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Seventh Report

of the

Defense Science Board Task Force

on

Vulnerability

REVIEW OF THE POSEIDON PROGRAM

27 May 1971

Office of the Director of Defense Research and Engineering
Washington, D. C. 20301

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OFFICE OF THE DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING
WASHINGTON, D. C. 20301

17 June 1971

TO: THE SECRETARY OF DEFENSE

THROUGH: THE DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING

The enclosed report is the seventh to be submitted by the Vulnerability Task Force of the Defense Science Board. The report presents a number of conclusions and recommendations regarding the vulnerability of the Poseidon missile to nuclear weapons effects and identifies some questions for further study. We understand that cognizant elements of the Navy and the OSD have already taken note of this report and are responding to it.

Gerald F. Tape
Chairman
Defense Science Board

OFFICE OF THE DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING
WASHINGTON, D. C. 20301

27 May 1971

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Review of Poseidon Missile Vulnerability

The vulnerability Task Force met on October 9 and 10, 1970 at the Lockheed Sunnyvale facility to review the in-flight, nuclear survivability of the Poseidon missile. Less formal meetings with various contractor personnel followed and have culminated in the attached report. Our recommendations and conclusions are highlighted throughout the text and are summarized in the first section of the report.

Harold P. Smith, Jr.
Chairman,
Vulnerability Task Force

INTRODUCTION AND SUMMARY

The Vulnerability Task Force met on October 9 and 10, 1970 at the Lockheed Sunnyvale facility to review the in-flight, nuclear survivability of the Poseidon missile. We report here our findings with recommendations and conclusions highlighted throughout the text.

Within the constraints of a two-day review, we were impressed by the thoroughness and sophistication demonstrated by the SSPO (Strategic ~~Systems Project Office) and its associated contractors. In general, the~~ program is adequate, but we note in the first section, "A Mature Technology," that our inability to discern major weaknesses is as easily attributable to the maturation of the field of nuclear effects as to a truly survivable missile. Clearly, continued testing of the missile system and components is required to validate its survivability. In particular, we call for establishment of a program of "wartime reliability" comparable to that associated with certification of the ability of the missile to perform adequately in the present benign environments.

We extended our review of the missile system to include the Mark 3 re-entry vehicle. Here, the major concern is the effect of internal EMP (electromagnetic pulse) which is the antithesis of a mature technology. It is clear that considerable increases in theoretical and experimental sophistication will be necessary to assess correctly this effect.

We would like to express our appreciation to our hosts, SSPO and the Lockheed Corporation management, for their hospitality and willingness to review in detail the many aspects of this program with which we were either unfamiliar or, more likely, that had escaped our memory.

NAVY 1.4(a),(h)

OSD 3.3(b)(8)

A MATURE TECHNOLOGY

Our review of Poseidon in-flight vulnerability indicated that hardening of missiles to the effects of nuclear explosions at distances where the vacuum x-ray fluence is of the order of [redacted] can be accomplished on a production-line basis. Such hardening is no longer merely a laboratory science; it is a mature technology. The major problem is not development of production-line techniques for achieving reliable hardening, but rather development of testing procedures to establish, with adequate confidence, that the required design levels have been attained and that they will remain throughout the lifetime of the system. Clearly, the Poseidon program has had the benefit of extensive knowledge of nuclear effects and appears to have woven successfully this knowledge into the production design. Two examples to demonstrate our conclusion are given below.

EMP Shielding - Laboratory scientists and engineers have long known how to shield sensitive instruments from radio frequency interference. Essentially, the laboratory approach calls for careful engineering design and practice, coupled with component and, eventually, full scale system testing. These basic features have been observed in the Poseidon program and have culminated in an almost perfect series of EMP simulation tests [redacted]

This, combined with North Star and additional EMP simulation data, should provide an adequate measure of the safety margin. Clearly, if that margin is small, circumvention should be implemented. Until the margin is known, implementation of circumvention must be seriously considered.

Ionizing Radiation - There appears to be a difference in the sensitivity to ionizing radiation of the preamplifiers of the guidance (MIT Instrumentation Laboratory) system versus those of the control (Lockheed) system. This inconsistency is resolved through the incorporation of preamplifiers that are considerably superior to those we have reviewed in past meetings. The amplifiers associated with the control system translate the electrical

*Albuquerque Los Alamos Electromagnetic Compatability Simulator

NAVY 1.4(a),(h)

OSD 3.3(b)(8)

[redacted]

It should be noted that there was some confusion concerning the capabilities of various ionizing radiation simulators, but it does not appear to be serious. There is a further concern associated with the performance of circumvention detectors to pulses of ionization that exceed the integration time of important electronic circuits. We have asked the Navy to examine these areas and to relay their findings, informally, to interested members of the Task Force.

Although the Task Force commends SSPO on its in-flight hardening program, this cannot be interpreted to mean that there are no in-flight vulnerabilities. Rather, the technology of hardening to in-flight nuclear effects has advanced to the point where a two-day program review by a panel not intimately associated with the program can no longer find major flaws by simple analyses based on first principles. There could indeed be serious flaws in the designs and tests, but since the Poseidon program has attempted --with considerable success--to incorporate most aspects of a mature technology, flaws that may exist lie deeper than our investigation has been able to probe.

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WARTIME RELIABILITY

The Poseidon program does not view survivability in the same manner as flight reliability. Whereas considerable planning has already been made to provide for continued flight testing of Poseidon missiles throughout their period in the inventory, very little planning has been undertaken to describe a test program to assess the continued capability of Poseidon to survive nuclear environments. In short, there is a clear program to insure peacetime reliability, but only a diffuse program to insure wartime reliability. Consider, for example, continued EMP simulation of the entire missile and upper stages in facilities such as ALECS. The tests to date, as noted above, have been successful, but they have been conducted on only one missile, and that missile was a Hangar Queen. No other missiles have been subjected to such testing. There is one more test planned, but it is not clear whether this will involve a new missile or the Hangar Queen. We recommend that a definite program be established to subject periodically inventory missiles to EMP environments. We certainly recommend that a new missile be chosen for the forthcoming ALECS tests.

The example represents a worst case. In other areas of nuclear effects vulnerability, the Navy expressed a clear intention to continue testing its production and inventory missiles. However, it was also clear that these programs are in a very formative stage. There are no precise numbers or dollars behind them. Consequently, we recommend that these programs be formulated and budgeted in detail. For example, in the area of ionization effects, a realistic and moderate confidence program to insure reliability would include threat level testing of the entire Poseidon "Bus" (i.e., guidance, flight control, and deployment modules located forward of the third stage engines) on a one-per-year basis. The AURORA facility appears adequate for this task.

VULNERABILITY OF THE MARK 3 RE-ENTRY VEHICLE (RV)

The Mark 3 RV has been designed, built, and tested to withstand the nuclear environment associated with [redacted] This particular hardness level was chosen to insure that the Soviets will have to expend at least one interceptor for each attacking RV. We describe below our initial review of the Mark 3 with respect to this criterion.

[redacted]

Because of our concern, some members of the Task Force participated following the Sunnyvale meeting, in an informal review with the Sandia Laboratories and Lawrence Radiation Laboratory of the research being conducted to improve the understanding of the IEMP situation. Calculations are being made to predict the cable currents that would be produced by threat fluxes on an actual Mark 3. The greatest uncertainty in these calculations is the conductivity created in the cable insulation. (The higher this conductivity, the greater the "shorting" of the currents, and the less severe is the problem.) Present best estimates of the conductivity are inconclusive: the predicted bridge wire currents are neither so small as to be negligible nor so large as to be clearly a killing mechanism. At the moment we can do little more than to urge that calculations and laboratory experiments be continued and that the Mark 3 design team consider engineering methods to deal with the excess currents should a retrofit prove necessary. For future systems, coaxial cables rather than the flat twin conductors should be incorporated.

[redacted]

NAVY 1.4(a),(h)

[redacted]

We investigated the arming, fuzing and firing (AF&F) subsystems in reasonable detail. In addition to the [redacted]

OSD 3.3(b)(8)

REMAINING QUESTIONS

Time did not allow us to investigate four additional areas given below:

1. What are the "silo" vulnerabilities of the Poseidon missile; i. e., is it possible to abort the Poseidon mission as a result of sudden displacement of the missile tube at distances from a nuclear explosion considerably greater than those that would severly damage the submarine?

2. Since the deployment of the Mark 3 RVs requires hot gas thrusting of the bus for approximately four additional minutes beyond the two minutes of powered flight, is some form of mid-course intercept feasible for the Soviets in which Mark 3 MIRVs could be destroyed on a greater than one-for-one basis?

3. Is it possible to create the analog to dust by using nuclear explosives to carry sea water to high altitude where ice particles would form and remain aloft for considerable periods of time? Could Poseidon survive transport through significant high-altitude ice clouds? Considering the large area deployment of SSBNs, could significant ice clouds coverage be attained at reasonable expense?

4. What is the survivability of the Mark 3 physics package?