



UNITED STATES GENERAL ACCOUNTING OFFICE  
WASHINGTON, D.C. 20548

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NATIONAL SECURITY AND  
INTERNATIONAL AFFAIRS DIVISION

B-217247

FEBRUARY 14, 1985

The Honorable Glenn English  
Chairman, Subcommittee on Government  
Information, Justice, and Agriculture  
Committee on Government Operations  
House of Representatives

The Honorable Dennis DeConcini  
Ranking Minority Member  
Subcommittee on Treasury, Postal Service,  
and General Government  
Committee on Appropriations  
United States Senate

Subject: Installation of an Air Force F-15 Aircraft Radar in  
a Navy P-3A Aircraft for Use by the Customs Service  
for Its Drug Interdiction Mission (GAO/NSIAD-85-31)

This report responds to your request that we monitor the  
installation of an F-15 radar in a Navy P-3A aircraft. You  
requested that we advise you of any schedule slippages in the  
established time frame to complete the modification.

As detailed in enclosure I, schedule delays and cost growth  
were experienced. The contractor delivered the modified aircraft  
to the Navy on June 29, 1984, 5 weeks later than the May 24, 1984,  
original schedule. The negotiated contract price of \$5,919,262  
reflects an increase of about \$750,000 in the areas of  
engineering, subcontracts, and flight operations over the  
\$5,167,000 rough order of magnitude estimates developed around the  
time of contract award. The contract price, however, was about  
\$407,000 less than the costs reported by the prime contractor,  
Lockheed-California Company, to complete the modification.

In addition, there were about \$550,000 in aircraft repair and  
maintenance costs that were absorbed by the Navy and the U.S.  
Customs Service. These expenses related primarily to the  
aircraft's overall mechanical condition, rather than to the  
modification work.

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Lockheed attributed both the delay and cost growth primarily to greater complexity of tasks than originally anticipated. Further, some minor modification work was not completed when the contractor delivered the aircraft to the Navy. However, the contractor has since completed the work.

The contractor's flight testing of the modified aircraft, in which Navy flight test personnel participated, was considered successful by company officials. The test report stated that the F-15 radar performance met or exceeded expectations. The Navy also flight tested the modified aircraft and reported the radar's potential to detect and track aircraft. (See enclosure II for illustrations of the radar installation design.) The aircraft was delivered to the Customs Service on August 30, 1984, following completion of Navy flight testing.

We reviewed the test report and concluded that it accurately identified the radar's maximum repeatable detection ranges under the conditions specified. Also, we believe that given the conditions under which it was tested, the aircraft performed in a manner consistent with its design.

We did not obtain official comments on this report from the Navy, Customs Service, or Lockheed. We did, however, discuss the contents of this report with agency and contractor officials, and their comments were considered in preparing this report.

We are sending copies of the report to the Navy, Customs Service, and Lockheed and will make copies available to other parties upon request.



Frank C. Conahan  
Director

Enclosures - 2

INSTALLATION OF F-15 RADAR  
IN P-3A AIRCRAFT

BACKGROUND

On March 24, 1983, the President signed into law the Emergency Jobs Supplemental Appropriation Bill (P.L. 98-8), which contained \$3,750,000 for use by the U.S. Customs Service in its drug interdiction program. In addition, Customs provided \$2,169,262 to cover the contract negotiated price of \$5,919,262. These funds were to cover the cost of modifying and testing an existing F-15 aircraft radar, installing the radar in a P-3A aircraft, and developing a prototype F-15 radar package. Upon delivery to Customs, the aircraft is to be used to detect and track potential drug carrying aircraft.

On September 22, 1983, the Naval Air Systems Command awarded an unpriced, cost-plus-fixed fee delivery order to Lockheed-California Company (LCC). The basic ordering agreement, N00019-82-G-0302, called for the modification of a Navy P-3A aircraft, with an F-15 aircraft radar (AN/APG-63). The P-3A aircraft was transferred to LCC and delivered to its Burbank, California, facility on August 26, 1983.

LCC managed the modification program, provided design engineering, procured selected material, and performed flight testing. However, the modification effort was primarily subcontracted to Lockheed Aircraft Services (LAS), Ontario, California. Technical support was obtained from McDonnell Douglas Corp., St. Louis, Missouri, the prime contractor for the F-15 fighter aircraft, and Hughes Aircraft Co., El Segundo, California, the manufacturer of the AN/APG-63 radar for the F-15 aircraft. A number of needed repairs were identified in the P-3A aircraft when it was delivered to Lockheed. A Navy team from the Naval Air Rework Facility (NARF), Alameda, California, was responsible for making most of the repairs while the aircraft was being modified at LAS.

PROGRAM SCHEDULE DELAYS WERE MODERATE

Schedule delays were experienced in various phases of contract performance, resulting in a 5-week delay in delivery of the aircraft (from May 24 to June 29, 1984). Delays were generally sequential in nature. For example, engineering drawings were not completed in sufficient time to place orders for material to meet leadtime requirements. Consequently, the late receipt of material adversely affected shop order planning and delayed fabrication assembly and parts kit installations in the aircraft. LCC attributed delays to uncertainties and difficulties normally associated with developmental programs of this nature. There were also delays in the delivery of government-furnished radar equipment; however, these did not affect the

aircraft modification schedule because delays in engineering drawings and material deliveries had already set back the program schedule.

### Material shortages

Although LCC considered the delivery of material a critical program activity to be closely monitored, shortages and delivery delays were experienced. Our analysis of material acquisitions reported in February 1984, for example, showed that 180 of 540 material orders by LCC had not been received. The need dates on 55 orders had already lapsed and the indicated delivery dates on another 40 also exceeded the need dates. By late February, LCC and LAS had issued 941 material orders, 653 of which had been received. The remaining 288 items were either on order (142) or still to be ordered (146). LCC attributed delays in material deliveries primarily to

- (1) delay in the availability of technical data and support from McDonnell Douglas and Hughes Aircraft,
- (2) longer material leadtime requirements than the periods between design completion and material need dates,
- (3) difficulty in finding suppliers for small quantity buys, and
- (4) late identification of some wiring and connector requirements.

In an effort to expedite material, additional personnel were assigned to transfer equipment and material from LCC, Burbank, to LAS, Ontario, and to release material to LAS shops. However, material shortages still existed at the time the aircraft was flown to LCC, Palmdale, for flight testing. Consequently, some modification work had to be accomplished in conjunction with the ground and flight test program.

### Aircraft modification

The LAS modification effort, which began on November 22, 1983, included the fabrication, assembly, and installation of parts kits and equipment. With material delivery delays, fabrication and assembly, along with installation of kits on the aircraft, were delayed.

In December 1983, LCC announced a 2-week delay in structural fabrication due to late material deliveries. However, the LAS program manager did not consider the problem serious and assured LCC that the modification effort would be completed as scheduled. By February 1984, the modification work was still

approximately 2 weeks behind schedule due to continuing material shortages. In March 1984, company officials advised that workaround measures would be implemented to bring the modification work back on schedule, including the addition of personnel and a 6-day/2 shift workweek at LAS. In mid-April, the program was still behind schedule despite these initiatives, and LCC reported that a schedule recovery was no longer possible.

On May 8, 1984, LCC requested a change in the aircraft delivery schedule from May 24 to June 30, 1984. The LAS modification schedule completion date was set back from April 13 to May 19, 1984. The company attributed the schedule slippage to uncertainties and difficulties normally associated with developmental programs, particularly with the

- interpretation of engineering drawings, and associated lists supplied by the radar and airframe manufacturer;
- installation of the F-15 radar (AN/APG-63) rack on the P-3A aircraft; and
- wire harness fabrication and installation.

#### Government-furnished equipment

The U.S. Air Force provided two F-15 AN/APG-63 radar sets and associated equipment for use in the modification program. One set was installed on the P-3A aircraft. The other served as spares support during the test phase. Prior to delivery to LCC, the radar sets were sent to McDonnell Douglas for acceptance and integration testing to ensure that all equipment would work as a system prior to installation on the Navy aircraft.

Late delivery of the radar sets by the Air Force delayed the start of testing by McDonnell Douglas. The delays, however, did not adversely affect the modification program schedule as it had already slipped due to the problems experienced in interpreting and completing the engineering drawings and in obtaining the material as discussed above.

Timely completion of integration testing for the first radar set was hampered by the late receipt of the radar oscillator, vertical situation display, identification friend or foe (IFF) reply evaluator, and air to air interrogator control panel. Additionally, some of the equipment, including the radar antenna, navigational control indicator, and the radar receiver, was not in operating condition upon receipt at McDonnell Douglas. Therefore, exchanges and replacements had to be made, which took time. With the integration delays, the first radar set was not delivered to LAS until February 29, 1984, a month after the initial schedule of February 1.

Delivery of the second radar set also was delayed. However, the delay did not affect the schedule because this radar set was intended to be used as a spare during the test phase of the program, which also was delayed.

#### NECESSARY AIRCRAFT REPAIRS WERE MADE

About 1,100 needed repairs were identified by Navy and LCC between the time the aircraft was transferred to LCC and the start of ground and flight testing in Palmdale. However, many of the discrepancies were superficial and did not require repair, according to a Naval Plant Representative Office (NAVPRO) official. The NAVPRO recommended repair on only 570 discrepancies. The NARF repaired about 465 and LCC repaired the balance.

The NARF was initially tasked to correct 260 discrepancies, the majority of which related to wing corrosion and fuel leaks. After repairs were made, air pressure tests by the NARF identified 206 more leaks, which the NARF repaired.

The P-3A aircraft fuel tank number five was found to be leaking during test checks and therefore was not filled during the LCC test program (May 17-June 25, 1984). This caused restricted flight operations, below the minimum flying time requirements of 12 hours. The NARF had repaired the tank, but additional work considered necessary to completely seal it was beyond the capability of the NARF field team. Navy officials advised us, however, that the tank was filled at the Naval Air Test Center (NATC) following the Navy flight test program, and no leaks were experienced that would restrict flight operations or on-station time. After the aircraft was delivered to Customs in New Orleans, a NARF Alameda team inspected the fuel tank and verified that there were no leaks.

#### PROGRAM COSTS EXCEEDED INITIAL ESTIMATES

The negotiated contract price of \$5,919,262 exceeded early program cost estimates by about \$750,000, and LCC's costs and estimates to complete the modification work further exceeded the contract price by about \$407,000. Additional costs for aircraft repair and unscheduled maintenance amounted to about \$550,000.

The Customs Service program included the aircraft modification effort under basic ordering agreement -0302, delivery order -0019, and repairs to the aircraft and other government-furnished equipment. The Customs Service funded the aircraft modification program and minor amounts for unscheduled maintenance and repair of government-furnished equipment. The Navy funded the aircraft repairs and minor amounts of unscheduled maintenance.

Costs of aircraft modification

LCC developed a rough order of magnitude (ROM) cost estimate of \$4,817,000 on September 2, 1983, for the modification program. An additional \$350,000 was included in the program cost estimate on October 24, 1983, for McDonnell Douglas and Hughes Aircraft support effort. LCC subsequently submitted a firm price proposal to the Navy on January 31, 1984, in the amount of \$5,882,024. On May 24, 1984, a revised proposal was submitted with a ceiling price of \$5,919,262 (see breakdown below). Cost increases of \$752,262 from the initial rough order of magnitude cost estimate were in areas of engineering, LAS subcontract, and flight operations. Lockheed attributed the cost growth to underestimating the complexity of the AN/APG-63 radar wiring and equipment installation.

<u>Breakdown of contract price</u>	<u>Price</u>
ROM of September 2, 1983	\$4,817,000
Support effort October 24, 1983	350,000
Increase over initial ROM	<u>752,262</u>
Negotiated contract price	<u><u>\$5,919,262</u></u>

Senator DeConcini's letter of May 9, 1984, to the President, LCC, expressed concern with cost growth and asked the company to absorb some of the increased program costs. LCC advised Senator DeConcini that the proposed ceiling price--\$5,919,262--reflected LCC's willingness to restrict further cost growth on the modification program.

Delivery order -0019 was negotiated in June 1984, at the ceiling price of \$5,919,262. LCC's recorded costs and estimates to complete the modification effort as of September 21, 1984, were about \$6,326,000, or about \$407,000 more than the contract price.

Repair of Navy P-3A aircraft and other program costs

A field team from the NARF incurred 7,020 hours and \$427,000 in labor and material costs to accomplish needed aircraft repairs. LCC also submitted a proposal for \$45,743 for assisting the NARF team at LAS, which had not been settled at the time we completed our review. Assisting the NARF team in aircraft repairs was considered unscheduled maintenance. In addition, the Navy issued several purchase orders to LCC for unscheduled aircraft maintenance in the amount of \$28,974. Aircraft repair and unscheduled maintenance costs were absorbed by the Navy.

The Navy contract administrator advised us that the Customs Service had expended about \$50,000 for unscheduled maintenance and repair of government-furnished equipment in addition to the Navy expenditures cited above. Therefore, aircraft repair and other program costs amounted to about \$550,000.

GROUND AND FLIGHT TEST OBJECTIVES WERE MET

The purpose of the test program was to provide a functionally operational F-15 AN/APG-63 radar and associated Customs Service special avionics systems to support a follow-on performance evaluation of the P-3A by the Navy. During the aircraft modification, LCC encountered and resolved difficulties related to incorrect designs, wiring connections, equipment installations, and defective equipment. At the conclusion of the test program on June 25, 1984, LCC reported that Customs Service special systems, including the AN/APG-63 radar and navigation and communications systems, were operational and ready for Navy performance evaluation. Navy flight test personnel participated in the LCC test program.

The program called for a 6-week schedule of ground and flight testing. Ground testing, delayed until mid-May, was completed in late June, about 5 weeks later than the original schedule. The delay was attributed to problems experienced in the modification effort discussed earlier in this report. Completion of the scheduled 2-week ground testing program was delayed a week because of problems with the modification work and the incorrect installation of the inertial measurement unit. Flight testing was completed 1 week ahead of the 4-week schedule.

The P-3A aircraft modification test program encompassed the following radar and Customs Service special systems:

- AN/APG-63 radar.
- AN/APX-76 IFF.
- AN/AAS-36 IRDS (infrared detection system).
- LTN-72 INS (inertial navigation system).
- Wulfsberg Flexcomm VHF/FM (multiband communications).
- VIR-31A VOR/ILS (airways navigation).
- DME-40 (distance measuring equipment).
- 618M3A VHF/AM (airways communications).
- LC-6 chronometer.
- ICS integration (inter-connect systems).

Ground testing was accomplished from May 17th through June 5th and included

- electrical power verifications,
- electrical wire continuity checks,
- equipment fit checks,
- flight test instrumentation,



- air flow and liquid cooling system checks,
- waveguide testing,
- equipment start-ups,
- LTN-72 INS operation and drift-run,
- communications system checks, and
- electromagnetic interference tests.

Flight testing was conducted to assess the airborne characteristics of the AN/APG-63 radar and P-3A aircraft. Six flights were made with a total of 22 hours and 20 minutes of evaluation time. Specifically, flight test objectives were as follows:

Flight number	Test objectives
1	airplane/data acquisition system functional check; ground electromagnetic compatibility safety of flight checks; and Customs Service special systems integration
2	east/west navigation verification of the LTN-72 inertial navigation system and Customs Service special systems integration
3	north/south navigation verification of the LTN-72; and Customs Service special systems integration
4	AN/APG-63 radar airborne evaluation, including air-to-air and air-to-ground targets over land and water
5	instrument landing system checks; and F-15 (AN/APG-63) and P-3A (AN/APS-80) radar evaluation
6	instrument landing system evaluation

At the completion of the test program, LCC reported that the AN/APG-63 radar system performed more reliably than expected. It was tested in all tracking modes and performance exceeded expectation in the slow target mode. Tests against known targets in the program showed that the modified AN/APG-63 radar with the model-125 target processor improved the detection and tracking range against slow moving targets, which are the primary concern of the Customs Service drug interdiction mission. LCC concluded that the AN/APG-63 radar cooling system was more than adequate and should enhance system reliability. Also, test results indicated no degradation in radar performance caused by other electrical systems. Tracking of targets in close proximity to the P-3A aircraft by the AN/AAS-36 infrared detection set was

confirmed through visual observations by the flight crew. Targets detected by the radar were confirmed by the infrared detection system. The Customs Service special systems were tested and reported to be functional and capable of supporting mission activities.

Some problems were encountered with the radar operations in the test program but for the most part they were resolved. For example, inaccurate ground speed of the aircraft on the radar displays was resolved after bias corrections were made in the inertial measurement unit. In addition, the inertial measurement unit was not correctly mounted in the aircraft, thereby providing inaccurate reference and heading information for the antenna. Equipment software changes were made to provide proper heading, pitch, and roll inputs. Initial problems also were experienced in pressurizing the AN/APG-63 radar waveguide with the AN/APS-80 air pump. Worn antenna rotary seals were believed to have caused the loss of waveguide pressure. A temporary fix, using an air bottle to augment the AN/APS-80 air pump, was used in the LCC flight test program. However, LCC installed a permanent modification during the Navy flight test program.

Problems experienced with the VIR-31A VOR/ILS airways navigation system were resolved through redesign and wiring modification to the navigation junction box. Subsequent utilization of the aircraft by Customs Service, however, revealed that the redesign and wiring modification to the junction box did not correct the navigation and communications equipment problems. Customs Service is working with Navy to permanently resolve the problems.

When LCC delivered the aircraft to the Navy on June 29, 1984, the following items remained to be corrected.

- (a) AN/APS-80 antenna control was not functioning.
- (b) AN/APG-63 radar waveguide pressurization needed to be permanently modified.
- (c) AN/APG-63 lighting circuit (five-volt) was connected to the wrong terminal board stud.
- (d) Radar target data processor, model-125 (spare), was to be provided as replacement for the -131 model.
- (e) Oscillator (spare) was at McDonnell Douglas undergoing repair and acceptance testing.
- (f) Antenna (spare) was at Hughes Aircraft for replacement of worn rotary waveguide seals.
- (g) Attitude direction indicator lighting was wired to the wrong voltage source.

- (h) Horizontal situation indicator knobs were too large and required redesign and fabrication.

Except for items (d) and (e), LCC corrected the above items while the aircraft was undergoing Navy flight testing. LCC completed items (d) and (e) after the aircraft was delivered to Customs Service.

#### NAVY FOLLOW-ON FLIGHT TESTING

The Naval Air Test Center (NATC), Patuxent River Naval Air Station, Maryland, evaluated the AN/APG-63 radar and other avionics installed in the P-3A aircraft. The NATC evaluation consisted of a total of 100 hours of ground tests and nearly 45 hours of flight tests. The flight tests used three different aircraft targets with varied radar to target aspects, including three different target background conditions (over land, over water, and over land/water). We monitored portions of actual flight tests at the Chesapeake Test Range and viewed five of the video tapes of the radar's display made during separate flight tests.

Overall, the NATC reported that the radar system demonstrated the potential to detect and track possible drug carrying aircraft. We believe that given the conditions under which it was tested, the aircraft performed in a manner consistent with its design.

The results of the evaluation were reported to Naval Air Systems Command by the NATC on September 14, 1984. We reviewed the interim NATC report and concluded that it accurately identified the radar's maximum repeatable detection ranges under the conditions specified. Since the specific test results are classified, we have not included them as part of this report. A final NATC report is being developed, which should provide a comprehensive assessment/analysis of the P-3A demonstrated performance.

#### OBJECTIVE, SCOPE, AND METHODOLOGY

Our objective was to monitor the modification and flight test program, performed by LCC under contract with the Navy, and to report any schedule slippages, cost increases, and performance that might adversely affect mission capabilities of the modified P-3A aircraft.

We monitored various stages of contract performance at LCC, Burbank and Palmdale, California, and LAS, Ontario, California. We reviewed production and management reports, purchasing documents and status reports, milestone schedules, and financial and contractual documents, along with ground and flight test results.

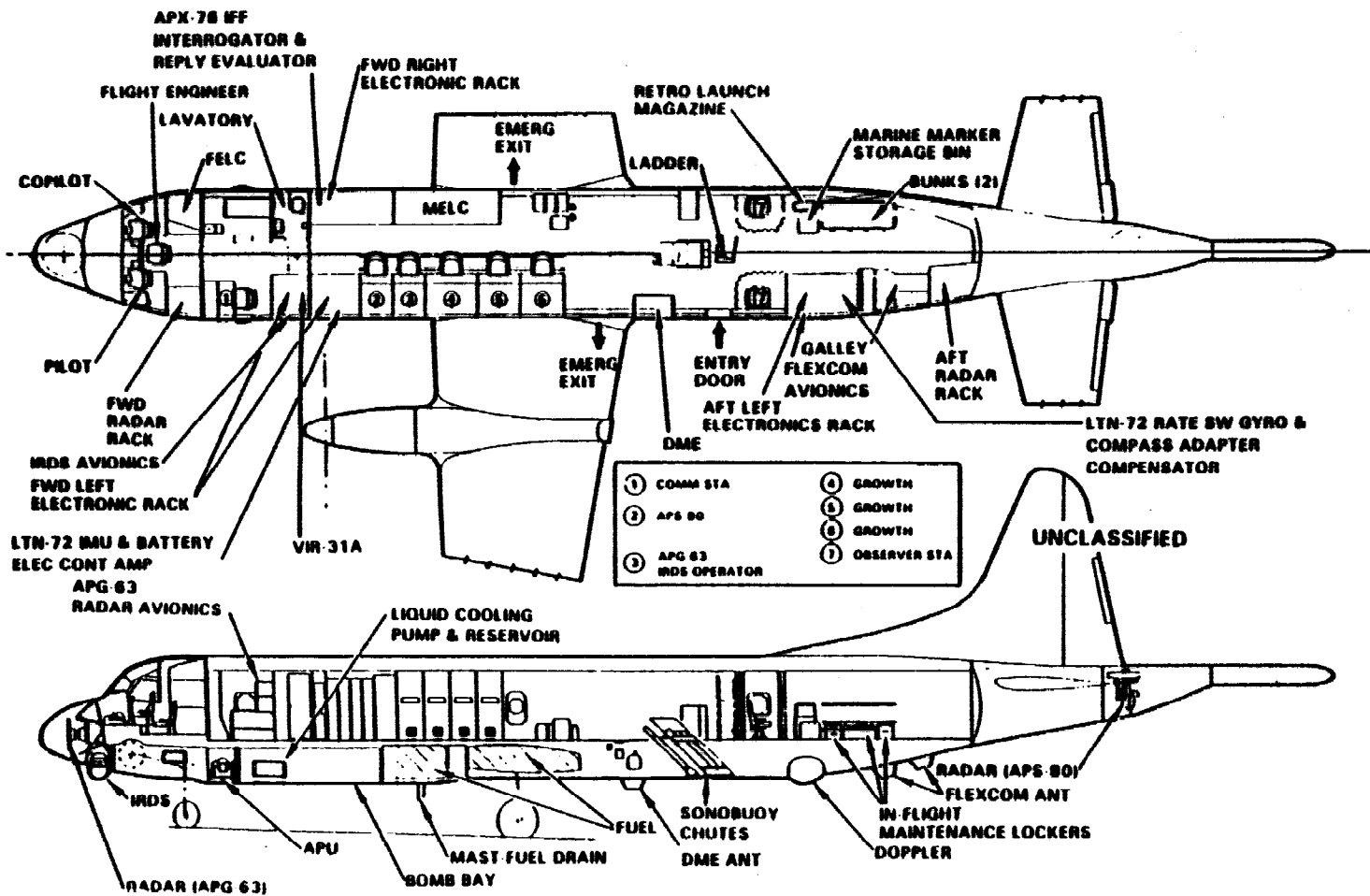
We monitored the status of government- and contractor-furnished material and equipment orders and receipts to determine if they would be available when needed. We attended engineering design and program review meetings when the status of the modification program was discussed with Navy and Customs Service officials. We also held discussions with LCC and LAS program management officials regarding the acquisition of material, fabrication and assembly, installation, and aircraft flight tests. Discussions also were held with Naval Plant Representative officials at LCC responsible for contract administration and a member of the NARF team responsible for aircraft repairs.

Our monitoring effort was limited to LCC contractual requirements and did not extend to program decisions of the Naval Air Systems Command or Customs Service regarding drug interdiction mission requirements and aircraft capabilities. In addition, we monitored the tests conducted at NATC during July and August 1984.

As requested by your office, we did not obtain official comments on this report. We did, however, discuss the contents of this report with agency and contractor officials, and their comments were considered in preparing this report.

Our review, conducted from November 1983 to September 1984, was made in accordance with generally accepted government auditing standards.

# APG-63 RADAR INSTALLATION DESIGN INBOARD PROFILE — AN/APG-63



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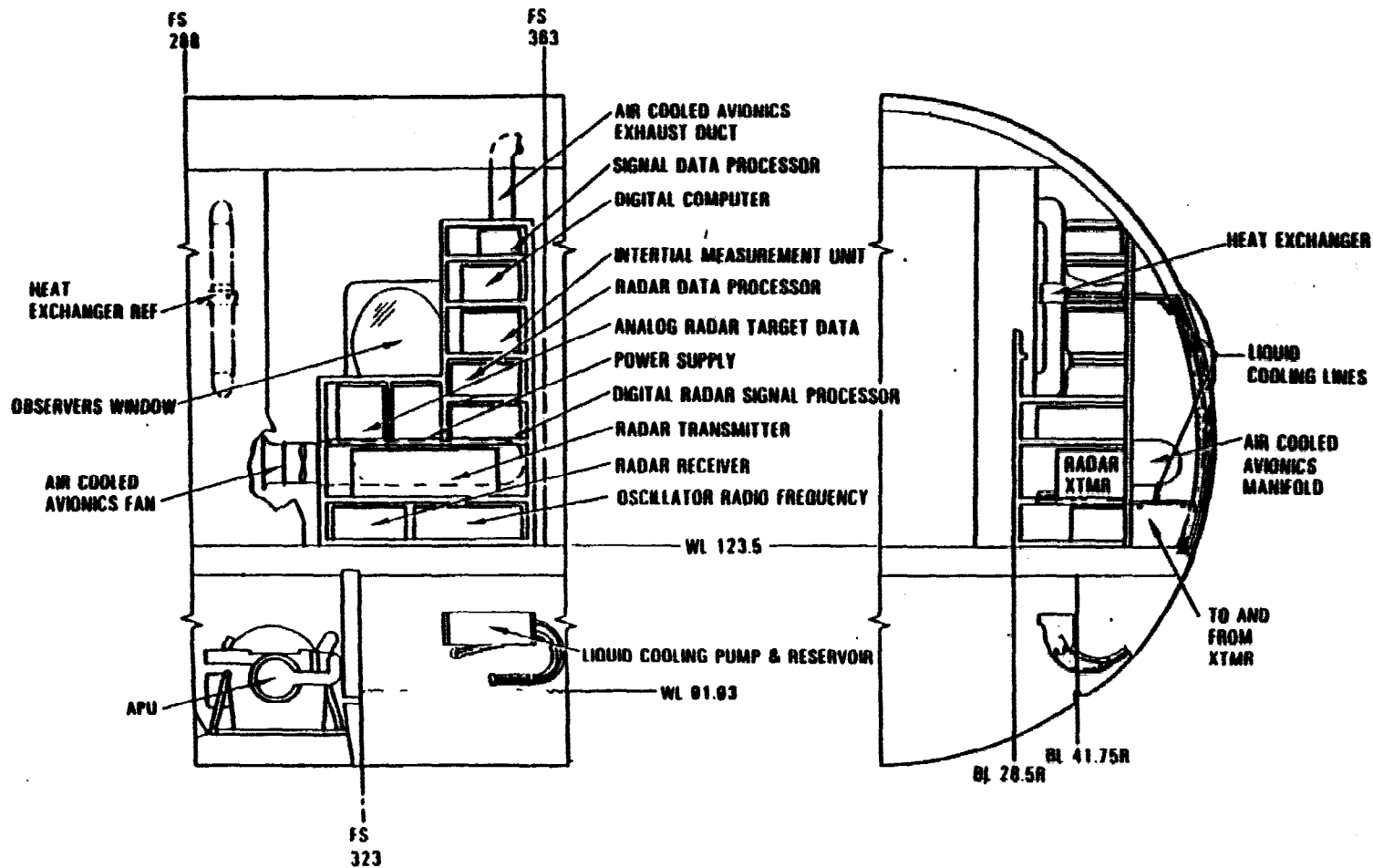
SOURCE: Lockheed-California Company

ENCLOSURE II

ENCLOSURE II



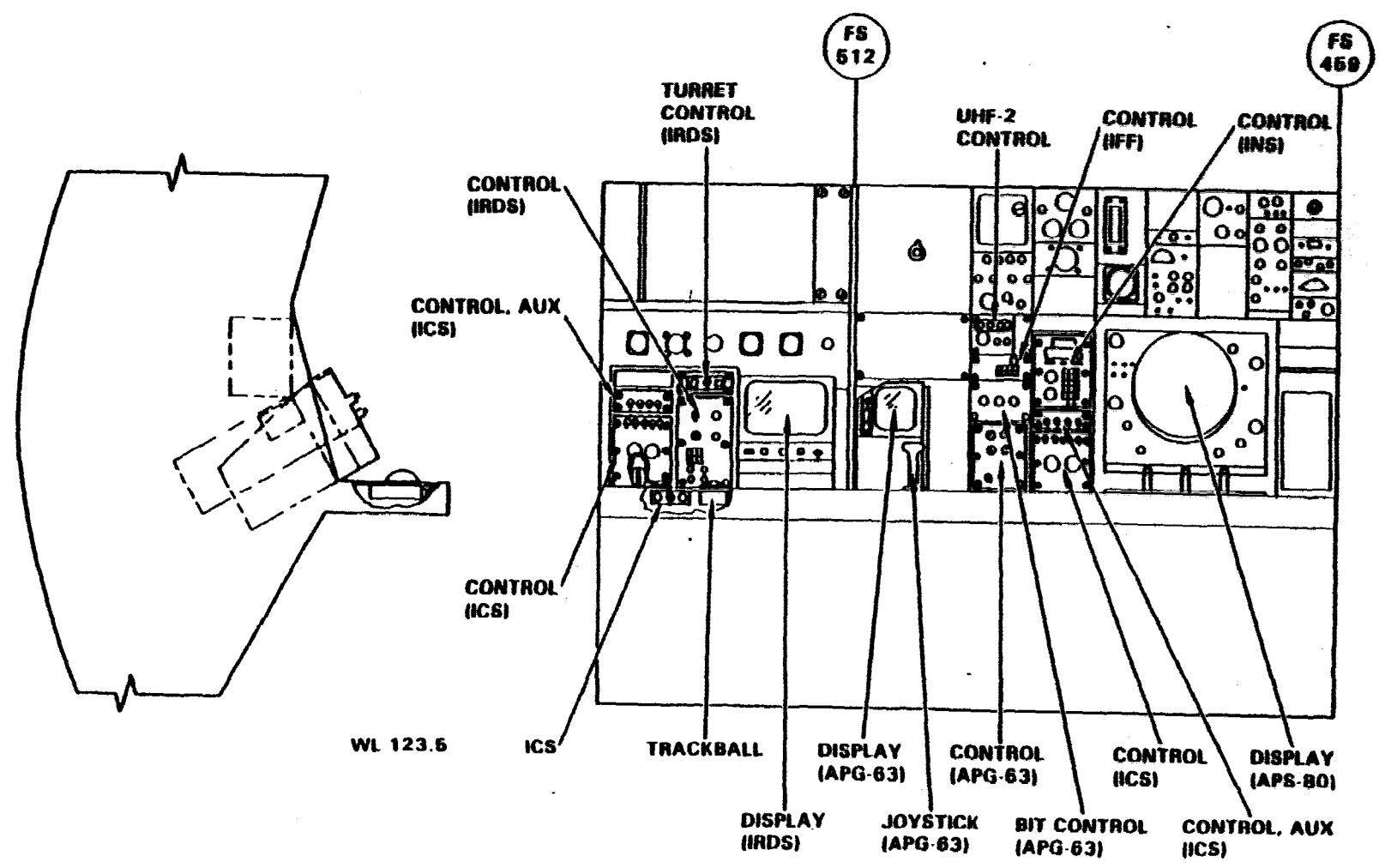
# APG-63 RADAR INSTALLATION DESIGN AN/APG-63 RADAR SYSTEM (RACK & EQUIPMENT)



SOURCE: Lockheed-California Company

# APG-63 RADAR INSTALLATION DESIGN SENSOR STATIONS 2 & 3

16



SOURCE: Lockheed-California Company