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B57 Special Study Report (U)

ROUGH DRAFT

September 21, 1992

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Attachment #6

Outline / Contents **Page**

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List Of Illustrations

List of Charts and Tables

Executive Summary

The B57 was fielded in 1963, in response to a Navy requirement for a nuclear depth bomb. Note that the design of this bomb predates formulation of all modern nuclear safety design methodology.

The following issues prevail:

Recommendations

1. Retirement should progress as rapidly as possible.
2. Alt 906 should be performed as necessary.
3. Alt 914 should be performed whenever Alt 906 is performed.
4. The MC1362 should be removed whenever Alt 906 is performed..
5. All shipments of the B57 should be by SST.

B57 Special Study Report

1.0 Purpose and Scope

This report was prepared to identify weapon system issues and to make recommendations to DOE headquarters. The scope of this special study examines the B57-1,2 from an operational status through subsequent logistics until the weapon is accepted by DOE at Pantex for dismantlement. The study covers the time frame from now through subsequent logistics consistent with P&PD 92-1. The weapon is described in sufficient detail to support safety and security issue discussions and recommendations.

1.1 History

The B57 was fielded in 1963, in response to a Navy requirement for a nuclear depth bomb. [redacted]

DOE b(3)

Through the ensuing twenty eight years, a total of seven Mods were fielded and all but two retired.

Significant dates are:

Phase 3		Jan. 1960
Phase 4		Jan. 1961
Phase 6		Jan. 1963
FPU Mod - 0	Retired, Convert to Mod - 1	Jan. 1963
FPU Mod - 1	Non-PAL	May 1964
FPU Mod - 2	PAL version	Sept. 1964
FPU Mod - 3	Retired, Convert to Mod - 1	Nov. 1965
FPU Mod - 4	Retired, Convert to Mod - 2	Dec. 1965
←Alt 269 initiated	Jan. 1966 ——— >	
FPU Mod - 5	Retired, Convert to Mod - 1	Sept. 1966
FPU Mod - 6	Retired, Convert to Mod - 2	Sept. 1966
←Alt 269 Complete		Mar 1969
←Production Complete		May 1967
←Retirement Started		June 1975

Only the Mod-1 (non-PAL) and the Mod-2 (PAL version) remain.

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2.0 Description of the B57 Bomb

The B57 is a single stage, lightweight, multipurpose bomb designed for use as a depth bomb, or in tactical and strategic weapon applications.

[redacted]

DOE (b)(3)

The B57 is currently fielded in two basic Mods, Mod-1 and Mod-2, which are essentially identical except Mod-2 incorporates a Category B PAL. Either Mod can be configured with any one of three field-interchangeable noses. The N57-0 Ballistic Nose, N57-1 Radar Nose or N57-2. The N57-2 is an improved high friction impact nose designed to remove the low level delivery restriction on the bomb with the Mod-0 Nose. The B57 may be deployed in either depth bomb or Laydown with any of the three noses; however, it must have the N57-1 Radar Nose for the Airburst options.

2.1 Nuclear System - Description

[redacted]

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2. High Explosive

Composition	Quantity (lbs)
PBX -9011	[redacted]
PBX - 9404	
Total	

DOE (b)(3)

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3. The Pit is a Type 104.

[redacted]

DOE (b)(3)

B. Reservoirs.

[redacted]

DOE (b)(3)

The following definitions apply:

Cycle Life - The interval from fill time to the time that the gas no longer meets the weapon yield certification because of tritium decay.

[redacted]

DOE (b)(3)

Extended Cycle Life - The interval from fill time to the time that "unacceptable" yield degradation results from tritium decay and helium generation. This time is greater than the cycle life and less than or equal to the limit life.

Limit Life - The interval from fill time to the time that the structural integrity of the reservoir, including an appropriate factor of safety, may be compromised, resulting in an increased probability of a tritium leak.

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Stockpile Life - The total number of years that a reservoir can be exposed to a tritium environment. It may limit the number of times a reservoir may be refilled.

C. The 1E valves used in the B57 application have a visible fusible plug, designed to release in a thermal environment or when the valve has been fired. This gives a positive indication of the status of the 1E valves.

2.2 Physical Characteristics

The B57 was designed for deployment in airburst, laydown and depth bomb options. The aluminum case (6060-T6) of the Center Bomb Subassembly, nominally 0.35 inches thick, encases those portions of the bomb that are required after impact in the laydown option, or after water immersion in the depth bomb option.

2.2.1 B57 Size/Weight, etc.

Weight	500 Pounds
Length	118 Inches
Diameter	14.75 Inches
Fin Span	25.25 Inches
[redacted]	
Fuzing Options	Freefall Airburst (with N57-1) Retarded Airburst (with N57-1) Laydown (with N57-0, -1, -2) Depth Bomb (with N57-0, -1, -2)

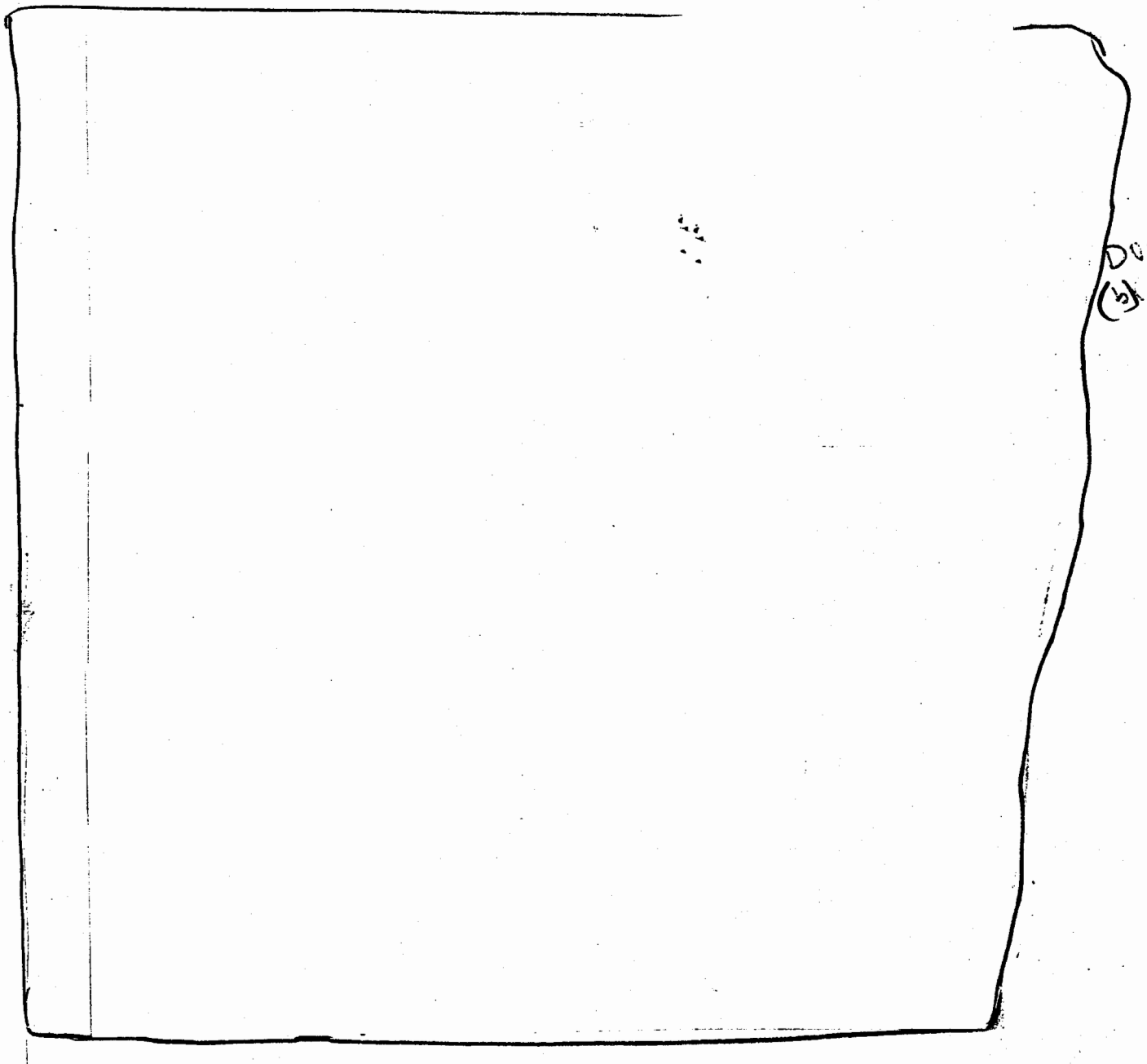
DOE (b)

Internal configuration is illustrated in Figure 1.

2.3 Power Sources and Sequence of Events

The B57 contains two internal power sources, the MC1192 Pulse Fast Rise Thermal Batteries (12 volt) and the MC1262 Main Thermal Battery (28 volt). In addition there are two MC1589 thermal Batteries in the N57-1 Radar Nose. The MC1192 batteries are initiated by aircraft power through the Pulse Plug at weapon release and power all the initial arming functions. They in turn initiate the two MC1262 Main Thermal Battery Power Supplies which power the fuzing and firing of the bomb. Aircraft power (Hot Drop) at release is required.

2.3.1 ARM and FIRE - Sequence of Events



2.4 Mods and Alts. The present stockpile of B57 bombs include only the Mod-1, Non-PAL version and the Mod-2 PAL version.
Significant Alts affecting the continuing Stockpile are:

Alt 259 - A Mod-1 weapon which retains the older Mod-0 Junction Boxes. The presence or absence of the MC1386 Strike Enable Plug cannot be verified electrically in Alt 259 bombs. There are still a few Mod-1 Alt 259 bombs in the field although they are being preferentially retired.

[redacted]

DOE (1)

Alt 284 added a stronger clevis and lug to allow carriage of the B57 on "High Performance " aircraft and removed a MAR restriction which limited the side load on the forward lug to a maximum of 1000 pounds.

[redacted]

DOD b(1) 1.6(a):X4

Alt 728 incorporates a thermal battery power supply in the N57-1 Nose. Alt 0 noses have a turbo-generator power supply. (No reported age related problem with this propellant.)

[redacted]

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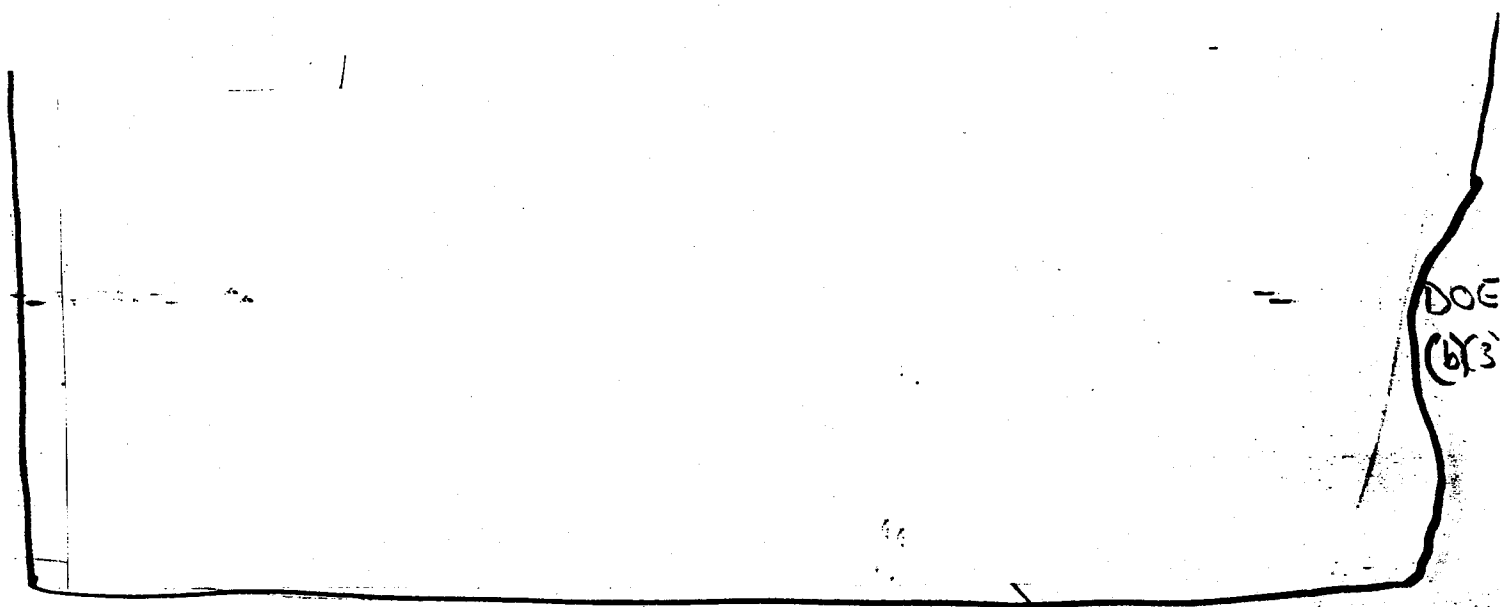
DOE b(3)


DOE
(b)(3)

2.5 Date and Currency of MAR

2.5.1 MAR number 1-74, Effective Date: 28 May 1974.

Identifies the Aircraft Compatibility Control Drawing (ACCD) as part of the MAR.

By the current issue of the ACCD (CD275961), the B57 is approved for carriage on all the presently active aircraft given in the following table. As indicated, the aircraft in the right column have no inflight PAL capability, so nuclear bombs carried on these aircraft must be enabled using a ground controller Those in the left column have an AMAC system that will allow them to operate a Category B PAL such as the one in the B57,

With Inflight PAL Capability	With NO Inflight PAL Capability
1. F-16C,D	1. A-6E
2. F-111E,F	2. F/A-18A,C,D
	3. NP-3C
	4. P3-C
	5. S3-A,B

[redacted]

DOE 6(3)

with the following exceptions and limitations:

1. B57 bombs without Alt 284 are limited to a maximum of 1000-pound side loads on the forward 30 inch suspension lug.

   All fielded B57 bombs have incorporated Alt 284.

DOD 5(1) 1.5(a)x: 4

There are still a few Alt 294 B57 bombs in the field although they are being preferentially retired.

[redacted]

DOE (b)(3)

This restriction still applies.

4. [redacted] DOE 6(3)

2.5.2 Current authorized STS is FC/10610257, RS 3446/1964, published 31 October 1961

Several revisions to this basic document have been proposed but none have been accepted due to the extensive test program that would have to be initiated to verify the requested changes in requirements that were proposed.

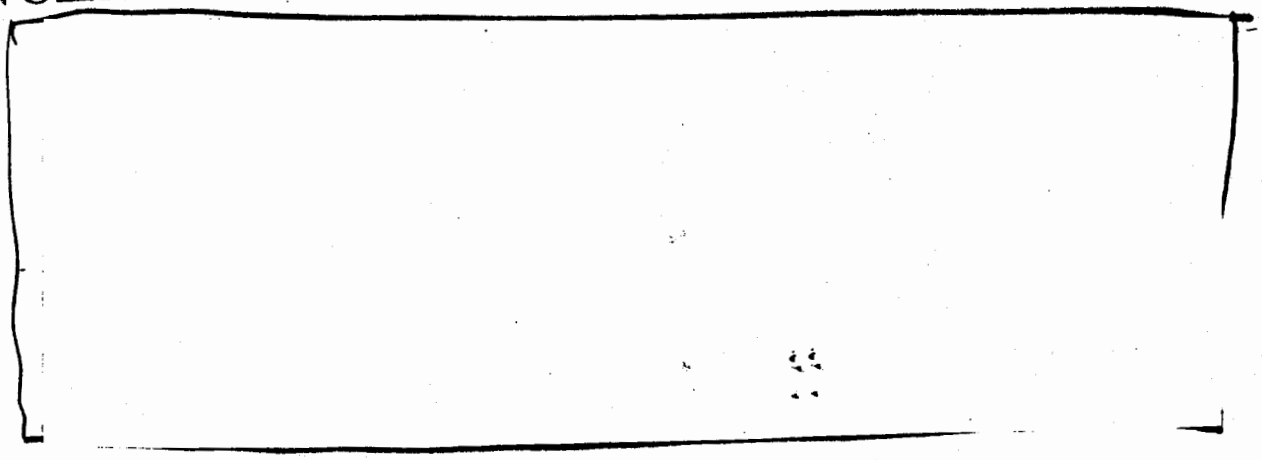
3.0 Description of Positive Measures

The B57 pre-dates Enhanced Nuclear Detonation Safety (ENDS) design methodology and components, Fire Resistant Pit (FRP) designs and the development of Insensitive High Explosive(IHE). It also pre-dates the development and definition of Nuclear Safety Rules. Following paragraphs identify design features that provide some assurance against the requirements of each of the Nuclear Safety Rules.

3.1 "There shall be positive measures to prevent nuclear explosives involved in accidents or incidents from producing a nuclear yield."

[redacted] DOE 6(3)

[redacted] DOE (6)(3)



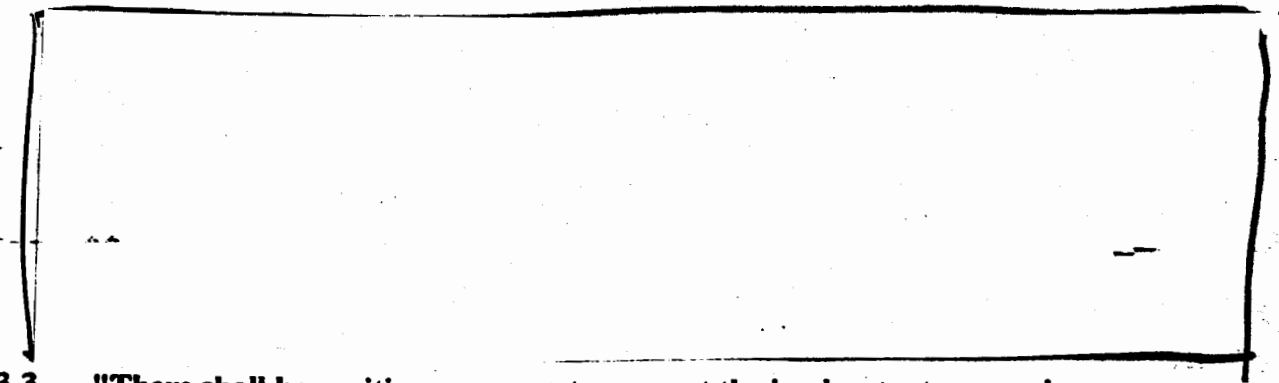
3.1.1 During carriage on a strike aircraft (accident or jettison):

1. The Ready/Safe switch should be in the "SAFE" position.
2. There should be no power on the pull-out cable, required to start the prearm sequence.

3.1.2 During a logistic movement operation (accident or incident):

1. The Ready/Safe Switch will be in the "SAFE" position, isolating internal power.
2. The Strike Enable Plug should be absent (isolating internal battery power).
3. There are no lanyard connections to either the pulse plug or the pull-out switch, both of which must function to initiate prearming.
4. Neither of the trajectory sensing systems will normally experience the environment required to operate the trajectory switch, thereby precluding further arming of the bomb.

3.2 "There shall be positive measures to prevent deliberate prearming, arming or firing of a nuclear explosive except when directed by competent authority."



3.3 "There shall be positive measures to prevent the inadvertent prearming, arming, launching, firing or releasing of a nuclear explosive in all normal and credible abnormal environment."

The required sequence of events under normal environments would act to preclude inadvertent prearm, arm or release.

[redacted]

DOE (b)(3)

3.4 "There shall be positive measures to ensure adequate security of nuclear explosives pursuant to the DOE safeguards and security requirements."

Security is handled by systems external to the weapon system. Such factors as fences, guards, two person control and Personnel Assurance Program (PAP) are examples of DOE (and DoD) security measures.

3.5 "There shall be positive measures to prevent accidental, inadvertent, or deliberate unauthorized dispersal of plutonium to the environment."

There are *no* **positive** measures; the B57 has conventional high explosive.

4.0 Summary of Past Safety Studies and Investigations

4.1 DOE and Laboratory Internal Studies

The B57 bomb is a weapon designed prior to the incorporation of the modern safety concepts of isolation, inoperability and incompatibility. The weapon does not utilize Enhanced Nuclear Detonation Safety (ENDS) nor does it have IHE or FRP.

[redacted]

DOE (b)(3)

4.1.1 Retrograde Surety

A study was conducted for the Executive Management Team for Dismantlement to identify options for enhancing Surety during the dismantlement process. In

recognition of system deficiencies, as detailed in paragraph 3 above, we have identified options to address these shortcomings. A tabulation of these options and the relative improvements to nuclear detonation safety and plutonium scatter is shown in the following table. Additional comments on each option are provided below:

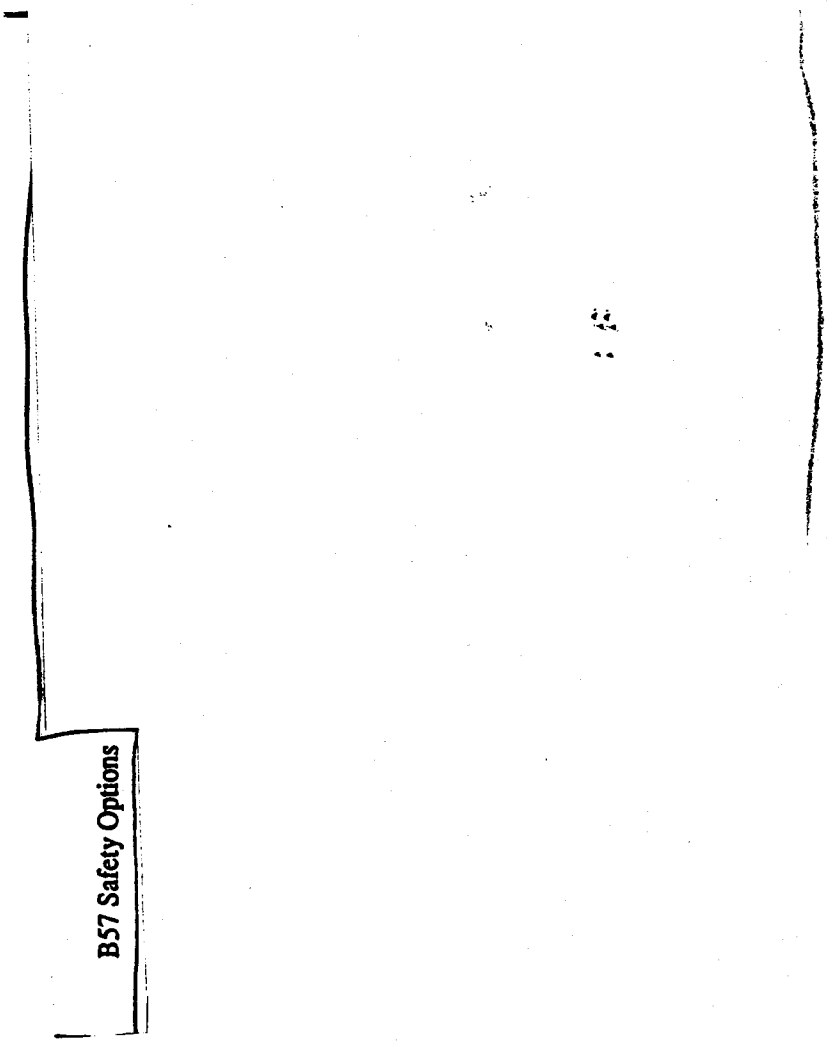
Option 1. [redacted]

Option 2. [redacted]

DOE (b)(3)

Option 3. Use of the Transportation Accident Resistant Container (TARC), in the B57 application, requires disassembly of the bomb and shipment of only the separate Center Bomb Subassembly in the container. Work is moving apace in the development, testing and fabrication of this configuration.

Option 4. Restricting shipment of B57 bombs to the SST is the recommended option.



[redacted]

4.2 TWG Reports. In 1975-76 there was a joint ERDA(DOE)/DoD effort to characterize "older weapons" in abnormal environments and combinations of these abnormal environments. The reports generated by these studies are referred to as "TWG Studies" (Technical, Working Group). The findings of these working groups are common across the services; only the individual accident scenarios differ..

- In mechanical abnormal environments, Impact, Crush, Immersion, Puncture, Acceleration, Blast, and Vibration, B57 response is completely predictable only in Immersion, Acceleration and Vibration environments.
- In Electrical abnormal environments, External Power Sources, Static Charge, EMR, and Lightning, the B57 response is completely predictable only in Static Charge and EMR environments.
- In Thermal environments the response of the B57 is predictable below 500°C or beyond the temperature at which the HE ignites. The possibility of Pu scatter as one result of HE ignition was not considered by the TWG.
- The B57 response to Chemical environment is predictable.

See Appendix B for additional details

4.3 Recent NWSSG Studies

4.3.1 Reports

Ref. 1. SRD Report, 3/26/92, RS3145A/92/00823; NWSSG 92-1, NWSSG 1087, Report of the Special Safety Study of the H1501 Series Shipping Containers with the B57 Bomb (U).

Observes that the B57 does not meet Modern Nuclear Safety Criteria and is nuclear safety enhancement.

Ref. 2. SRD Report, 5/92, RS3913-2/92/00401; NWSSG 92-2, Report of the Special Safety Study of the Product Change Proposal 2-92 of Alt 914 for the B57 Bomb.

Observes that incorporation of Alt 914 in the B57 bomb does not alter the non-conformance with the first and third DOE safety Standards of weapon system employing the B57 bomb.

Ref. 3. RD Report, 3/91, RS3141/91/1154; Special Safety Study of Navy B57-1,-2 and B61-0,-2 Older Nuclear Weapons Systems (April 1991).

Observes that older weapons are unable to satisfy the four DOE Safety Standards and should be prohibited from Nuclear Exercises (Readiness). A Minority report countered the last comment.

Ref. 4. SRD Report, Sept. 1991, RS 3145A/91/03064; NWSSGR 91-6, Nuclear Weapon System Safety Group Report of Operational Safety Review of the P-3C Aircraft with the B57 Bomb (U).

Ref. 5. [redacted] DOD b(1)

4.3.2 Safety Rules, Air Force Nuclear Weapon Systems

Ref. 1. AFR 122-26, Safety Rules for the US F-16A/B/C/D Weapon System, October 1988
Ref. 2. AFR 122-27, Safety Rules for the Non-US NATO F-16A/B/C/D Weapon System, December 1998.
Ref. 3. AFR 122-37, Safety Rules for the F-111A Weapon System, July 1990
Ref. 4. AFR 122-47, Safety Rules for the FB-111A Weapon System, July 1990

4.3.3 Safety Rules Navy Systems. (TBD)

4.4 Last NESS. Pantex in Oct. '88

4.4.1 Specific Nuclear Safety Rules, Pantex Facility
Ref. AL5610.11, Chapter XII

Article 13. Specific Safety Rules for the B57 Bomb

a. Upon bomb return and before disassembly operations are performed, an electrical continuity test shall be made to verify that the Ready/Safe switch is in the SAFE position and that the inertial switches and the switches in the explosive switch pack (located in the fuzing component assembly) are in the unactuated position.

b. When installed on the nuclear explosive, the Ready Safe Switch shall be maintained in the SAFE position.

c. The Strike Enabling Plug shall not be installed on the nuclear explosive and shall be controlled in a manner to preclude unauthorized use.

d. When installed on the nuclear explosive, the pullout switch shall be maintained in the unactuated position.

e. When the interconnecting box (located in the preflight selection bomb subassembly) is on the nuclear explosive, the J1 telemetry connector shall have the specified electrical connector cover installed.

5.0 Summary of Known Safety or Security Issues While in DoD Custody

5.1 Safety

Items of concern are discussed elsewhere (Section 6).

5.2 Security

[redacted]

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6(3)

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(b)(3)

5.3 Use Control

[redacted]

DOE
(b)(3)

6.0 Summary of Other Issues

6.1 Reliability Issues

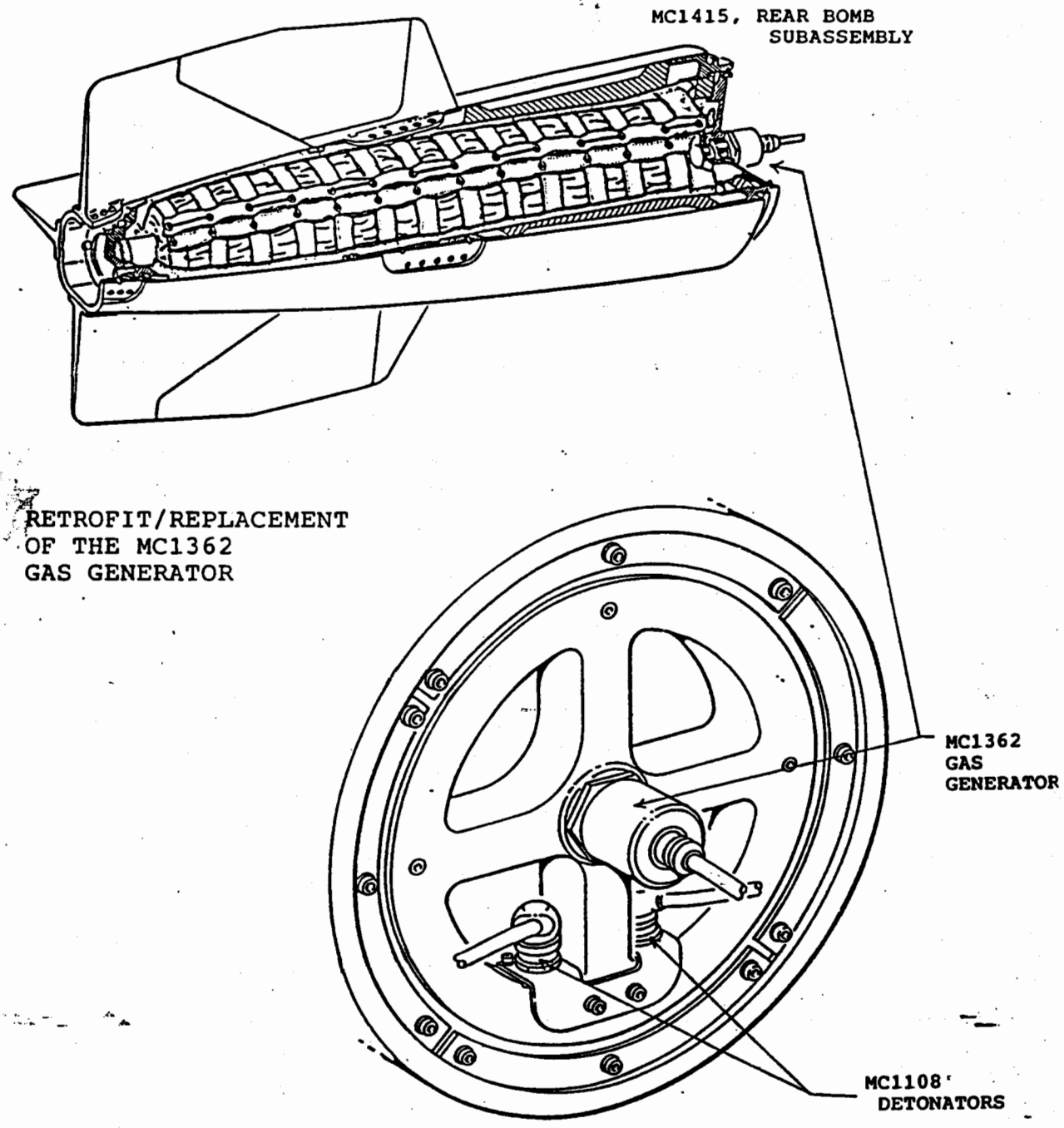
[redacted]

6.2 Personnel Safety Issues

A. MC1362 Gas Generator Problem. IMR4350 Propellant in the MC1362 Gas Generator, used to deploy the parachute, has gone well beyond the recommended age in stockpile. Based on a series of tests performed on this propellant (IMR4350), it was recommended that the MC1362 be retired. No evidence of imminent danger was found but the propellant is approaching the limit of assured safety. Should the propellant auto-ignite during transportation and/or storage, it would deploy the parachute. This would present both personnel and facility hazards. Should the propellant auto-ignite during maintenance inspection or limited life component exchange operations, it would also present threat to both personnel and facilities.

[redacted]

insert tail section and gas generator illustration


MC1415, REAR BOMB SUBASSEMBLY
RETROFIT/REPLACEMENT OF THE MC1362 GAS GENERATOR
MC1362 GAS GENERATOR
MC1108 DETONATORS

7.0 Findings and Recommendations

7.1 General

Although the B57 bomb meets the Military Characteristics and Stockpile-to-Target Sequence specified, it does not incorporate enhanced nuclear detonation safety design features and predates the development of insensitive high explosives(IHE) and plutonium scattering safety features. Thus, there is no assured level of safety in a broad range of abnormal environments such as could be encountered during alert, force generation exercises, and air transport.

The following issues prevail:

- The MC1362 Gas Generator propellant is approaching the limit of assured safety. The threat, the failure mechanism, is possible auto ignition, presenting a personnel / facility hazard.

DOE (b)3

DoD b(1)

7.2 Recommendations

DOE (b)(3)

- As a DOE position, the use of SSTs is the only proven safe, secure means of transporting the B57.
- Air transportation should be considered only if other factors eliminate the use of SSTs. If air transportation is necessary, both the use of TARCs (H1501 or H1501A) and the employment of Alt 914 should be required. Alt 914 improves the nuclear detonation safety, with or without the use of the TARC, two to three orders of magnitude. The use of TARC will improve Pu scatter probability by an order of magnitude.

Appendix A

The B57 was designed with very limited abnormal environmental requirements. No combined abnormal environmental requirements were imposed on the system at all. As a result, the weapon does not meet modern safety requirements due to the following soft spots:

[redacted]

DOE (4)(3)

Appendix B

ERDA(DOE)/DoD TECHNICAL WORKING GROUP (TWG) STUDIES OF 1976

During the TWG studies no attempt was made to quantify anticipated responses to abnormal environments, or combinations of environments as represented by accident scenarios studied. Rather, anticipated responses to these environments were characterized as one of three predefined conditions:

PREDICTABLE	A predictable response is one in which a critical component, subsystem or system can be depended upon with a high degree of confidence to respond in a manner that is known and safe.
UNPREDICTABLE	An unpredictable response is one in which a component, subsystem or system responds in a manner that is not always repeatable and may contribute to the weapon being unsafe.
UNDESIRABLE	An undesirable response of a critical component or subsystem in one in which it is expected to respond in a manner that contributes to a weapon being less safe. An undesirable response for a system is one in which it is expected to respond in a manner that is unsafe.

Note that the single concern was nuclear contribution to an accidental detonation. Plutonium scatter was not a concern during this era. Hence an assured HE detonation which will have no nuclear contribution was termed "Predictable".

B57 response to the various abnormal environments individually is common to both Air Force and Navy TWGs and are summarized in Table 1.

B57 responses to Air Forces Accident Scenarios is presented as Table 2. Navy responses are presented in Table 3.. The effects of performing Alt 914 on anticipated Navy accident scenarios responses is presented as Table 4.

Table 1. B57 Response To Abnormal Environments
TWG Summary

Air Force Studies

1. Air Force/ERDA - Joint Nuclear Stockpile Safety Evaluation of USAFE/PACAF Aircraft Weapon Systems Report, dated 9 August 1976
2. Air Force/ERDA - Joint Nuclear Stockpile Safety Evaluation of Non-NATO Aircraft Weapon Systems Report, dated 7 July 1976

Air Force Accident Scenarios envisioned by the Task Group and the B57 responses are summarized in Table 2.

Table 2. B57 Responses To Air Force Accident Scenarios

Navy Studies

Joint Navy/ERDA Nuclear Safety Evaluation of Navy Attack Aircraft Weapon Systems: NWEF Reports (1) 11316, dated March 1976, (2) 1136, dated June 1976, and (3) 1136-1 Executive Summary, dated June 1976. A summary of the accident scenarios envisioned and the B57 responses are presented as Table 3.

Table 3. B57 Responses to Navy Accident Scenarios

Table 4. B57, with Alt 914, Responses to Navy Accident Scenarios

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Appendix C

References, in the order mentioned in the text of this report:

1. MAR 1-74, Effective date 28 May, 1974

2. STS, FC/10610257, RS 3446/1964, Published 31 October, 1961

3. DOE Order AL5610.10, dated 10/10/90

4. SECRET RD/CNWDI Report, Nuclear Weapons Council Report on the Special Stockpile Improvement Plan Review, (SSIPR), dated January 1992., NWCWSC Comment Draft, RS3145A/92/00324.

5. SECRET/CNWDI Report, RS3141NC/503186, Air Force/ERDA -Technical Working Group, Subgroup Report, Joint Stockpile Nuclear Safety Evaluation of USAFE/PACAF Aircraft Weapon Systems, dated 9 August 1976

6. SECRET/CNWDI Report, RS3141NC/503097, Air Force/ERDA -Technical Working Group, Subgroup Report, Joint Stockpile Nuclear Safety Evaluation of NON US-NATO Aircraft Weapon Systems, dated 7 July 1976

7. SECRET/CNWDI Report, RS 3141NC/502974; NWEF Report 1131, dated. March 1976, Subject: Navy/ERDA Technical Working Group, Subgroup Report. Joint NAVY/ERDA Nuclear Safety Evaluation of Air launched Antisubmarine Warfare (ASW) Weapon Systems (B57/P-3A, B & C; S-3A: SH-3A,D,G&H)

8. SECRET/CNWDI Report, RS 3141NC/502974; NWEF Report 1131-1, dated. March 1976, Subject: Navy/ERDA Technical Working Group, Executive Summary, Joint NAVY/ERDA Nuclear Safety Evaluation of Air Launched Antisubmarine Warfare (ASW) Weapon Systems (B57/P-3A, B & C; S-3A: SH-3A,D,G&H)

9. SECRET/CNWDI Report, RS 3141NC/502976; NWEF Report 1131-2, dated. March 1976, Subject: Navy/ERDA Findings of The Navy/ERDA Nuclear Weapons Safety Study Group, Addendum to Joint NAVY/ERDA Nuclear Safety Evaluation of Air Launched Antisubmarine Warfare (ASW) Weapon Systems (B57/P-3A, B & C; S-3A: SH-3A,D,G&H)

10. SRD Report, RS3145A/92/00823; NWSSG 92-1, NWSSG 1087, Report of the Special Safety Study of the H1501 Series Shipping Containers with the B57 Bomb (U), dated 3/26/92

11. SRD Report, RS 3913-2/92/00401; NWSSG 92-2, Report of the Special Safety Study of the Product Change Proposal 2-92 of Alt 914 for the B57 Bomb, dated 5/92

12. SRD Report, RS3141/91/1154; Special Safety Study of Navy B57-1,-2 and B61-0, -2 Older Nuclear Weapons Systems (April 1991), dated 3/91

13. SRD Report, RS 3145A/91/03064; NWSSGR 91-6, Nuclear Weapon System Safety Group Report of Operational Safety Review of the P-3C Aircraft with the B57 Bomb (U), dated Sept. 1991

14. [redacted]

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b(1)

15. AFR 122-26, Safety Rules for the US F-16A/B/C/D Weapon System, October 1988

16. AFR 122-27, Safety Rules for the Non-US NATO F-16A/B/C/D Weapon System, December 1998

17. AFR 122-37, Safety Rules for the F-111A Weapon System, July 1990

18. AFR 122-47, Safety Rules for the FB-111A Weapon System, July 1990

19. DOE Order AL5610.11, Chapter XII, Article 13, Specific Safety Rules for the B57 Bomb

20. Uncl. Memo, Lawrence M. Ford, 9522, to James O. Harrison, 5115, dated August 10, 1992, Subject: Security Issues Concerning the B57 and W69

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