



Testimony

Before the Subcommittee on Federal Services, Committee on
Governmental Affairs, United States Senate

For Release on Delivery
Expected at
9:30 a.m., EST
Wednesday,
March 25, 1992

ELECTRONIC WARFARE

DOD Did Not Meet Test Criteria Before Production of the Airborne Self-Protection Jammer

Statement of Louis J. Rodrigues, Director, Command, Control,
Communications, and Intelligence Issues
National Security and International Affairs Division



Mr. Chairman and Members of the Subcommittee:

I am pleased to be here today to discuss our review of the Navy's Airborne Self-Protection Jammer (ASPJ) program.

ASPJ is an electronic warfare jammer intended to protect the Navy's F-14D and F/A-18 aircraft from threat weapons. It accomplishes this by transmitting electronic signals that interfere with the radars used to control threat missiles and guns.

As you will recall, the Department of Defense (DOD) authorized ASPJ's initial limited production, called Lot I, in August 1989 despite its marginal performance during initial operational tests. In May 1990, that decision was the subject of a hearing before this Subcommittee.

At the hearing, we and the DOD Inspector General testified that no further limited production should occur. We agreed with the Inspector General's proposal that deliveries under the Lot I contract should be stretched to allow for complete and adequate operational testing without a break in production. We pointed out that if this recommendation were implemented, DOD could substantially reduce program risks by ensuring that the jammer demonstrated the required performance before making further production commitments. DOD chose not to accept our recommendation.

At the hearing, the Deputy Secretary of Defense testified that Lot I production had been authorized because of the urgent need for the jammer and the absence of a suitable alternative and because corrective actions had been taken to eliminate deficiencies in the jammer's performance.

The Deputy Secretary also testified that he had directed the establishment of firm criteria to measure ASPJ's performance and reliability and had directed that the Defense Acquisition Board delay consideration of further ASPJ production until completion of selected reliability growth and other performance tests. He testified that DOD would not allow the program to proceed if ASPJ did not successfully meet the established criteria.

As you requested, we evaluated DOD's compliance with the Deputy Secretary's commitment to allow further procurement of ASPJ only if it met its reliability growth criterion.

RESULTS IN BRIEF

ASPJ did not meet the criterion established for further production. Although the criterion was established and approved for ASPJ's reliability growth tests, after system failures began to occur during the tests, the Navy changed the criterion to exclude software failures from the scoring of test results. Changing the criterion allowed ASPJ to pass the tests; otherwise, it would have

failed by a large margin. By excluding the software failures, the Navy circumvented DOD's testing standards and failed to recognize the adverse impacts of software problems experienced with other electronic warfare systems similar to ASPJ. Reliability growth tests conducted after the Defense Acquisition Board allowed the program to proceed show that ASPJ's software problems are continuing.

ASPJ'S RELIABILITY GROWTH CRITERION

The Defense Acquisition Board approved ASPJ's original reliability growth criterion on November 16, 1990. The criterion specified a measure of reliability growth called "mean-time-between-failure-instantaneous." This measure differs from the standard calculation of mean-time-between-failure, which is the total test time divided by the total number of system failures, in that it compensates for progress made in improving reliability during the course of testing. For example, a system showing rapid improvement in reliability during testing would have a higher mean-time-between-failure-instantaneous than one that continued to fail at a constant rate, even if both had the same number of failures during testing.

ASPJ's criterion was that the system must achieve a mean-time-between-failure-instantaneous of at least 75 hours during a minimum of 650 hours of testing. The test plan defined failure to include several types of malfunctions but did not distinguish between hardware and software-induced failures.

WITHOUT CRITERION CHANGE
ASPJ WOULD HAVE FAILED
RELIABILITY GROWTH TESTS

ASPJ's reliability growth testing started in August 1990 and was stopped in March 1991. The scored test results identified 17 failures during 729 hours of testing, which resulted in a mean-time-between-failure-instantaneous of 83.75 hours. According to the Navy's ASPJ Program Office, ASPJ was thus considered to have passed its reliability growth tests.

However, this score did not reflect 43 additional failures of ASPJ's built-in test equipment that the Navy attributed to software problems. These failures were excluded because near the end of testing in March 1991, the Navy revised the test plan to exclude software-induced failures from the scoring of test results. Charts I and II show key portions of the original criterion and the criterion as changed by the Navy. (These charts are included in this testimony as attachments I and II, respectively.)

To determine the impact of the change in the criterion, we included the 43 software failures and recalculated the mean-time-between-failure-instantaneous. We found that if the failures had been included in the scoring, ASPJ's mean-time-between-failure-instantaneous would have been about 9 hours, well below the 75-hour requirement. Thus, ASPJ would have failed its reliability growth tests if the Navy had not changed the criterion.

ASPJ ALLOWED TO PROCEED

The Defense Acquisition Board approved the ASPJ program for Lot II production after meeting on June 24, 1991. Before the approval, Defense Acquisition Board officials were provided documentation showing that software-induced failures had been excluded from the scoring of reliability growth tests.

The Chairman of the Board advised us that the officials approved Lot II production to avoid a production break. DOD officials also told us that although excluded from the scoring, the software-induced failures had not been ignored in the decision. They said that other tests conducted outside the reliability growth program, including developmental flight tests and contractor tests using modified software, had provided reasonable assurance that the software problems had been corrected.

We disagree that DOD officials had reasonable assurance that the software problems had been corrected for several reasons:

- The developmental flight tests were of insufficient duration to verify the adequacy of software corrections. These tests lasted only 45.5 hours, while reliability growth tests require 220 hours to verify the adequacy of corrections.

- The purpose of the developmental flight tests was to evaluate other aspects of ASPJ's performance, such as its capability to correctly identify threats, not to evaluate software under reliability growth conditions.
- The contractor tests were also of insufficient duration to verify the adequacy of software corrections.
- The decision memorandum recording Lot II approval directed the Navy to verify built-in test software performance under actual reliability growth conditions. This indicates to us that rather than having reasonable assurance that ASPJ's software problems had been solved, DOD officials were concerned that the problems had not been corrected.

The Chairman advised us he was aware that the jammer did not meet all of its specifications and that he had designated specific criteria it would have to meet before granting approval of Lot III production. The Chairman also informed us that the Deputy Secretary of Defense did not participate in the decision to approve Lot II production.

EXCLUDING SOFTWARE FAILURES
WAS INAPPROPRIATE

In excluding ASPJ's built-in test equipment failures attributed to software problems from the scoring of test results, the Navy circumvented DOD's testing standards. ASPJ's test plan identified

Military Standard 2068 (AS) as the governing standard for the test. This standard classifies built-in test equipment as relevant in scoring the test and does not authorize excluding software failures from the scoring.

In October 1986, Military Standard 781D superseded 2068(AS). This standard does not exempt built-in test equipment failures from being counted in scoring test results. It does exempt software failures if they are corrected and the adequacy of the corrections are verified during reliability growth testing. However, software changes that addressed ASPJ's built-in test equipment failures were not retested during reliability growth testing before Lot II production was approved.

ASPJ'S Software Problems Continue

After the approval of Lot II production, ASPJ's reliability growth testing resumed using modified software intended to correct the problems revealed during the earlier tests. The additional tests show that ASPJ's software problems have not been corrected: 21 of the 43 failures that occurred during the first phase of reliability growth testing have recurred during the second phase. The later tests have also revealed new failures not detected during the first phase.

Software Problems Degrade
Electronic Warfare Systems

Our work on other electronic warfare systems similar to ASPJ has shown that software problems are among the most serious in weapon acquisitions. To illustrate:

- Improved ALQ-135 jammers produced for the Air Force's F-15 aircraft were placed in storage rather than delivered to tactical units because of software design problems.
- The Air Force's ALQ-131 Block II jammer for the F-16 and other aircraft was used by tactical units in Europe with an inactive receiver/processor because of missing software.
- In 1987 we testified before another congressional committee that as a result of software and other problems, the ALQ-161A system for the B1-B bomber performed poorly and prevented operation of a complete defensive system. In early 1991, DOD was still trying to solve the software problems.

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Before concluding my testimony, I would like to reiterate our position on the ASPJ program. We believe, as we testified at the May 1990 hearing, that no further procurement of ASPJ should be approved until operational test results demonstrate that the system's performance is satisfactory.

This concludes my testimony. We will be pleased to answer any questions you or any members of the Subcommittee may have.

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GAO ASPJ Reliability Growth Test Plan October 1990

ATTACHMENT I

ATTACHMENT I

ASPJ PRODUCTION VERIFICATION PROGRAM RELIABILITY GROWTH TEST (RGT) PLAN

(REVISION C)

OCT 1990

CONTRACT N00019-87-C-0300

CLIN 0116

CORL ITEM AF01

PREPARED FOR:

NAVAL AIR SYSTEMS COMMAND

DEPARTMENT OF THE NAVY

WASHINGTON, D.C. 20381

PREPARED BY
CONSOLIDATED ELECTRONIC COUNTERMESURES
500 WASHINGTON AVENUE
MURRY, NJ 07710

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item under test, test equipment, instrumentation, or the test facility. Independent failures will be classified as relevant.

b. Dependent Failure - A secondary failure. A failure caused as an effect of the failure of item external to the failed item. Dependent failures will be classified as nonrelevant.

c. Intermittent Failure - Any momentary or out-of-spec condition or momentary fault indication. The first and second occurrence of an intermittent failure of any one item under test shall be classified as non-relevant. The third and subsequent occurrences of an intermittent failure of any one item under test shall be counted as a relevant failure.

d. Multiple Failures - The simultaneous occurrence of two or more independent failures. Each independent failure will be classified as relevant.

e. Pattern Failure - The occurrence of two or more independent failures of the same part in identical or similar application which are caused by the same basic failure mechanism. Each independent failure will be classified as relevant. Following failure analysis and implementation of corrective action, all occurrences of the pattern failure, except the initial occurrence, shall be counted from calculations of cumulative and instantaneous MTBF, provided that at least 720 hours of MTBF valid operating time has been accumulated since the implementation of the corrective action without recurrence of the pattern failure.

5.3.3.3 FAILURE TYPES

a. Design Failure - Failure due to design deficiencies. Each independent Design Failure will be classified as relevant.

b. Workmanship Failure - Failures resulting from poor workmanship or quality control. Each independent Workmanship Failure will be classified as relevant.

c. Component Failure - Failures due to defective component parts. Each independent component failure will be classified as relevant.

d. BIT (Built-In-Test) Failures - A failure of the BIT function that degrades system performance or a BIT false alarm. Such independent BIT failures will be classified as relevant.

e. Soft Failure - A failure that requires operator intervention such as manual system reset, re-initialization, reboot, cycling of power, or switching of system functions (Off/Standby/Receive/Transmit). A soft failure will be classified as relevant.

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GAO ASPJ Reliability Growth Test Plan

March 1991

ASPJ PRODUCTION VERIFICATION PROGRAM

RELIABILITY GROWTH TEST (RGT) PLAN

(REVISION D)

MMA 1891

CONTRACT N00019-87-C-0300

CLIN 0116

CDRL ITEM AF01

PREPARED FOR:

NAVAL AIR SYSTEM COMMAND
DEPARTMENT OF THE NAVY
WASHINGTON, D.C. 20361

PERFORMED BY
CONSOLIDATED ELECTRONIC COUNTMEASURES
360 MILLER AVENUE
MIDDLETOWN, CT 06457

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- facility. Independent failures will be classified as relevant.
- Dependent Failure** - A secondary failure. A failure caused as an effect of the failure of item external to the failed item. Dependent failures will be classified as non-relevant.
 - Intermittent Failure** - Any momentary or out-of-spec condition or momentary fault indication. The first and second occurrence of an intermittent failure of any one item under test shall be classified as non-relevant. The third and subsequent occurrences of an intermittent failure of any one item under test shall be counted as a relevant failure.
 - Multiple Failures** - The simultaneous occurrence of two or more independent failures. Each independent failure will be classified as relevant.
 - Pattern Failure** - The occurrence of two or more independent failures of the same nature within a specified application which are caused by the same basic failure mechanism. Each independent failure will be classified as relevant. Following failure analysis and implementation of corrective action, all occurrences of the pattern failure, except the initial occurrence, shall be omitted from calculations of cumulative occurrence rate, provided that at least 220 hours of RGT valid test time have been expended since the implementation of the corrective action without recurrence of the pattern failure.

5.3.1.3 FAILURE TYPES

- Design Failure** - Failure due to design deficiencies. Each independent Design Failure will be classified as relevant.
- Workmanship Failure** - Failures resulting from poor workmanship or quality control. Each independent Workmanship Failure will be classified as relevant.
- Component Failure** - Failures due to defective component parts. Each independent Component Failure will be classified as relevant.
- Software Failure** - A failure mode detected that is attributable to a software error. Software failures will be classified as non-relevant.
- Soft Failure** - A failure that requires operator intervention such as manual system reset, re-initialization, reboot, cycling of power, or switching of system functions (off/standby/maintenance/transmit). A Soft Failure will be classified as relevant.

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