long before bypass of the rolamites or the housing is possible.

It is important to note that "trajectory sensing" implies the parachute was deployed and the resultant retardation forces were sufficient to close the rolamite switch or the bomb spin rate is adequate to close similar, radially oriented rolamite switches. No discrimination capability between an "intended use" and a "trajectory" resulting from an accident is possible. Any airborne accident can result in damage to the bomb tail section and resultant parachute deployment or adequate spin rates developing due to the bomb fin cant necessary to maintain roll rate for accuracy in freefall deliveries.

MC4137 TSSG

Where the MC4175 depends solely on the stronglink/weak-link design philosophy, the MC4137 also incorporates "intent-enablement" as a safety enhancement. The "intent-enabled" design of the MC4137 requires the MC4137 TSSG electronics to "store" the IUQS signal which enables the MC2969 Intent Strong Link Switch in the firing set during the prearming of the bomb before aircraft release. The TUQS signal is not "stored" in the MC4137 electronics. Without the information content of the IUQS signal, the MC4137 cannot formulate the TUQS signal. The strong link/weak-link packaging of the TSSG is also retained since the "intent-enablement" is a nuclear safety "enhancement." The trajectory safety subsystem is required to provide 1 x 10 $^{-3}$ protection in abnormal and normal environments requiring independence of the three safety subsystems. The strong link/weak-link packaging of the TSSG will be addressed during development as rigorously as would be required if the TUQS were "stored."

To improve the packaging for abnormal environments, both channels of the MC4137 are packaged in a single steel/aluminum enclosure (Figures 18 and 45). Conductive housing and barriers of steel are used to maintain mechanical integrity in abnormal environments. The steel housing, exclusion region barriers, and rolamites are electrically conductive and designed to divert unintended, accident-induced energy to ground. Isolation of all signals from the case is required in normal environments for reliability.

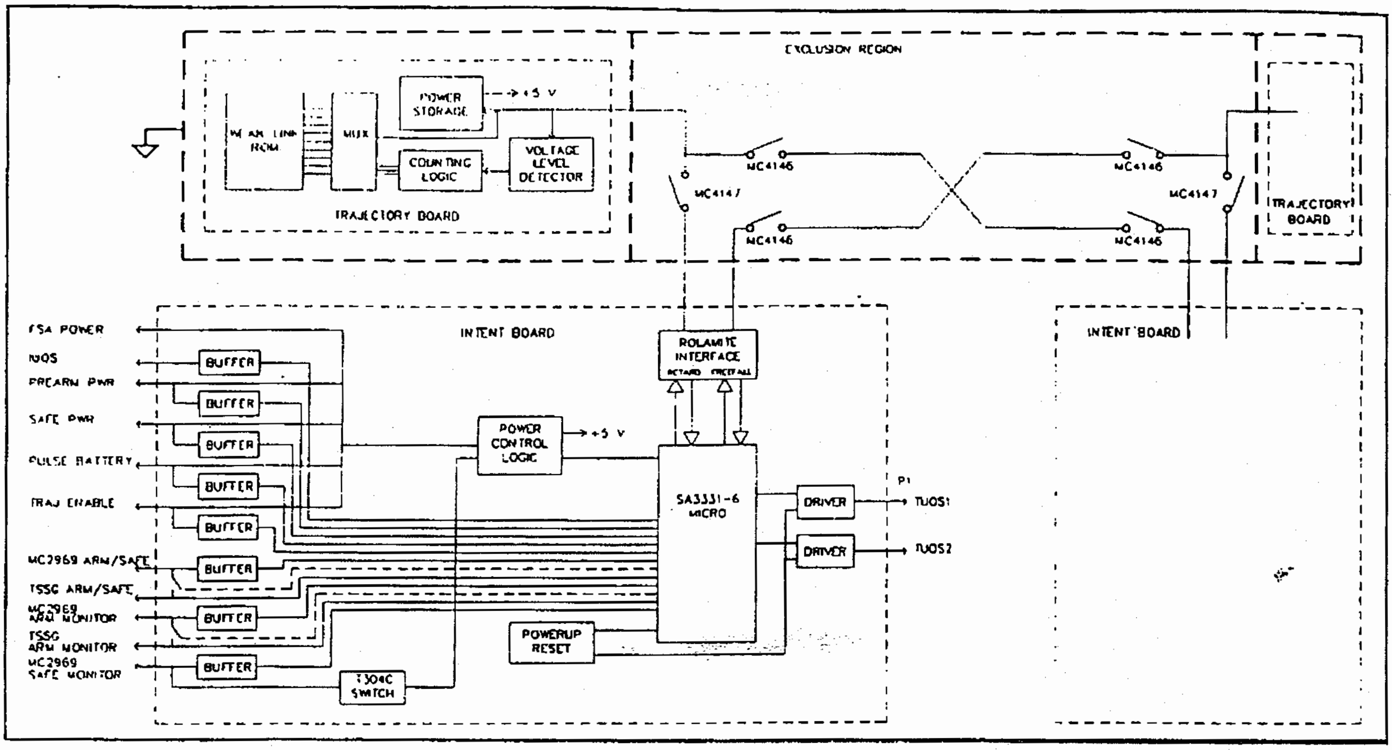

Figure 45. Block Diagram, Trajectory Safety Subsystem with MC4137 TSSG

Both of the new rolamites in development (MC4146 to sense bomb spin and MC4147 for retarded drops) are steel-case, hermetically sealed assemblies. As in the MC4175, there are two spin rolamites per channel connected in series, diametrically opposed in the bomb to require true spin of the bomb. Previous rolamite designs have been constructed of insulative materials with the conductive band as the signal (power) path between the actuate contacts. The new rolamites are designed for increased ruggedness and predictability in abnormal high shock environments. The steel rolamites and TSSG housing (exclusion region barrier) will each incorporate mechanical mounting features that will insure integrity of the rolamite/barrier union through all abnormal environments. This design will result in the rolamite case electrically grounded to the housing (system ground). Therefore the contact block in the roller is required to be isolated from the roller and the band. The required electrical path is through the pins and the contact block (see Chapter 2).

In the block diagram (Figure 45) shown above, the exclusion region encompasses the rolamites, weak-link ROM, and circuitry necessary to interface with the SA3331-6 microprocessor. Each "intent board" is packaged outside the exclusion region and contains the aircraft interface circuitry, microprocessor, and TUQS drive circuits. To format the TUQS signal, each independent channel of the MC4137 TSSG (an intent board and a trajectory board plus three rolamites) will combine the information from the IUQS signal stored in the microprocessor with 24 bits stored in a thermal weak-link ROM (read only memory). Low melt alloy loops on a printed circuit board (Figure 18) form the 24 bits of the weak-link ROM. Melting of the "loops" in high temperatures from abnormal environments will result in either opening or shorting to the board. Either alternative is "safe"; combining with the IUQS signal would lock up the MC2935 TSLS. Early thermal testing of the TSSG has recently led to redesign of the housing and weak-link ROM to mount the ROM to the outer wall of housing. An instrumented unit with representative rolamites and housing indicated the weak-link ROM would reach guaranteed failure temperature as the rolamite temperature was approaching its design temperature limit of 500°F, with the ROM mounted on the ceramic board. Mounting of the ROM near the outer TSSG wall resulted in considerable margin.

An additional nuclear safety enhancement achieved in the design of the MC4137 TSSG is the use of "volatile" memory (without power the IUQS code will be lost) to store the IUQS code during the prearm of the bomb. A permanent memory ("non-volatile") would require certification of the erasure of the IUQS after in-process, acceptance, and system level testing. On a "first principles" basis, the incorporation of the "volatile" memory is most attractive and defensible from a nuclear detonation safety standpoint. Capacitive "hold up" energy storage in the MC4137 will assure that the IUQS is retained for a minimum of 7 seconds in the event of an intermittent aircraft power dropout. If all arming power and monitor power is lost for longer than 7 seconds minimum

[redacted]

DOE/DOD b(3)

One B61-6,8 system test is being planned. A nose-on impact test at a velocity (to be determined) greater than the last B61-7 test (328 fps) and less than 492 fps will be conducted to confirm the extrapolations made on the B61-7 test. This test unit may also be used to investigate the effect of combined abnormal environments (thermal followed by impact).

Of the new components in development to support the B61-6,8, only the MC4137 TSSG has abnormal environment requirements. The weak-link ROM will be characterized in shock on both component-level testing and system tests where appropriate.

Crushing

This environment is a semi-static situation where, for example, during an accident a structural member of the aircraft comes to rest on the weapon case.

Design Theme. The MC2969 and MC2935 stronglink switches are required to hold off any energy reaching the fire set in this environment. With the structural properties of the thick aluminum center case and the steel support sleeve serving to protect the exclusion region from direct exposure to the outside world in any credible static crush abnormal environment, no weak-link needs to be identified.

Response Analysis/Tests. Tests conducted on the B61-5 and the B61-3,4, each with the identical center case (but with different support sleeve designs), showed almost linear deformation with applied load until case rupture at 305,000 lbs and 335,000 lbs, respectively. In each test, loading was applied through a rigid 2-inch bar placed perpendicular to the longitudinal axis of the bomb over the firing set. In accident possibilities for the B61-6,8, the forces necessary to rupture the center case do not exist. For example, a fully loaded B-52 weighing about 500,000 lbs could rest at most one-half or 250,000 lbs on a B61-6,8.. Maintaining the integrity of the center case, with the stronglinks ensuring electrical isolation to the practical limit of the environment, assures meeting the 1 in 10^6 safety requirement.

Thermal

Complete or partial bomb engulfment by a JP-series kerosene (jet fuel) fire is possible. Fuel supplies are assumed to be sufficient to allow all processes to run to completion.

Design Theme. In abnormal thermal environments, predictable nuclear safety is accomplished by stronglink/weak-link colocation within an exclusion region whose barriers primarily consist of a high-temperature insulation material, MXB-71, and ceramic dielectric in the stronglink switches. The applicable weak-links are the X-unit capacitor and the nuclear system high explosive and detonators.

Response Analysis/Tests. Tests demonstrating safe response in abnormal thermal environments conducted during the B61-3,4 program included the following:

- High-temperature tests on switches and barriers up to 1000°F
- High-temperature tests on weak-links (capacitors and IHE) to determine failure threshold
- High-temperature tests on 12 firing sets at temperatures up to 1850°F
- High-temperature tests on four B61-3,4 test units.

The mechanical packaging and therefore the thermal properties of the B61-6,8 is identical to that of the B61-7. [redacted] The test unit was configured to provide exposure of a 120° arc of the center case directly to the fire with the remaining portion of the bomb exterior insulated and protected from direct flames. In this way, the most preferential heat path to the stronglink switches is obtained and therefore a worst-case test results. The thermocouple data (Figure 46) indicated the desired close thermal-tracking of the stronglink and weak-link temperatures. Thermocouples within the IHE indicated that in this orientation the IHE starts burning before the X-unit capacitor reaches failure temperature. The bomb IHE was totally consumed in the fire without detonating. Posttest examination of the firing set revealed total thermal destruction of the mylar X-unit capacitor while the stronglinks retained voltage

Combined Abnormal Environments

The B61-6,8 MCs require nuclear detonation safety be achieved "for individual or credible combinations of abnormal environments specified in the STS." The applicable STS for the B61-6,8 has been distributed for comments and revision. The section defining credible combined abnormal environments is being discussed and a revision has been proposed. Therefore the specific STS guidance to which the design and evaluation program for the B61-6,8 will be judged is not available.

The bombs response to combinations of abnormal environments relies on the demonstrated safe response to individual abnormal environments by virtue of the stronglink/weak-link/exclusion region design concept. For all single abnormal environments identified in the STS, it has, or will be shown that either the weak-link elements of the nuclear system or firing set become irreversibly inoperable prior to the stronglink failure, or the stronglinks maintain electrical isolation. Additionally, the relative stronglink/weak-link failure levels are sufficiently separated so that an abnormal environment not severe enough to disable the weak-link is below the level necessary to degrade the stronglink/exclusion region isolation. Thus, there are two predictably safe responses to an abnormal environment that have a direct bearing on system response to sequential exposure to abnormal environments:

1. The weak-link has become irreversibly inoperable prior to stronglink failure or bypass.
2. The stronglinks remain intact (the weak-link has not failed).

Given response #1, bomb exposure to subsequent abnormal environments would not result in a nuclear detonation since the system was rendered inoperable by the initial exposure.

Given response #2, the bomb is expected to withstand additional abnormal environments terminating in a safe condition with either the stronglinks intact or with the weak-link inoperable prior to stronglink failure or bypass.

There has never been a entire bomb system exposed to an ordered sequence of abnormal environments. There has been abnormal environment testing performed at the major component level (e.g., the firing set) to identify potential problem areas. Numerous tests have been performed on the MC2918 Firing Set to establish structural properties and dielectric properties of the stronglink/exclusion region following a high thermal abnormal environment. There are development activities in progress to improve the structural support of the stronglink switches following elevated temperatures resulting from fire and therefore address a combined abnormal environment of high thermal followed by shock. An aircraft crash (shock, static loading of the case) followed by fire is a "more credible" order of the combined environments and one for which the firing set response is predictably safe.

There are plans to test the new MC4137 TSSG to combined shock and thermal tests. The steel case (exclusion region) and rolamites were selected based on the threat of combined abnormal environments. The sequence of the thermal and shock should pose no threat to the predictability of the all-steel design.

5. Reliability

Summary

The reliability of the B61-6,8 has been predicted using the methods briefly described in this chapter. [redacted] To predict the bomb reliability, a failure analysis is performed for each component. Current assessments are used for the components of the parent weapon or those that are common to the B61-7 or B61-3,4 based upon stockpile data. Predictions for new components are based on all available data from similar components in comparable weapon systems and on data for individual piece parts and their design use.

DOE b(3)

The command disablement system is to have the following MC-specified reliability and premature probability characteristics:

[redacted]

DOE b(3)

Delimiting Conditions

The predicted reliability is conditional on the following:

1. Stockpile and use environments will be no more severe than the normal logistical and operational environments described in the STS.
2. All AMAC inputs will be present and proper.
3. There will be no human errors in bomb handling or preparation for use that will reduce its reliability.
4. The bomb and all of its components will be built to the usual DOE standard of production and process control.
5. The specified end-of-life of limited-life components will not be exceeded. Reliability assessments are considered to apply at the end of specified-life for limited-life components.
6. Failure events not treated otherwise are mutually exclusive or statistically independent.

Conclusions

[redacted]

DOE b(3

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6. Use Control

The B61-6,8 use control features include a command disable system and a Category D PAL System. Additional details about these features are discussed in the Use Control Addendum for the B61-6,8 Bomb (Reference 37).

Command Disable System

Command disablement of the B61-6,8 can be initiated from the aircraft or at the preflight controller (Figure 23) on the bomb. [redacted] The disablement system is composed of a DE1002 Coded Device and a MC3246A Thermal Battery.

DoD b(3)

Disablement results when (1) the correct three-digit disablement code is set on the DE1002 Code Switches, (2) the function select switch is set to the DI (disable) position, and (3) the T-handle is extracted, mechanically initiating the MC3246A battery. The disablement loads located within the bomb center case, each isolated by discreet resistors within the MC4139 Junction Box, are in parallel off the output of the MC3246A battery.

Category D PAL

The B61-6,8 Category D PAL subsystem consists of an MC2907A Multiple Code Coded Switch (MCCS), an MC2946 Output Switch, and a PAL Regulator. When the subsystem is locked, the bomb cannot be prearmed. The PAL subsystem is shown schematically in Figure 47.

MC2907A Multiple Code Coded Switch

[redacted]

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parallel. Similarly, it can only recode one weapon at a time in the recoder mode (Figure 53).

The T1563 was developed to ease the burden of the PAL code management. It offers the user a more effective and efficient means to accomplish secure code selection, insertion, and verification with functions such as no-knowledge recode and automatic verify. It is compatible with all presently fielded PAL weapons, Air Force and Army, and the software can be changed to support future PAL interfaces. It also has a communications port to allow the transfer of information to and from the T1565 Headquarters Code Processor (HCP) using the T1572 Portable Data Module (PDM). It can be powered by a T436 battery or T1571A power supply. For ease of use, the T1563 is operator interactive and portable.

The T1572 Portable Data Module contains encrypted Permissive Action Link (PAL) recode and verification data generated either by the T1563 Automated PAL Controller or the T1565 PAL Headquarters Equipment. The T1572 is used as a mass storage device (nonvolatile read/write memory) to carry both recode and recode verification data (data is encrypted) between the T1563 and the T1565; also, the T1572 would be used by the T1565 to read Source Data PROMs (read only memories) generated by NSA containing encrypted recode data. The T1572 can also be used to interrogate the T1563 concerning previous weapon access.

T1569 Adapter

This adapter is used with the CT1504 Cable to connect the T1535, T1536, T1539, T1555, or T1563 PAL Controllers to the B61-6,8 Pullout Connector.

T1571 and T1571A Power Converters

The T1571 Power Converter can replace the T436 and the T436B power supplies whenever standard ac power is available. The T1571A is compatible with European ac voltage and frequency.

CT1478 Power Cable

This cable connects either a T1535, T1536, T1539, or T1563 with the T436B Power Supply.

CT1504 Controller Cable

This cable is used with the T1569 Adapter to connect either a T1535, T1536, T1539, T1555, or T1563 PAL Controller to the pullout connector.

CT1505 Test Cable

This cable is used with the T1569 Adapter to connect the T304C Continuity Test Set to the pullout connector to monitor the PAL. It will also mate directly with the J1 PAL connector on the MC4136 Preflight Controller.

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8. Ancillary Equipment

Most B61-6,8 ancillary equipment (training, test, and handling equipment) is used on previous Mods of the B61. Any new or modified pieces of ancillary equipment necessary for B61-6,8 operations will be determined by a Joint Task Group (JTG) to be scheduled.

Shipping and Storage

H1125/H1242/H1012

The H1125 Bomb Cradle, either singly or stacked a maximum of two high with the H1242 Swivel Caster Set, or its alternate, the H1012 Hand Truck, is used for transportation and storage of the B61-6,8. These are carryover items that are interchangeable between the various B61 Mods.

H1127 Storage Bag

The H1127 is used on each B61-6,8 to store one-for-one items shipped with the weapon.

Field Test and Handling Equipment

Field test and handling equipment is authorized as required for B61-6,8 safety operations, bomb subassembly and assembly, monitoring, PAL control and training, limited-life component exchange (LLCE) and maintenance. Equipment previously developed for existing B61 Mods will be used wherever possible; new equipment will be designed only where necessary.

Safety Operations

The following carryover equipment will be authorized for use with the B61-6,8.

T290A Sampler, Air

The T290A is used to detect tritium in the air and measure the level of concentration. The T290A is an alternate for the T446 Tritium Alarm Monitor when used as a portable monitor.

T446 Alarm Monitor, Tritium

The T446 is used to detect tritium in the air and measure the level of concentration. It may be powered by the T2071 Power Supply. The T446 is an alternate for the T290A Air Sampler.

T464 Charger, Battery

The T464 can be used to operate the T446 Tritium Alarm Monitor from 115-V ac power while charging, or maintaining a charge on, the batteries in the T446. It will operate the T446 only with batteries installed. The T2071 Power Supply must be used with the T446 when batteries are not installed.

T2071 Power Supply

The T2071 allows direct and continuous use of the T446 Tritium Alarm Monitor from 115-V ac power lines.

Limited Life Component Exchange Equipment

The following carryover DOE-designed equipment is required to perform the planned LLCE, including weapon leak testing. New, additional equipment will be defined only if necessary.

H631 Handling Tool, Caster

The H631 is used to facilitate turning casters on the H1012 Hand Truck or H1242 Swivel Caster Set. It is an alternate for the H1216.

H869 Strap, Hoisting

The H869 adapts the rear bomb subassembly to overhead handling equipment. It is used during parachute replacement or if the subassembly is removed for further access into the preflight and center bomb subassemblies.

H1004 Adapter, Hoisting, Bomb

The H1004 adapts the bomb to an overhead hoist or fork lift using bomb lugs as points of attachment. It is used to transfer the bomb from the H1125 Bomb Cradle to other equipment.

H1011 Socket Set, Socket Wrench

The H1011 is used to loosen and tighten electrical connector retaining nuts.

H1082 Pump and Control Box, Hydraulic

The H1082 is used with the H1134 Hydraulic Ram and the H1135 Ram Restraining Frame to apply pressure to the cover plate during removal and installation of the threaded ring in the center bomb subassembly.

H1130 Handling Device, Bomb Tail

The H1130 attaches to the tail bomb subassembly to provide for manual lifting. It is used during parachute replacement and removal to gain further access to the interior of the weapon.

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H1134 Ram, Hydraulic

The H1134 is used with the H1082 Hydraulic Pump and Control Box and the H1135 Ram Restraining Frame to apply pressure to the cover plate for disassembly and reassembly of the center bomb subassembly.

H1135 Frame, Restraining, Ram

The H1135 is used with the H1134 Hydraulic Ram and H1082 Hydraulic Pump and Control Box to apply pressure to the cover plate during removal and installation of the threaded ring securing the cover plate.

H1136 Handling Device

The H1136 attaches to the cover plate of the center bomb subassembly and provides a means for manual removal and installation.

H1176 Wrench, Spanner

The H1176 is used to remove and install the threaded ring which secures the cover plate in the center bomb subassembly.

H1199 Wrench, Torque

The H1199 is used to remove and install nuts securing connectors of flat electrical cables to the ECA.

H1200 Wrench, Open End

The H1200 may be required to hold the hex studs while the nuts are being removed from the flat electrical connectors with the H1199 Torque Wrench.

H1201 Removal Tool, Electrical

The H1201 is used to disconnect the flat electrical connectors from the ECA.

H1216 Tool, Caster

The H1216 is used to facilitate turning casters of the H1012 Hand Truck or H1242 Swivel Caster Set. It is an alternate for the H631 Caster Tool.

H1228C Protector Kit, Electrical Connector

The H1228C contains the connector covers and shorting plugs required when any electrical disconnection is made during maintenance operations.

H1229 Stand, Bomb

The H1229 is used to rotate and secure the center bomb subassembly in a vertical position while components are being replaced. This stand is for use on board naval aircraft carriers. It is used with the H1238 Assembly Platform at other locations.

H1234 Wrench, Torque

The H1234 is used to tighten or install the studs in the MC4139 Junction Box located in the ECA.

H1238 Platform, Assembly Stand

The H1238 is used with the H1229 Bomb Stand during the replacement of limited life components. It is required at all locations except naval ships, and provides a base for the H1229.

H1248 Removal Tool, Machine Screw

The H1248 is required to loosen screws securing case sections together if commercial tools fail to loosen screws. It is an alternate for the H1354 Screw Removal Tool.

H1354 Screw Removal Tool

The H1354 is required to loosen the screws securing case sections together if commercial tools fail to loosen the screws. It is an alternate for H1248 Machine Screw Removal Tool.

H1379A Tool, Handling

The H1379A will be used for removal and installation of the ECA.

H1493 Wrench

The H1493 will be used to torque the gland into the Acorn and 2M assemblies.

T304C Test Set, Continuity, Multiple Purpose

The T304C is used to check electrical continuity. When connected to the umbilical connector of the B61-6,8, through the CT1520 cable, the T304C will verify the status of the MC2969 Intent Stronglink Switch. When used with the CT1505 cable through the J1 connector on the MC4136 Preflight Controller, the T304C will indicate the PAL status (lock/unlock).

T461 Panel, Leak Detection

The T461 is used with the T489 or T460 Leak Detection Chambers to check the seal integrity of the center bomb subassembly case.

T489 Chamber, Leak Detection

The T489 is used with the T461 Leak Detection Panel to check the seal integrity of the center bomb subassembly after replacement of limited life components in the B61-6,8.

9. Test and Evaluation

Nuclear System Tests

Nuclear Tests

[redacted]

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Hydrodynamic Tests

[redacted]

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B61-6,8 System Tests

Development Test Program

The B61-6,8 development test program will provide assurance that the system will function properly and safely throughout its stockpile life. Four categories of tests are being conducted to meet this objective: STS environment, laydown shock, flight, and special laboratory tests. Table 3 summarizes the B61-6,8 test program. The A, B, and C prefixes of the test unit numbers indicate the three phases of the program that relate the hardware development progress. Phase A employs first prototype hardware; new design major components are constructed by Sandia using commercially available piece-parts that have not yet been qualified. Phase B hardware will be constructed by the DOE manufacturing agency using mostly qualified piece-parts. If any design changes are identified by Phase A results, they will be incorporated. Phase C hardware is WR-quality material constructed during production qualification (TMS) activities at the DOE plant. About twenty functional AF&F test units will be assembled in addition to many nonfunctional, units designed to collect environmental data.

[redacted]

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No tests will be conducted in the areas of acoustic, pressure, humidity, precipitation, wind, and suspended particle environments. Bomb ballistic performance will be monitored and evaluated to ascertain applicability of Navy aircraft weapon delivery software.

STS Environmental Series Tests

These tests will demonstrate the B61-6,8 will function reliably after experiencing the extremes of mechanical shock, vibration, and temperature tabulated or inferred (aircraft carriage and flight conditions) in the STS for Stages 1 to 5.

The SE (STS environments) test units will verify that the B61-6,8 will survive the environments. In addition, FT (flight test) units beginning with FT4 will be subjected to STS environments before being flown. The STS test series will verify weapon reliability after handling, storage, transportation, and flight environments based on worst-case data accumulated via prior B61 development programs.

Laydown Shock Tests

The ability of the B61-6,8 nuclear system and firing set to survive the severe mechanical shocks of laydown delivery against hard, irregular targets will be verified both in the special tests and flight tests. Drop tower tests were conducted durign the B61-7 program to measure the response of the nuclear system and AF&F to impacts with hard, irregular targets. The B61-7 test unit was dropped with its longitudinal axis horizontal to strike a railroad rail at the weapon primary and at the firing set station. Because the B61-6,8 is identical to the B61-7 at these stations, the conclusion from these tests, coupled with B61-3/4 testing and analysis, is that no release altitude restrictions are required in using the B61-6,8 against hard, irregular targets.

The rocket launcher facility will be used to simulate worst-case slapdown and longitudinal impact conditions with the unit at both its maximum and minimum temperatures. From the early tests, component response data at the Acorn assembly was obtained which will be used in component qualification. Additional worst-case laydown delivery conditions will be conducted with fully functional AF&F hardware at maximum and minimum temperatures at the rocket launcher facility.

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Table 4. B61-6,8 Development Test Plan

TEST Ident	Facility	Configuration	Hardware Quality	Date	Purpose
LS1(A)	SNL	Short Center Case	MU	6-8/88	Acorn survivability in simumlated laydown
ES1(A)	SNL	AF&F, open setup	FF	6/88	Bench test of new breadboard components & new tester
SLIM(A)	SNL	Center Case	MU	9/88	First Sandia Los Alamos Interface Mockup
SE1(A)	SNL	Bomb, lateral	MU	12/88	Maximum laydown impact using rocket launcher, Acorn
SE2(A)	SNL	Bomb, axial	MU	4/89	Maximum laydown impact using rocket launcher, Acorn
SE3(A)	SNL	Bomb	FF	2,3/89	STS shock, vibration with fully functional AF&F
ND1(A)	LANL	Primary +	MU	6/89	Time of shock arrival at neutron generator location
SLIM2(A)	SNL	Center Case	MU	3/89	Second Sandia Los Alamos Interface Mockup
SLIM3(B)	SNL	Center Case	MU	6/89	Sandia Los Alamos Interface Mockup, "WR" foam
MAT1(B)	LANL	Center Case	FF	7/89	One-year Accelerated Aging Unit for material comp.
MAT2(B)	SNL	Preflight+Tail	FF	4/89	Resultant salt air environment inside tail & preflight
CTU1(B)	SNL	Special	FF	7/89	"Intent-enabled" TSSG aircraft compatibility test unit
ECT1(B)	SNL	AF&F+JTA	FF	7/89	Bench test followed by bomb configuration test of JTA
SE5(B)	SNL	Bomb-JTA	FF	8/89	STS test series followed by max. lateral impact with JTA
SE6(B)	SNL	Bomb-WR	FF	6/89	STS + max. lateral impact at min. temperature (WR)
SE7(B)	SNL	Bomb-WR	FF	7/89	STS + max. lateral impact at max. temperature (WR)
SE8(B)	SNL	Bomb	MU	6/89	STS + max. axial impact at min. temperature, Acorn surv.
SE9(B)	SNL	Bomb	MU	7/89	STS + max. axial impact at max. temperature, Acorn surv.
FT1(B)	WSMR	Bomb	FF	8/89	A-4, JTA-6
FT2(B)	WSMR	Bomb	FF	9/89	A-7E, WR, REG
FT3(B)	WSMR	Bomb	FF	9/89	A/F-18, JTA-8
FT4(B)	WSMR	Bomb	FF	11/89	A-6, JTA-3 preceeded by STS environments
FT7(B)	Dabob	Bomb	FF	1/90	F/A-18, JTA-7 preceeded by STS environments
FT6(B)	TTR	Bomb	FF	3/90	A-7E, WR, REG preceeded by STS environments
FT5(B)	TTR	Bomb	FF	5/90	B-1B, JTA-2 preceeded by STS environments
FT8(B)	TTR	Bomb	FF	7/90	F/A-18, REG, WR preceeded by STS environments
FT9(B)	TTR	Bomb	FF	9/90	B-52H CSRL, JTA-8, preceeded by STS environments
FT10(C)	TTR	Bomb	FF	11/90	F/A-18, JTA-1 preceeded by STS environments
FT11(C)	WSMR	Bomb	FF	2/91	F/A-18, JTA-6 preceeded by STS environments
FT12(C)	TTR	Bomb	FF	2/91	F/A-18, Design Demonstration Test preceeded by STS
ND2(B)	SNL	Center Case	FF	6/90	Neutron Generator "proof test"
SE10(B)	SNL	Center Case	MU	5/89	Hydrostatic pressure capability of center case
NS1(B)	SNL	Bomb	FF	12/89	Nuclear safety certification unit (combined env.)
NS2(B)	SNL	Bomb	FF	3/90	Electro-static Discharge (reliability) + nuc. cert. unit
UC1(B)	SNL	Bomb	FF	7/90	Command disable effectiveness
UC2(B)	SNL	Special	FF	4/90	Command disable bench tests (multiple), MU loads
EM1(B)	SNL	Bomb	FF	2/90	EMR evaluation
SE11(B)	SNL	Bomb	FF	6/90	STS + max. lateral impact, late development components
SE12(B)	SNL	Bomb	MU	7/90	[redacted] DOD b(3)
TR1(B)	SNL	Bomb	FF	3/90	ET-5C trainer for Pantex (WR)
TR2(B)	SNL	Bomb	FF	6/90	ET-5D trainer for Pantex (JTA)
TR3(B)	SNL	Bomb	FF	6/90	Type 3, 3A, 3E Training unit evaluations

Test Ident Code:

LS = Lab Simulated laydown shock
ES = Electrical System
SLIM = Sandia Los Alamos Interface Mockup
SE = STS Environments (shock, vib., thermal)
ND = Nuclear Development

MAT = Material Compatibility
CTU = Compatibility Test Unit
ECT = Electrical Compatibility Test
FT = Flight Test
NS = Nuclear Safety

UC = Use Control
EM = Electromag. Rad.
TR = Trainer evaluation

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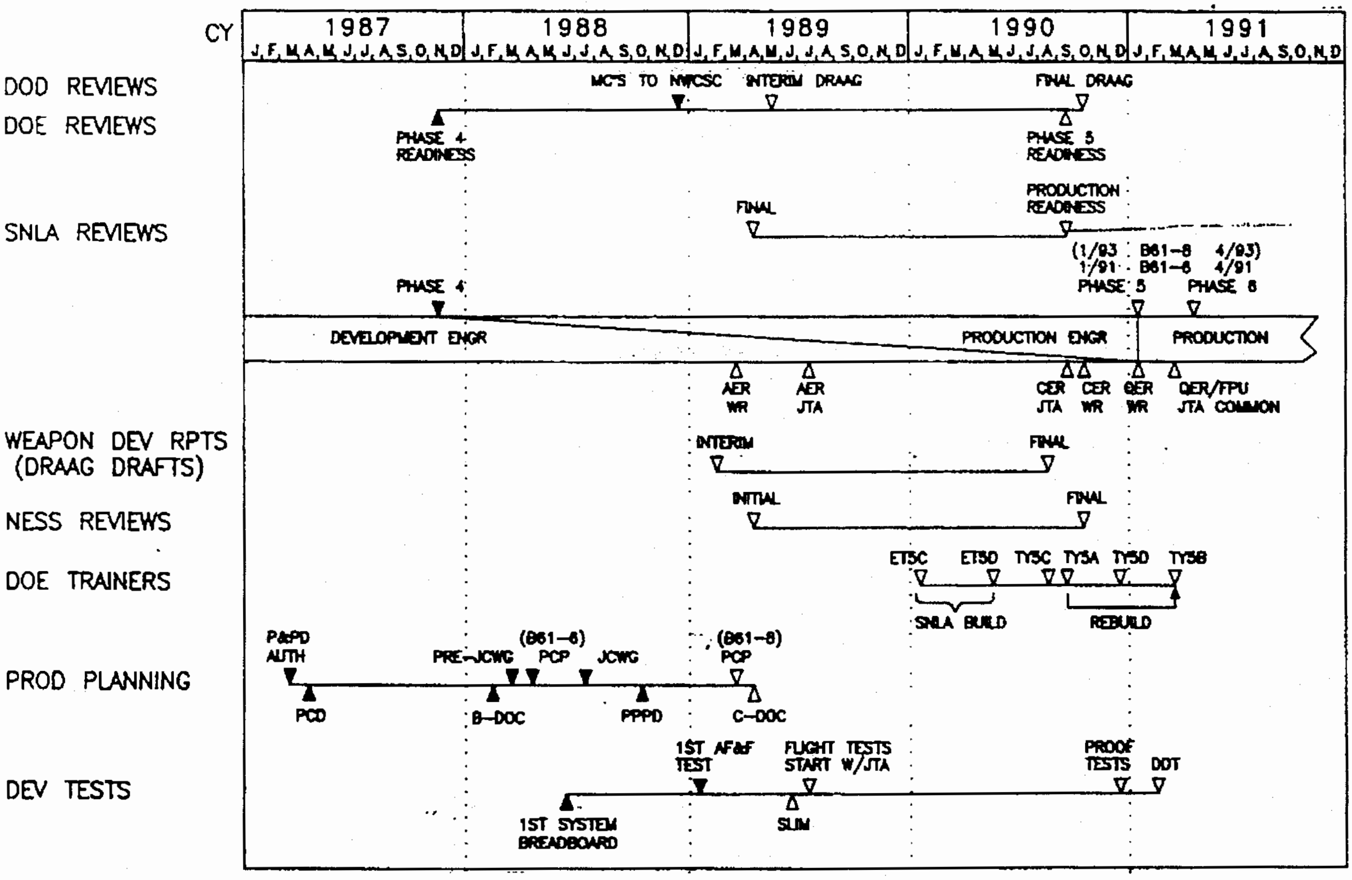
10. Programming

Since the B61-6,8 is a factory retrofit of the existing B61-0,2,5 stockpile, the normal early program support through Phase 1 and Phase 2 studies involving both nuclear laboratories are not appropriate. The chart below lists the significant development and production milestones to be accomplished.

B61-6/8 PROGRAM SCHEDULE

DOD-DOE/SNLA MAJOR MILESTONES



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APPENDIX A

Military Characteristics for the B61-6,8
(Proposed)

Military Characteristics | Comments

1. (U) *General*

1.1 (C-FRD) *Purpose*: This portion of the Military Characteristics (MC's) specifies the requirements of the Department of Defense (DOD) to the Department of Energy (DOE) for the B61 Mods 6 and 8 (B61-6,8) gravity bombs. The modifications are to incorporate modern safety, security, and operational features. The B61-6, 8 designs shall have the features delineated in paragraph 2 of these MCs.

1.1.1 (U) The B61 Mod 6 is a modification of the B61 Mod 0.

1.1..2 (U) The B61 Mod 8 is a modification of the B61 Mods 2 and 3.

1.2 (U) *Contingencies*: The design, development, test and evaluation of the bombs will be coordinated by the B61 Project Officers Group (POG). Should it appear impractical to meet any of these characteristics or that meeting them will unduly delay development or production of the bombs, incur unreasonable costs, or require excessive special nuclear materials, prompt notification shall be made by the Lead Project Officer (LPO) via service channels to the Nuclear Weapons Council Standing Committee (NWCSC).

1.3 (U) *Competing Characteristics*: In the event that compliance with these MCs results in design conflict, priorities shall be observed in the order listed below, giving consideration to tradeoffs which allow higher priority MCs to be attained while minimizing the degradation of the competing lower priority MCs. Operational effectiveness, technical feasibility, schedule, and cost will provide the basis for making tradeoffs among the desired competing characteristics. Tradeoffs may be made with the guidance and approval of the B61 POG. The NWCSC must approve all MC changes.

1.3.1 (U) Nuclear Safety
1.3.2 (U) Minimum Intrinsic Radiation
1.3.3 (U) Reliability
1.3.4 (U) Physical Characteristics
1.3.3 (U) Yield
1.3.6 (U) Radioactive Material Dispersal
1.3.7 (U) HE Safety
1.3.8 (U) Economical Use of Nuclear Material
1.3.9 (U) Operational Simplicity
1.3.10 (U) Command and Control Features
1.3.11 (U) Maintenance

2. (U) *Bomb Characteristics*

2.1 (U) *General Considerations:*

2.1.1 (U) The bombs shall not require functional testing in the stockpile.

2.1.2 (U) The bombs shall be designed so that the likelihood of plutonium dispersal in an accident environment is minimized.

b(3)

[redacted]

Military Characteristics | **Comments**

2.1.4 (U) Provision shall be made for easy removal of some component of the electrical system vital to the function of the bombs. This provision shall not compromise Service operational requirements or storage criteria. Since this feature is a use-control function only, the bomb must meet all nuclear safety requirements in paragraph 2.8 whether the separable component is installed or removed.

2.1.3 (U) The design of the bomb shall be consistent with the environmental conditions delineated in the stockpile-to-Target Sequence (STS) and shall be deliverable in accordance with aircraft profiles in the STS.

2.2 (U) *Operational Considerations:*

[redacted]

DOE/DOD b(3)

[redacted]

DOD b(3)

2.3.3 (U) Groundburst (Freefall)

2.3.4 (U) Laydown: (Retarded delayed groundburst.) The firing times shall be the same as the parent bomb.

[redacted]

DOE DOD b(3)

2.3.6 (U) The bombs shall be capable of functioning properly in water depth to the limits of the Laydown timers.

2.4 (U) *Physical Characteristics:*

2.4.1 (U) Weight: 770 pounds (nominal)

2.4.2 (U) The length shall be 141.6 inches maximum.

2.4.3 (U) The body diameter shall be 13.3 inches maximum.

2.4.4 (U) The shape and geometry of the bombs shall be such as to minimize drag and adverse flight characteristics on the strike aircraft during all phases of the flight profile.

2.4.5 (U) War reserve bombs shall be identified with permanent and distinctive markings.

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