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Joint DoD/DOE Phase 2 Feasibility Study of a High Power Radio Frequency (HPRF) Weapon

Final Report (U)

20 February 1996

11/06/99

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NAME: ML ROLBAY	5. CLASSIFICATION CANCELLED
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Sandia National Laboratories NM

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Department of Energy

Headquarters Defense Nuclear Agency

United States Strategic Command

Air Force Space Command

Department of the Army

Nuclear Weapons Integration Division

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Classification sources:

1. [redacted] HPRF-1 DOE & DTRA (b)(1) & USAF
2. Joint DOE/DOD Nuclear Weapons Classification Policy Guide, CG-W-5, Jan 84
3. Air Force Nuclear Weapons Security Classification Guide, Jun 85
4. Draft HPRF Program Security Classification Guide, Mar 1995

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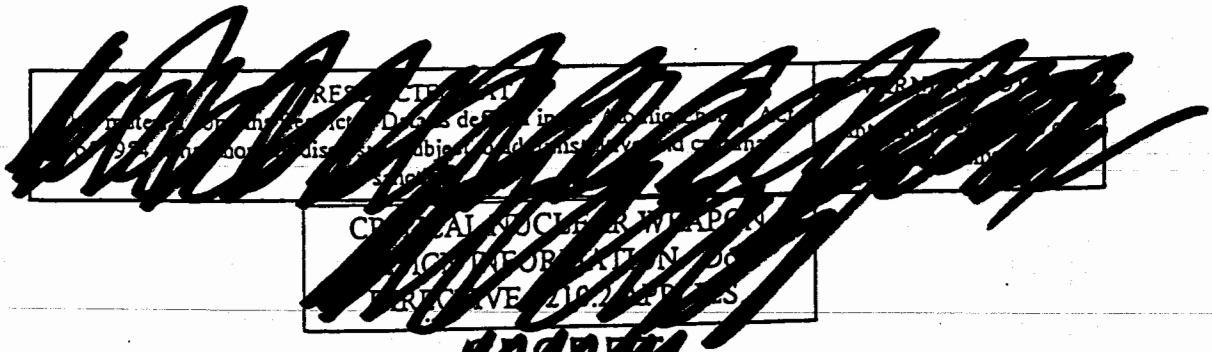

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(U) Also, additional vulnerability data should be acquired to complete the following three tasks, but not part of the 12-month study.

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CG HPRF-1

(U) ABSTRACT

(U) The High Power Radio Frequency (HPRF) Phase 2 Feasibility Study Group completed 30-months of work and the study was terminated. This final report documents the study findings, conclusions, and recommendations.

(U) An additional 12-month study should be conducted to complete the following two tasks.

(U) Executive Summary

1.0. (U) PURPOSE

(U) The purpose of this study was threefold.

[redacted]

DOE & DTRA b(3) & USAF

2.0. (U) BACKGROUND

A. (S-FRD) The Air Force conducted a Phase 0 Scoping Study from August 1989 to May 1990 examining enhanced bomber penetration through Soviet Integrated Air Defenses (IAD).

[redacted]

CG HPRF-1

DOE & DTRA b(3) & USAF

The High Power Radio Frequency (HPRF) Phase 1 Conceptual Study was conducted from January 1991 to April 1992 using bomber penetration through the Soviet IAD as the mission of interest.

[redacted]

CG HPRF-1

DOE & DTRA b(3) & USAF

The Air Force initiated a 30-month HPRF Phase 2 Feasibility Study in August 1992 requesting Department of Energy (DOE) participation through the Nuclear Weapons Council Standing and Safety Committee.

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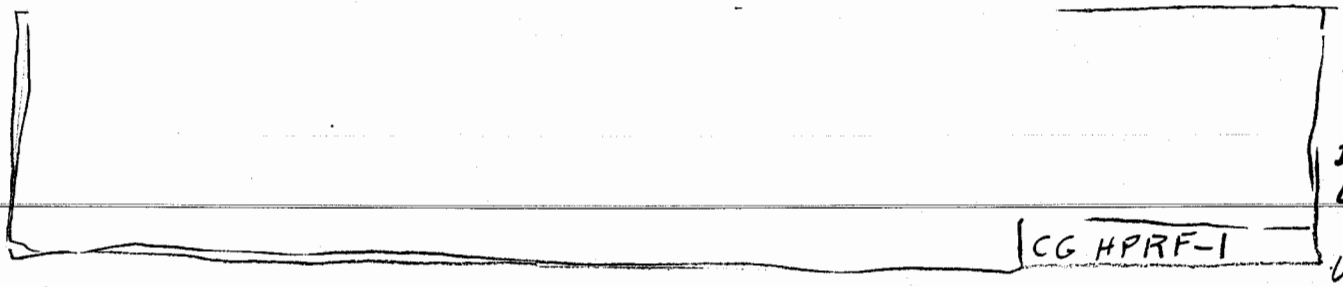
CG HPRF-1

DTRA b(3)

DTRA b(3) & DOE & USAF



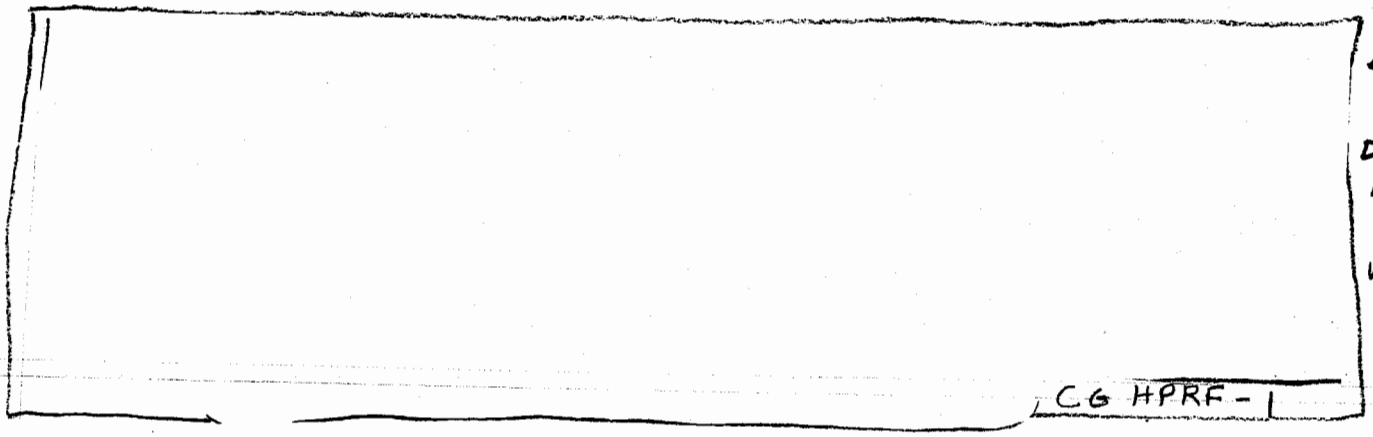
C. (U) Systems Engineering. Numerous trade studies which compared the implementation issues associated with missile system integration were conducted. Conceptual designs for integrating each HPRF warhead candidate into the MM III missile system were developed. A wide range of packaging and system engineering options were explored. Strategies were developed for implementing the different options. No show stoppers were identified in trade studies performed among the various options. Key issues from a weaponization and safety standpoint are CG HPRF-1 and strategic ICBM system use control.

USAF b(1)

D. (U) Nuclear Surety. A Quality Function Deployment evaluation of the warhead candidate designs was conducted in the areas of nuclear detonation safety, operational safety, nuclear material dispersal, and use control. This approach provided a structured appraisal of each candidate's surety features and contributed significantly to design refinement throughout the study. Upon completion of the evaluations, the data were combined to obtain an overall evaluation. The data for each area were normalized to cover the same range of values and then weighted with customer-supplied weights. With the exception of New Mexico (NM)-4, which had the lowest overall score, there was surprisingly little spread in the scoring. This was due to different candidates having strengths in different areas causing scores to even out. NM candidates scored higher in nuclear detonation safety with the exception of NM-4. California candidates scored somewhat higher in operational safety and nuclear material dispersal. CAT-F Permissive Action Link candidates received the highest scores in use control.

4.0 (U) CONCLUSIONS

(U) The study confirmed the following conclusions.



5.0 (U) RECOMMENDATIONS

A. (U) An additional 12-month study should be conducted to complete the following two tasks.

DOE & DTRA b(3) & USAF

CG HPRF-1

B. (U) Also, additional vulnerability data should be acquired to complete the following three tasks, but not part of the 12-month study.

DOE & DTRA b(3) & USAF

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USAF b(1)

DOE b(3)

DOE & DTRA & USAF b(3)

ACKNOWLEDGEMENTS

(U) We would like to thank a very diverse group of people from many different organizations for the time and effort expended in this study. Please be aware that the following list of participants is not all inclusive. The involvement of those who are not listed here is also greatly appreciated.

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CG HPRF-1 USAF b(1)

(U) Vulnerability Working Group (VWG)

CG HPRF-1 USAF b(1)

(U) Mission Analysis Working Group (MAWG)

CG HPRF-1 USAF b(1)

(U) Systems Engineering Working Group (SEWG)

CG HPRF-1 USAF b(1)

(U) Surety Working Group (SWG)

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(U) Requirements Working Group (RWG)

CG HPRF-1 USAF b(1)

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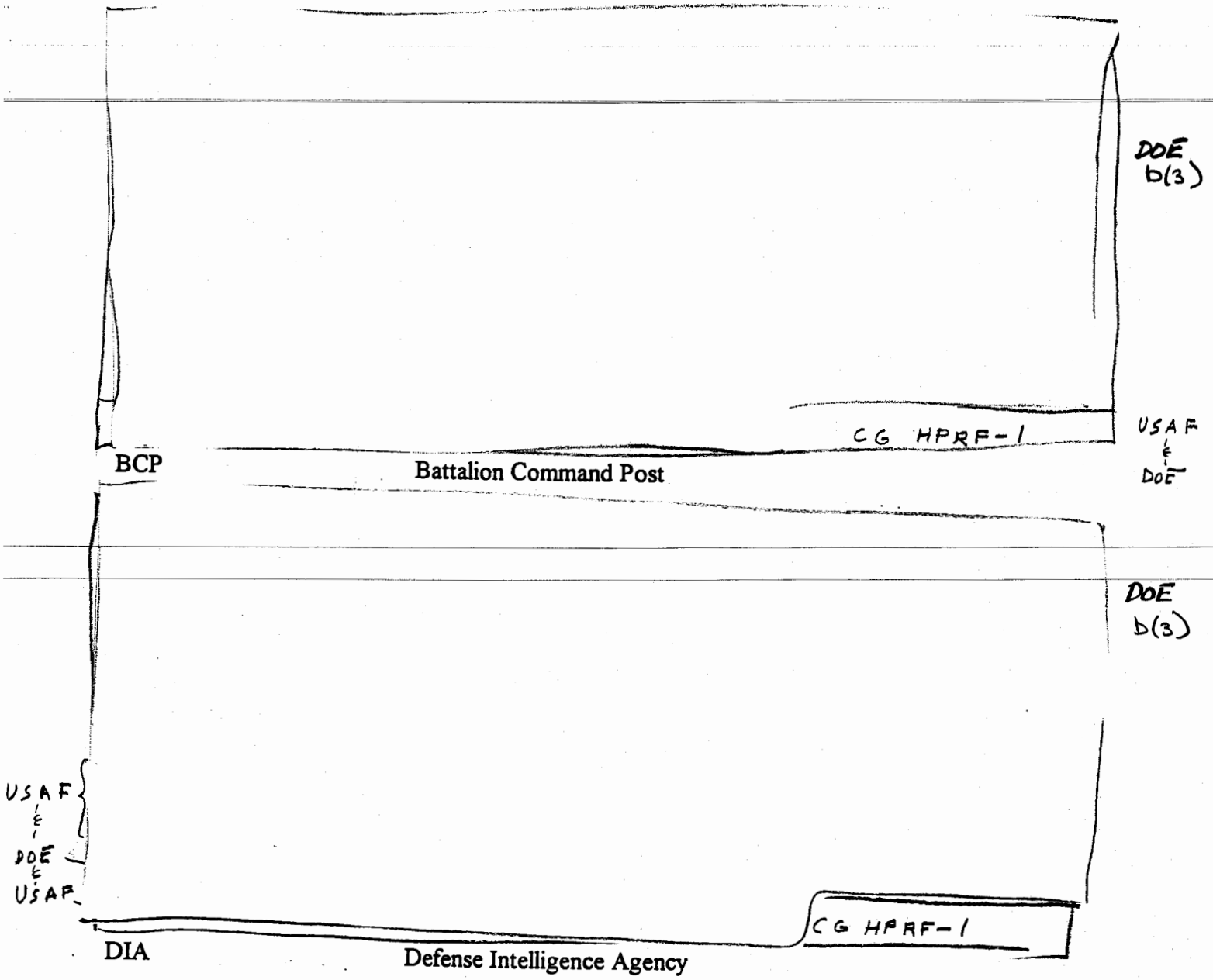
ACRONYMS



DIA	Defense Intelligence Agency
DMA	Defense Mapping Agency
DNA	Defense Nuclear Agency
DoD	Department of Defense
DOE	Deparment of Energy
DOE AL	Department of Energy, Albuquerque Operations Office
DOE HQ	Department of Energy, Headquarters

ACRONYMS (continued)

USAF

CG HPRF-1

DOE b(3)

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DOE b(3)

OO-ALC	Ogden Air Logistics Center
OSD	Office of the Secretary of Defense
OUPs	Manned Repeater Stations
PAL	Permissive Action Link
PBV	Post Boost Vehicle
PEIS	Programmatic Environmental Impact Statement
PIP	Program Implementation Panel
PL	Phillips Laboratory
PSS/E	Power System Simulator/Engineering
PTP	Probability to Penetrate

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CG HPRF-1

DOE b(3)

RCS	Radar Cross-Section
RF	Radio Frequency
RS	Reentry System
RV	Reentry Vehicle

ACRONYMS (concluded)

TTL	Transistor-Transistor Logic
USSTRATCOM	United States Strategic Command
VWG	Vulnerability Working Group
WDWG	Warhead Design Working Group
WES	Warhead Electrical System

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DOE & DTRA b(3) & USAF

CG HPRF-1

1.5 (U) STUDY ORGANIZATION

(U) An Executive Working Group (EWG) was formed to guide the HPRF Phase 2 Feasibility Study. The membership of the EWG was made up of the chair of each working group and/or a representative of each participating organization. The organizations involved with this study and which provided EWG members were:

Headquarters Defense Nuclear Agency (HQ DNA)
Field Command Defense Nuclear Agency (FCDNA)
Sandia National Laboratories New Mexico (SNL NM)
Sandia National Laboratories California (SNL CA)
Lawrence Livermore National Laboratory (LLNL)
Los Alamos National Laboratory (LANL)
Headquarters Air Force Space Command (HQ AFSPC)
Headquarters Air Combat Command (HQ ACC)
US Strategic Command (USSTRATCOM)
Phillips Laboratory (PL)
San Antonio Air Logistics Center, Nuclear Weapons Integration Division (SA-ALC/NWI)
Space & Missile Center, Det 10 (SMC, Det 10)
Ogden Air Logistics Center (OO-ALC)
Department of Energy, Headquarters (DOE HQ)
Department of Energy, Albuquerque Operations Office (DOE AL)
US Army Armament Research, Development & Engineering Center (ARDEC)

(U) The study group was organized into six working groups as follows:

USAF b(1)

[redacted]

DTRA b(1)

USAF b(1)

CG HPRF-1

1.6 (U) CLASSIFICATION AND SECURITY

(C-FRD) The classification levels involved in the HPRF Phase 2 Feasibility Study cover a wide range. The classification guides for this study are listed on the inside of the front cover of this report.

DOE & USAF b(3)

DTRA b(2)

A draft HPRF Security Classification Guide was prepared to address those areas not clearly defined in the referenced classification guides and is included in Appendix C.

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2.0 (U) WARHEAD CANDIDATE DESIGNS

2.1 (U) INTRODUCTION

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USAF
b(3)

CG HPRF-1

CG HPRF-1

DOE & DTRA & USAF b(3)

USAF

A brief list of salient features of these HPRF candidates are listed in Table 2-1. Additional weapon design details can be found in Section 4.3 and References 11 and 12.

DOE & DTRA & USAF b(3)

DOE b(3)

DOE & DTRA & USAF b(3)

CG HPRF-1

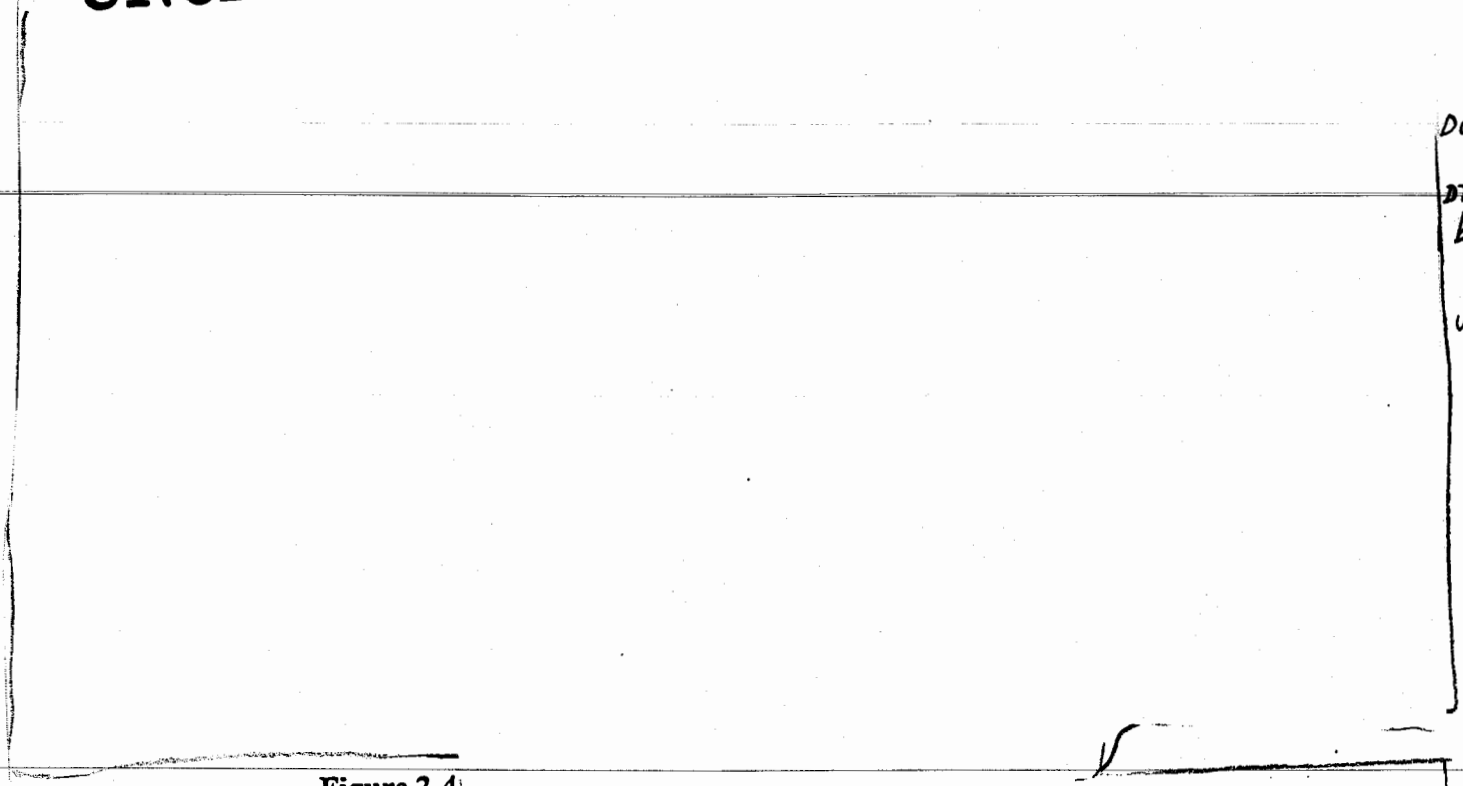
DOE & DTRA & USAF b(3)

CG HPRF-1

(S-RD) Anticipating the less than optimal performance of warhead candidates packaged in the constrained geometry of the Mk12A/Mk21, the New Mexico team choose to pursue a less constrained design option, the NM-3 candidate. The imposed design constraints were to fit within the shroud of the MM III and to be at or below the payload mass capable of being carried by the missile and delivered to target.

DOE & DTRA USAF b(3)

CG HPRF-1



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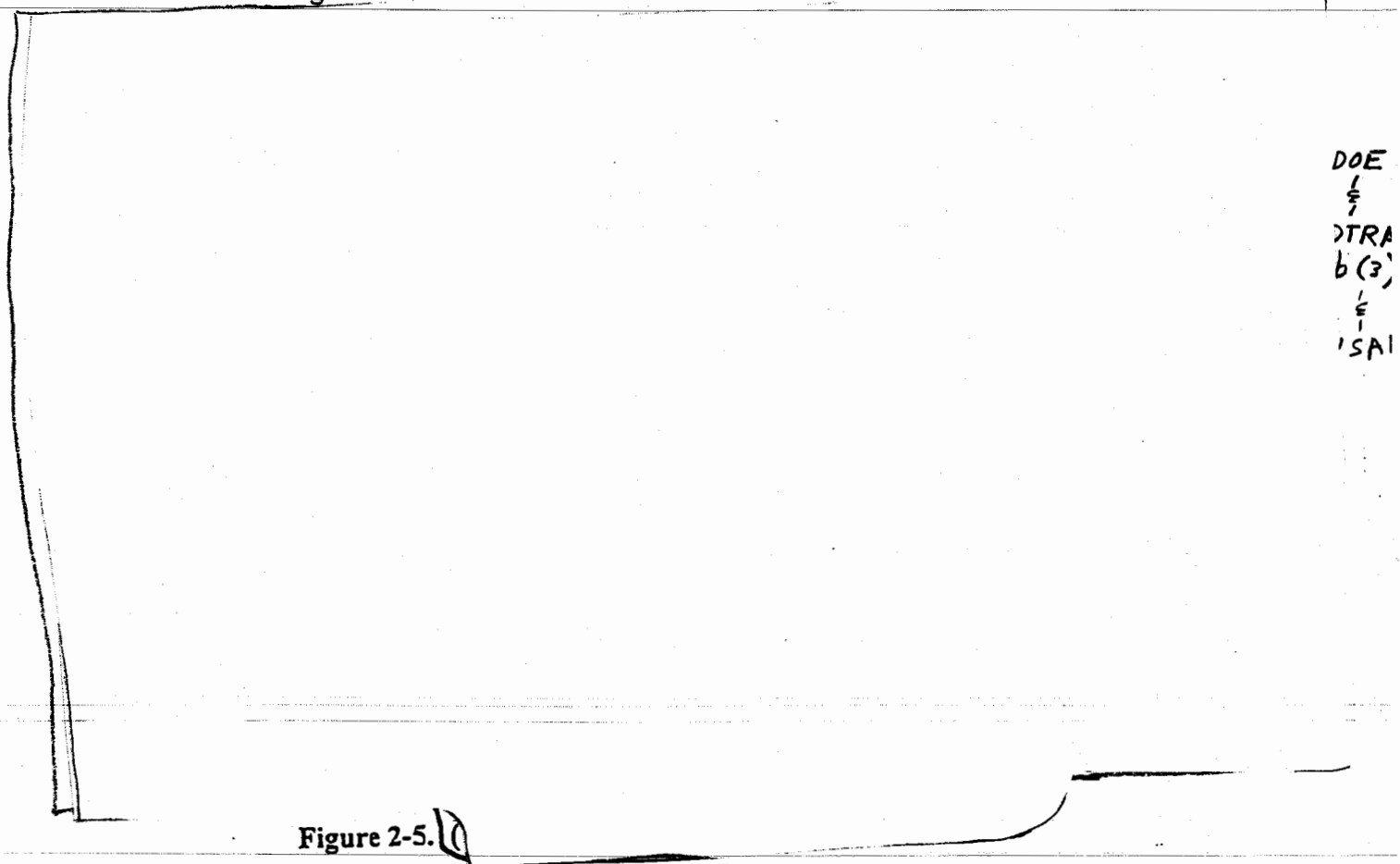

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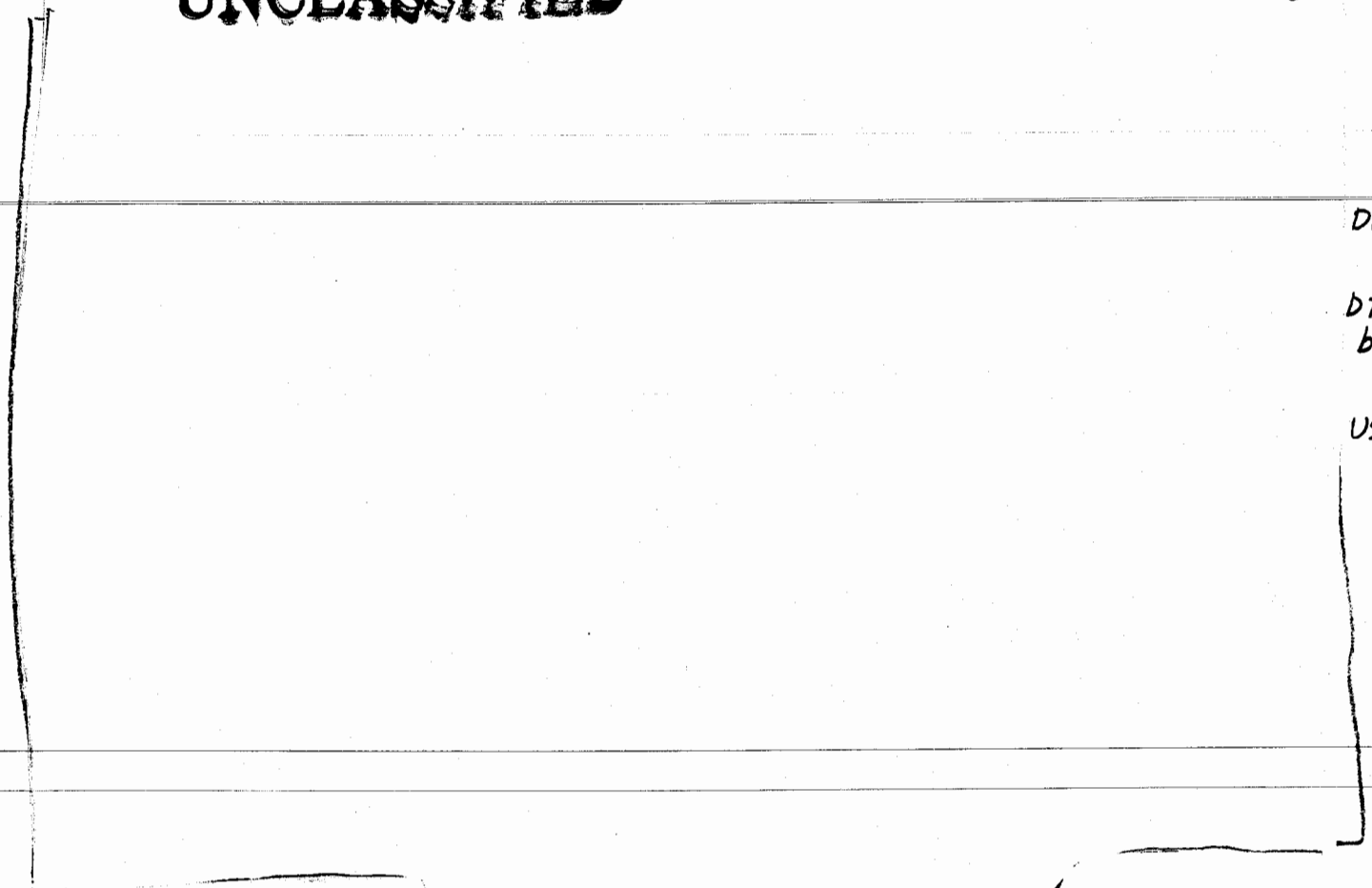

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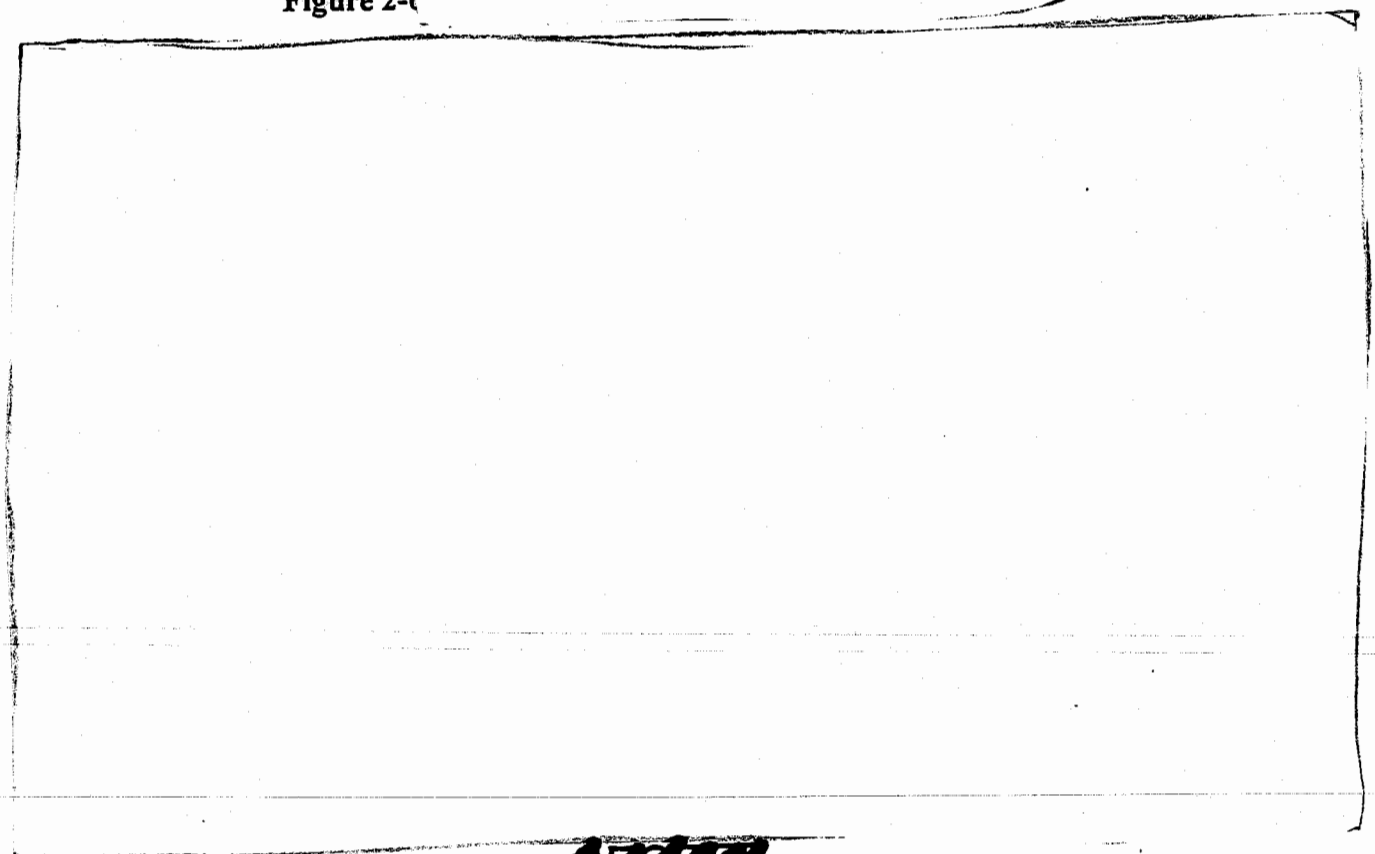
USAF

Figure 2-



DOE
&
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b(3)
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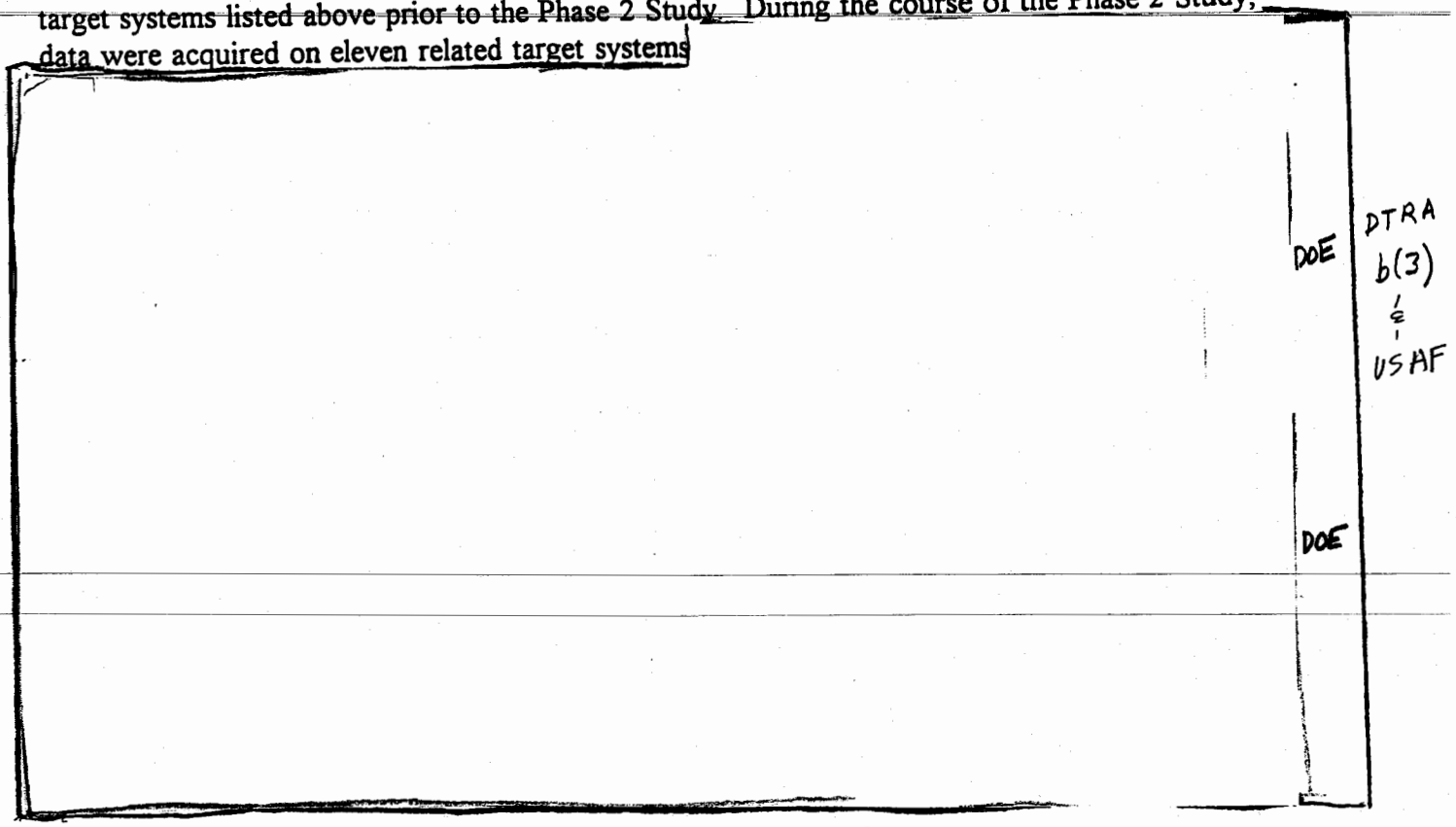
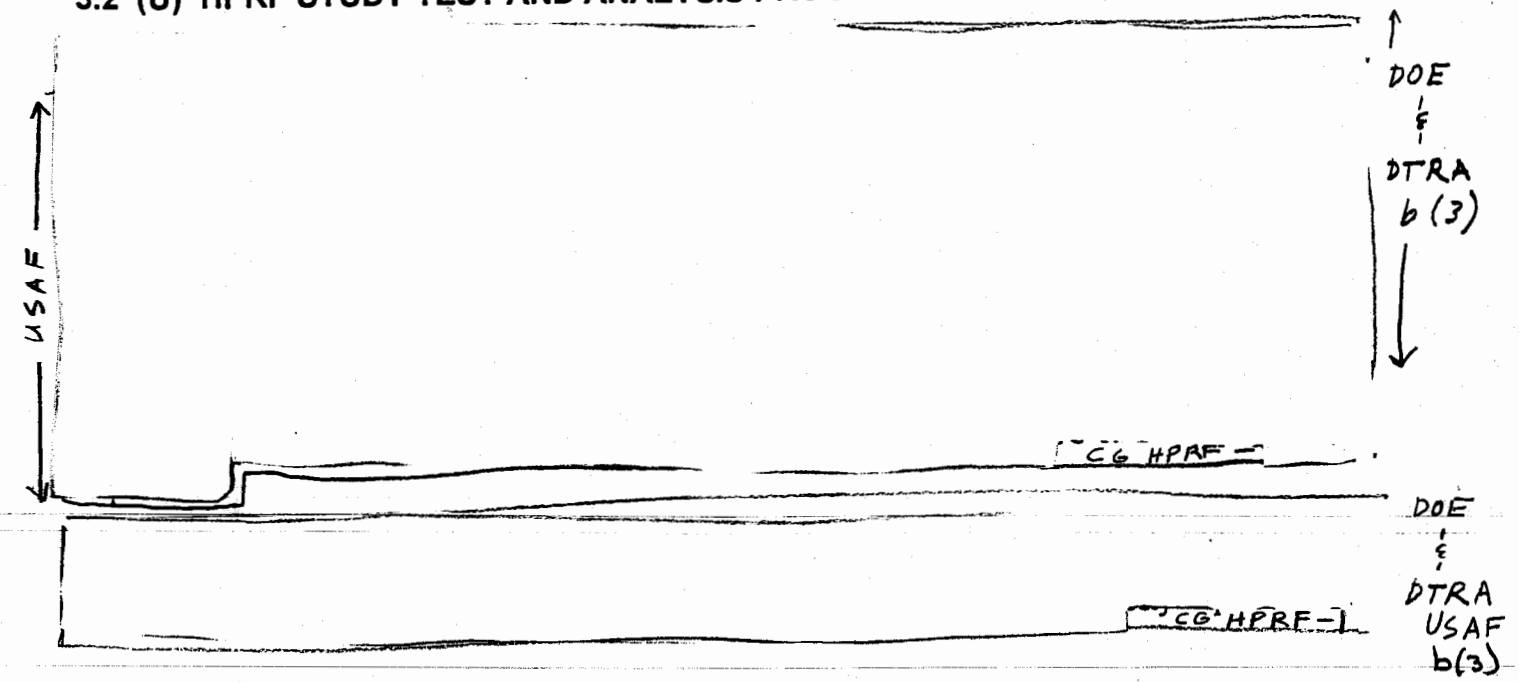
USAF

(S) Each of these missions and the associated target systems for each will be discussed in more detail later in this section. The community had essentially no vulnerability data on any of the target systems listed above prior to the Phase 2 Study. During the course of the Phase 2 Study, data were acquired on eleven related target systems



3.2 (U) HPRF STUDY TEST AND ANALYSIS PROGRAM



DOE & DTRA b(1), b(3)

USAF

USAF

DOE & DTRA b(1), b(3)

CG HPRF-1

(C-FRD) The results of the tests are difficult to capture in a concise manner because of the complexities associated with the tests.

DOE & DTRA b(1), b(3) USAF

DOE & DTRA b(3) & USAF

CG HPRF-

3.2.1 (U) Test Results

DOE & DTRA b(3)

USAF

CG HPRF-1

DOE & DTRA b(3)

The following paragraphs summarize the cases of mission critical failures.

DOE & DTRA b(3). USAF

CG HPRF-1

DOE &
DTRA, b(3) &
b(1), USAF

[redacted]

UNCLASSIFIED

UNCLASSIFIED

C6 HPRF-1

[redacted]

[redacted]

DTRA b(1)

DOE

USAF

DOE & DTRA b(3)

CG HPRF-1

(U) Other general results that were noted are included below.

[redacted]

DOE & DTRA & USAF b(3)

CG HPRF-1

[redacted]

[redacted]

DOE & DTRA b(1) & USAF

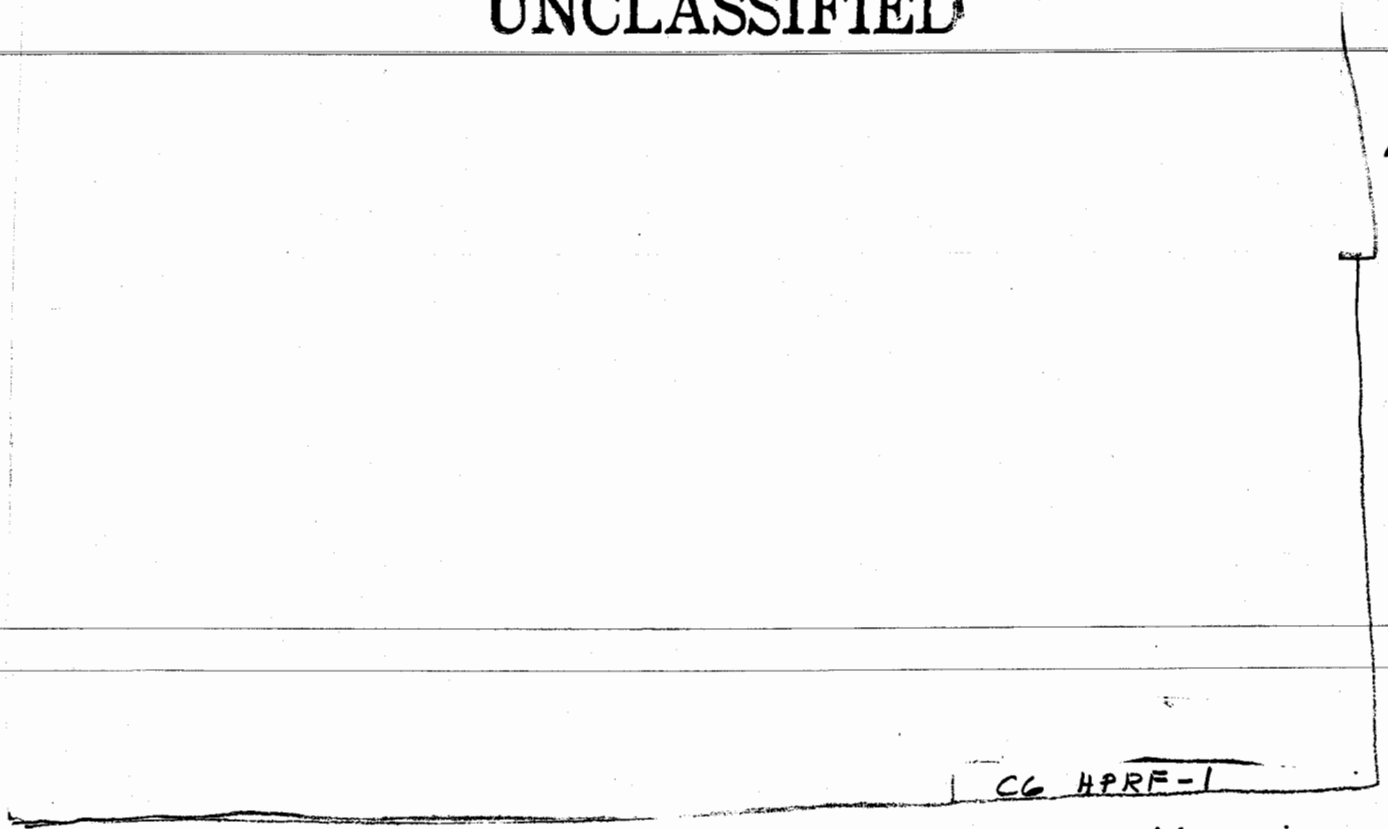
UNCLASSIFIED

UNCLASSIFIED

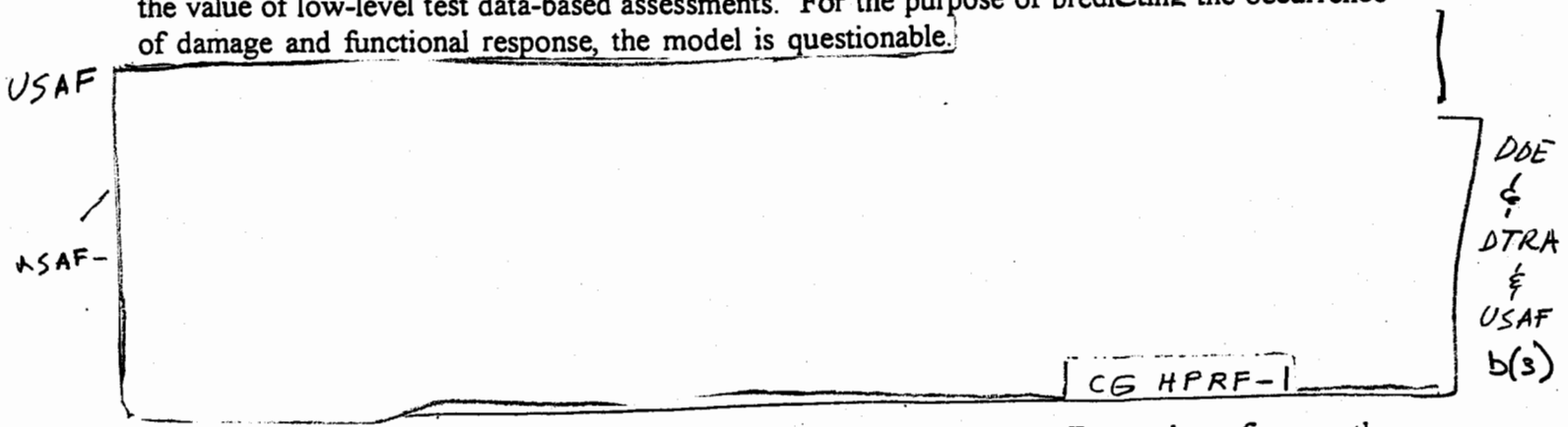
[redacted]

Figure 3-1.

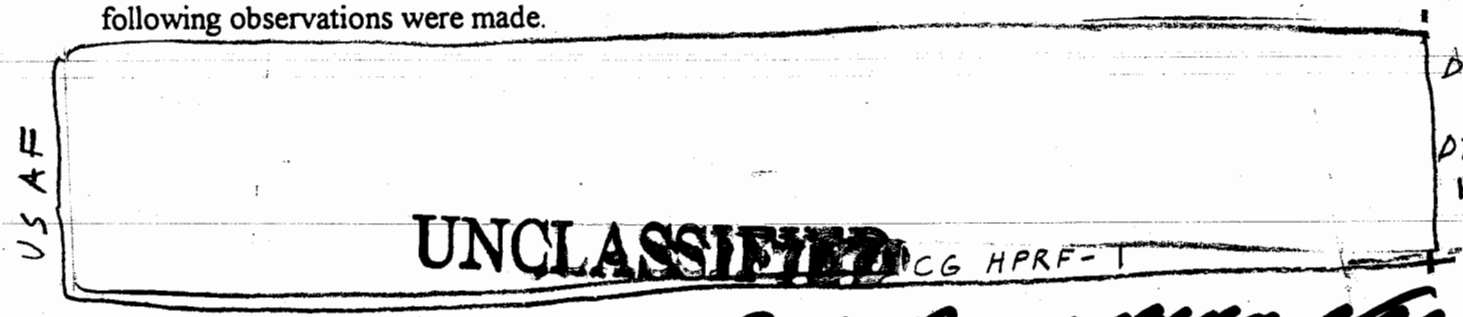
[redacted]



(U) Given the limitations of the analysis model based on low-level test data, one might question the value of low-level test data-based assessments. For the purpose of predicting the occurrence of damage and functional response, the model is questionable.



(U) The computed stresses are shown in Figure 3-2 through 3-4. From these figures, the following observations were made.



[redacted]

Table 3-5.

UNCLASSIFIED

DOE & DTRA b(1) b(3)

b(1) USAF

UNCLASSIFIED

CG HPRF-1

DOE & DTRA

[redacted]

DOE &
DTRA b (1)
& USAF
b(3)

[redacted]

[redacted]

UNCLASSIFIED

UNCLASSIFIED

CG HPRF-1

[redacted]

[redacted]

b(3) DOE +
DTRA
b (1) & 1
USAF

UNCLASSIFIED

UNCLASSIFIED

CG HPRF-1

[redacted]

DOE §
b(3) DTRA §
b(1) USAF

[redacted]

UNCLASSIFIED

UNCLASSIFIED

CG HPRF-1

[redacted]

[redacted]

3.3 (U) FOREIGN ASSET ASSESSMENT TEAM (FAAT) ANALYSIS

(U) The analytical assessments of systems and system elements described in the previous sections were generally based on a methodology developed by FAAT[23]. The FAAT was composed of members from government and industry. The FAAT charter was to perform effects assessments of foreign assets by working with the intelligence community. The FAAT was requested to support the HPRF during the early scoping study by identifying targets of interest and performing an assessment of these targets. The user and intelligence community assisted by providing target scenarios for four missions and the following target descriptions.

- (U) Target employment.
- (U) Operational features.
- (U) Countermeasures and effectiveness.
- (U) Mission critical electronic subsystems.
- (U) Genealogy/surrogating.
- (U) Target ranking.
- (U) Target construction features and electronics vintage.

DOE & DTRA b(1) & USAF

[redacted] CG HPRF-1 . The methodology was largely "paper-based", but relevant experimental data was applied when available. Probabilistic tools are applied to obtain the probability-of-effect (P_E). The FAAT analyst introduced random, systematic and judgmental uncertainties to the assessment process in arriving at the system P_E. The FAAT results may be useful for the following reasons.

- (U) Identifying applications that show promise.
- (U) Performing intra- and inter-group ranking.
- (U) Identifying blue and red surrogates for possible exploitation.
- (U) Identifying useful avenues for source development.
- (U) Identifying platform mission needs.

(U) The FAAT convened several times during the study and performed their zero-order assessments. Originally the HPRF Phase 2 was organized to test specific systems that were part of the four missions selected, however, most of the required systems were not available and other substitute systems were tested to obtain data for updating the FAAT models.

USAF b(1) DOE b(3)

[redacted] CG HPRF-1

(U) The major program findings and recommendations are as follows.

DOE & DTRA b(1) & USAF

[redacted] CG HPRF-1

[redacted]

CG HPRF-1

(U) [redacted]

CG HPRF-1

(U) Values of P_E obtained from an analysis and/or low-level testing should be recognized as unreliable for real-world predictions. Not only are analysis and low-level test-based predictions unreliable, but the uncertainties associated with these predictions are often too large to be useful in narrowing possible engagement outcomes. Nevertheless, analysis/low-level test-based predictions may prove useful as inputs to parametric engagement analyses (e.g., sensitivity studies). In addition, low level tests improve our knowledge of linear stresses that may be expected at critical locations inside the system.

[redacted]

[redacted]

DOE & DTRA & USAF b(3)

CG HPRF-1

3.5 (U) MISSION ANALYSIS

3.5.1 (U)

[redacted]

DTRA b(1)

USAF

CG HPRF-1

3.5.1.1 (U) Simulation Model Description.

[redacted]

DOE & DTRA b(1), b(3)

USAF

CG HPRF-1

[redacted]

OE
>(3)

USAF

CG HPRF-1

not deviate from the planned routes and did not react to any actions by defensive forces. No jamming or other counter-measures were employed.

DOE
(E)
DTRA
b(1)
&
USAF

Cc HPRF-1

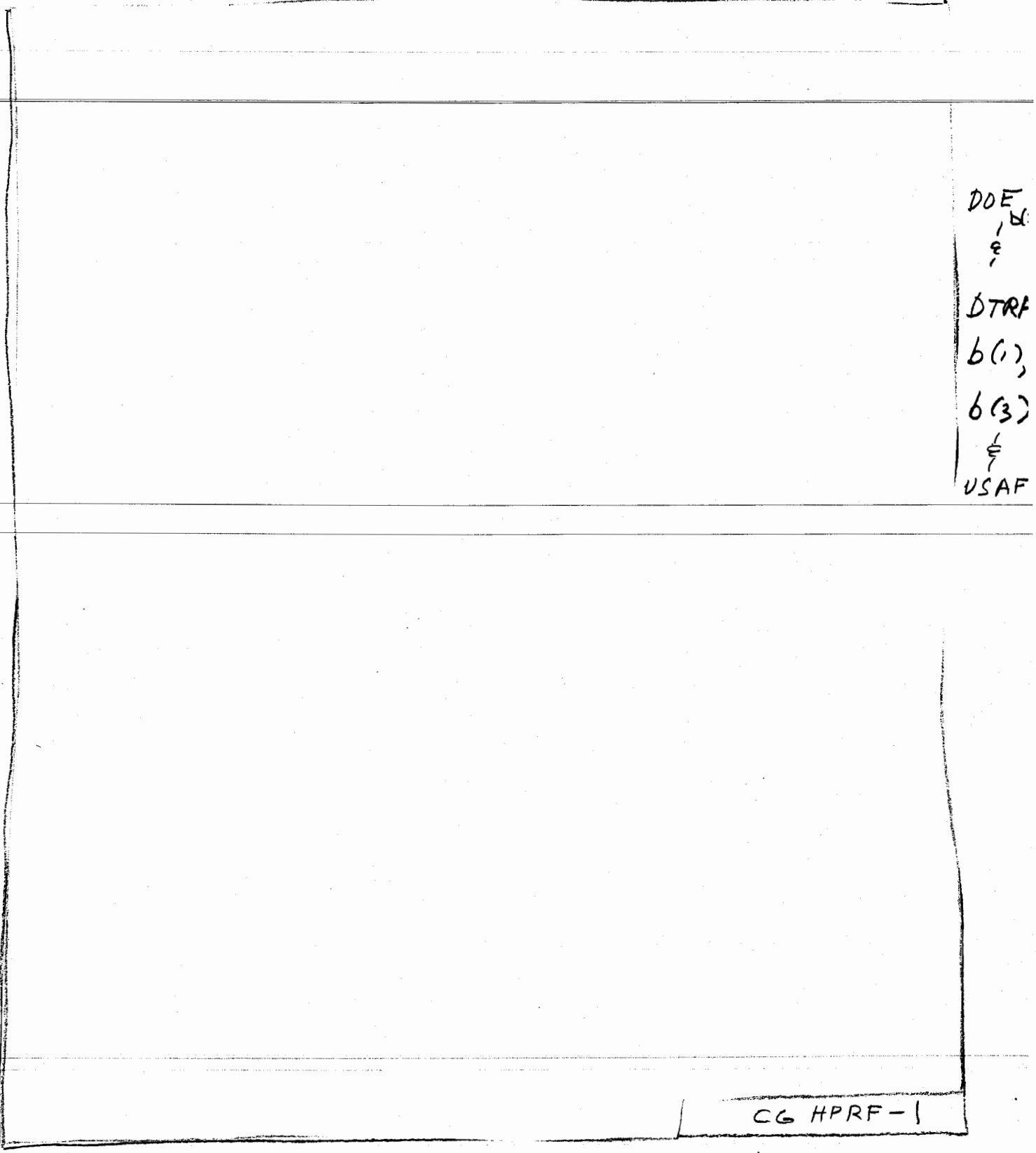
CG HPRF-I

DOE
§ b(3)
DTRA
b(1) §
USAF

3.5.1.3 (U) Baseline and Parametric Results.

DOE
§ b(3)
DTRA
b(1)
§
USAF

CG HPRF-II


DOE
DTRA
b(1),
b(3)
USAF
CG HPRF-1

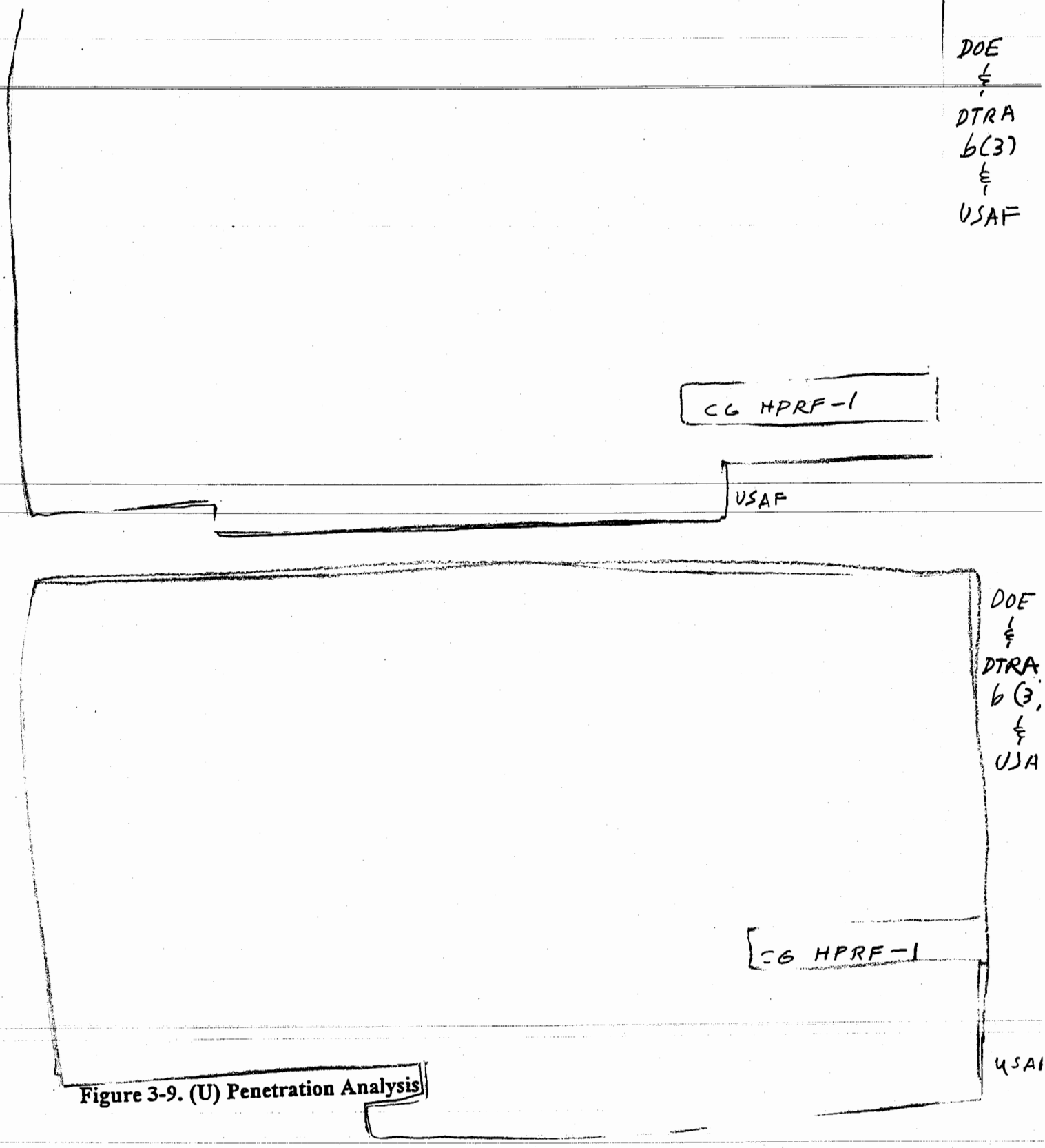


Figure 3-9. (U) Penetration Analysis

[redacted]

DOE & DTRA b(3) b(1) & USAF

CG HPRF-1

3.5.2.1 (U) Mission/Target Description.

[redacted]

DOE b(1) & DTRA b(1) & USAF

DOE b(3)
DTRA
b(1)
USAF

CG HPRF-1

[redacted]

DOE & DTRA b(1), b(3) & USAF

CG HPRF-1

3.5.2.2 (U) Approach

[redacted]

CG HPRE-1

DOE & DTRA b(1), b(3) & USAF

Figure 3-11 illustrates the assessment methodology. The following paragraphs briefly summarize the key elements.

[redacted]

DOE & DTRA b(1), b(3) & USAF

CG HPRF-1

[redacted]

[redacted]

DOE b(3) & DTRA b(1) & USAF

CG HPRF-1

3.5.2.3 (U) Results.

[redacted]

DOE b(3) & DTRA b(1) & USAF

CG HPRF-1

Unfortunately, there are so many variables and unknowns that formulation of such an MOE does not appear possible at this time.

[redacted]

CG HPRF-1

DOE (b3)
DTRA
b(3)
USAF

3.5.2.4. (U) Conclusions.

[redacted]

CG HPRF-1

DOE
DTRA
b(3)
USAF

[redacted]

[redacted]

DOE & DTRA b(3) & USAF

CG HPRF-I

3.5.3 (U) [redacted] CG HPRF-I USAF

3.5.3.1 (U) Introduction.

DOE & DTRA b(3) & USAF

3.5.3.2 [redacted]

DOE & DTRA b(3)

DOE & DTRA b(3)

USAF

DOE & DTRA b(3)

CG HPRF-I

[redacted]

DOE & DoD
DTRA 6(1) &
USAF

CG HPRF-1

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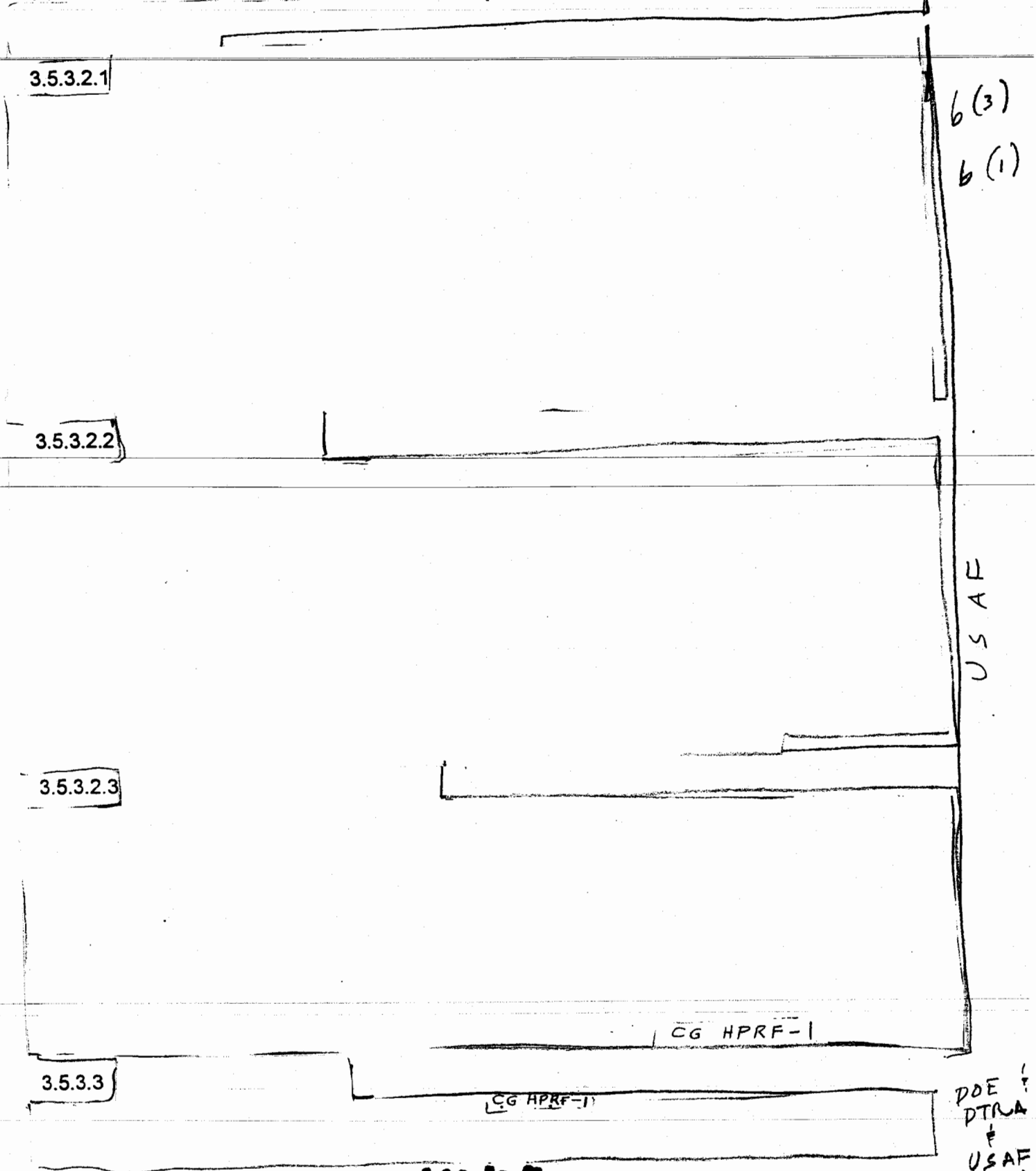
DOE & DTRA

(S) Figure 3-15 illustrates how these elements are interconnected.



[redacted]

DOE
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DTRA
b(1)
b(3)
&
USAF

CG HPRF-1

Figure 3-15.

DOE b(3) & DTRA b(1) & USAF

CG HPRF-1

3.5.3.3.3 (U) Analysis.

DOE b(3) & DTRA b(1) & USAF

CG HPRF-1

The vulnerability inputs are

DOE b(3) [redacted] TRA b(1) & USAF

discussed later.

CG HPRF-1

[redacted]

DOE
&
DTRA
6 (3)
&
USAF

6 (3)

CG HPRF-1

 [redacted]

DOE b(3)
&
DTRA
b(1)
&
USAF

DOE
&
DTRA
b(3)
b(1)
&
USAF

CG HPRF-1

USAF

DOE
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DTRA
b(3),
b(1)
&
USAF

CG HPRF-1

DOE b(3)
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DTRA
b(1)
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USAF

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DOE b(3)
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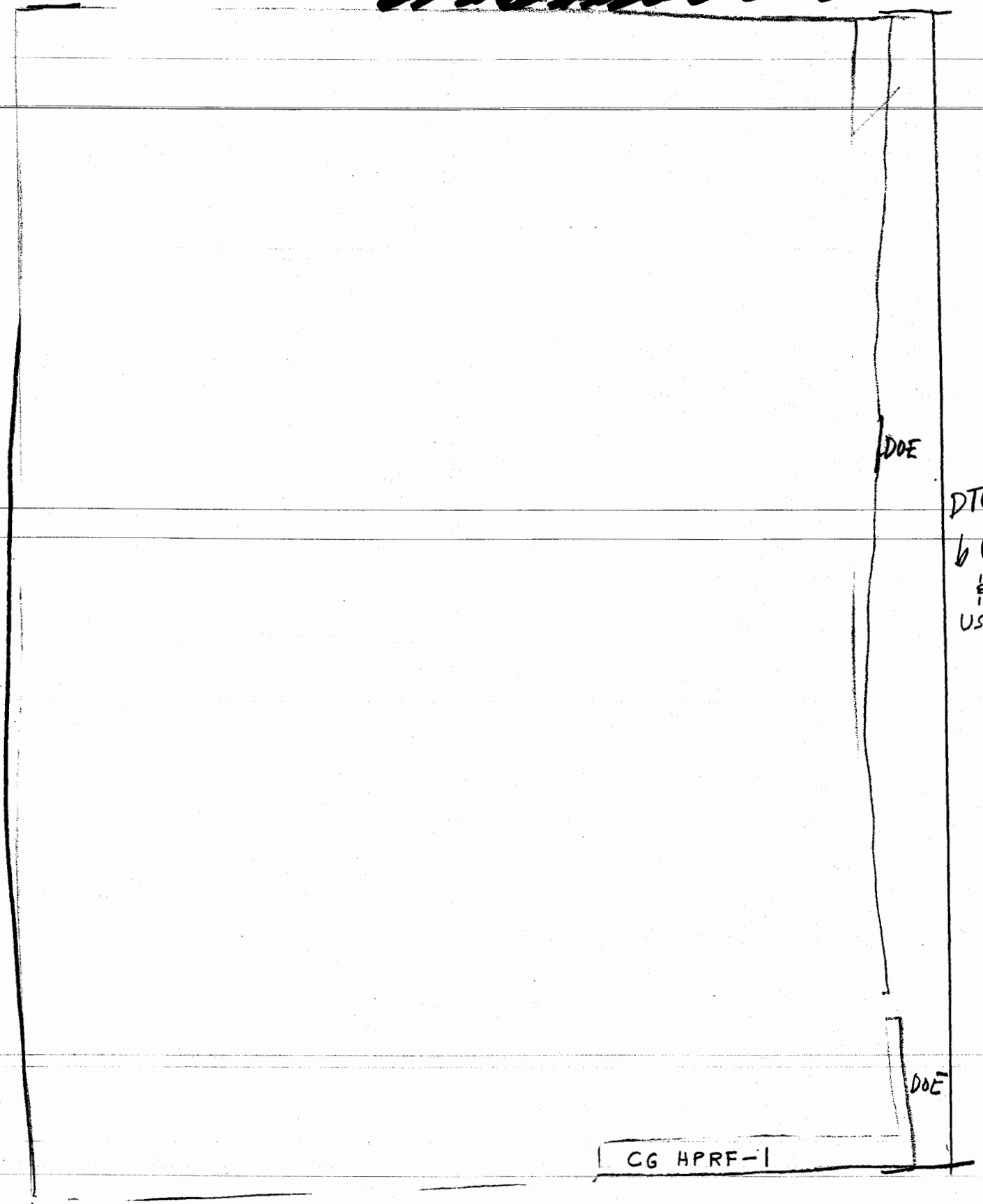
DTRA
b(1)
&
USAF

USAF

CG HPRF-1

[redacted]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3.5.4.2.3

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b(3)
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CG HPRF-1

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DOE & DTRA b(3) & USAF

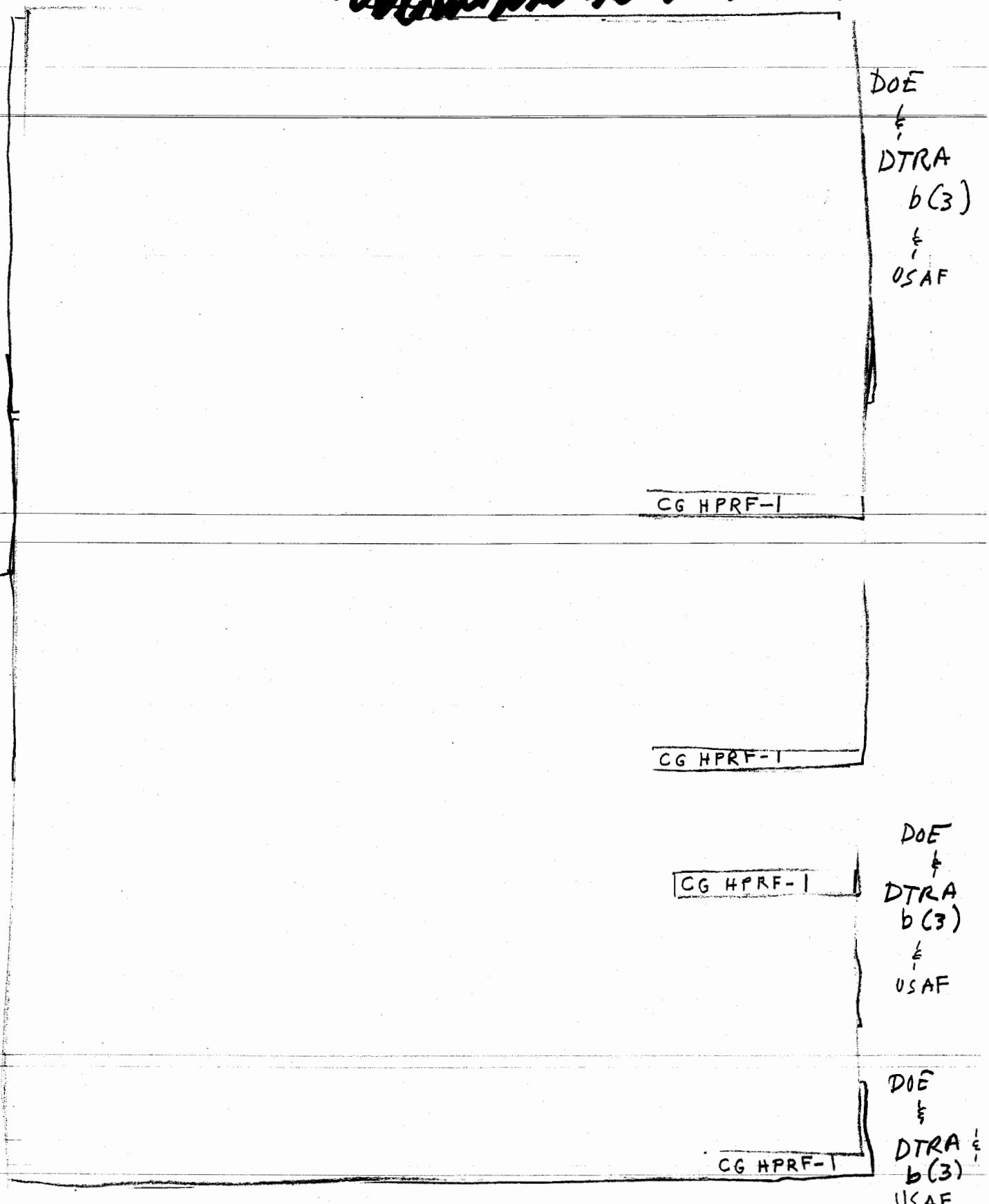
CG HPRF-1

USAF

DOE & DTRA b(3) & USAF

CG HPRF-1

[redacted]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b(3)
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DOE
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DTRA
b(3)
&
USAF

[redacted]

DOE & DTRA b(3) & USAF

[redacted]

CG HPRF-1

3.6 (U) VULNERABILITY AND MISSION ANALYSIS CONCLUSIONS AND RECOMMENDATIONS

3.6.1 (U) Conclusions

[redacted]

DOE & DTRA b(3) & USAF

[redacted]

CG HPRF-1

USAF

DOE b(3) & DTRA b(1)

[redacted] Analysis combined with direct injection experiments is preferred since high fidelity simulation is not possible.

[redacted]

CG HPRF-1

High confidence results depend on high level testing of actual systems. Systems directly relevant to the missions considered were not available during the Phase 2 Study.

[redacted]

CG HPRF-1

3.6.2 (U) Recommendations

[redacted]

CG HPRF-1

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4.0 (U) SYSTEMS ENGINEERING

4.1 (U) INTRODUCTION

(S-RD) The Systems Engineering Working Group (SEWG) was organized to assess the issues associated with integrating the HPRF warhead into the MM III missile system. USAF, DOE & DTRA b(3)

[redacted] CG HPRF-1 (d.a) USAF

(U) Some of these designs only suggest the possible and are not optimized nor exhaustive. Features to be highlighted in one concept, might work equally well in other designs, but are shown only once for brevity. The final point designs will likely extract features from several different concepts.

4.1.1 (U) Technical Objectives

(S-FRD) The technical objectives of the SEWG were to document the information in a fashion that would provide a substantial starting point to subsequently develop this concept further. DTRA b(1)

[redacted] The engineering effort developed implementation strategies for several different options but did not rank order the design options or down-select the candidates. Selecting the final candidates will be done when the MCs are finalized and a warhead is chosen. The SEWG was responsible for concept design of the warhead exclusive of the nuclear explosive package (NEP).

4.1.2 (U) Methodology

DOE b(& DTRA b(1) USAF

[redacted] The Air Force is planning several changes for the MM III missile system: (1) "de-MIRVing" the missile, (2) replacing the guidance computer and (3) replacing some of the Mk12A/W78s with the Mk21/W87 warhead. The "de-MIRVing" and warhead replacement are dependent on ratification of START II. The guidance computer replacement is currently underway.

(S-FRD) The SEWG was divided into two design teams. The New Mexico team (Los Alamos National Laboratory (LANL) and Sandia National Laboratories New Mexico (SNL NM)) engineered the LANL warhead proposals, concentrating on their use in the Mk12A aeroshell and the California team (Lawrence Livermore National Laboratory (LLNL) and Sandia National Laboratories California (SNL CA)) investigated the integration issues associated with placing the LLNL warhead candidates into Mk21 aeroshells. Insight gained by one team was useful to both

teams. The result is a data base that would permit engineering any candidate into either aeroshell. The New Mexico team also proposed a larger device which was not constrained by the Mk12A or Mk21. The New Mexico team designed a fixture for mounting the larger device directly on the MM III bus and provided its own aeroshell.

4.1.3 (U) Assumptions

(S-FRD) There were three major assumptions applied during the SEWG assessment.

DOE & DTRA b(3) & USAF

CG HPRF-1

(S-FRD) The secon assumption, which applied to most of the candidate options, was that the HPRF warhead wou be compatible with the Mk12A or Mk21 RV. This was partially driven by Air Force Operation ecurity particularly during START inspections.

DTRA b(1) & USAF

CG HPRF-1

(U) The third assumption was that the MM III Single Reentry Vehicle (SRV) and Guidance Replacement Program (GRP) would be completed. Completing the GRP is critical because warhead safety intent signals, use control features, and the Mk21 interface depend on the new guidance computer.

USAF, DOE & DTRA b(3)

CG HPRF-1

4.1.4 (U) Constraints

DOE & DTRA b(3) USAF

Compatibility further requires that the electrical and mechanical interface of the existing RVs be maintained.

DOE & DTRA b(3) USAF

CG HPRF-1

(C) The third constraint involved incorporating use control features into the HPRF warhead. The DoD issued a new use control directive, i.e., DoD Directive S-3150.7, towards the end of the

Table 4-1. (U) Summary of Candidates Attributes.

SECRET-RESTRICTED DATA

UNCLASSIFIED

[redacted]

UNCLASSIFIED

[redacted]

CG HPRF-1 (d, g, b)

SECRET-RESTRICTED DATA

DOE
E
DTRA
b(3)
USAF

DOE
&
DTRA
b(3)
& USAF

Table 4-1. (U) Summary of Candidates Attributes (con't).

[redacted]

USAF, DOE & DTRA

CG HPRF-1 (d.a,b)

b(3)

CG HPRF-1 (d.a,b)

(S-RD) The NM-1 and NM-1A designs match the stockpile weights and center of gravity (CG) more closely than the other concepts. As a result, a flight testing/qualification program may be avoided or at least minimized.

CG HPRF-1 (d.a, b)

DOE & DTRA b(3) USAF

CG HPRF-1 (d.a, b)

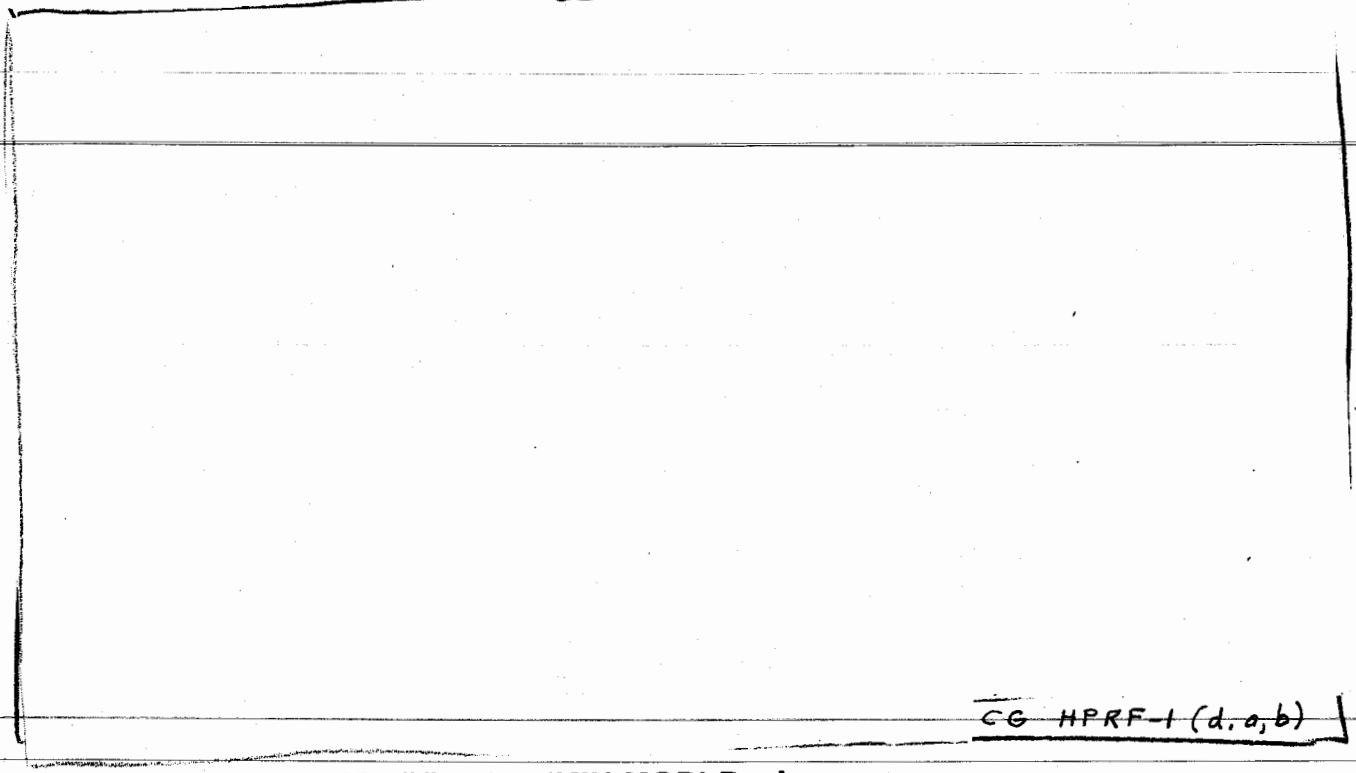
(S-RD) A basic design goal was a vehicle that was indistinguishable from the Mk12A/Mk21 RV when hidden beneath an opaque cover.

DOE & DTRA b(3) USAF

CG HPRF-1

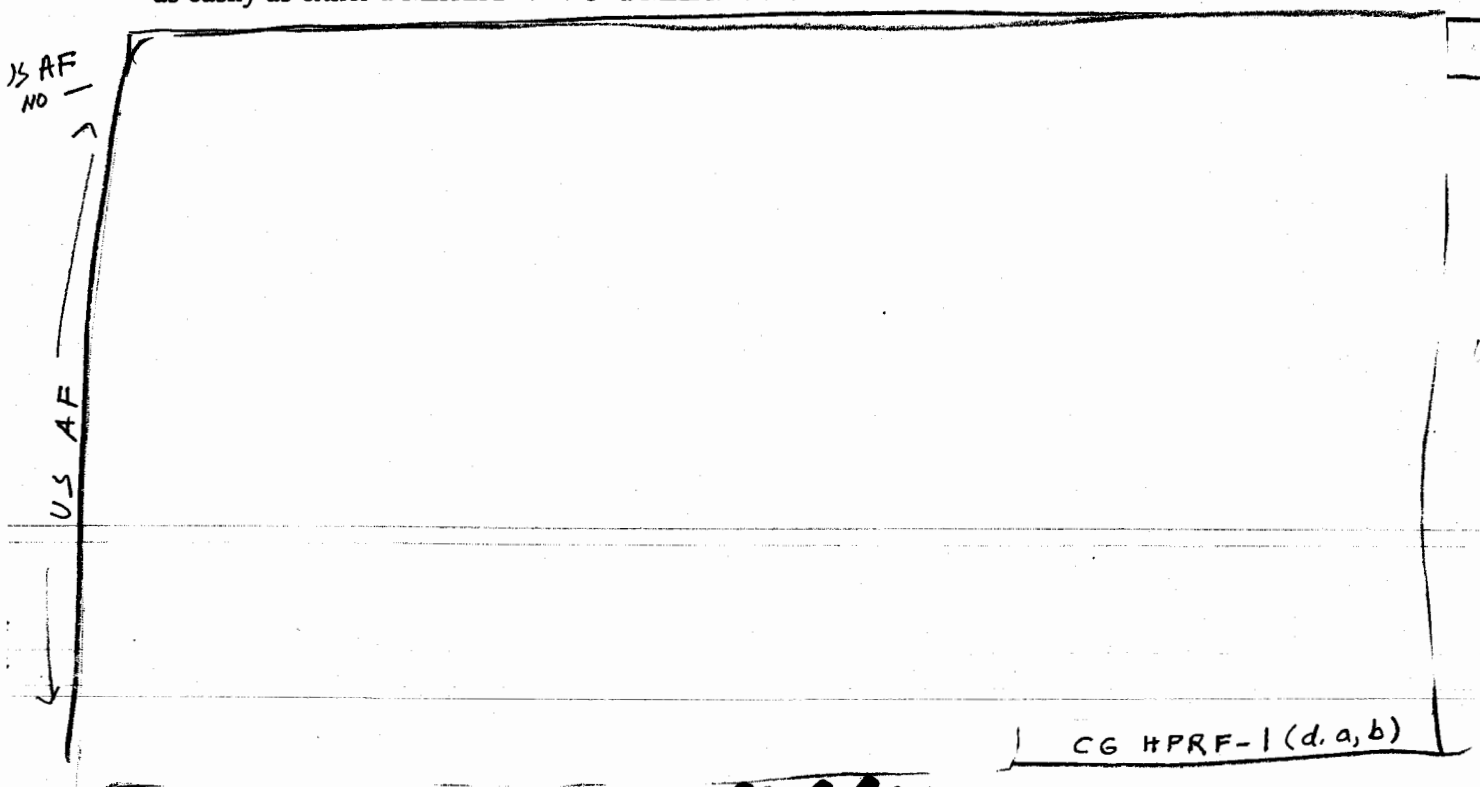
CG HPRF-1

[redacted]



4.3.3 (U) Minimum-Modification (MIN-MOD) Designs

(U) The purpose of these MIN-MOD designs is to present warhead options that minimize the cost to the Air Force. The goal was to maintain the current warhead-to-missile interface and to eliminate the need for flight testing. Simply stated, a MM III could launch a MIN-MOD candidate as easily as either a Mk12A/W78 or a Mk21/W87.



[redacted]

CG HPRF-1

DOE & DTRA b(3) USAF

The final payload specifica were based on a trade study of payload weight to range (Figure 4-1). The selected values w onsistent with the mission maximum range requirements.

CG HPRF- 1, a, b)

DOE & DTRA b(3) USAF

The warhead mounts directly on top of the support structure. The RS module support platform has been modified in the past to hold different configurations of weapons. Modification of the platform for this new weapon will also be required.

DOE & DTRA b(3) USAF

CG HPRF-1 (1, a, b)

The ascent shroud does not add significant weight to the system.

4.3.5 (U) Navy Packaging Excursions

DOE & DTRA b(3) USAF

CG HPRF-1

4.4 (U) SPECIFIC DESIGN INTEGRATION ISSUES

CG HPRF-1

DOE & DTRA b(3) & USAF

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203.5
CG HPRF-1 (d.g)

DOE b(1) & DTRA b(1) & USAF

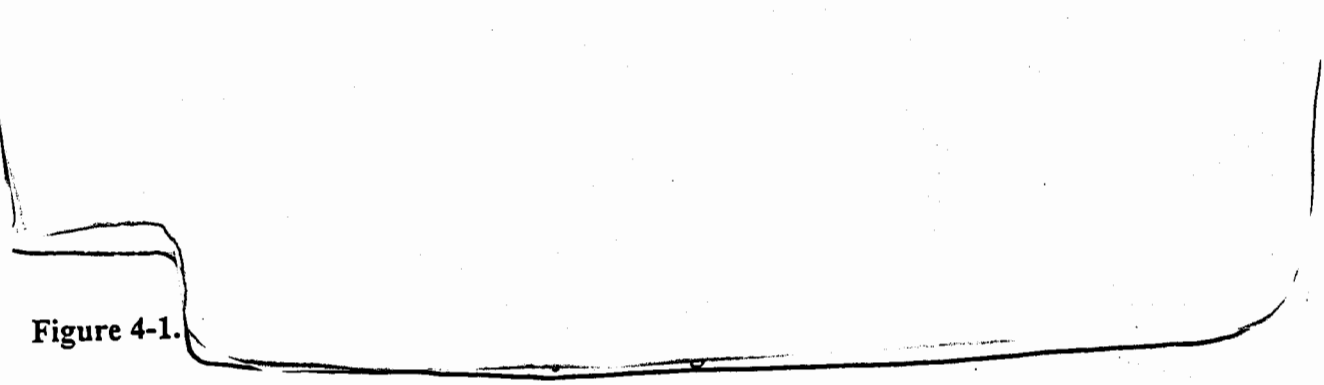

Figure 4-1.

4.4.2 (U) Use Control

(U) Use control themes have been developed using both current and developing technologies (See Table 4-2). The themes allow weapon use only when authorized by the National Command Authority (NCA) and prevent or delay unauthorized use. Absolute denial of the use of the weapon or the Special Nuclear Material (SNM) it contains, to a determined adversary, is not feasible with the condition that the penalties invoked will not harm personnel in the vicinity. This limitation leads the use control designs to focus on providing a time delay to allow security forces to recover possession of the weapon before it can be used in either the intended mode or an unintended mode.

(U) The hardware proposed to implement the use control theme ranges from stockpile examples to R&D technologies. It ranges from no PAL to CAT-D PAL to CAT-F PAL, and also includes CD and CAT-E PAL in appropriate assembly configurations.

(S-FRD) The baseline WES for the New Mexico designs uses a conservative approach. The volume for the WES components is adequate so that space and form factor requirements do not stress component design. The designs feature simple interconnections and stockpile hardware where possible.

USAF b(1)

The proposed system designs allow all of the nuclear safety and use control hardware to be built directly into the package as opposed to an add-on to a current WES. The New Mexico baseline WES design features a Dual Stronglink Assembly (DSA). The DSA concept was designed and developed in the late 1980s to implement and optimize modern concepts of safety and control.

DOE & DTRA b(3) USAF

Implementation could be done either by keeping the designs separate as partitions of an overall single assembly, or by having a completely integrated design.

Table 4-3. (U) New Mexico WES Options

USAF b(1)

FOR OFFICIAL USE

Safety Theme		Feature	Trajectory sensor
A		CDU+DSA	SESD
B		CDU+SSA+DSSL	SESD
C		DOI	SESD
D		MC 2969 SLS	MC 3160 ESD

FOR OFFICIAL USE ONLY

(U) The California designs all use the W87 WES modified to accommodate use control features, if desired, and a programmer to interface with the new functions.

DOE & DTRA b(3)

4.4.4 (U) Flight Performance

DOE & DTRA b(3) & USAF

CG HPRF-1

[redacted]

DOE & DTRA b(3) & USAF

UNCLASSIFIED

UNCLASSIFIED

CG HPRF-1

[redacted]

DOE & DTRA b(3) & USAF

CG HPRF-1

Finally, the reader should be reminded that not every variant satisfied every mission/warhead option.

(U) It is recommended for any future work on new, silo-based warheads, that a mutually agreed upon definition of "CAT-F PAL comparable protection" consistent with Reference 31 be determined at the onset of the study.

5.0 (U) NUCLEAR SURETY

5.1 (U) INTRODUCTION

(U) Nuclear surety normally encompasses three subjects: (1) nuclear safety, (2) use control, and (3) physical security. Nuclear safety deals with nuclear detonation safety and radiological material dispersal, principally plutonium. It involves design concepts and methodologies for the prevention of unintended nuclear detonation of, or the dispersal of radiological material from, nuclear weapons. Use control involves concepts and features designed to prevent unauthorized use while allowing authorized use when directed by the National Command Authority (NCA).

(S-RD) The Surety Working Group (SWG) defined four areas of surety for evaluation: (1) nuclear detonation safety, (2) operational safety, (3) nuclear material dispersal (plutonium and tritium), and (4) use control. The SWG addressed nuclear safety and use control for all of the proposed warhead design concepts but did not address physical security. This is the first time that use control has been addressed in a Phase 2 Study for a silo-based strategic system.

DOE & DTRA b(3) & USAF

[redacted] CG HPRF-1 (d.a)

(U) The evaluation approach was to employ Quality Function Deployment (QFD) methodology to the warhead candidate designs as provided by the Systems Engineering Working Group (SEWG). The QFD methodology is a structured process which involves the assessment and rating of alternate designs and processes from conceptual design to production. For a Phase 2 Study, only the parts of the process which compare the design concepts and their evaluation are involved. The results of nuclear surety are presented below in an abbreviated form. The complete results are included in the SWG report.[32]

5.1.1 (U) Requirements

5.1.1.1 (U) Nuclear Safety

(U) Nuclear warheads are built to basic nuclear safety standards prescribed by the DOE (DOE Directive 5610.10).

5.1.1.2 (U) Use Control

(U) The requirements for command and control in the HPRF Military Characteristics (MCs) include use control. These use control requirements are consistent with DOE and DoD policies and directives,[31,33] and the FARR Study recommendations.[34]

5.1.2 (U) Special Concerns and Unique Issues

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5.2 (U) NUCLEAR DETONATION SAFETY

5.2.1 (U) Introduction, Approach, and Evaluation Criteria

(U) The DOE and DoD share responsibility for nuclear safety. The draft MCs and the Stockpile-to-Target Sequence (STS) include requirements for nuclear detonation safety. The candidate warheads are designed to meet the STS and MC requirements and to provide the required levels of protection against inadvertent nuclear detonation in the absence of specified safety-critical inputs. The DoD must assure protection against unintentionally generating those specific safety-critical inputs (warhead enabling stimuli in normal and abnormal environments plus the warhead arming signals in normal environments) to a level commensurate with the assured protection provided by the HPRF warhead design.

(C-FRD) The Warhead Design Working Group (WDWG) and SEWG provided the candidate designs including safety themes to the SWG for evaluation. The safety themes are based on a number of safety principles including isolation, incompatibility, and inoperability of detonation critical components from enabling energy (e.g., electrical or optical). In addition, first-principle approaches include exclusion regions, exclusion region barriers, stronglinks, weaklinks, collocation, and unique signals.

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(U) The nuclear explosive package (NEP) is one-point safe for all candidates, and for all except NM-4, incorporates IHE and an FRP. In all the safety themes, there are two stronglink switches, in series, to exclude electrical energy from the firing set until intended. One of these is opened by a human intent unique signal, the other by a unique signal from a trajectory-activated environmental sensor. The human intent signal is provided in conjunction with the emergency action message enabling launch. Weaklinks, in most cases the firing set capacitor, are designed to fail and preclude firing before the exclusion region fails in an abnormal environment. For Direct Optical Initiation (DOI), the stronglink prevents laser output until intended rather than isolating external energy. The associated thermal weaklink is a critical optical component in the laser.

(U) Each safety theme defines three safety subsystems; human intent, trajectory and arming, each with an assumed safety level of one in 10^3 in STS environments.

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5.2.4.1.1 (U) Exclusion Region Thermal Robustness.

(U) A measure of the ability of the exclusion region to maintain integrity and provide isolation during or following exposure to high temperatures. The key features here are the use of high melting point materials for all elements of the barrier and minimization of the impact of joints and penetrations. Weight = 10.

5.2.4.1.2 (U) Exclusion Region Mechanical Robustness.

(U) A measure of the ability of the exclusion region to maintain integrity and provide isolation when exposed to such mechanical environments as crush, impact, vibration or puncture. The key features here are the use of high strength and ductile materials for all elements of the barrier and strong joints between exclusion region elements. Weight =10.

5.2.4.1.3 (U) Stronglink Resistance to Bypass.

(U) A measure of the thermal, mechanical and electrical robustness of the stronglink and its attachment to the exclusion barrier. A magnetic stronglink is seen as having better electrical high voltage standoff capability than a mechanical switch or a typical ESD because it is not susceptible to high-voltage arcing. A welded attachment is usually better than an attachment with screws. A protected location is preferable to cantilevering from the end of the firing set. Large physical size, strength, and thermal integrity are advantageous. Weight =8.

5.2.4.1.4 (U) Stronglink Location.

(C-FRD) A criteria which measures the location of stronglinks at the firing set versus the detonators. There is believed to be an advantage to locating the stronglink as close as possible to the physics package so that protection may be maintained even if the fire set is torn away or the exclusion barrier is otherwise compromised. Weight =8.

5.2.4.1.5 (U) Weaklink(s).

(U) A measure of an element or component that is necessary to produce a nuclear detonation, that becomes irreversibly inoperable at an environmental stress level lower than that which will threaten the exclusion region (including stronglinks). Weight =6.

5.2.4.1.6 (U) Discrimination Level of Stronglinks.

(U) A measure of the methods for introducing or generating the unique signal and the discrimination ability of the stronglink actuator. An electromechanical discriminator is rated better than an inertial ESD. Weight =5.

5.2.4.1.7 (U) Resistance to Direct Multipoint Initiation.

(U) A criterion measured by lack of electrical paths to the high explosive other than the intended mode through the detonators (lack of or well protected penetrations into exclusion region). The lack of possible alternate electrical paths and well designed penetrations is important, because nuclear detonation can only be achieved for a one point safe NEP by initiating the main charge

explosive at more than a single point, either at multiple discrete points or along a line or surface. Weight =5.

5.2.4.1.8 (U) Insensitivity of Detonators.

(U) A criteria measured by insensitivity to energy applied to the detonators which includes signal amplitude, waveform, and uniqueness. DOI, Slapper detonators, and explosive bridge wires are in decreasing order of insensitivity. Weight =2.

(U) Table 5-2 is the evaluation or Pugh matrix for the safety themes presented against the evaluation criteria and weighting.

5.2.5 (U) Nuclear Detonation Safety Summary and Conclusions

(U) Based upon the assessment methodology described, the weighted totals for the six HPRF safety themes fall into three general groups. New Mexico candidate safety themes A, B, and C scored 76, 83, and 78 respectively. The two California candidate safety themes received weighted totals of 28 and 38. New Mexico candidate safety theme D had a weighted total of -28. These three general groups represent the evolution of safety technology over time. Candidate D scored the lowest since it utilizes first generation ENDS technology. The first generation ENDS technology has been improved upon and enhanced through the development of better stronglinks and barriers. The California candidates, which are based upon W87 technology, fell in the middle of the scoring range due to the utilization of enhancements like detonator safing. The remaining three New Mexico candidates, which use the most current safety enhancements, scored the highest by better implementation of safety technology.

5.3 (U) OPERATIONAL SAFETY

5.3.1 (U) Introduction - QFD Approach, Definitions, and Evaluation Criteria

(S-RD) The QFD evaluation of operational safety started with the use of the House of Quality (HOQ) rather than with a Pugh matrix. [redacted] Criteria have not been developed for evaluating this feature, and the HOQ serves to identify appropriate measures for doing so. The HOQ and its application to defining the measures is fully described in the SWG Final Report.[32]

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5.3.2 (U) Warhead Candidate Operational Safety Evaluation

(U) The rating system developed for the candidates is based on a 0, ±1, ±2 scale, applied to the measures from the HOQ, as defined in Table 5-3. Table 5-4 defines important operational safety design elements of the proposed warhead candidates. Table 5-5 lists the measure values for each of the warhead candidates. The next step in the process is to create the Pugh matrix. Table 5-6 is the unweighted Pugh or evaluation matrix. Table 5-7 is the weighted Pugh matrix. The evaluation criteria on the left are the measures from the HOQ. The importance is a weighting factor derived from the HOQ. The warhead candidates are listed in the row across the top of the Pugh matrix.

Table 5-2. (U) Nuclear Detonation Safety Evaluation Matrix.

EVALUATION CRITERIA	Wt
ER THERMAL ROBUSTNESS	1
ER MECHANICAL ROBUSTNESS	1
SL BYPASS RESISTANCE	8
STRONGLINK LOCATION	8
WEAKLINKS	8
SL DISCRIMINATION	5
DIRECT INITIATION RESISTANCE	5
INSENSITIVITY OF DETONATORS	2
TOTALS (UNWEIGHTED)	
WEIGHTED TOTALS	

Weightings are from 1 to 10, 10 being the best

Rankings are from -2 to + 2, +2 being the best

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Table 5-3. (U) Measure Evaluation Criteria.

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Table 5-5. (U) Candidate Warhead Design Parameters.

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Table 5-8. (U)

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(U) Table 5-11 contains the weights for the various design features, applies these to the scores in Table 5-10, and provides a total score for each design. The weights indicate how important one feature is relative to the others. In the absence of a lengthy and detailed analysis that indicates the relative importance of each design feature, and lacking the design detail that would make such an analysis possible, the assignment of weights to each design feature can only be subjective.

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5.4.3 (U) Nuclear Material Dispersal Conclusions

(U) Taking the dispersal of all radioactive materials into account, candidate NM-4 does not have IHE or FRP and has a higher risk of Pu dispersal

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Table 5-10. (U) Unweighted Evaluation Matrix for Tritium Dispersal Safety.

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5.5 (U) USE CONTROL

5.5.1 (U) Introduction

(U) One of the taskings of the HPRF Phase 2 Study was to investigate possible warhead use control options. This is the first time that warhead use control has been considered for a silo-based strategic system, although it was considered for the Small ICBM.[35] The HPRF use control tasking was a direct result of the FARR Study.[34] In April 1990 the Senate Armed Services Committee formally requested the Secretary of Defense to perform "an independent and objective top-to-bottom review of current fail-safe procedures." A Federal Advisory Committee was appointed in March 1991 to conduct a comprehensive and independent review of the DoD Nuclear Command and Control Structure. The FARR Study concluded that protection equivalent to that afforded by CAT-F PAL should be required in all new weapon systems. A DoD Directive[31] was issued on 20 June 1994 in response to the FARR Study recommendations. Previously, DOE issued a policy memorandum[33] mandating that all new warheads shall have positive measures against deliberate unauthorized use while in DOE custody. There are, however, differences between how DOE has treated warhead use control and the policy outlined in the DoD Directive. DOE has treated warhead use control as self-contained within the warhead. The DoD Directive also includes weapon system level physical security and procedures as use control measures to achieve "protection comparable to CAT-F PAL". While possible approaches involving physical security and procedures as well as the DOE approaches were discussed, the proposed use control themes in this study are all based upon warhead implementations. This conservative approach was the result of both the late arrival of the DoD Directive in the course of the study and the difficulty of defining what is meant by "protection comparable to CAT-F PAL".

(U) Interface issues for implementing CAT-F PAL comparable use control were briefly reviewed. A preliminary conclusion was that there appears to be no show stoppers to the implementation of use control up to and including CAT-F PAL through the launch control center (LCC) and missile system communications. Issues involving code interfaces, National Security Agency involvement, nuclear certification, and software changes required were not addressed. The new missile guidance computer appears to have sufficient capacity at present, but future availability could change.

[redacted]

5.5.2 (U) Use Control Categories and Use Denial

(U) Use control is defined as the positive measures that allow the authorized use, and prevent or delay unauthorized use of nuclear weapons. In the DoD weapon system context, use control is accomplished through a combination of weapon system design features, operational procedures, security, and system safety rules. In contrast, DOE's definition of use control includes warhead design features only and excludes physical security and procedures. In the DOE context, coded control and use denial form the basis of use control. The PALs are a family of devices and subsystems designed to reduce the possibility of obtaining nuclear detonation from a nuclear warhead without the use (insertion) of a controlled numerical code.

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because of their low weights. The remaining three figures of merit; technology risk, maturity of concept, and STS coverage, are discussed below.

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Table 5-14. (U) Pugh Matrix for New Mexico Candidates.

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6.0 (U) REQUIREMENTS

(U) The Requirements Working Group (RWG) was responsible for developing and documenting two primary products; the HPRF Military Characteristics (MC) and the Stockpile-to-Target Sequence (STS) documents. The RWG was further tasked to document any unique issues associated with the HPRF warhead. The HPRF Phase 2 Feasibility Study showed there were unique issues to the HPRF warhead when compared with other standard warheads as well as issues related to the current situation of nuclear weapons development. In preparing the MC and STS documents, it became apparent that these issues needed to be addressed. These issues are documented in Section 7 of this report.

6.1 (U) MISSION NEED STATEMENT

(U) A Mission Need Statement is required to document a mission deficiency. There was a tentative statement prepared (SAC XO5-91, dated 10 September 91), but it was never finalized.

6.2 (U) MILITARY CHARACTERISTICS (MC)

(U) The MCs cover the performance requirements and physical characteristics for those parts of the HPRF warhead that are the sole responsibility of the DOE to design, develop, certify, and produce. The MCs become design requirements only after formal DOE acceptance at Phase 3. Prior to that time, they are draft goals of the Air Force requirements. The draft MCs are provided in Appendix D. The draft MCs were written to ensure any unresolved issues get addressed during future development activities. The MCs were prepared in a two column format to allow the documentation of remarks/comments associated with a specific MC in the right hand column. The purpose of this format is to ensure any concerns and/or issues related directly to that MC are fully documented and not lost. These comments address the MCs only.

6.3 (U) STOCKPILE-TO-TARGET SEQUENCE (STS)

(U) The STS document provides the DOE with Air Force requirements, design goals, and supplemental data which amplify the MCs by providing additional detailed information necessary for development of the HPRF warhead.

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The STS is a living document and should continue to be reviewed and updated, as necessary, to reflect the most current data.

6.4 (U) STOCKPILE TESTING AND RELIABILITY

6.4.1 (U) Systems Evaluation

(U) The DOE and its laboratories plan for and develop a Systems Evaluation Program (SEP) on all their weapons. The SEP consists of testing newly built weapons (New Material Testing) and weapons withdrawn from the stockpile (Stockpile Testing). Both flight and laboratory tests are normally conducted.

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Over 20 years, weapon components and aeroshells will be consumed for testing and must be replaced, but compared to the initial build, the material to support sampling is small.

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Stockpile sampling now becomes a large part of the overall weapon cost. Hence samples from small stockpiles are perceived as having a very high cost for the benefit they provide. As stockpiles decrease, the percentage becomes even more extreme.

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There is a recognized need to address the issue, and some preliminary thoughts are offered for consideration.

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- (U) It is still believed to be important to select some samples for testing in environments and/or flight.
- (U) To assure high reliability, it is important to consider design features that will accommodate testing at the users facilities. This may be implemented as: built-in test capability, or field testing rather than testing at Pantex.
- (U) Increasing design redundancy by installing redundant components in the weapon or by redundant targeting may help meet the reliability objectives for the mission.

- (U) Use of components (or modules) that are common with other systems, and tested in other systems, may help.

6.4.2 (U) Reliability

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associated with the stockpile program discussed above, the DoD will have to determine what the lowest acceptable reliability will be for this system. This may require a trade study to determine what is the acceptable reliability based on cost in Phase 2A.

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7.0 (U) RELATED ISSUES

(U) The HPRF weapon system is new and it requires a specific warhead designed for a specific purpose. Issues that need to be addressed are covered here as related issues. These issues are addressed only to the extent appropriate at this time. Most issues are addressed more thoroughly elsewhere in the report.

7.1 (U) STRATEGIC ARMS REDUCTION TREATY (START) IMPLICATIONS

(C-FRD) Both USSTRATCOM and HQ AFSC requested that the candidates be packaged to the greatest extent possible in either the Mk12A or Mk21 RVs. This was partially driven by Air Force operations security particularly during START inspections. [redacted] This requirement has been documented in the draft MCs, but may have to be further defined in Phase 2A. Currently, this requirement severely limits the design options available.

7.2 (U) WARHEAD CERTIFICATION

7.2.1 (U) Yield Certification: Procedures and Precedents

(U) Current nuclear warhead certification procedures are based on a series of agreements which can be traced from the original "1953 Agreement" ("An Agreement between the Atomic Energy Commission and Department of Defense for the Development, Production, and Standardization of Atomic Weapons", March 21, 1953) through a series of supplementary agreements, to the set of agreements negotiated among the weapon laboratories in the 1990-1993 period (Table 7-1). These agreements describe a review and acceptance process which is embedded in the Joint DoD/DOE weapon development program phases, shown in Figure 7-1. Warhead certification, a formal responsibility of the cognizant laboratory directors, is the final step of this multi-year process.

(U) Formal weapon certification is the final step in a weapon development program, in which an initial design concept is taken through increasing levels of definition by the efforts of a multi-disciplinary team. Development of a design is based on extensive use of calculational models and a major testing program, of which nuclear testing has historically been an important, but by no means the only component. Non-nuclear testing has a wide array of techniques, including hydrodynamic testing of primary components, engineering testing (for both performance and safety) of both non-nuclear and nuclear components over the range of stockpile environments, materials testing, and operational testing to verify interface compatibility and performance in real flight environments. Results of calculations, non-nuclear testing, and constraints imposed by production and interface requirements are combined as a design is developed to increasing levels of definition.

Table 7-1. (U) Agreements Forming the Basis for Current Warhead Certification Procedures.

"An Agreement between the Atomic Energy Commission and Department of Defense for the Development, Production, and Standardization of Atomic Weapons," March 21, 1953.
Supplement to 1953 Agreement. An updated agreement is now under review.
"Policy and Procedures for Certifying High-Yield Nuclear Warhead Designs for Stockpile," S.S. Hecker and J.H. Nuckolls, June 15, 1990.
"Inter-Laboratory Peer Review for Nuclear Weapon Development." T.P. Seitz and L. Woodruff, December 18, 1991.
"Amended Agreement on Inter-Laboratory Peer Review," W.J. Shotts, E.E. Ives, and T.P. Seitz, February 26, 1993.

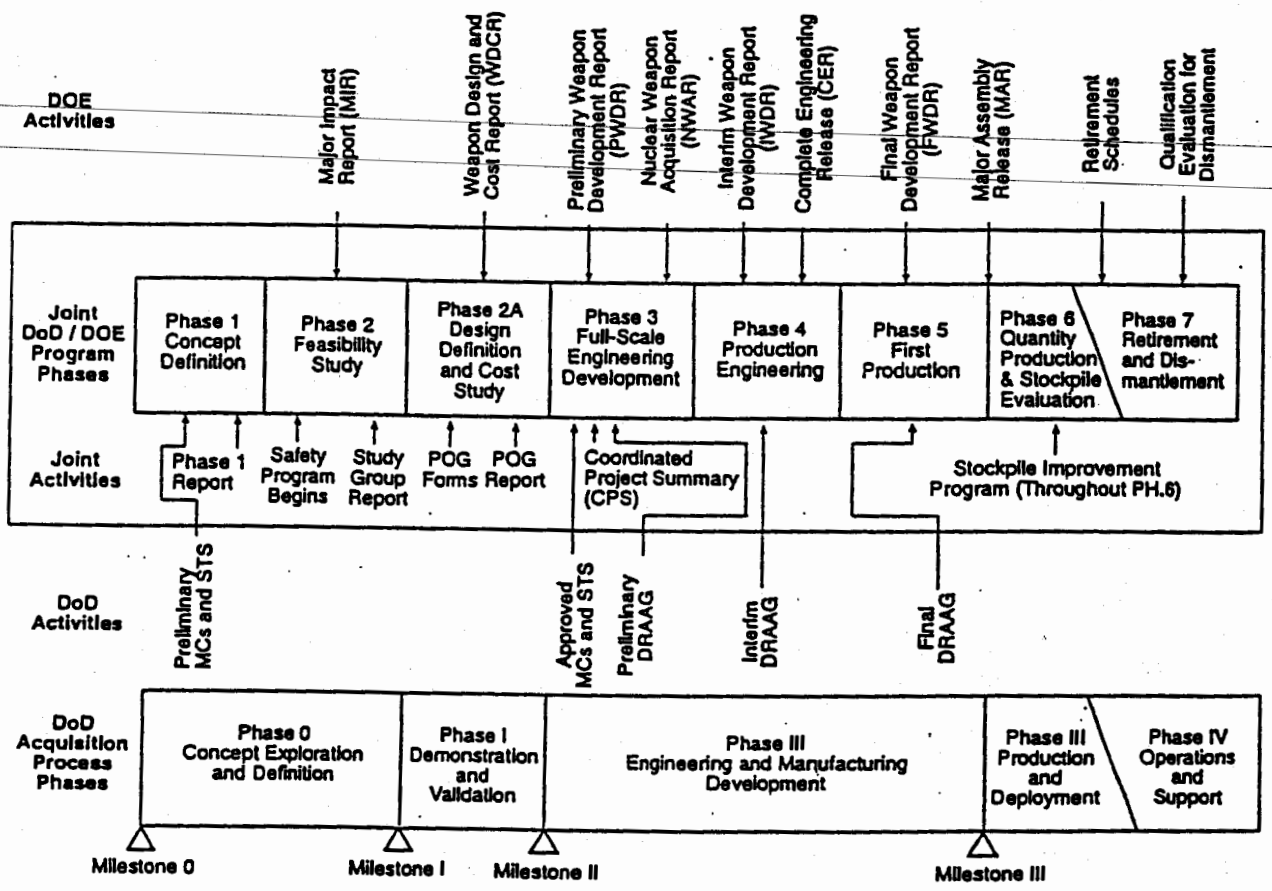

Figure 7-1. (U) Joint DoD/DOE Nuclear Weapon Program Phases and DoD Acquisition Process Phases Compared.

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8.2 (U) VULNERABILITY TESTING AND MISSION ANALYSIS

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After analyzing the vulnerability test data, the target systems were modeled and mission effectiveness analyses were performed.[36] The magnitude of the uncertainties associated with the vulnerability assessments developed for the target systems in each of the mission areas, precluded mission effectiveness conclusions.

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Detailed test reports exist that describe in depth the test conditions, caveats, and results.

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(S) The study was unable to conclusively assess the effectiveness of an HPRF weapon in damaging target systems.

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In addition, by analyzing the damage that occurred across all of the systems that experienced damage, a determination must be made to assess whether the level of understanding of the conditions and mechanisms by which damage occurred is sufficiently mature to enable the application of these results to other systems that have not been tested.

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features and contributed significantly to design refinement throughout the study. Upon completion of the evaluations, the data were combined to obtain an overall evaluation. The data for each area were normalized to cover the same range of values and then weighted with customer-supplied weights. With the exception of NM-4, which had the lowest overall score, there was surprisingly little spread in the overall scoring. This was due to different candidates having strengths in different areas causing scores to even out. NM candidates scored higher in nuclear detonation safety with the exception of NM-4. CA candidates scored somewhat higher in operational safety and nuclear material dispersal. CAT-F PAL candidates received the highest scores in use control.

9.0 (U) CONCLUSIONS AND RECOMMENDATIONS

9.1 (U) CONCLUSIONS

(S) The study confirmed the following conclusions.

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In addition, by analyzing the damage that occurred across all of the target systems that experienced damage, a determination must be made to assess whether the level of understanding of the conditions and mechanisms by which damage occurred is sufficiently mature to enable the application of these results to other systems that have not been tested.

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9.2 (U) RECOMMENDATIONS

(U) An additional 12-month study should be conducted to complete the following two tasks.

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(U) Also, additional vulnerability data should be acquired to complete the following three tasks, but not part of the 12-month study.

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APPENDICES

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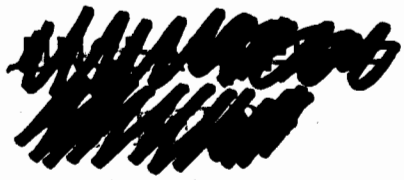

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APPENDIX B - TASKING

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the Phase 2. In addition, I request the Study Group report at least yearly to the NWCSC on their progress and conclusions.

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Sincerely,

John H. Birely
Acting Chairman

Enclosure

cc:
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CNO (OP-91B)

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DEPARTMENT OF DEFENSE
AND
DEPARTMENT OF ENERGY

NUCLEAR WEAPONS COUNCIL
STANDING COMMITTEE
WASHINGTON, DC 20301-3050

11 AUG 1992

MEMORANDUM FOR CHIEF OF NAVAL OPERATIONS (OP-65)

SUBJECT: High Power Radio Frequency (HPRF) Weapon Phase 2 Warhead Study

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(U) For this reason, I request the Navy join the Air Force in the HPRF Phase 2 Feasibility Study so that the study group can investigate both the ICBM and SLBM basing options.

John H. Birely
Acting Chairman

cc: SAF/AQQ
DAMO

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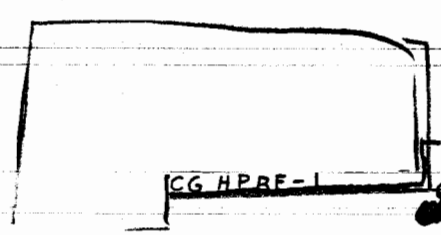

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DEPARTMENT OF THE AIR FORCE
WASHINGTON DC

OFFICE OF THE ASSISTANT SECRETARY

SAF/AQQ
Pentagon Rm 4E342
Washington DC 20330-1000

AUG 3 1 1992

MEMORANDUM FOR AFMC/XR

SUBJECT: Phase 2 Warhead Feasibility Study of a Strategic High Power Radio Frequency (HPRF) Weapon (U) -- ACTION MEMORANDUM

(U) Request the Office of Aerospace Studies (OAS) initiate and lead for the Air Force a joint DOD/DOE Phase 2 Warhead Feasibility Study to investigate the development of a Strategic High Power Radio Frequency (HPRF) weapon. The Study Group will complete the effort in 30 months. OAS should schedule a kickoff meeting within 30 days. In addition, within 90 days after the kickoff meeting, the Chairman of the Study Group will report to the Nuclear Weapons Council Standing Committee (NWCSC), through SAF/AQQS, on the study goals, strategy, and milestones. In particular, this report should address the plan for validating the lethality methodology.

(S) The NWCSC has approved the Air Force request for this study and asked the DOE to join the study. At the request of the Deputy Assistant Secretary of Defense (Policy), the study will consider possible SLCM delivery of the HPRF weapon. To accomplish this additional goal, the NWCSC has asked the Navy to join the study. We expect that the Navy will have a significant role in the study, and may designate a deputy chairman for the study group. This letter includes the NWCSC letters to DOE and the Navy as attachments.

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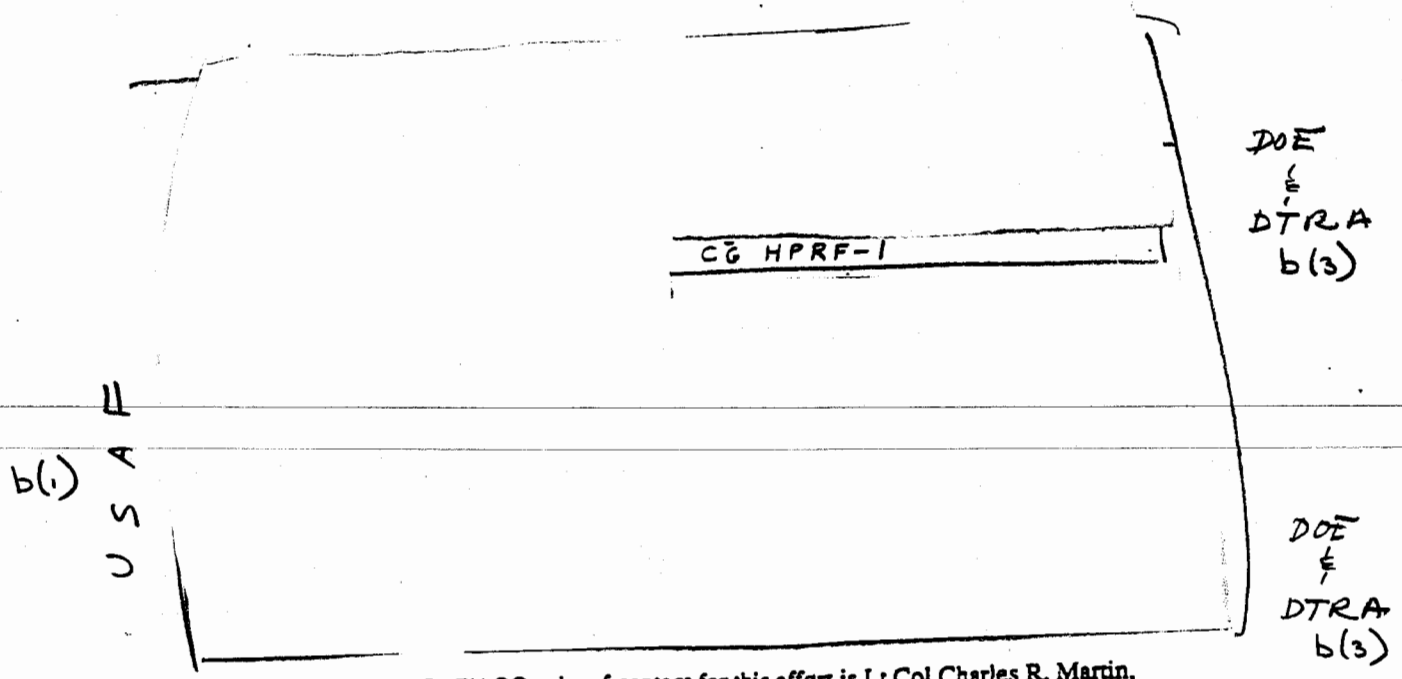

(U) The SAF/AQQ point of contact for this effort is Lt Col Charles R. Martin, SAF/AQQS, DSN 223-6303 or (703) 693-6303.

Patrick P. Caruana

PATRICK P. CARUANA, Major General, USAF
Director of Strategic, SOF, and
Airlift Programs
Assistant Secretary for Acquisition

3 Atch
1. NWCSC Letter to DOE (SFRD)
2. NWCSC Letter to Navy (SFRD)
3. Nominal Warhead Parameters (SFRD)

cc: OAS(AFMC)

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Department of Energy
Washington, DC 20585

This document consists of 1 page
No. 1 of 20 copies, Series A

SEP 14 1992

MEMORANDUM FOR Manager, DOE Albuquerque Field Office
Director, Los Alamos National Laboratory
Director, Lawrence Livermore National Laboratory
President, Sandia National Laboratories

Request you join the Air Force in a Phase 2 feasibility study of a High Power Radio Frequency (HPRF) weapon. The tasking guidance for this study is enclosed. The Office of Aerospace Studies will lead the study. You should plan to complete the study in 30 months.

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DOE & DTRA & USAF b(3)

[redacted] Therefore, the Air Force recommended to proceed to a Phase 2 feasibility study.

Joe Gazda, Weapons Development and Acquisition Division (DP-251), (301)903-2984, will oversee and coordinate DOE participation in the study.

W. G. Ellis
Rear Admiral, U.S. Navy
Deputy Assistant Secretary
for Military Application
Defense Programs

Enclosure:
Phase 2 Tasking Guidance for High Power Radio Frequency Weapon (S/FRD)

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No. 7 of 27 copies, Series A

September 4, 1992

Phase 2 Tasking Guidance for
High Power Radio Frequency Weapon (U)

This tasking guidance is for a Joint Department of Defense (DOD) and Department of Energy (DOE) Phase 2 Feasibility Study of a High Power Radio Frequency (HPRF) weapon. This study is a follow on to the recently completed Joint DOD/DOE HPRF Phase 1 Study (Reference 1). The purpose of this study is twofold: (1) perform aboveground testing to acquire the necessary failure-level vulnerability test data on foreign assets, and (2) perform a feasibility study on weapon concepts that can provide the failure-level output. The Phase 2 study period is 30 months.

The initial emphasis of the study will be to: (1) gather the vulnerability test data; (2) validate and, if necessary, improve vulnerability assessment models; and (3) improve and expand the Phase 1 mission analysis.

The DOE laboratories should coordinate and integrate their vulnerability test plans with those of the DOD.

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Initially, the study group will use the W78/Mk12A and W87/Mk21 Military Characteristics (MC) and Stockpile-to-Target Sequence (STS) environments for engineering trade studies. Similarly, engineering trade studies for a Submarine Launched Ballistic Missile delivery system will use warhead MC's and STS as identified by the Navy.

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Pit reuse will be considered for the Phase 2 candidates, and all candidates will meet the April 1990 DOE Use Control Policy and DOE Nuclear Explosive and Weapon Safety Program Order 5610.10.

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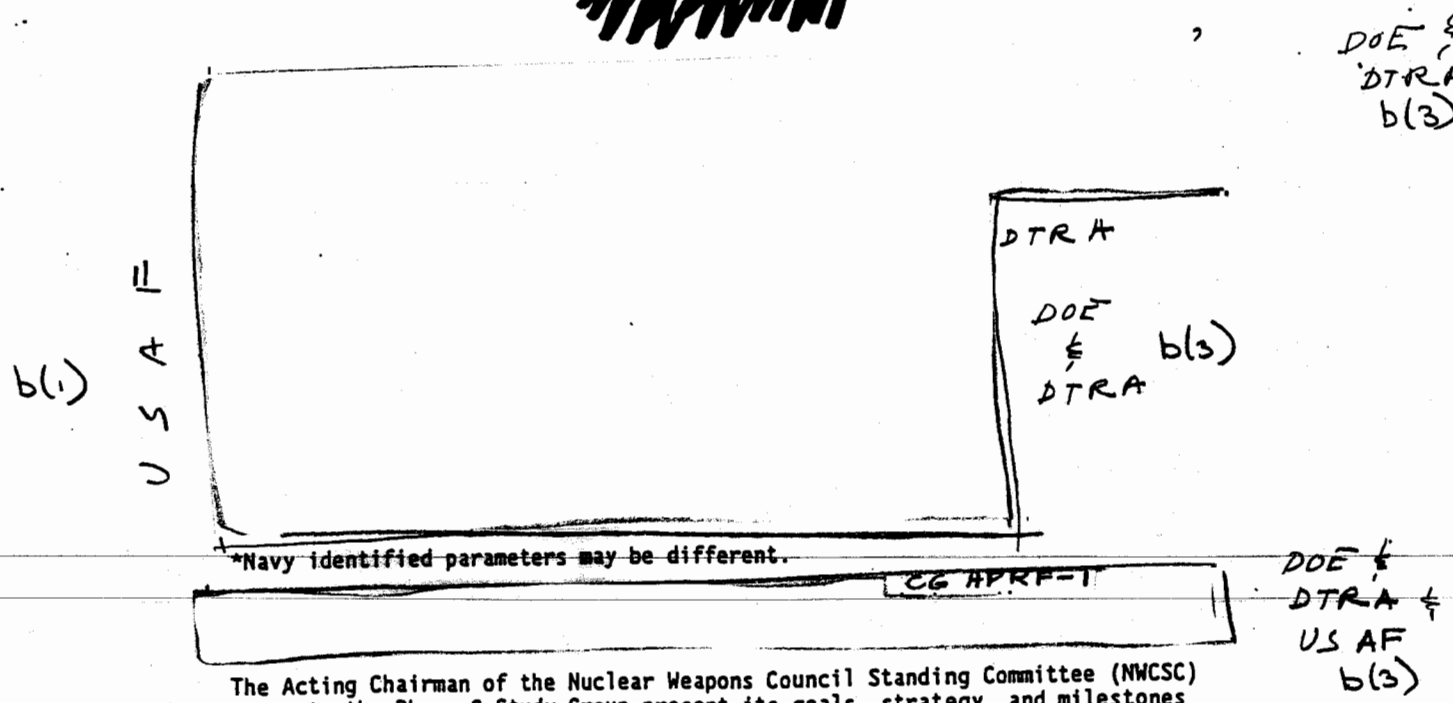

The Acting Chairman of the Nuclear Weapons Council Standing Committee (NWCSC) requests the Phase 2 Study Group present its goals, strategy, and milestones to the NWCSC within 90 days of initiation of the Phase 2 study. Further, the Acting Chairman requests the Study Group report at least yearly to the NWCSC on its progress and conclusions.

At least 4 months prior to the end of the study the preferred weapon candidates will be submitted for peer review and as an input for a Major Impact Report (MIR).

The Phase 2 report will include descriptions of each weapon candidate, the results from the engineering trade studies, and results from the peer review. The MIR or an executive summary of the MIR should be an appendix in the Phase 2 report. For each candidate, the report will include: (1) details of safety and use control themes, and (2) any concerns that might arise from the current underground nuclear testing policy. The overall Phase 2 report format and contents should follow the guidelines shown in DOD Instruction 5030.55, dated January 21, 1974, enclosure 4.

Reference:

1. "High Power Radio Frequency (HPRF) Phase 1 Study (U) Final Report," 15 April 1992, OAS-TR-92-1

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APPENDIX C - HPRF SECURITY CLASSIFICATION GUIDE - DRAFT

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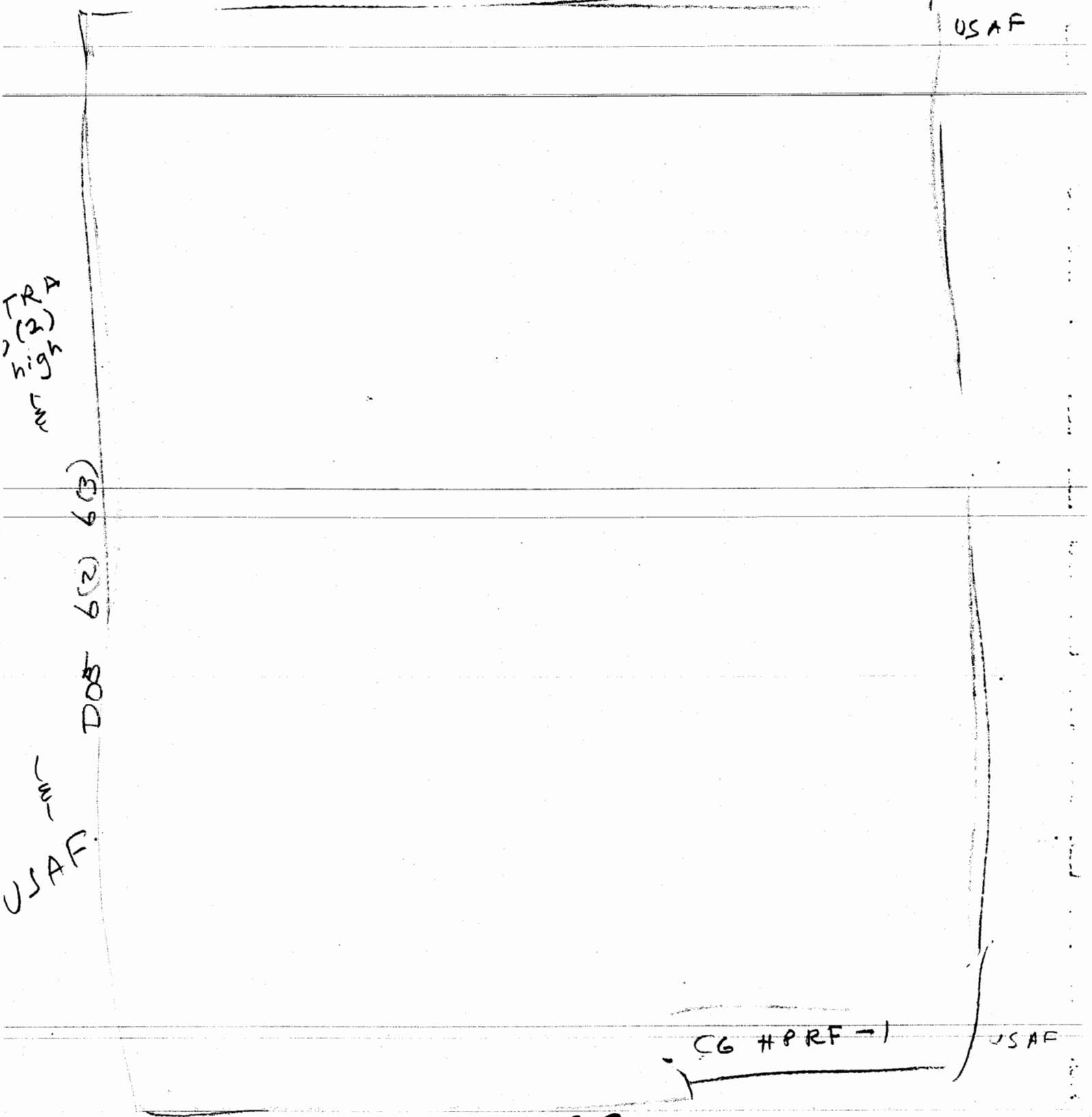

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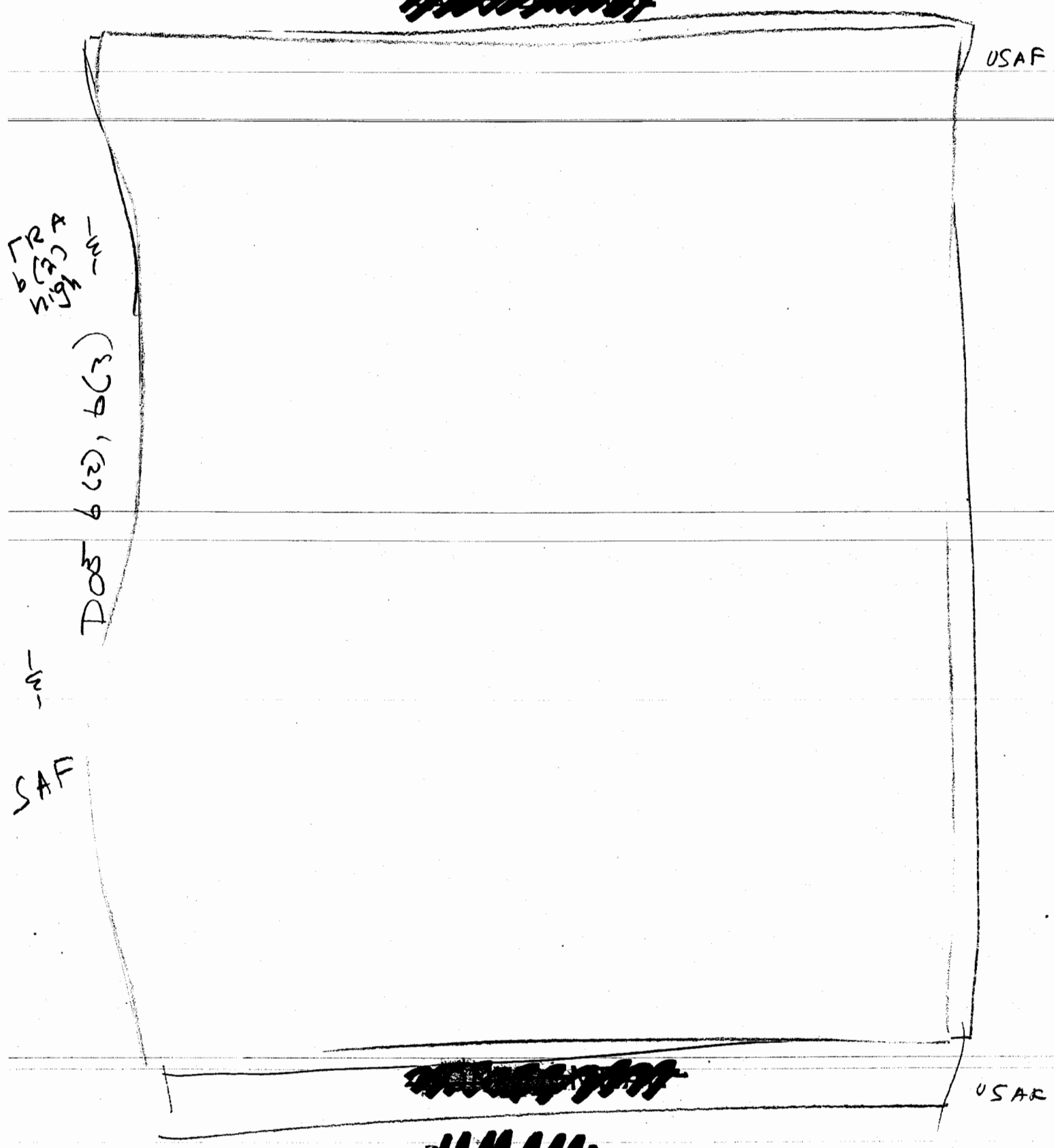

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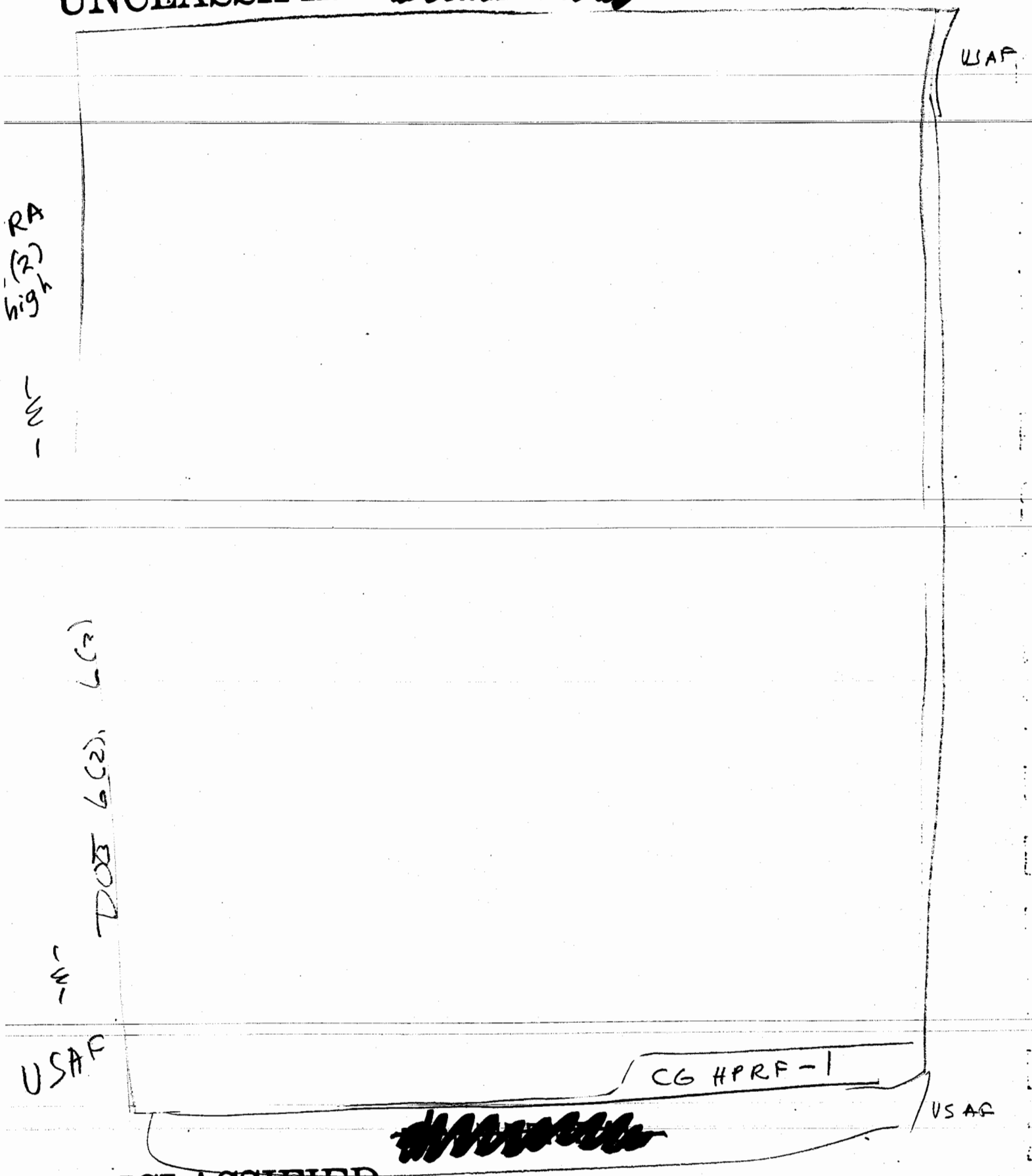

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APPENDIX D - MILITARY CHARACTERISTICS

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MILITARY CHARACTERISTICS FOR THE HIGH POWER RADIO FREQUENCY (HPRF) WARHEAD (U)

DRAFT
January 1996

NUCLEAR WEAPONS INTEGRATION DIVISION
NUCLEAR WEAPONS DIRECTORATE
SAN ANTONIO AIR LOGISTICS CENTER
AIR FORCE MATERIEL COMMAND
1651 FIRST STREET SE
KIRTLAND AIR FORCE BASE, NEW MEXICO 87117-5617

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MILITARY CHARACTERISTICS FOR THE
HIGH POWER RADIO FREQUENCY (HPRF) WARHEAD (U)
DRAFT
January 1996

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2.0 WARHEAD CHARACTERISTICS 3

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CHARACTERISTICS	REMARKS/COMMENTS
1.0 (U) GENERAL.	
1.1 (U) Purpose. These Military Characteristics (MCs) define the Department of Defense (DoD) requirements for a High Power Radio Frequency (HPRF) nuclear warhead.	1.1 (U) The MCs were written in a two column format. The left hand column contains the MC requirement and the right hand column is used to document any remarks/comments associated with the MC requirement. The purpose for this format is to ensure any concerns and/or issues identified during Phase 2 are fully documented. These comments are intended to address the MCs only.
1.2 (U) Contingencies. Should it appear impractical for the Department of Energy (DOE) to meet any of these MCs, or should it appear meeting any criterion specified herein will delay the initial operational capability, modify the delivery rate, or increase the warhead cost by an amount deemed by the joint DoD/DOE HPRF Warhead Project Officers Group to be unreasonable, immediate notification shall be made to the Nuclear Weapons Council Standing and Safety Committee (NWCSSC).	
1.3 (U) Definitions.	1.3 (U) Definitions for the RV, RS, and RSA are defined specifically for the HPRF warhead design purposes and may not be the same definitions for other warheads. The STS reflects the same definitions.
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1.3.2 (U) The reentry vehicle (RV) is the DoD provided structure to contain DOE warhead components as well as the arming, fuzing, and firing (AF&F).	1.3.2 (U) The AF&F is a DoD responsibility. An integrated AF&F is a concept being considered by the Air Force. This concept would have to be fully documented (i.e. responsibility, definition, etc).

1.3.3 (U) The RS is defined to be the RV and DOE warhead components as well as the AF&F within the structure.

1.3.3 (U) The AF&F is a DoD responsibility. An integrated AF&F is a concept being considered by the Air Force. This concept would have to be fully documented (i.e. responsibility, definition, etc).

1.3.4 (U) The Reentry System Assembly (RSA) is defined as the mated RS, Deployment Module and Ascent Shroud.

1.3.5 (U) The Deployment Module is defined as the structure which includes the payload bulkhead support for mounting the RVs and chaff dispensers.

1.3.6 (U) The Ascent Shroud is defined as the low-drag aerodynamic shape which covers the arrangement of payload RVs during powered flight in the atmosphere.

1.4 (U) Competing Characteristics. In the event compliance with these MCs results in design conflicts, the HPRF Warhead POG shall evaluate design options on a case-by-case basis and forward recommended changes to the NWCSSC for approval. Trade-offs for reasons of technical feasibility and cost may be made with the guidance and approval of the HPRF Warhead POG and NWCSSC.

1.4.1 (U) Highest priority will be given to nuclear safety.

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2.6 (U) Reliability Requirements. The following reliability requirements apply to the warhead in the normal environments specified in the HPRF Warhead STS document.

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2.7 (U) Nuclear Safety Requirements. The warhead design requires positive measures to prevent premature detonation in normal and abnormal environments as defined in the HPRF Warhead STS document.

2.7.1 (U) The warhead shall contain a human intent unique signal driven stronglink which shall prevent prearming until the unique signal is received. The warhead shall contain features which preclude arming until the warhead experiences environments and events associated with normal missile flight and receipt of a nuclear arming signal from the missile. At least two independent signals shall be required to arm the warhead and at least one signal shall be continuous. The warhead design shall allow arming to occur as late in the functional sequence as practical.

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2.7.13.4 (U) Not present high explosive, chemical, or other personnel hazards during maintenance, handling, and other operations in normal environments.

2.7.13.5 (U) Include provisions for the probability of high explosive detonations and plutonium dispersal to be in as low as reasonably achievable in abnormal environments.

2.7.13.6 (U) Include human engineering characteristics to reduce the opportunity for personnel error including, but not limited to, all maintenance and EOD operations.

2.7.14 (U) All material used in the warhead design shall be chemically compatible in normal HPRF Warhead STS environments.

2.7.15 (U) The warhead shall contain no electrical power source, either dormant or active, which could arm or fire the warhead detonating system.

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2.8 (U) Maintenance, Monitoring and Equipment Requirements.

2.8.1 (U) Warhead Maintenance. The warhead shall be designed for ease of maintenance.

2.8.1.1 (U) The warhead shall require no scheduled maintenance between the shortest LLCE interval.

2.8.1.2 (U) The warhead shall be designed so field level maintenance, handling, and inspections can be accomplished in the normal HPRF Warhead STS environmental conditions. As a goal, the warhead shall be designed so only existing nuclear certified special and test equipment, and standard mechanics' tools are required for all field-level maintenance, handling, and inspection tasks.

[redacted]

2.8.1.3 (U) The warhead shall be designed to keep personnel safety hazards as low as reasonably achievable during Stages 1 through 5 of the HPRF Warhead STS document.

2.8.1.3 (U) This includes exposure during maintenance to all warhead coatings, materials, and compounds.

2.8.1.4 (U) Provisions shall be made for ease of assembly/disassembly of the RS so repair or component retrofit of the warhead can be achieved.

2.8.2 (U) DOE-Supplied Equipment.

2.8.2.1 (U) DOE-supplied equipment to be used with this warhead shall be capable of functioning in the same normal environments as the warhead, as defined in Stages 1 through 5 of the HPRF Warhead STS document.

2.8.2.2 (U) If required, newly developed DOE equipment shall be as compatible as possible with existing warheads. To the extent practical, all such equipment shall be kept to a minimum and be compact, lightweight, transportable by common carrier, adequately identified, provided with operating instructions, and designed to keep the opportunity for human error as low as reasonably achievable.

2.8.2.3 (U) As a goal, the DOE maintenance and support equipment will require no calibration or be self-calibrating.

2.8.2.4 (U) Any DOE warhead shipping and storage container for DoD use shall be compatible with the warhead storage, transportation, and handling systems identified in the HPRF Warhead STS document. Specific container requirements will be defined in a separate, jointly approved requirements document. If additional requirements are driven by DoD use of this container, funding details will be addressed in a DOE/DoD Memorandum of Understanding for the Division of Responsibilities.

2.8.3 (U) Maintenance Procedures.

2.8.3.1 (U) The RS shall be compatible with removal from, or installation on, an RSA in less than TBD hour(s), with a goal of TBD minutes as defined in the HPRF Warhead STS document.

2.8.3.2 (U) The DOE-defined warhead maintenance and LLCE procedures shall be compatible with the requirements of the HPRF Warhead STS document. All maintenance activities must be performed within TBD 8 hour shift(s). To support this requirement, the LLCE will take no longer than TBD hours, with a goal of TBD hours, once the warhead has been placed in the maintenance stand and all preparatory actions have been accomplished.

2.8.3.3 (C-FRD) Provisions shall be made for relatively simple replacement of LLCs by the Services with a minimum of special facilities or controlled environments.

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2.8.4 (U) Monitoring. Weapon system serial numbers and other data as determined by the HPRF Warhead POG shall be obtained from the warhead by either visual, electronic or optical means.

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2.9 (S-FRD) Inclusion of the following two documents in the MCs was a topic of considerable discussion. (See Section 7.3 of the HPRF Warhead Phase 2 Study Final Report).

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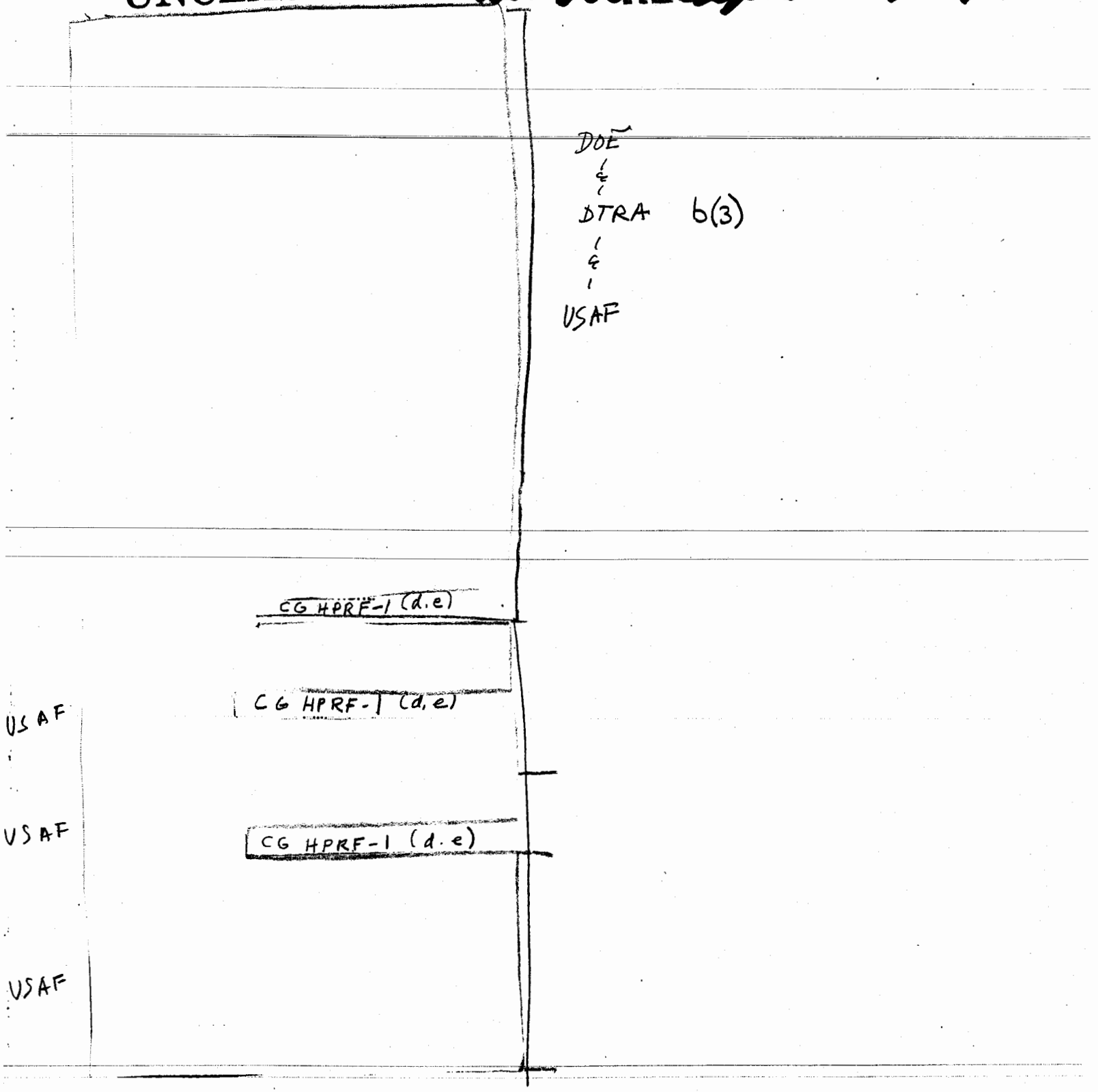
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AIR FORCE

STOCKPILE-TO-TARGET SEQUENCE

FOR THE

HIGH POWER RADIO FREQUENCY (HPRF) WARHEAD (U)

PHASE 2 STUDY

January 1995

DRAFT

NUCLEAR WEAPONS INTEGRATION DIVISION

Air Force Materiel Command

Kirtland Air Force Base, NM

SUBJECT TO EXPORT CONTROL LAWS

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NUCLEAR WEAPONS INTEGRATION DIVISION
Air Force Materiel Command
Kirtland Air Force Base
New Mexico

This Stockpile-to-Target Sequence (STS) is classified SECRET - RESTRICTED DATA because it contains nuclear weapon design data and information concerning operational strategy. It does not contain Critical Nuclear Weapons Design Information (CNWDI).

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Contracting Disclaimer

Nothing in this STS may be construed to constitute a change to any contract. Any questions concerning allowability under, or changes to, any contract must be resolved by the government contracting officer before proceeding in any manner which might obligate the government beyond any existing contract.

Approval: The original STS was reviewed by the POG and formally approved by the Nuclear Weapons Council Standing and Safety Committee on _____.

Historical Record of Revisions/Changes

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[redacted] by the reentry vehicle designers are described in Figure 1-2.

1.5.3 (U) Reentry Vehicle (RV). The reentry vehicle is the DoD provided structure to contain DOE warhead components as well as arming, fuzing, and firing.

1.5.4 (U) Reentry System (RS). The RS is defined to be the RV and DOE warhead components as well as AF&F within the structure.

1.5.5 (U) Reentry System Assembly (RSA). The RSA is defined as the mated RS, Deployment Module and ascent shroud.

1.5.6 (U) Ascent Shroud. The Ascent Shroud is defined as the low-drag aerodynamic shape which covers the arrangement of payload RVs during powered flight in the atmosphere.

1.5.7 (U) Deployment Module (DM). The Deployment Module is defined as the structure which includes the payload bulkhead support for mounting the RVs and chaff dispensers.

1.5.8 (U) Post Boost Vehicle (PBV). The post boost vehicle is defined as: stage IV, including the DM, with the RS attached to the DM, and the residual portion of the ascent shroud which remains attached to the DM after the ascent shroud has been jettisoned. The missile guidance system and related equipment is installed in stage IV.

1.5.9 (U) Missile. The missile consists of the RS, ascent shroud, PBV and the assembled booster.

1.5.10 (U) Reentry Vehicle Axes Notation. The axes system and sign conventions used

1.6 (U) Weapon System Description.

1.6.1 (S) Missile System. The LGM-30G is the Aerospace Vehicle Equipment (AVE) which is associated with the Minuteman III (MMIII). The LGM-30G missile consists of a three stage solid propellant booster, propulsion system rocket engine (PSRE), missile guidance system (MGS), RSA and missile integrating hardware. Each missile is stored and launched from an underground Launch Facility (LF) which is controlled from a manned Missile Alert Facility (MAF) or alternatively from the Airborne Launch Control Center (ALCC). MM III missiles are deployed at four wings with one to four squadrons in each wing. Each wing is supported by a Strategic Missile Support Base (SMSB). Each squadron includes fifty LFs and five MAFs. Each MAF controls and monitors at least 10 LFs. Any two MAFs are capable of launching any of the squadrons' missiles individually, in salvo, in partial salvo, or in ripple mode. Each missile is capable of storing trajectory and fuzing data for four preselected target sets. Each target set can have up to three different targets.

1.6.2 (U) Single Reentry Vehicle (SRV). To meet the Strategic Arms Reduction Treaty (START) requirements, no more than one RV may be carried with each missile system.

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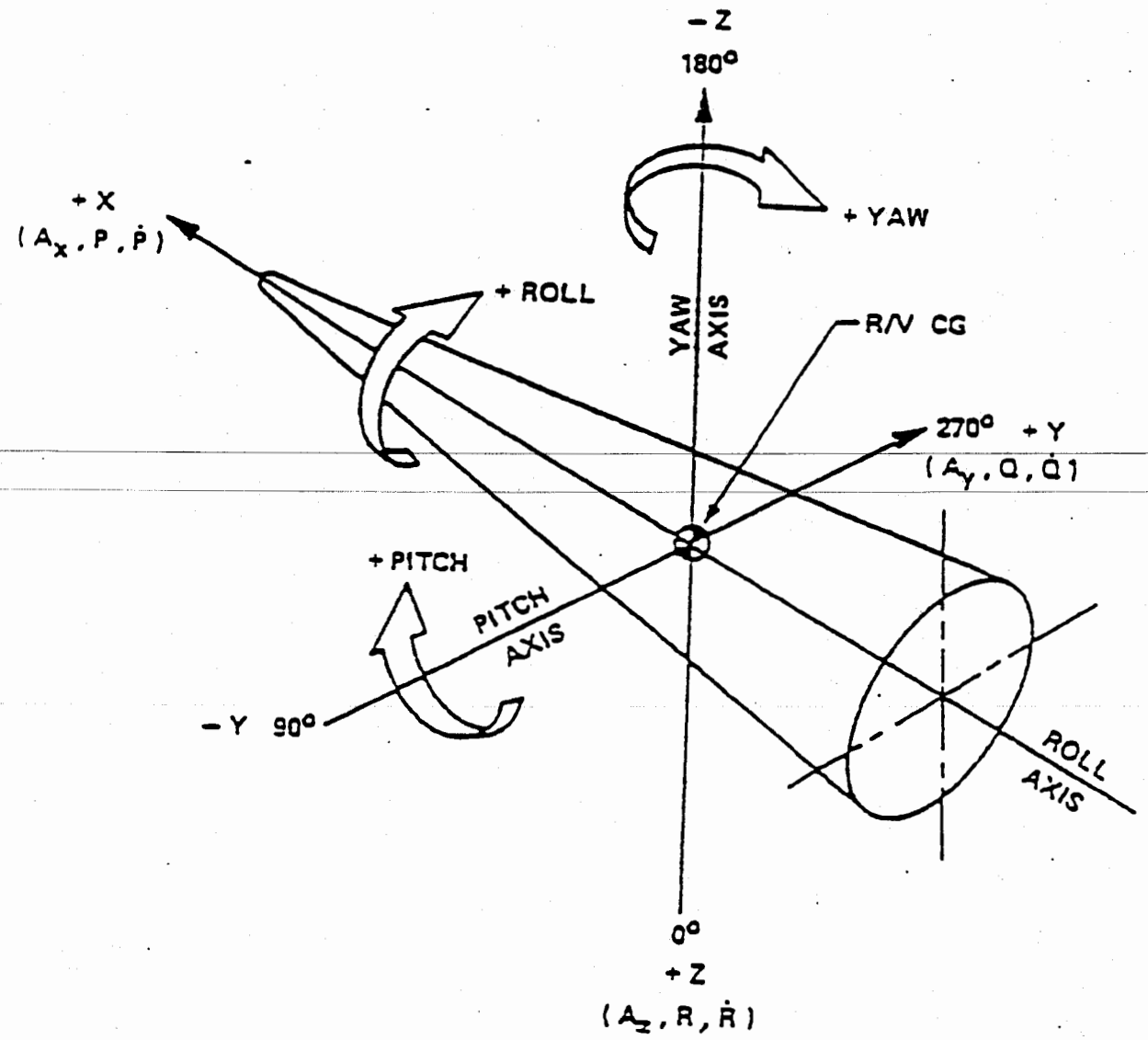

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Figure 1-2 Reentry Vehicle Roll, Pitch and Yaw Axis Definition (U)

SECTION 2
(U) LOGISTIC AND EMPLOYMENT CONCEPTS

2.1 (U) Logistics Plan. The information in this section is descriptive only and is not a statement of requirements. Logistical support for the MM III missile system, as it relates to the WXX HPRF War Reserve (WR) warhead, will generally be consistent with procedures presently employed with similar systems, although some changes to current procedures may be required. New technical development in warhead logistic support procedures should be accomplished jointly by the DoD/DOE and incorporated into this document. Logistical support is based upon concepts developed by the Air Force Materiel Command (AFMC), Air Combat Command (ACC), and the Air Force Space Command (AFSPC). The Directorate of Nuclear Weapons (DNW) at San Antonio Air Logistics Center (SA-ALC) is the focal point for nuclear ordnance logistics support and will act as Nuclear Ordnance Commodity Manager (NOCM) for the warheads, arming and fuzing system, warhead test and handling equipment, and associated support equipment.

2.2 (U) Logistics Flow. A description of the warhead logistics flow for the MM III/WXX system is shown in Figure 2-1 and Table 2-1 respectively.

2.2.1 (U) Department of Defense (DOD) Contractors. DOD contractors will provide RS subassemblies and associated components to the DOE. They will also provide RS components to Air Force facilities for final RSA assembly.

2.2.2 (U) Department of Energy (DOE). The Department of Energy (DOE) has full responsibility for the WXX HPRF warhead assembly until it is delivered to the DOD. Within the DOE facility, the DOD components and subassemblies will be mated with the DOE nuclear components to form the WXX HPRF warhead assembly.

2.2.2.1 (U) Shipping Configurations. The DOE will ship the warhead assembly, in a DOE provided shipping and storage container (S/SC), by safe secure trailer (SST) to either the Munitions Squadron or to the Weapons Storage Area (WSA) at the Main Operating Base (MOB).

2.2.2.2 (U) Container Compatibility. The warhead S/SC shall be compatible with present military transportation systems, handling and storage procedures for nuclear warheads, and military support equipment as close as practical.

2.2.2.3 (U) DOE Procured Test Equipment. Appropriate warhead test and handling equipment, warhead trainers, and the necessary spares to support the nuclear warheads will be routed through SA-ALC/NW for distribution to the MUNS or WSA.

2.2.3 (U) Military First Destination (MFD). The WXX HPRF warhead assembly will be shipped to the appropriate MFD in a DOE-provided shipping container. The MFD can either be the depot Munitions Squadron (MUNS) or the host Strategic Missile Support Base (SMSB). When the warheads arrive at the MFD. acceptance check and inspections will be performed. The WXX HPRF warhead assembly will be stored, within its shipping container, in a storage facility. Required maintenance for the warheads, including Limited Life Component Exchange (LLCE), could be provided by the TBD in accordance with existing DOE/DOD agreements. If warheads were sent to the MUNS, the MUNS, when directed, will

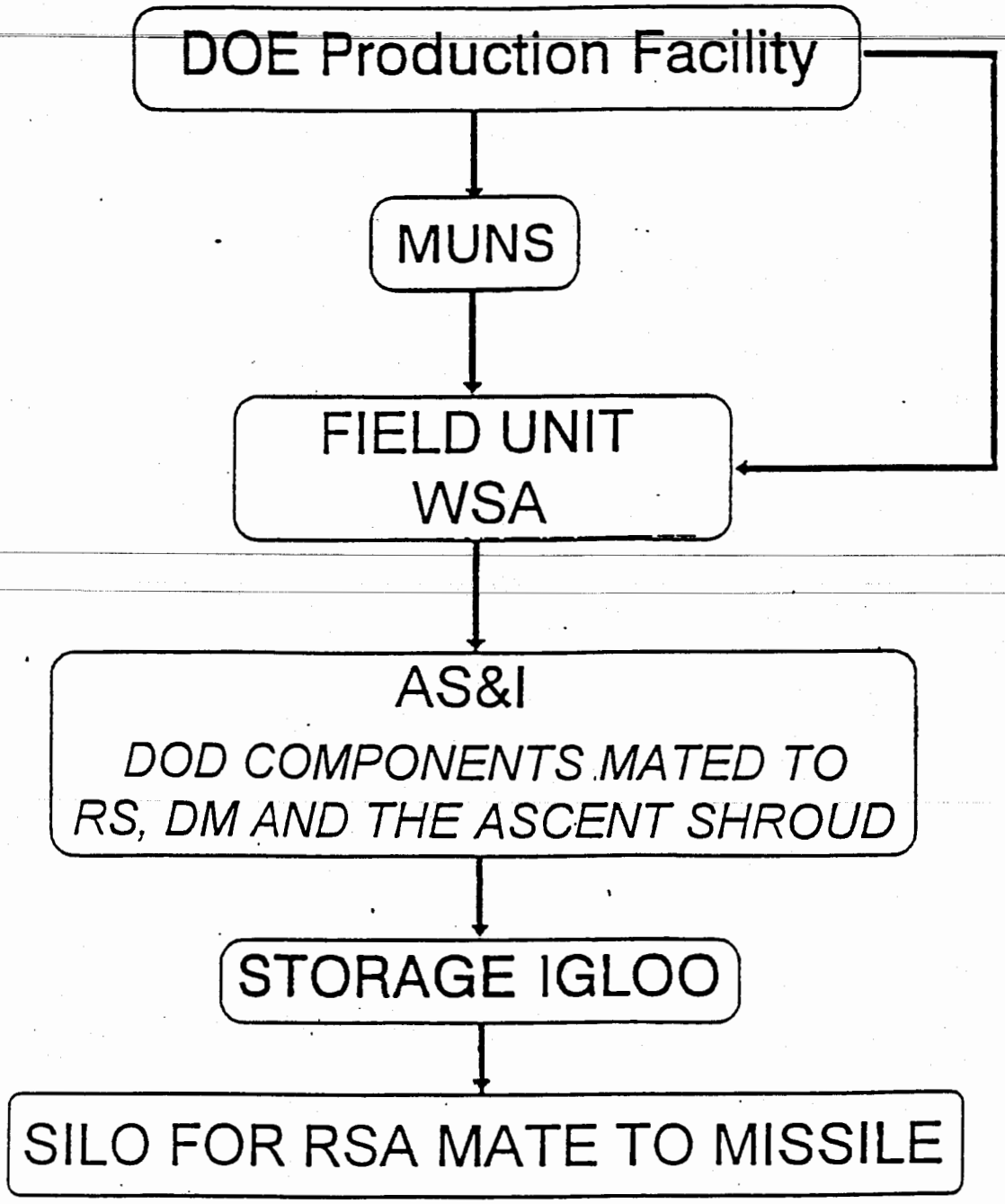

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Figure 2-1 Warhead Logistic Flow Diagram (U)

provide the SMSB with the required number of warheads. The warheads will be stored at the SMSB in the weapon storage area (WSA). Depot level maintenance will be provided for warhead test and handling equipment, warhead trainers, spares, and DOD provided support equipment.

2.2.4 (U) Weapon Storage Area (WSA). The WSA will be provided by the using organization and is manned by AFSPC personnel. Figure 2-2 shows the typical orientation of the WSA. Upon arrival at the WSA the warhead assembly, in its S/SC, is taken to the RS AS&I receiving and inspection area where the container is inspected for damage, and the warhead serial number is verified. After a satisfactory inspection, the unit may be placed in temporary storage in a DOE shipping container or prepared for assembly with RS components. The RS components arrive at the WSA as major subassemblies in DOE or DOD shipping containers. The RS is assembled and tested at the munitions facility by AFSPC personnel. The RS and the ascent shroud are mated to the DM to complete assembly of the RSA. The RSA, in a nose-up position, is mounted on a pallet for transportation. The RSA is stored in the storage facility or transported to the silo for mating to the missile. The RSA is capable of being transported only in the vertical position.

2.2.5 (U) Launch Silo. The Payload Transporter (PT) moves the RSA from the AS&I to the launch silo. Here it is transferred in the RSA carriage from the container into the emplacer. An environmental cover provides some protection to the RSA during transfer. The RSA carriage is locked to the emplacer rails, the RSA sling is attached to the emplacer hoist and the RSA is lowered into the silo and attached to stage IV of the missile. Acceptance checks are made and the missile is readied for strategic alert. Figures 2-3 and 2-4 show the PT Van and the PT III Van.

2.3 (U) Storage. The RS and the RSA encounter a variety of storage environments within the STS flow of events. The length of time associated with the storage requirements will also vary. At the WSA, the WXX HPRF, in its S/SC, will be subjected to ambient, uncontrolled temperature and humidity within the storage igloo. All other storage environments will be controlled to the extent of the design requirements for the structure.

2.4 (U) Transportation and Handling. The warhead, while in the S/SC, RS, or RSA, will be subjected to many types of transportation and handling equipment. Methods of transportation and handling are given in Table 2-1.

2.5 (U) **Maintenance.** The three levels of authorized maintenance are organizational, intermediate and depot; however, maintenance should be accomplished at the lowest possible level and it should be simple, safe, and use existing support equipment where practical.

2.5.1 (U) Organizational. Line Replaceable Unit (LRU) removal and replacement will be performed by AFSPC crews at the organizational level. This level of maintenance will restore a missile to alert status or prevent loss of alert status. No RSA or RS maintenance actions will take place at the organizational level.

2.5.2 (U) Intermediate. Intermediate level maintenance is performed by TBD personnel in the WSA. The AS&I will be the key maintenance repair area for RS/RSA and will be the only facility accomplishing RS/RSA build-up and repair activities. Maintenance activities on the RS which could affect DOE components will be

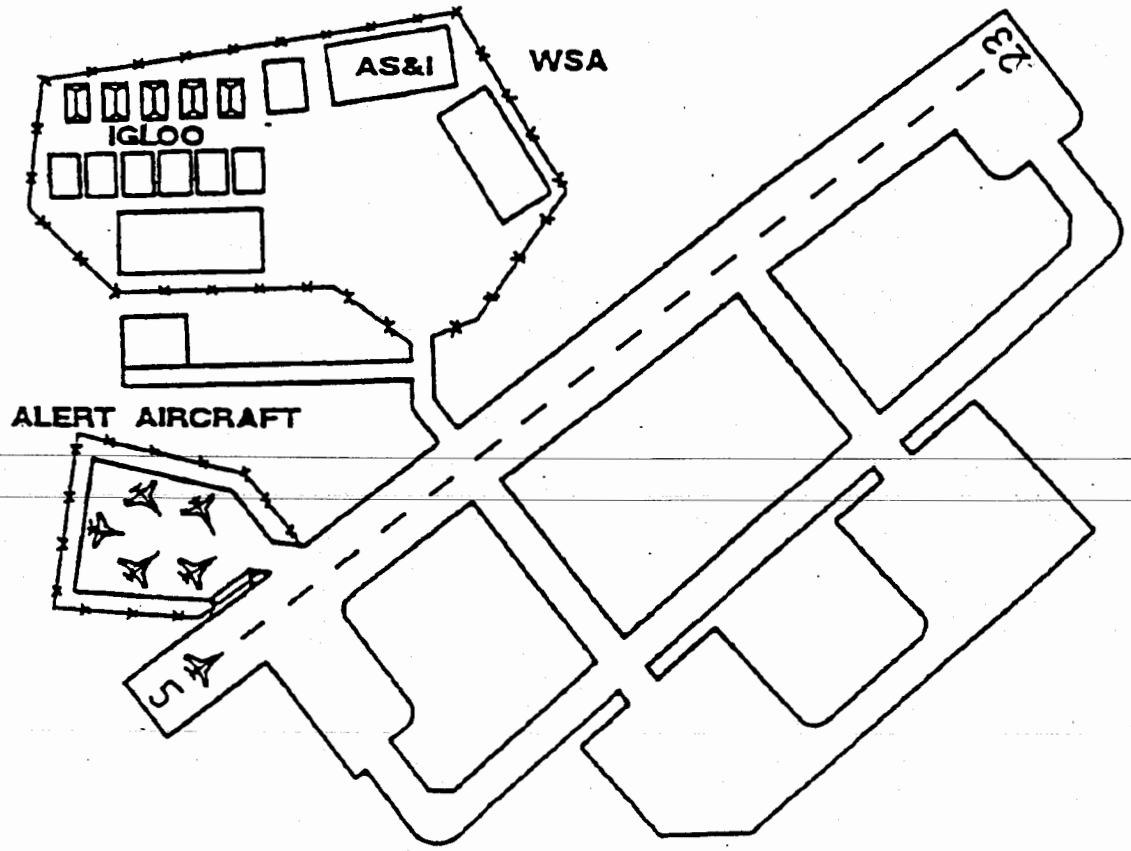

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Figure 2-2 Typical Orientation of Weapons Storage Area (WSA) (U)

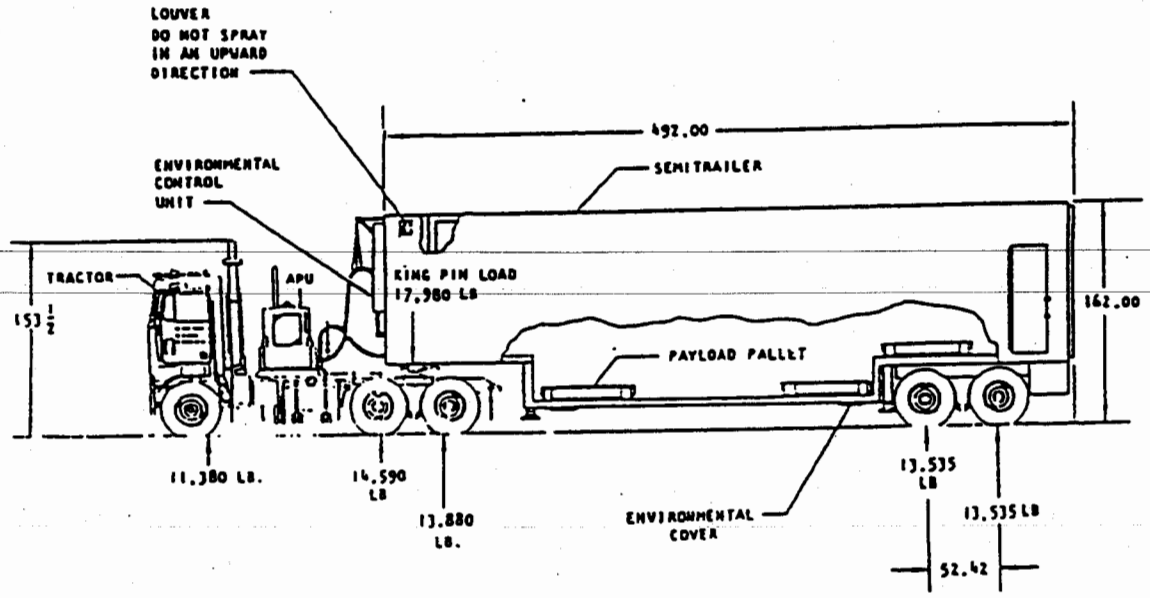

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Figure 2-3 Payload Transporter (PT) Van (U)

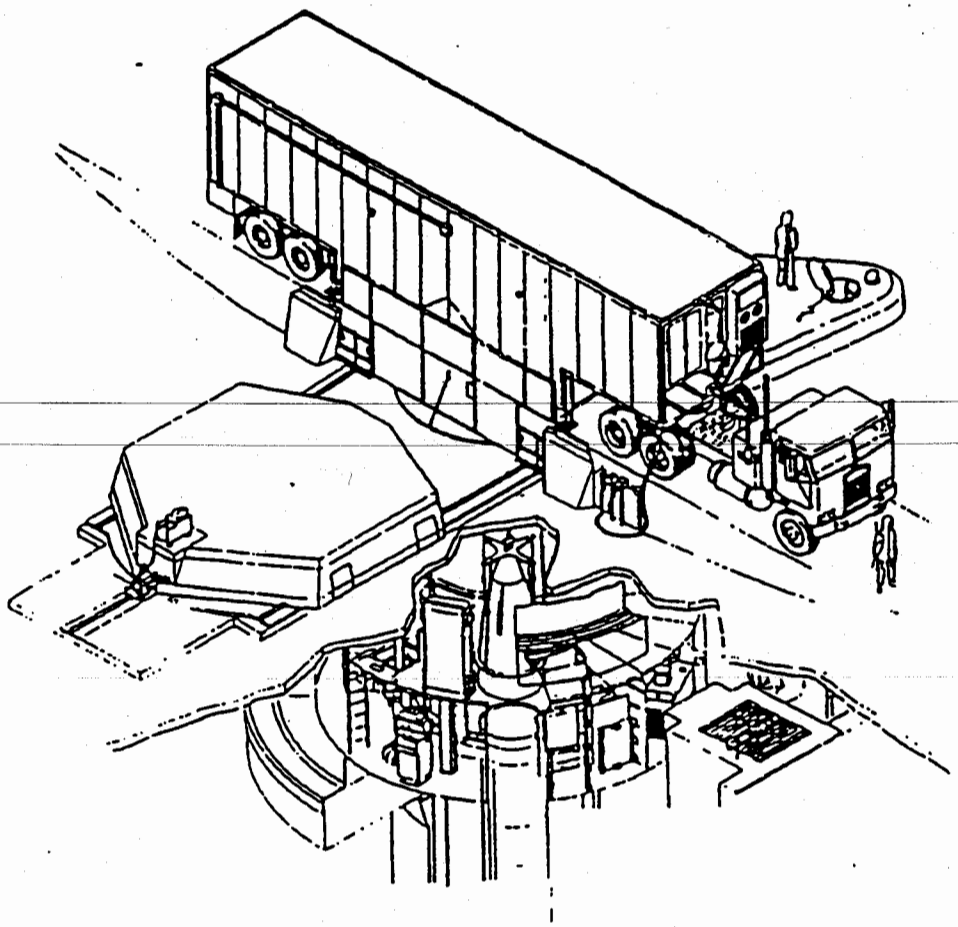

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Figure 2-4 Payload Transporter (PT) III Van (U)

TRANSFER POINT	PRIMARY METHOD	SECONDARY METHOD	CONFIGURATION
DOE TO OSS OR MOB	SAFE SECURE TRAILER		
OSS UNLOAD/LOAD AREA (SST) TO STORAGE OR MAINTENANCE AREA	25 FT FLATBED 40 FT FLATBED	FORKLIFT	WARHEAD ASSEMBLY IN SHIPPING AND STORAGE CONTAINER
WSA UNLOAD/LOAD AREA (SST) TO AS&I FACILITY	FORKLIFT		
OSS STORAGE TO 25/40 FT FLATBED	FORKLIFT		
OSS TO FLIGHTLINE	25 FT FLATBED 40 FT FLATBED		
OSS TO MOB	MILITARY AIR CARGO		
AIRCRAFT TO 25/40 FT FLATBED	FORKLIFT		
FLIGHTLINE TO AS&I FACILITY	25 FT FLATBED 40 FT FLATBED 40K LOADER		
AS&I FACILITY	FORKLIFT	OVERHEAD HOIST	
SHIPPING CONTAINER TO RS MAINTENANCE STAND	OVERHEAD HOIST WITH RS MATING AND HANDLING SLING		WARHEAD ASSEMBLY
RS MAINTENANCE STAND TO BALL-LOCK STAND			REENTRY SYSTEM
BALL-LOCK STAND TO RSA MAINTENANCE STAND		NONE	REENTRY SYSTEM ASSEMBLY
RSA MAINTENANCE STAND TO RSA PALLET	OVERHEAD HOIST		
RSA PALLET TO PAYLOAD TRANSPORTER	PAYLOAD TRANSPORTER HOIST	NONE	
RSA TO MISSILE SITE	PAYLOAD TRANSPORTER	NONE	
PAYLOAD TRANSPORTER TO MISSILE	PAYLOAD TRANSPORTER HOIST	NONE	

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Table 2-1 Methods of Transportation and Handling (U)

follow these standards unless otherwise noted.

3.1.5.1 (U) **Configuration.** The environment specified is that applied to the external boundaries of any assembled configuration containing the warhead during the applicable stage unless otherwise stated. Table 3-1 displays how to use each environment table.

3.1.5.2 (U) **Level of Environments.** During initial system design, warhead level environments are not always available and system level estimates are included. When this is the case, the external boundary of the configuration will be specified.

3.1.5.3 (U) **Descriptions of Data.** In this STS, the actual environments or environmental requirements will be used as the limits for data. Weapon designers will account for their own margin of safety in design and reliability computation. Where a figure contains data that are intensified or incorporate a safety margin, the extent of the intensification will be noted in the figure.

3.1.5.4 (U) **Environmental Specifications.** Environmental specifications and operational requirements will change over time. In particular, the method of presentation for climatic conditions has been changed from MIL-STD-210B (1974)[5] to the current MIL-STD-210C (1987).[6] In a very few cases, the new data may have made the environmental specifications more stringent. Definitions used in MIL-STD-210C are as follows:

3.1.5.4.1 (U) One percent extreme/risk/value is an environment which occurs roughly 1 percent of the time, e.g., if a temperature occurs or is exceeded for an average of seven hours in a 31 day month (744 hours). A 5, 10, and 20 percent (extreme/risk/value) can be defined in like manner.

3.1.5.4.2 (U) 10, 30, and 60 year extremes are long-term climatic values that are expected to occur at least once, for a short duration (less than three hours), during approximately 10, 30, and 60 years of exposure.

3.1.5.4.3 (U) MIL-STD-210C recommends that design and testing efforts generally consider the 1 percent extreme data points rather than the most extreme values ever recorded. This assumes acceptance of some level of degradation under conditions of maximum environmental stress. Engineering analyses and cost/capability trade-offs will be required to determine the final design parameters of a munition. Some areas where the 1% extreme is not recommended as guideline are:

- extreme cold temperature - use 20% extreme;
- rainfall - use 0.5% extreme;
- hail - use 0.1% extreme where human life is involved; and
- pressure - use most extreme values.

3.1.5.5 (U) **Multiple Effects.** The compounding of effects caused by both natural and induced environments may be more than the sum of the individual effects and must be considered. Any situations of worst case synergism must be examined. Fragmentation, dropping, or crush prior to or during exposure to a fire with subsequent exposure to fire fighting chemicals is an example.

3.2 (U) **Normal Environments.** The following sections describe the single normal environments for the WXX HPRF warhead.

3.2.1 (U) **Normal Biological Environments.** A summary of normal biological environments is presented in Table 3-2.

3.2.2 (U) Normal Thermal Environments. A summary of normal thermal environments is presented in Table 3-3.

3.2.3 (U) Normal Pressure Environments. A summary of normal pressure environments is presented in Table 3-4.

3.2.4 (U) Normal Humidity Environments. A summary of normal humidity environments including absolute and relative humidity is presented in Table 3-5.

3.2.5 (U) Normal Precipitation Environments. A summary of normal precipitation environments is presented in Table 3-6.

3.2.6 (U) Normal Wind Environments. A summary of normal wind environments is presented in Table 3-7.

3.2.7 (U) Normal Suspended Particles Environments. A summary of normal suspended particles environments is presented in Table 3-8.

3.2.8 (U) Normal Chemical Environments. A summary of normal chemical environments is presented in Table 3-9.

3.2.9 (U) Normal Electromagnetic Radiation Environments. A summary of normal electromagnetic radiation environments is presented in Table 3-15.

3.2.10 (U) Normal Electrical Environments. Normal electrical environments include lightning and electrostatic discharge and are summarized in Table 3-17.

3.2.11 (U) Normal Mechanical Environments. These environments are described in terms of shock, vibration, acceleration, and acoustics. Shock is considered to be rapidly changing large accelerations of short duration.

3.2.11.1 (U) Normal Shock Environments. A summary of normal shock environments is provided in Table 3-18.

3.2.11.2 (U) Normal Vibration Environments. A summary of normal vibration environments is provided in Table 3-19.

3.2.11.3 (U) Normal Acceleration Environments. A summary of normal acceleration environments is provided in Table 3-22.

3.2.11.4 (U) Normal Acoustic Environments. A summary of normal acoustic environments is provided in Table 3-24.

3.2.12 (U) Normal Nuclear Environments. Nuclear environments are those environments caused by a nuclear event. They are presented in this STS in four categories--blast, thermal, radiation and electromagnetic pulse (EMP). Table 3-25 summarizes these environments.

Stage	Environment
1 Transportation	*If there are no line between stages in any column, the requirement applies to all stages*
2 Storage	
3 Handling & Assembly	
4 Transportation Handling	
5 Preflight	*If there are lines between stages in any column, the requirement applies to the stages bounded by the lines.*
6 Powered Flight	
7 Ballistic Flight	

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Table 3-1 Warhead Configurations (U)

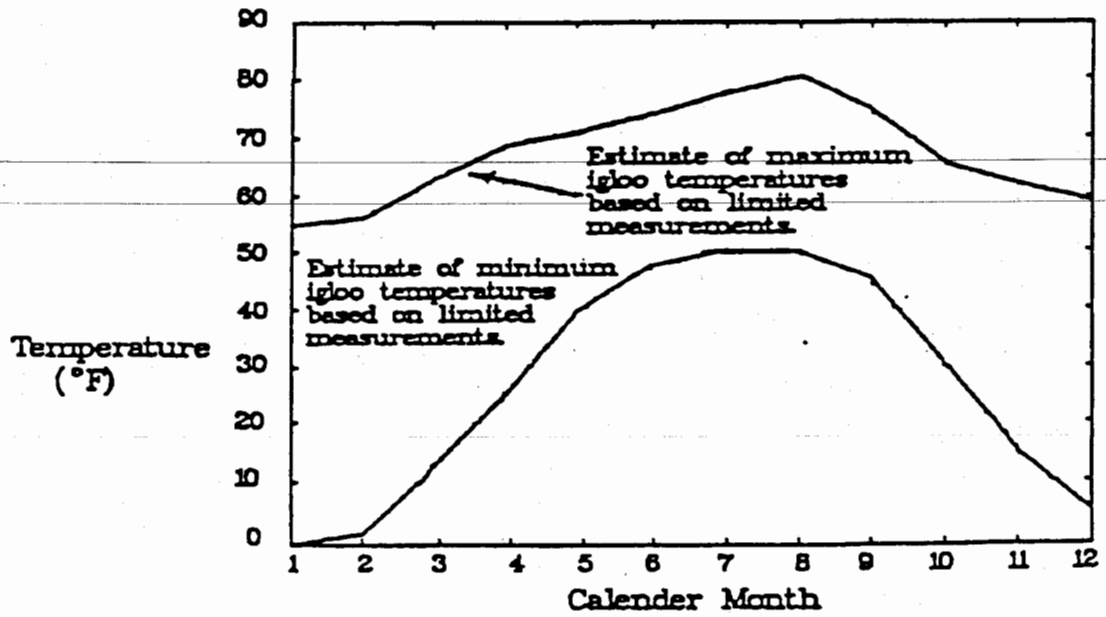

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Figure 3-1 Igloo Storage Temperatures (Hot and Cold) (U)

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Stage	Pressure	
1 Transportation	Sea Level:	The worldwide surface record high atmospheric pressure is 1083.8 mb. The worldwide surface low atmospheric pressure recorded was 870 mb in the eye of a typhoon.
2 Storage	1.8 km Extremes: (6 kft)	High: 840 mb Low: 750 mb
	Pressurized Cargo A/C:	Kept at nominal 586 mb.
	Pressure Shock:	586 mb to 190 mb in 3 seconds (decompression at 12 km est.)
3 Handling & Assembly	Air Density Extremes:	High: 1.783 kg/m^3 - highest recorded Low: 0.707 kg/m^3 @ 4.5 km
4 Transportation Handling	TBD	
5 Preflight		
6 Powered Flight	High: 1083.8 mb - highest recorded Low: 0 mb - exoatmospheric. 1.08 - 0 kg/cm^2 in about 120 sec.[11]	
7 Ballistic Flight	0 kg/cm^2 for up to 55 min.[11] Low: 0 mb - exoatmospheric.	

Note: MIL-STD-210C bases low atmospheric pressure and low surface density on the highest elevation contemplated for ground military operations: 4572m.

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Table 3-4 Normal Pressure Environments (U) [6,10,11]

Stage	Humidity
1 Transportation	High Absolute: 1% extreme: 30,000 ppm @ 37-41°C Low Absolute: 1% extreme: 5.2 ppm @ frost point of -26°C
2 Storage	High RH with High Temperatures: (1%) 100% @ 26 to 27°C High RH with Low Temperatures: (20%) 100% @ -51°C
3 Handling & Assembly	Low RH with High Temperature: 3% @ 49°C Low RH with Low Temperature: Not available
4 Transportation Handling	
5 Preflight	
6 Powered Flight	
7 Ballistic Flight	

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Table 3-5 Normal Humidity Environments (U) [6]

Stage	Wind
1 Transportation	Surface Winds: 1% extreme: 1 min steady: 22 mps gust: 32 mps
2 Storage	N/A
3 Handling & Assembly	Same as Stage 1 N/A during indoor maintenance
4 Transportation Handling	N/A
5 Preflight	
6 Powered Flight	
7 Ballistic Flight	

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Table 3-7 Normal Wind Environments (U) [6]

Stage	Suspended Particles
1 Transportation	Sand and Dust: - Size: 0.1 to 1000 µm; most airborne particles smaller than 74 µm Hardness: 1 to 9 Mohs Typical Concentrations: 0.177 gm/m^3 (natural conditions) 1.06 gm/m^3 (surface vehicles/unpaved road) Airborne Salt: pH 8.1 - 8.3 (in air) Size: 0.1 - 20 µm radius; 98% larger than 8 µm Concentration: rain: approx. 1 ppm limited to altitudes below 3 km; 33-40 parts/1000 in coastal areas Fallout: estimated between 1.8-45 kg/acre/year in U.S.
2 Storage	Expected to be less than 10% of that for Stage 1
3 Handling & Assembly	Same as Stage 1 Same as Stage 2 during indoor maintenance.
4 Transportation Handling	N/A
5 Preflight	
6 Powered Flight	
7 Ballistic Flight	

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Table 3-8 Normal Suspended Particles Environments (U) [6,12]

Stage	Chemicals
1 Transportation	Surface preservatives/solvents/thinners for maintenance: As specified in the appropriate Technical Orders; see Table 3-10. Fuels: See Table 3-11. Exposure will involve only limited areas Fire Fighting Chemicals: See Table 3-12.
2 Storage	Hydraulic Fluids: Air Force approved hydraulic fluids and their chemical characteristics are contained in MIL-H-5605E and MIL-H-83282. Lubricants: Aircraft engine lube oils and their chemical characteristics are specified in MIL-L-7808J. Representative lubricants are listed in Table 3-13.
3 Handling and Assembly	Exposure will involve only limited areas for up to 48 hr. Natural: Ozone; see Table 3-14.
4 Transportation Handling	N/A
5 Preflight	
6 Powered Flight	
7 Ballistic Flight	

Note: Incidental exposure to these chemicals can be treated as normal environments when followed by maintenance procedures specified in the appropriate Technical Order.

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Table 3-9 Normal Chemical Environments (U) [6,13,14,15,16]

Cleaning Solvents

Cleaning Solvent	Remarks	Expected Exposure Times	Expected Exposure Areas
Isopropyl Alcohol	Removes fungus growth from rubber surfaces	5 min	Limited areas
5% solution of germicidal and fungicidal disinfectant	Removes fungus growth from unpainted surfaces.		
Trichloroethylene*	For cleaning painted surfaces only		

Thinners

Thinners		Expected Exposure Times	Expected Exposure Areas
Acetone	Aliphatic Naphtha	5 min	Limited areas (not total inundation)
Dope and Lacquer	Methyl Ethyl Ketone*		
Methyl Isobutyl Ketone*	Mineral Spirits		
Toluene*	Xylene*		

Surface Preservatives

Surface Preservation	Surface	Constituents	Remarks
Alodine*	Aluminum	Nitric Acid Chromium Trioxide	Protects aluminum alloy parts from corrosion. Primarily used for touch-up work on previously coated surfaces.
Chromic Acid Solution*	Magnesium	10 gm Chromium Trioxide 7.5 gm Calcium Sulfate 1.0 liter water	For repair of magnesium surfaces with scratches that expose bare metal. Coating should be followed by an organic finish.
(Kit. resin-acid)	Steel	80 v/o resin compound 20 v/o acid compound v/o = % by volume	For repair of cadmium or zinc plated steel surfaces with scratches or other defects. Coating should be followed by an organic finish.
Primer	____	Vinyl-Zinc Chromate	Used as required.
Organic Finish	____	Vinyl-Alkyd Paint	
Epoxy Resin Epoxy Polyamide Polyurethane Coating Compound	____	____	For repairing surface preservations.

*Under Review

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Table 3-10 Representative Maintenance Chemicals (U) [13]

Castrol 399	PQ Turbine Oil 4236
Brayco 880	PQ Turbine Oil 4706
Delta Jet Lube 7808	AO Syn Jet III
Exxon Turbo Oil 2389	PQ 4707
Hatcol 1278	RM 248A
Hatcol 1280	Rm 272
Matrex AF Oil 01	Turbonycoil 160
Matrex AF Oil 02	Royco 808
Matrex AF Oil 07	Aeroshell Turbine Oil 308
PQ Turbine Oil 8365	Technolube Synturbo #3
PQ Turbine Oil 9900	Synturbo #3B

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Table 3-13 Representative Lubricants (U) [16]

Altitude (km)	Ozone Concentration ($\mu g/m^3$)
0	220
1	205
2	190
4	170
6	170
8	460
10	735
12	865
14	975
16	1110
18	1075
20	845

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Table 3-14 Ozone Concentrations at Altitudes (U) [6]

Stage	Electromagnetic Radiation
1 Transportation	See Table 3-16 and Figure 3-2.
2 Storage	Assumed to be negligible in earth-covered igloos.
3 Handling & Assembly	See Table 3-16 and Figure 3-3. See Figures 3-2, 3-4 and 3-5.
4 Transportation Handling	
5 Preflight	TBD
6 Powered Flight	
7 Ballistic Flight	

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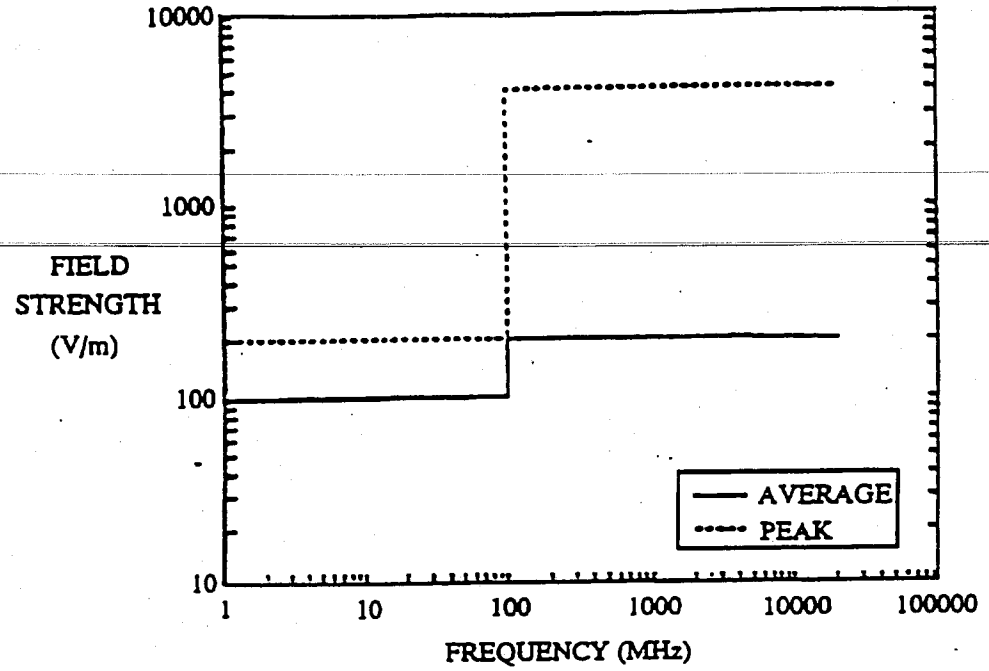
Table 3-15 Normal Electromagnetic Radiation Environments (U) [17-23]



Note: For testing purposes only, assume maximum duty cycle of 5% and a pulse repetition frequency of 2500 Hz.

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Figure 3-2 EMR Field Strengths for Stages 1-4 (U) [20-22]

Frequency (MHz)	Power Density (mW/cm^2)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
0.01 - 3	100	632	1.58
3 - 30	$900/f^2$	6.32 (30/f)	0.158 (30/f)
30 - 100	1.0	63.2	0.158
100 - 1000	f/100	63.2 ($f^{0.5}/10$)	0.158 ($f^{0.5}/10$)
100 - 300,000	10	200	0.5

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Note: These levels are averaged over any six-minute period of operation and represent the maximum permissible exposure limits in restricted areas for human exposure to radiofrequency radiation.

Table 3-16 Average EMR Field Strengths in Stages 1-4 (U) [18]

Stage	Electrical
1 Transportation	A nearby lightning strike is considered a normal environment. The lightning environment associated with a nearby flash is by convention the magnetic field produced by a stroke of either 200-kA peak amplitude at a distance of 100 meters or 20-kA peak at 10 meters. See Figure 3-6. A direct lightning attachment to missile silo is considered a normal environment.
2 Storage	The following parameters define the extreme magnetic field due to a nearby lightning strike. Fields greater than this are likely to be accompanied by the direct attachment of the strike to the warhead, thereby constituting an abnormal environment. The electric field from a nearby lightning strike produces system effects several orders of magnitude smaller than those due to the magnetic field of the same strike. The electric field is, therefore, not specified.
3 Handling & Assembly	Lightning Magnetic Field: Maximum Intensity — 320 amperes per meter Maximum Rate of Change of Intensity — 640 amperes per meter per microsecond
4 Transportation Handling	The waveform of the magnetic field due to a nearby lightning strike can be usefully approximated as $$H(t) = \frac{325}{e^{\frac{-(t-t_0)}{0.113}} + e^{\frac{(t-t_0)}{50}}}$$ where t is in μsec and $t_0 = 1.0$ μs.
5 Preflight	Electrostatic Discharge (ESD): The human electrostatic discharge environment is defined as that which results from the discharge of the equivalent electrical model of the human body given in Figure 3-7 due to an initial voltage of like polarity on both capacitors of 25 kilovolts. Other sources of electrostatic discharge are assumed to be less severe than the human model and are enveloped by the human model.
6 Powered Flight	Nearby lightning only - no human ESD.
7 Ballistic Flight	N/A

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Table 3-17 Normal Electrical Environments (U) [24,25]

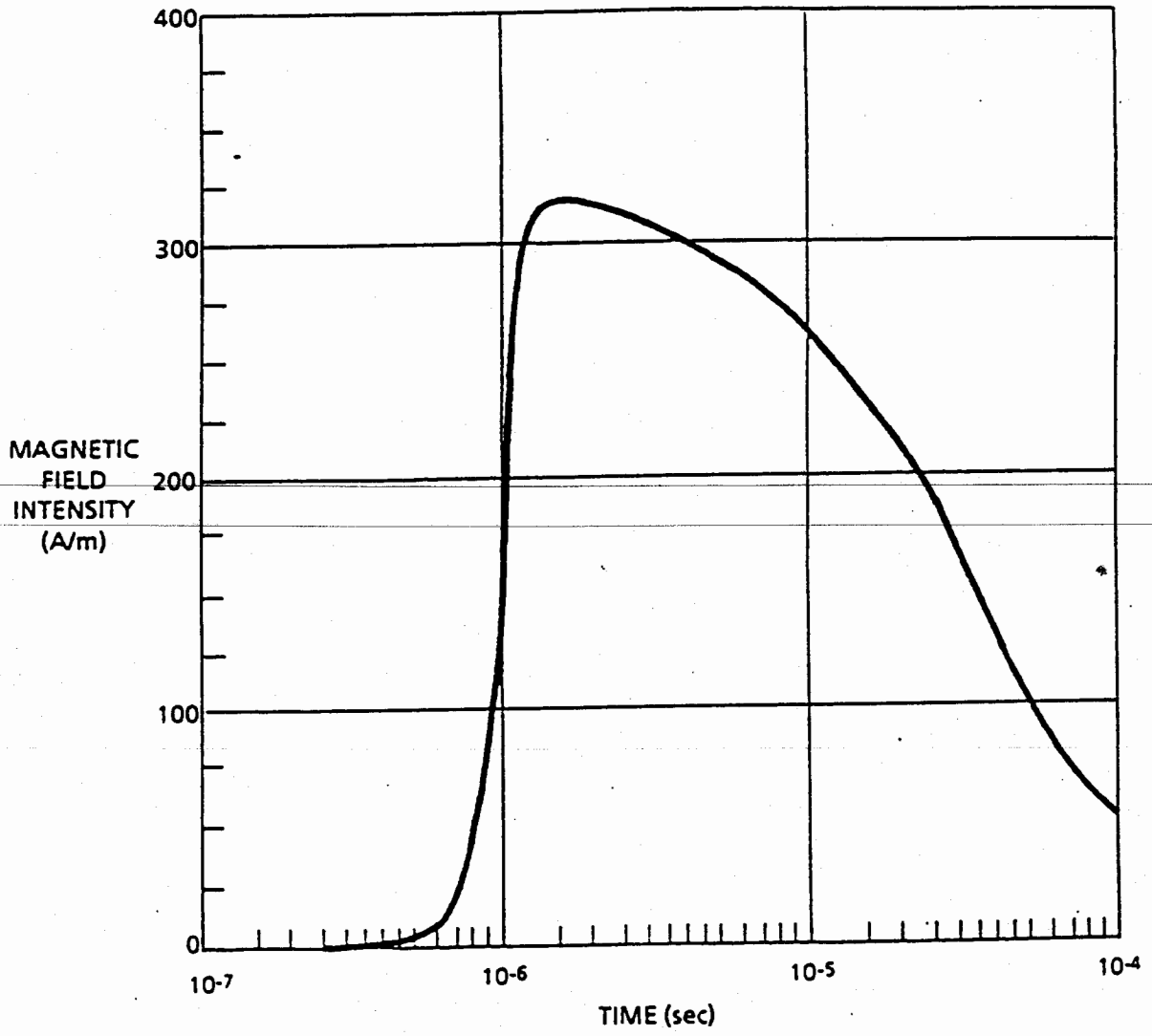
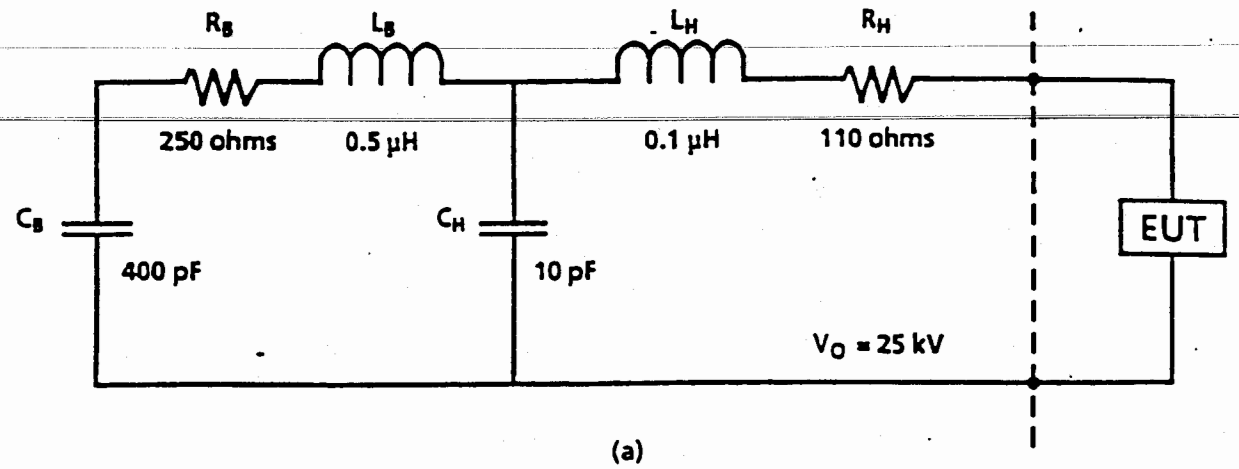
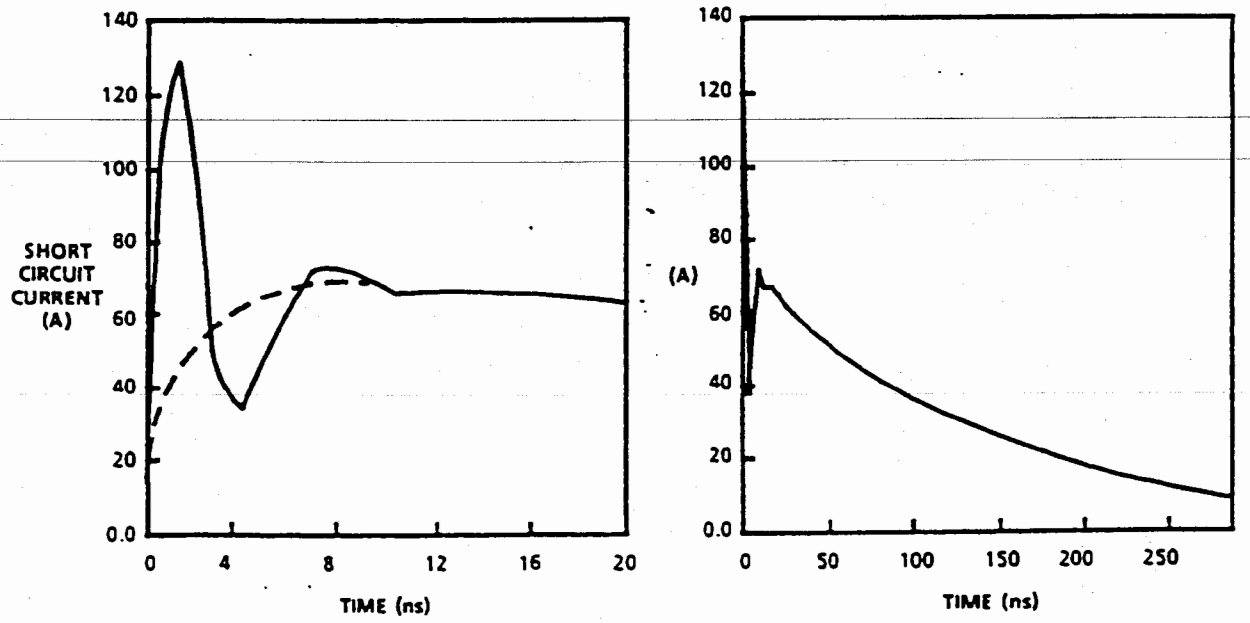


Figure 3-6 Magnetic Field Waveform Resulting from Nearby Lightning (U) [24]



(a)
Human ESD Equivalent Source Circuit



(b) Early Time

(c) Full Duration

Note: This figure represents the recommended human ESD equivalent source circuit and computed discharge current to ground. (The dotted line in (b) represents the component of current due to the main body capacitance.) Both the definition of the worst case ESD waveform from the literature data base and the derivation of a corresponding simulation circuit ignore possible additional return path inductance. That is, in an actual ESD event to a victim system, significant inductance may be present between the system case and the ground against which the person is charged.

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Figure 3-7 Recommended Human ESD Equivalent Source Circuit and Computed Discharge Current to Ground (U) [25]

Stage	Shock
1 Transportation	Truck: See Figure 3-8. Cargo Aircraft: See Figure 3-9.
2 Storage	N/A
3 Handling & Assembly	Forklift: See Figure 3-10.
4 Transportation Handling	See Figure 3-11 (PT III Van)
5 Preflight	N/A
6 Powered Flight	See Figures 3-12, 3-13 & 3-14
7 Ballistic Flight	TBD

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Table 3-18 Normal Shock Environments (U) [26,27]

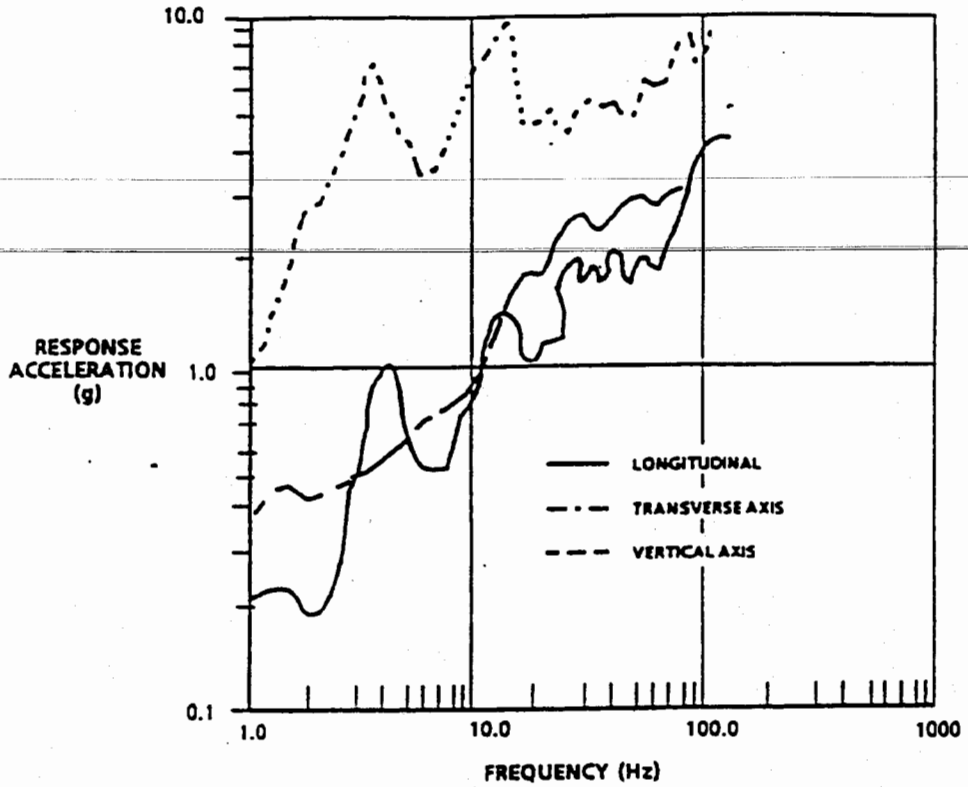

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Figure 3-8 Truck/Tractor-Trailer: Discrete Excitation Model Shock Spectra (3% Damping) (U) [26]

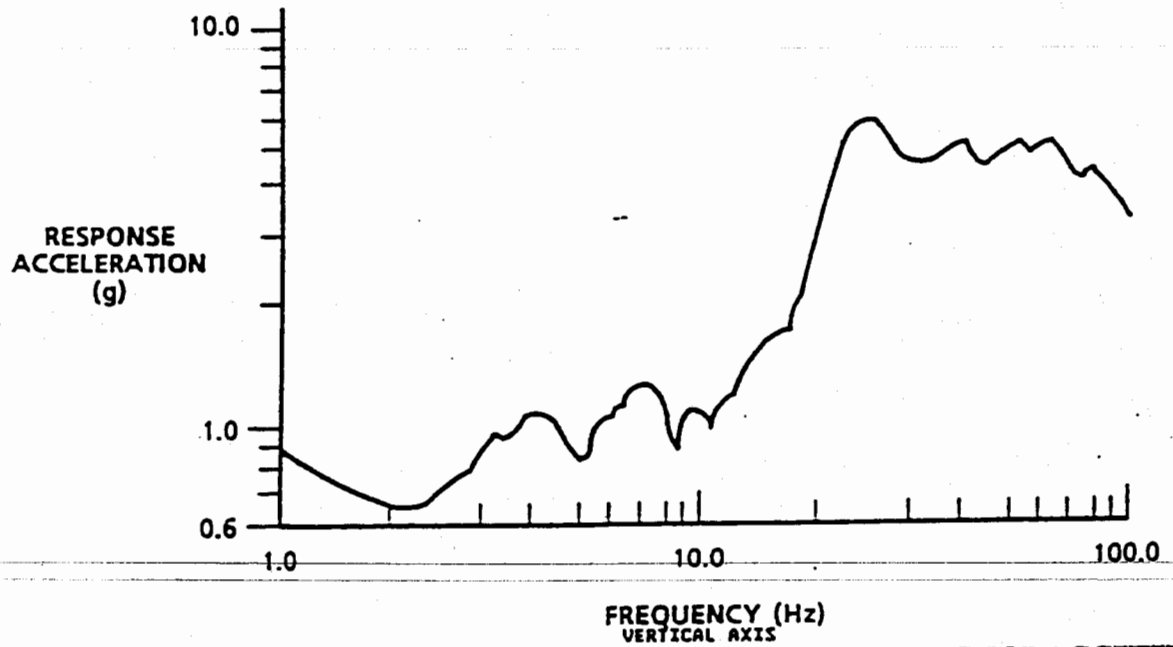

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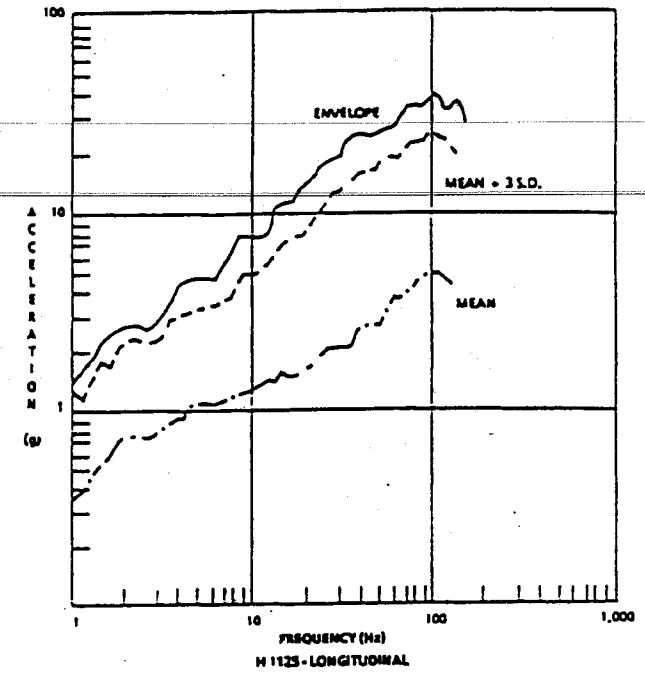
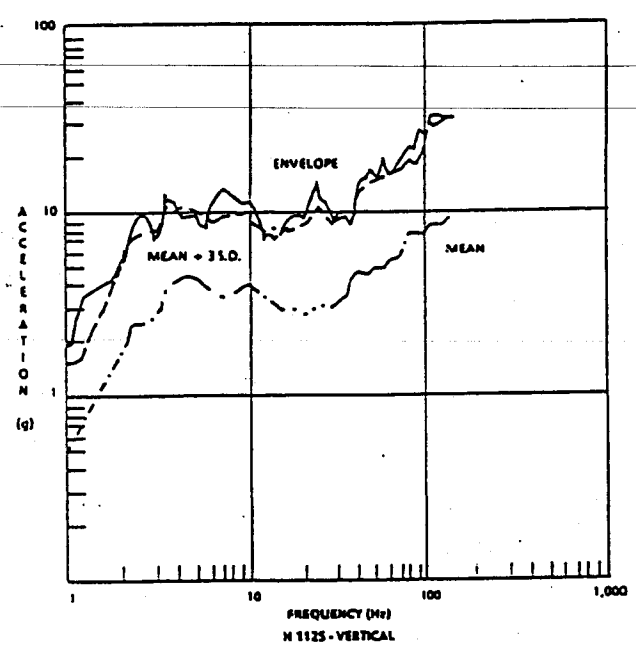
Figure 3-9 Turbojet: Landing Shock Spectra (Representative) (3% Damping) (U) [26]





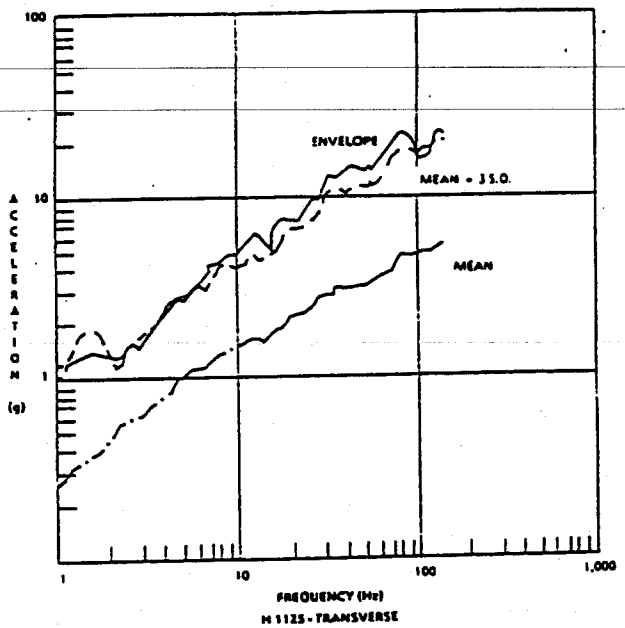


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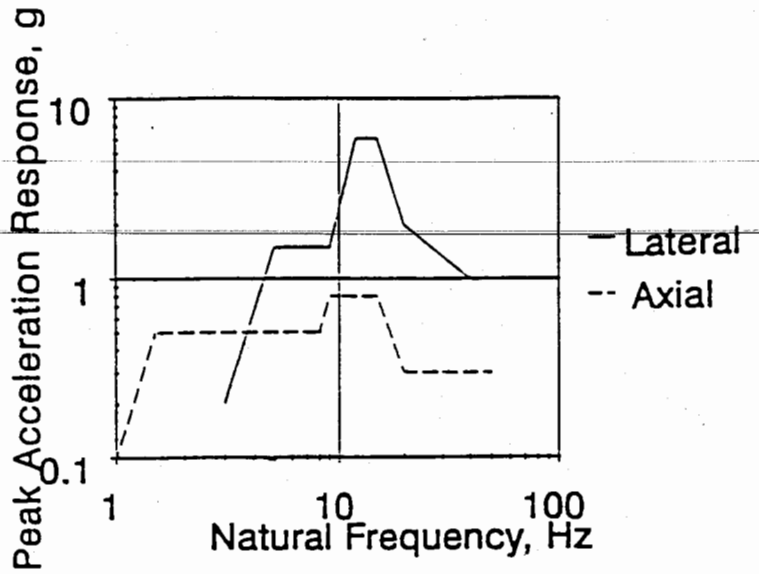
Figure 3-10 Forklift: Summaries of Response Spectra of all Forklift Trucks (U) [27]



Envelopes of RV/PTIII Transport Shock Spectra			
Axial		Lateral	
f,Hz	g	f,Hz	g
1	0.1	3	0.2
1.5	0.6	5	1.5
8	0.5	9	1.5
9	0.8	12	6.0
15	0.8	15	6.0
20	0.3	20	2.0
50	0.3	40	1.0
		50	1.0

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Note: Testing need not be performed below 10 Hz or 70% of lowest resonance, whichever is lowest. If required, shift components of time history which are under lowest frequency of test equipment to above that frequency but under 70% of the RV's, or mounted warhead's, lowest resonance frequency. Lateral peak G of time history=1.0 G, axial peak G of time history=0.3 G.

Figure 3-11 Shock Environment, RS/PTIII Transportation [11]

TBD

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Figure 3-12

DTRA b(1)

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TBD

Figure 3-13

DTRA b(1)

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Stage	Vibration
1 Transportation	Truck: See Figure 3-15. Aircraft: See Figures 3-16 through 3-19.
2 Storage	N/A
3 Handling & Assembly	TBD
4 Transportation Handling	WS-133PT: See Table 3-20. PT III Van: See Figure 3-20.
5 Preflight Carriage	N/A
6 Powered Flight	See Table 3-21*
7 Ballistic Flight	See Figures 3-21 & 3-22

* Powered flight vibration environments are from the W78 STS and are provided for information purposes until better information is available.

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Table 3-19 Normal Vibration Environments (U) [26,28,29]

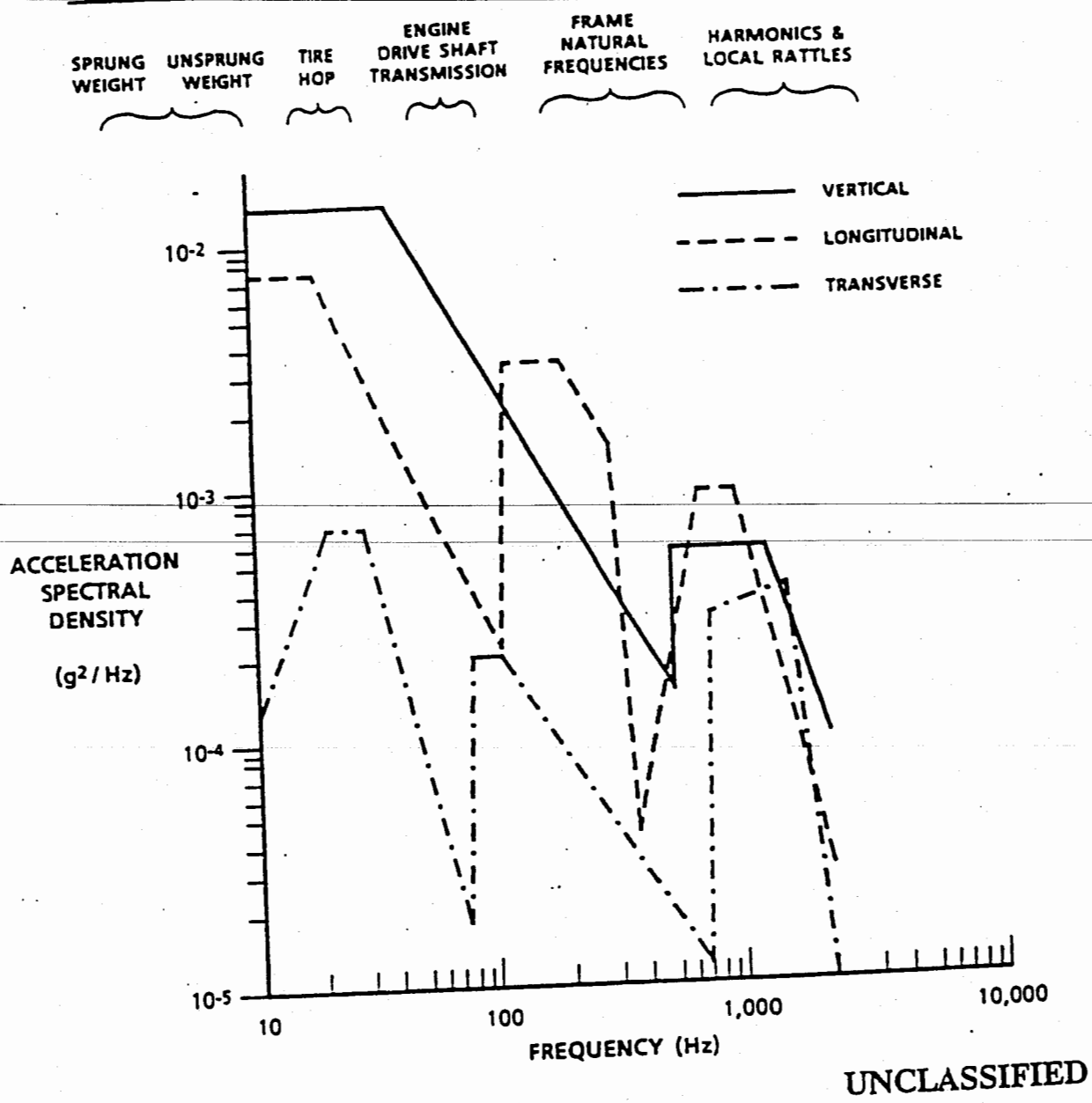

Figure 3-15 Truck/Trailer Transportation (U) [26]

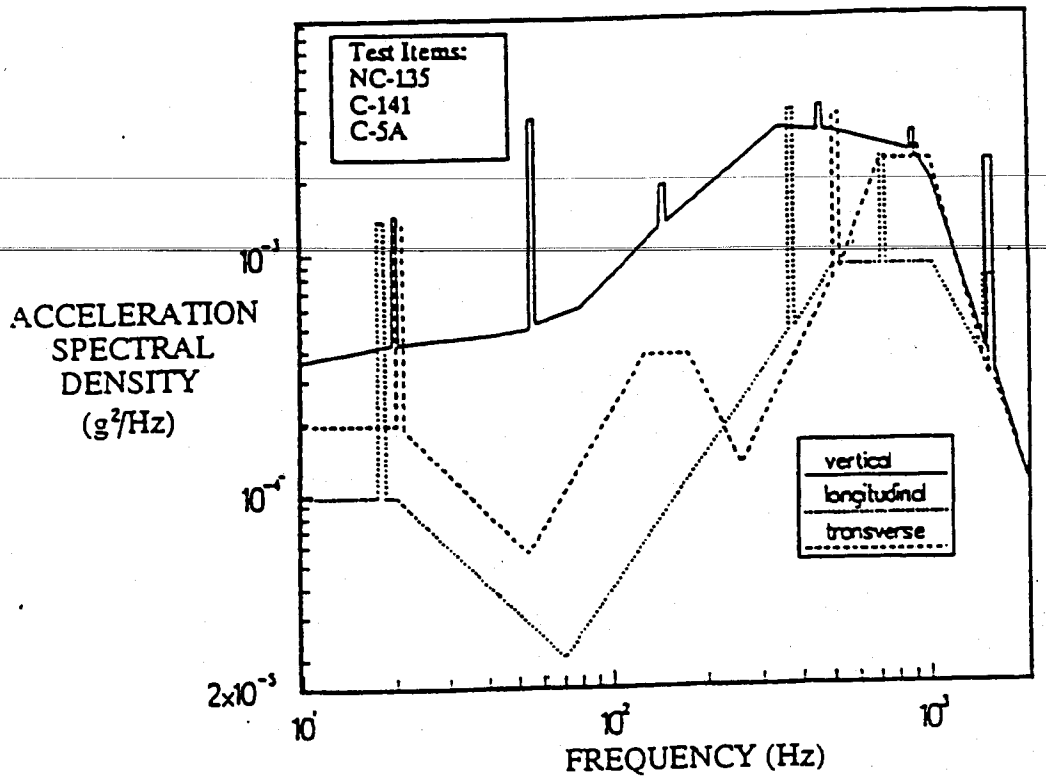

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Figure 3-16 Turbojet Cargo Aircraft (Takeoff/Climb) (U) [26]

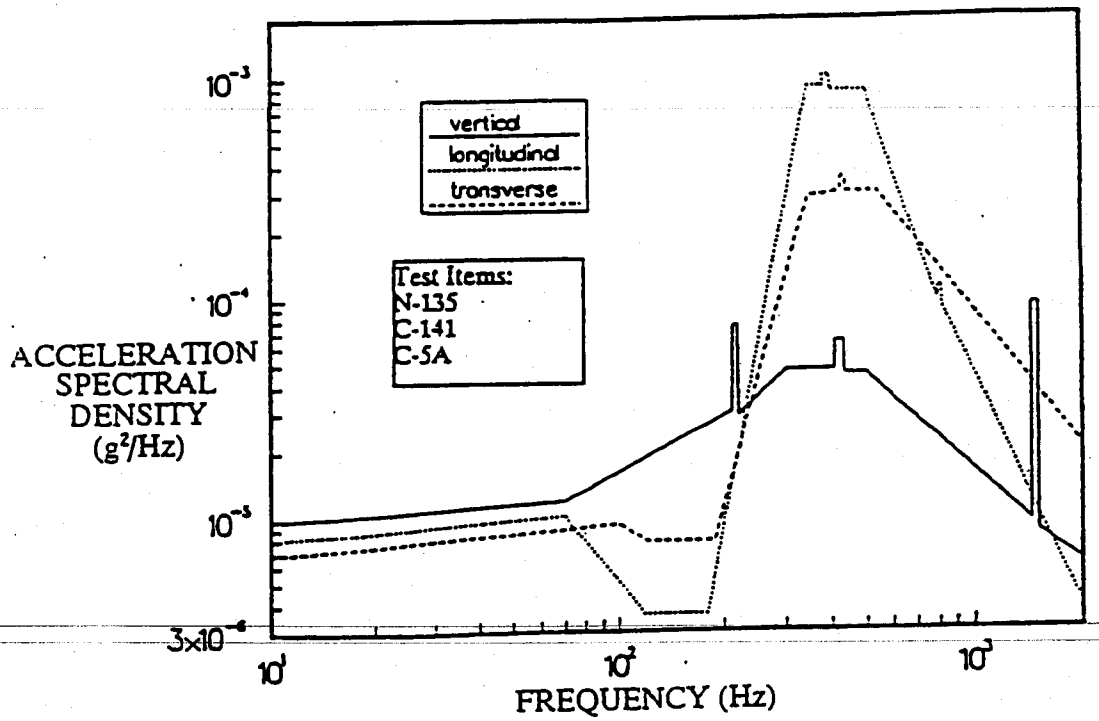

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Figure 3-17 Turbojet Cargo Aircraft (Cruise) (U) [26]

Longitudinal	
Frequency, Hz	**Level, g peak**
< 5	0
5-12	0.5
12-15	Linear decrease in 0.5 to 0.25 (log/log?)
15-300	0.25
>300	0
Transverse	
Frequency, Hz	**Level**
<5	0
5	0.33 inch D.A.
5-7.3	0.33 inch D.A.
7.3-12	0.9 g peak
12-15	Linear decrease in log/log 0.9 to 0.5 g peak
15-30	0.5 g peak
30-35	Linear decrease in log/log 0.5 to 0.25 g peak
35-300	0.25 g peak
>300	0

Note: During Transport of RV by WS-133PT, RV/CG should be limited to 0.8 g in direction of input.

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Table 3-20 Longitudinal and Transverse Axes Vibration Levels at Installation Kit Interface During Stage 4 (U) [28]

Sinusoidal		
Frequency, Hz	Levels, (g) Peak	
	Longitudinal	Lateral
165	0	0
165-350	3.3	1.1
750-900	6.7	2.2
Random (along the longitudinal axis)		
Frequency, Hz	Power Spectral Density, g^2/Hz	
14.4	0.0001	
35-2000	0.0054	

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Table 3-21 Vibration Levels at Installation Kit (Ball Locks) During Stage 6, Powered Flight (U) [28]

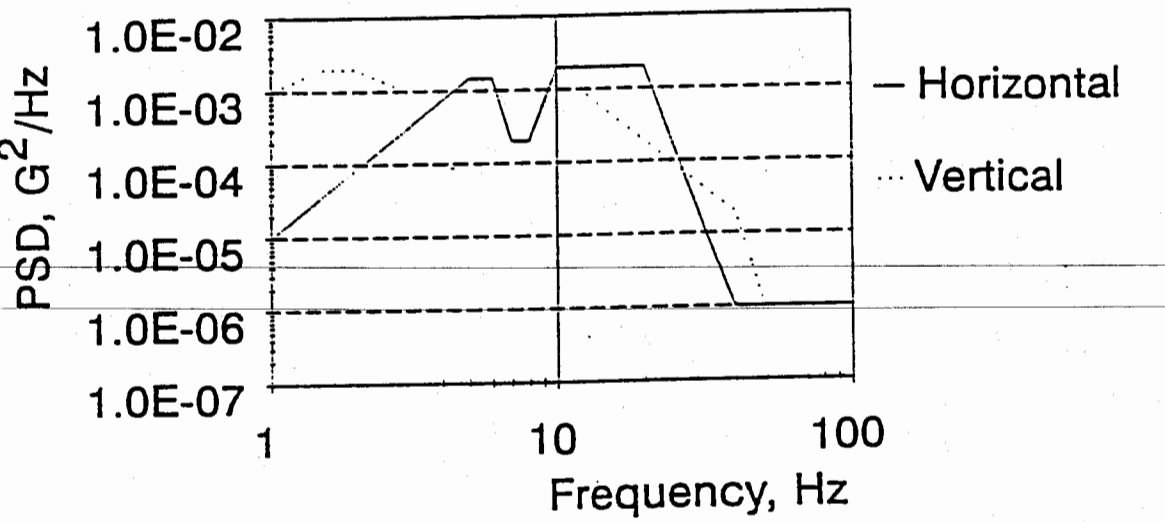

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Figure 3-20 Vibration Environment, RS/PTIII (U) [11]

Stage	Acoustic
1 Transportation	Flight Line: Noise levels vary from 143 dB at 100 ft to 98 dB at 10 kft from fighter aircraft operating with afterburner (re 0.0002 dynes/cm^2). At a fixed distance, the maximum level occurs at about $\pm$140° from aircraft heading. [30]
2 Storage	
3 Handling & Assembly	Cargo Aircraft [29]
4 Transportation Handling	TBD
5 Preflight	
6 Powered Flight	140 dB with no more than 132 dB in any 1/3 octave band up to 10kHz (Reference is 2x10^{-4} dynes/cm^2 [28]
7 Ballistic Flight	TBD

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Table 3-24 Normal Acoustic Environments (U) [28-30]

Stage	Nuclear
1 Transportation	N/A
2 Storage	
3 Handling & Assembly	
4 Transportation Handling	
5 Preflight	Single Burst: See paragraph 3.2.12.1 Multiple Bursts: See paragraph 3.2.12.2 Total Dose: See paragraph 3.2.12.3
6 Powered Flight	Single Burst: See paragraph 3.2.12.4 Multiple Bursts: See paragraph 3.2.12.5 Total Dose: See paragraph 3.2.12.6 See paragraph 3.2.12.10
7 Ballistic Flight	Single Burst: See paragraph 3.2.12.7 Multiple Bursts: See paragraph 3.2.12.8 Total Dose: See paragraph 3.2.12.9 See paragraph 3.2.12.10

Note: The normal nuclear environment from the W78 STS is provided for information purposes.

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Table 3-25 Normal Nuclear Environments (U) [39]

[redacted]

Sections 3.2.12.1 through 3.2.12.10 are TBD. However, information contained within these sections are provided for information purposes acquired from the W78 STS dated November 1994 [11].

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USAF NO

3.2.12.1 (U) Preflight Nuclear Threat (Single Burst). This threat will be directed towards the missile during preflight.

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CG HPRF-1 (d.a)

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&
1

USAF
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USAF
No

CG HPRF-1

3.2.12.6 (U) Powered Flight (Total Ionization Dose). The Total ionization dose is specified in 3.2.12.3 added to that accumulated from exposure to the radiation environments specified in ~~3.2.12.4.1, 3.2.12.4.5, 3.2.12.4.6, 3.2.12.4.7~~ and 3.2.12.5. The total ionization dose includes Compton effect (photon scattering), photofluorescence, inelastic neutron scattering, neutron capture, and charged particle production.

CG HPRF-1

DOE & DTRA & USAF b(3)

3.2.12.7 (S-RD) Ballistic Flight (Single Burst). This threat will occur during Stage 7 (Flight - from Apogee to Detonation) of the STS.

DOE & DTRA & USAF b(3)

CG HPRF-1

3.2.12.7.3 (S-RD) Neutrons. The total neutron fluence is specified in Figure 3-37 as a function of altitude.

Intensity and time history shall include pulse time spreading resulting from a range of neutron energies (velocities), and energy spectrum degradation by air scattering (where appropriate).

DOE & DTRA & USAF b(3) USAF NO

DOE & DTR. & USAF b(3)

CG HPRF-1

CG HPRF-1

3.2.12.7.5 (S-RD) Neutron Induced Ionization. The neutron induced ionization pulse results from exposure to the neutron environment of 3.2.12.7.3.

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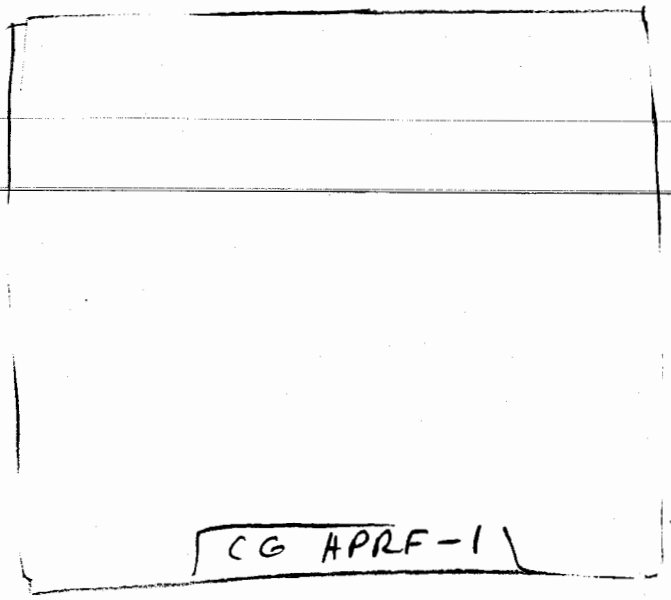
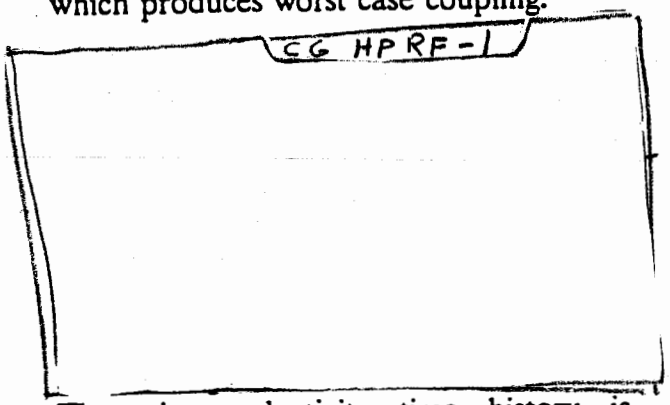


3.2.12.7.8 (U) Electromagnetic Pulse. The electromagnetic pulse environments are of two types with two sets of characteristics:

USAF b(1)

For both types, burst direction will be that which produces worst case coupling.

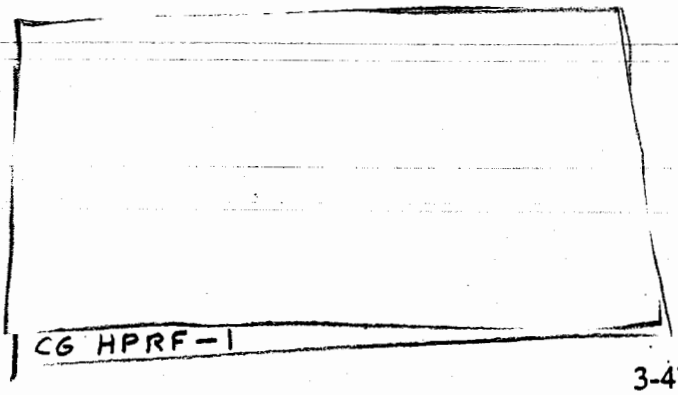
DOE & DTRA & USAF b(3)



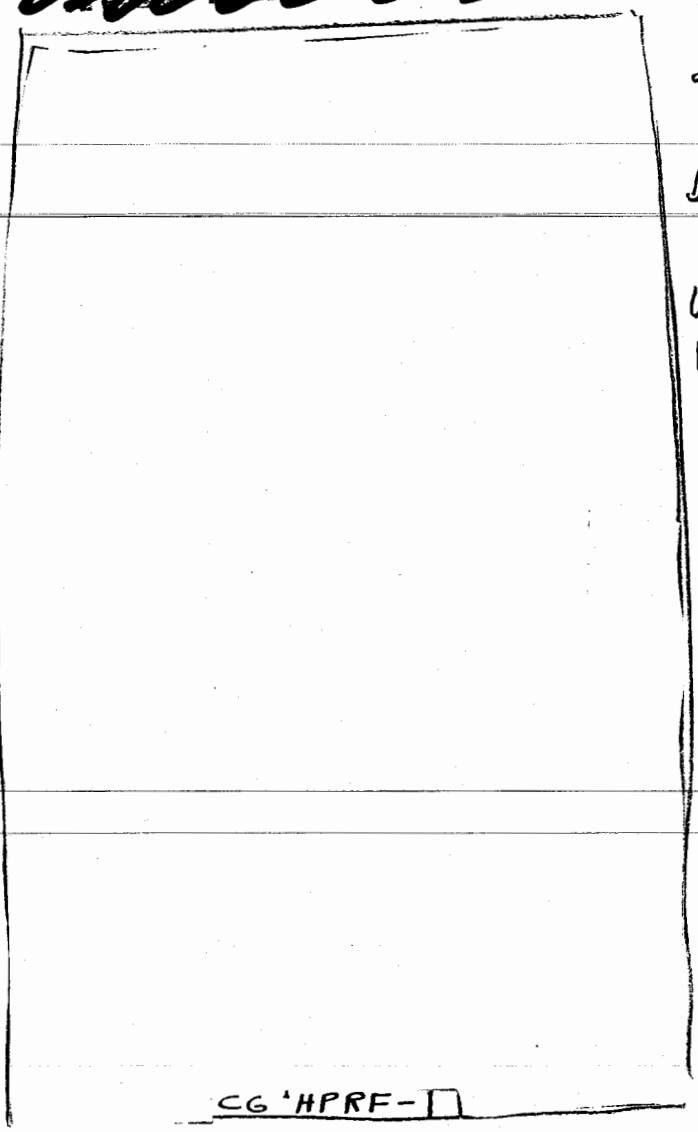
The air conductivity time history is specified in Figure 3-45.

3.2.12.7.10 (S) Distant Bursts. Distant bursts produce electric and magnetic fields as given in 3.2.12.4.8.

DOE & DTRA & USAF b(3)



DOE & DTRA & USAF b(3)



3.2.12.9 (U) Ballistic Flight (Total Ionization Dose). The total ionization dose is specified in 3.2.12.6 added to that accumulated from exposure to the radiation environments specified in 3.2.12.7.1, 3.2.12.7.5, 3.2.12.7.6, and 1.25 times that specified in 3.2.12.7.7. Total ionization dose includes Compton effect (photon scattering), photofluorescence, inelastic neutron scattering, neutron capture, and charged particle production.

3.2.12.10 (U) Fireball Thermal Radiation. The time history of the environment at the location of the reentry vehicle is specified in Figure 3-48.

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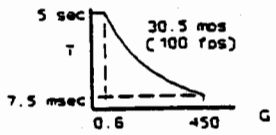
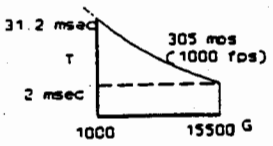
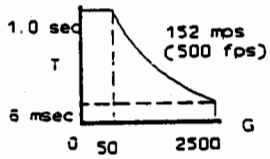
Shock: [5]
Ground Transport — as defined by the curve to the right.



Air Transport — as defined by the curves below.





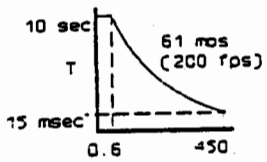


Figure 3-49 Abnormal Shock Environments (U) [11]

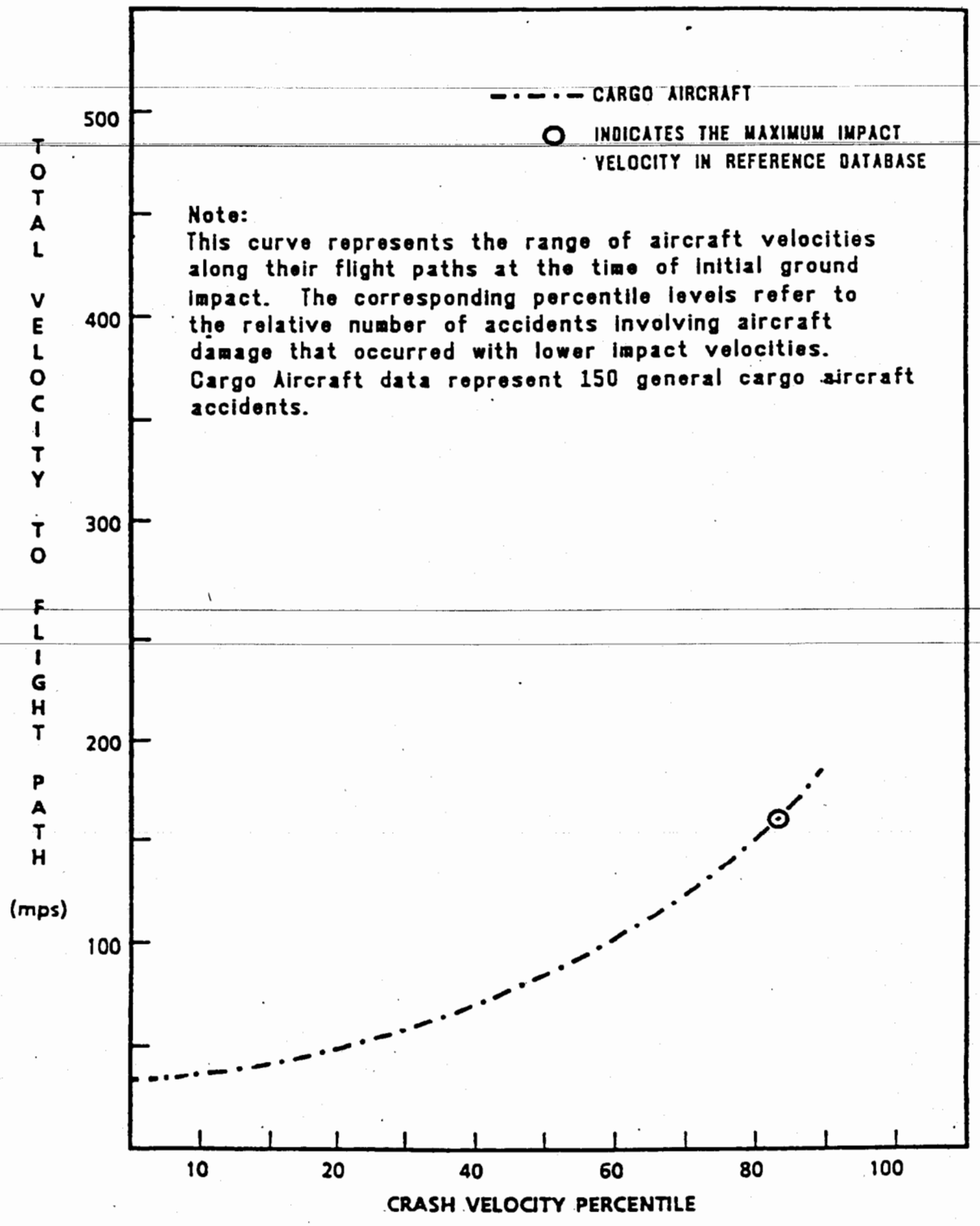


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Figure 3-50 Impact Velocities Along Flight Path (U) [34]

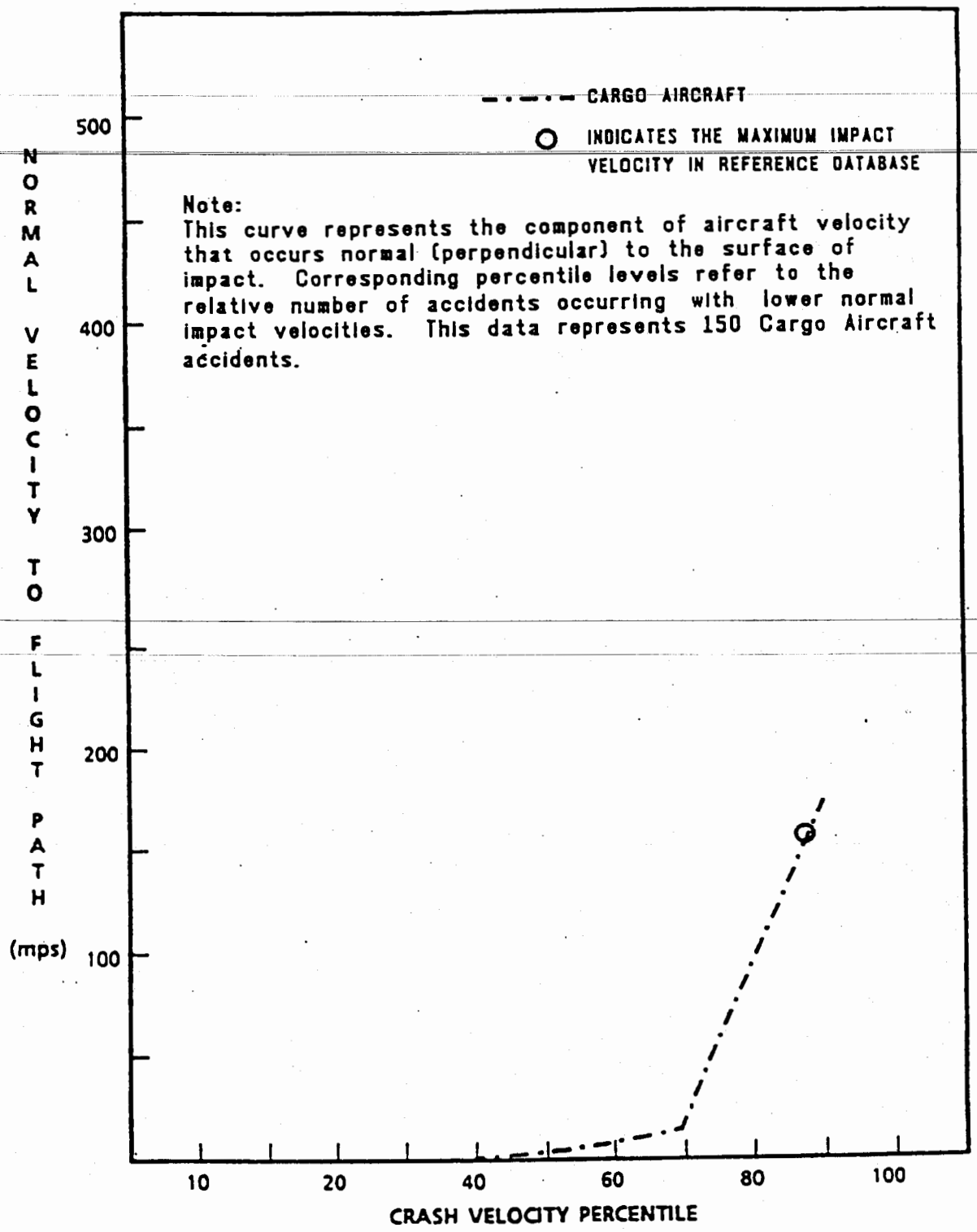

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Figure 3-51 Impact Velocities Normal to Flight Path (U) [34]

3.4 (U) Combinations of Abnormal Environments. Table 3-33 shows some possible combinations of abnormal environments. The numbers in the table indicate possible order of occurance. *Example*: in an aircraft crash the combinations could include impact followed by fire. At the minimum every combination on this list should be considered when evaluating abnormal environments.

COMBINATIONS OF ABNORMAL ENVIRONMENTS - EXAMPLES

ACCIDENT CONFIGURATION			THERMAL		MECHANICAL					ELECTRICAL		CHEMICAL/ IMMERSION	
No.	Accident Scenario	STS Stage	Hydro-carbon Fuel	Rocket Fuel	Impact (Shock)	Crush		Puncture		Lightning	Unintended Sources	Fire Fighting	Immersion
						Uniform	Nonuniform	Fragment	Projectile				
1	Truck Crash	I			1		2						
2	Cargo A/C Crash	I	3		1		2					3	
3	Aircraft Crash into WSA		2				1						
4	Forklift Crash	III			1			2				3	
5	Facility Fire	III	2				1				3		
6	Drop RS During Hoisting	III			1		2						
7	Vehicle Electrically-Induced Fire	IV	2								1	3	
8	Small Arms Fire Strikes RV	IV			1				2				
9	Emplacer Hoist Fails	V		3	1		2					4	
10	Lightning Strike on RS Emplacer Vehicle	V	2							1		3	
11	Sump Pump Fails/Floods	VI									1		2
12	Inadvertent Stage I Ignition	VI		2	3		1					4	

Note: Numbers indicate possible order of occurrence

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Table 3-33 Credible Combinations of Abnormal Environments (U)

Abnormal Environments Applied to Warhead:
1) Impact into ground
2) Fragment puncture

5. Facility Fire

Weapon Configuration:
1) Warhead assembly

STS Phase:
1) Storage of warhead assembly in the OSS/WSA

Initiating Event:
1) OSS or WSA facility fire

Subsequent Events:
1) Fire engulfs combustible materials
2) Part of building collapses onto warhead
3) Fire engulfs warhead
4) Fire fighting chemicals applied to warhead

Abnormal Environments Applied to Warhead:
1) Crushing forces
2) High temperatures
3) Fire fighting chemicals

6. Drop RS During Hoisting

Weapon Configuration:
1) RSA

STS Phase:
1) Handling and assembly operations in the AS&I building

Initiating Events:
1) Drop RSA onto electrical cord during hoisting

Subsequent Events:
1) RS crashes onto heavy electrical cord

Abnormal Environments Applied to Warhead:
1) Impact shock
2) Localized Crush
3) Unintended Electrical Sources

7. Small Arms Fire Strikes RS

Weapon Configuration:
1) RS

STS Phase:
1) Transportation of RS on storage pallet

Initiating Events:
1) Small Arms Fire

Subsequent Events:
1) Small Arms Fire strikes RS
2) Causes Punture in RS

Abnormal Environments Applied to Warhead:
1) Impact shock
2) Projectile punture

8. Emplacer Hoist Fails

Weapon Configuration:
1) RSA

STS Phase:
1) Installation of RSA in silo

Initiating Events:
1) Emplacer hoist fails after RSA is centered over silo opening

Subsequent Events:
1) RSA strikes stage IV
2) RSA punctures stage IV fuel tank
3) Stage IV propellant fire
4) Other stages ignite

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APPENDIX F - PRELIMINARY MAJOR IMPACT REPORT FOR JOINT DOD/DOE PHASE 2 FEASIBILITY STUDY OF HPRF WEAPON

PRELIMINARY MAJOR IMPACT REPORT

FOR

JOINT DOD/DOE PHASE 2 FEASIBILITY STUDY OF A HIGH POWER RADIO FREQUENCY (HPRF) WEAPON

SEPTEMBER 1995

(U)--I. SCOPE

(U)--This Preliminary Major Impact Report (PMIR) was prepared in conjunction with the Joint DOD/DOE Phase 2 Feasibility Study of a High Power Radio Frequency (HPRF) Weapon. The request for the Department of Energy Albuquerque Operations Office (AL) participation in the Phase 2 Study and request to prepare a Major Impact Report (MIR) is documented in a September 14, 1992 memorandum from RADM W. G. Ellis, Deputy Assistant Secretary for Military Application and Stockpile Support. That memorandum also had attached to it Phase 2 tasking guidance dated September 4, 1992.

(CRD)--The recommendation of the HPRF Phase 2 Study is to conduct further studies on the effectiveness of an HPRF weapon on identified military targets. Because an HPRF weapon is not recommended to go forward to a Phase 2A Study at this time, a PMIR was prepared. A final MIR can be prepared if further studies are undertaken and recommend that an HPRF weapon proceed to Phase 2A. The PMIR identifies those aspects of warhead design proposals which may influence the meeting of program objectives.

(U)--II. PROPOSED WARHEAD DESIGNS

(CRD)--Table I summarizes the major characteristics of the proposed warhead designs as presented in the joint DOD/DOE HPRF Phase 2 Study Report.

DOE & DTRA & USAF b(3)

CG HPRF-1 (d. a)

(U)--III. ANALYSES

(U)--A MIR meeting was held after the HPRF Executive Working Group (EWG) meeting May 31, 1995 at the Nuclear Weapons Integration Division, Air Force Material Command, Albuquerque, New Mexico. The development of a MIR was discussed, and subsequently, a draft of the PMIR was sent to appropriate DOE and National Laboratory EWG members for review.

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TABLE I--MAJOR CHARACTERISTICS OF HPRF WARHEAD CANDIDATES

CG HPRF-1

[redacted]

DOE & DTRA & USAF b(3)

CG HPRF-1

(U)--VI. GENERAL CONSIDERATIONS

(U)--A. Reconfiguration

(U)--In September of 1993, DOE finalized plans to consolidate its nonnuclear operations. Three donor sites, Pinellas, Mound, and Rocky Flats are in the process of transferring personnel, equipment, and records to other sites within the nuclear weapons complex. The reconfiguration of nuclear operations and additional reconfiguration of nonnuclear operations in the DOE weapons complex is currently being studied. Options under consideration will be published in late 1995 in a Draft PEIS for Stockpile Stewardship and Management and in a final PEIS in late 1996.

(U)--B. Warhead Certification

(U)--The following discussion of warhead certification is excerpted from a June 1995 draft of the Replacement Warhead Assessment Final Report. The technical basis for the certification of warheads in the current stockpile has been vigorous experimental and analytical programs that included the ability to conduct nuclear tests as required. The basis for a future warhead certification will consist of several elements: data from above-ground experiments; data from previous nuclear tests that incorporated the same or related designs or technologies; numerical simulation of experiments and of warhead performance; and peer review.

[redacted]

(U)--While each of these played a role in previous certifications, the key element was nuclear testing. Without the ability to conduct nuclear tests, the relative importance of the other elements increases. The final balance among them will depend on certain factors that will be characteristic of the particular nuclear design, including: the availability of relevant nuclear test data, the applicability of above-ground experiments to key design issues, and the applicability of available calculational techniques.

(U)--The consequences of the inability to conduct nuclear tests will be manifested in two ways. First, the uncertainties associated with the estimates of expected performance will be greater. Secondly, the degree of confidence that warhead performance will be unaffected by a previously unrecognized factor will be diminished.

(U)--VII. SUMMARY

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DOE & DTRA & USAF b(3)

Production facilities to manufacture both nuclear and nonnuclear components should be available to support the production of such a weapon considering the time it would take a design team to produce a warhead design chosen for final development and the total quantity required.

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