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GIANT BOOM TEST. ENLISTED RADAR/SYSTEMS OPERATOR KC-135.(U)

DEC 76 J TUCKER

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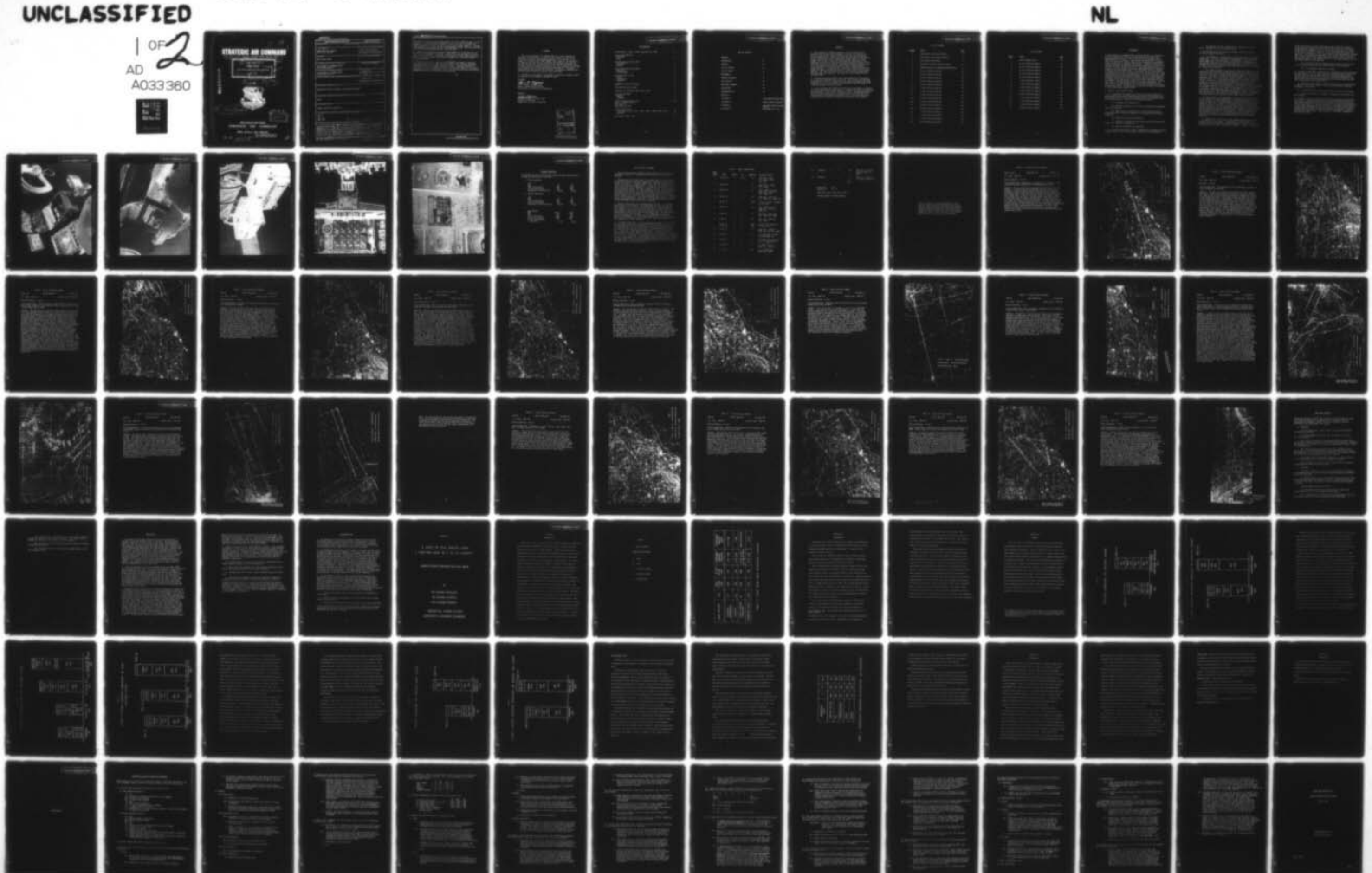

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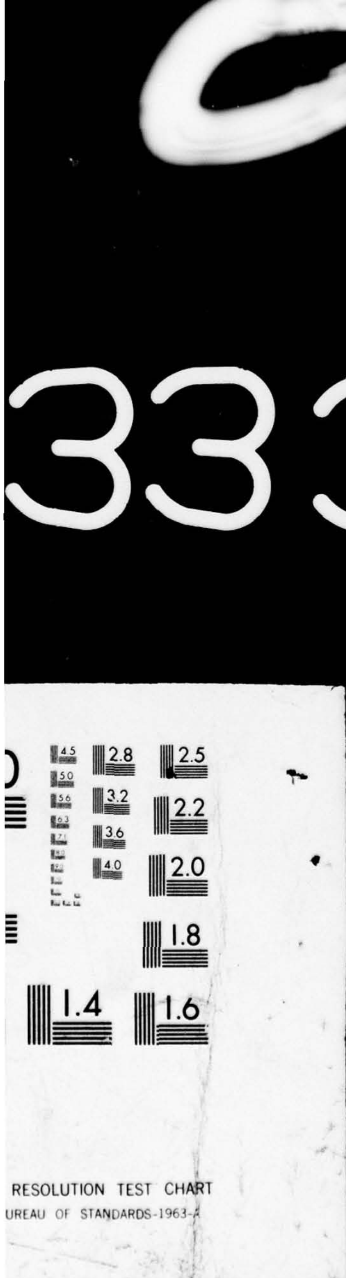

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STRATEGIC AIR COMMAND

(9) Final rept. Nov 75–Mar 76,

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FINAL REPORT

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KC-135.

(11) 15 DEC 1976

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Offutt Air Force Base, Nebraska

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1. The Strategic Air Command conducted a test to determine the feasibility of replacing the navigator on the KC-135 crew with an enlisted radar/systems operator while at the same time maintaining mission effectiveness. This crew composition was based on the results of the previous dual Inertial Navigation System (INS) test, GIANT CHANGE. The results of that test indicated that reducing the crew complement to three, with the copilot assuming navigation duties utilizing a dual INS, was not feasible. Additional workloads imposed

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on the pilot and copilot during some phases of flight created potential safety problems. To alleviate this condition, a fourth enlisted crew member was added to perform the duties of safety observer and systems operator. The test crew consisted of a pilot, copilot, radar/systems operator, and a boom operator. The exercise term assigned the test was GIANT BOOM.

2. Fourteen productive missions were flown between Jul 76 and Sep 76 on an aircraft configured with a dual INS. Test sorties were designed to evaluate the aircrew's capability to perform the Emergency War Order (EWO) mission as well as missions covering nearly the full range of air refueling squadron flying activities.

3. It was concluded that addition of the ~~fourth~~ 4th crew member, a specially trained enlisted radar/systems operator, reduced pilot overload conditions during emergencies and critical phases of flight. Although workloads on the pilots were ~~understandably~~ increased during certain phases of the flight because of navigation responsibilities, at no time did pilot/copilot overload ~~condition~~ constitute a discernible safety problem.

FOREWORD

1. This is the Strategic Air Command report on a test conducted to determine the feasibility of replacing the navigator on the KC-135 crew with an enlisted radar/systems operator. This test was an outgrowth of a previous test, GIANT CHANGE, which explored the possibility of reducing the crew size by eliminating the navigator crew position. The test aircraft was configured with a dual Inertial Navigation System and those functions normally performed by the crew navigator were assumed by the copilot and the enlisted radar/systems operator. Navigation responsibility was assigned to the pilots. The test was conducted from Jun 76 to Sep 76 under the exercise term GIANT BOOM.

2. The OPR for this report is HQ SAC/DOT. Questions or comments should be addressed to HQ SAC/DOTPX, AUTOVON 271-4256.

REVIEWED:

Gene O. Myers

GENE O. MYERS, Colonel, USAF
Chief, Training Plans Division
Directorate of Training, DCS, Operations

APPROVED:

Richard A. Burpee

RICHARD A. BURPEE, Colonel, USAF
Director of Training
Deputy Chief of Staff, Operations

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TABLE OF CONTENTS

ABSTRACT

1. The Strategic Air Command conducted a test to determine the feasibility of replacing the navigator on the KC-135 crew with an enlisted radar/systems operator while at the same time maintaining mission effectiveness. This crew composition was based on the results of the previous dual Inertial Navigation System (INS) test, GIANT CHANGE. The results of that test indicated that reducing the crew complement to three with the copilot assuming navigation duties utilizing a dual INS was not feasible. Additional workloads imposed on the pilot and copilot during some phases of flight created potential safety problems. To alleviate this condition, a fourth enlisted crew member was added to perform the duties of safety observer and systems operator. The test crew consisted of a pilot, copilot, radar/systems operator, and a boom operator. The exercise term assigned the test was GIANT BOOM.

2. Fourteen productive missions were flown between Jul 76 and Sep 76 on an aircraft configured with a dual INS. Test sorties were designed to evaluate the aircrew's capability to perform the Emergency War Order (EWO) mission as well as missions covering nearly the full range of air refueling squadron flying activities.

3. It was concluded that addition of the fourth crew member, a specially trained enlisted radar/systems operator, reduced pilot overload conditions during emergencies and critical phases of flight. Although workloads on the pilots were understandably increased during certain phases of the flight because of navigation responsibilities, at no time did pilot/copilot overload condition constitute a discernible safety problem.

LIST OF FIGURES

LIST OF TABLES

BACKGROUND

1. The Strategic Air Command (SAC) has been involved in a continuing effort to modernize the avionics on board the KC-135 tanker fleet. Improvement/modernization of the KC-135 navigation equipment holds a high priority in this effort. SAC has been considering the installation of an Inertial Navigation System (INS) to provide the navigational accuracy necessary to accomplish the mission. CINCSAC directed that tests be conducted to determine the expanded capabilities of the KC-135 aircraft if a dual INS were installed. The INS equipment and the configuration of the aircraft used for the GIANT BOOM test were identical to that of the GIANT CHANGE test. The reliability of this equipment, its adaptability to the air refueling mission, and the fact that it does significantly expand the capabilities of KC-135 aircraft were all established during the conduct of GIANT CHANGE. This test (GIANT BOOM) was designed to examine the feasibility of altering the aircrew composition to replace the navigator with a specially trained, nonrated, enlisted crew member. The two persons chosen to fill this new position, for the test, were KC-135 boom operators with considerable experience. The pilots were to assume responsibility for aircraft navigation utilizing the dual INS system. The designation of the new enlisted aircrew member is the Flight Systems Operator (FSO).

2. Specific test objectives were:

a. To determine the capability of the Flight Systems Operator to perform those duties normally performed by the aircrew navigator with the exception of actual aircraft navigation which was the responsibility of the pilot/copilot. These duties included such items as:

(1) Equipment turn on/operation.

(2) Monitoring departure, cell join up, enroute cell procedures, and station keeping.

(3) Radar scope interpretation to include position fixing, weather detection, electronic rendezvous, and airborne radar directed approaches.

(4) INS position fixing and plotting.

(5) Monitor of aircraft position during copilot overload situations, i.e., refueling, emergencies.

(6) Monitor penetration and approaches.

b. To assess the impact of special communication procedures, mission changes while in flight, and emergency procedures on crew workloads.

c. To determine the crews' capability to complete the mission with a simulated loss of the inertial system.

3. The 509 BMW, Pease AFB, NH and the 93 BMW, Castle AFB, CA were selected to support the mission.

a. The 509 BMW was to supply two of the aircrews used in the GIANT CHANGE test. This was to preclude the requirement to train the pilot/copilot team in the dual INS system. Unfortunately, only one of the GIANT CHANGE crews was still intact and available so a replacement was selected and trained in the INS system along with the two FSOs. The 509 BMW also provided two highly experienced boom operators to be trained as flight systems operators.

b. The 93 BMW developed a course to train the boom operators in the operation of the navigators equipment and to perform all the tasks outlined in the test plan (atch 4) and mentioned as specific objectives of this test. (See atch 2, 93 BMW Course Control Document.) The course was conducted from 1 Jun 76 thru 30 Jun 76 and included: 72 hours of classroom instruction, five T-10 trainer periods and four aircraft orientation flights. (See atch 1, GIANT BOOM Training Plan.) In addition the 93 BMW and 1 CEVG modified a KC-135 navigator's checklist to reflect the duties of the flight systems operator. It should be noted that a dual INS equipped aircraft was not available for the training flights conducted by the 93rd. Therefore, the flight systems operator was not trained on a dual INS aircraft where the pilots are responsible for navigation. A dual INS was used on the GIANT BOOM test missions at Pease. This lack of INS training was to later impact on the number of sorties required before valid data could be collected on the new flight systems operators.

4. As stated previously, the equipment used for this test was identical to that used for the GIANT CHANGE test. Its make-up and location will also be included in this report because of its essential function in the conduct of this test. The PINS (Palletized Inertial Navigation System), leased from Delco Electronics, is a palletized version of the standard Carousel IV system. This system requires approximately 15 minutes for ground alignment before the aircraft can taxi. Because of this, it would not meet SAC's fast reaction alert criteria. Discussions with Delco representatives indicate that a permanent installation integrated with the aircraft doppler and with certain software modifications, could provide a fast alignment (seven minutes) and an in-flight alignment capability.

a. Modification of the aircraft was accomplished at Pease with the assistance of Delco personnel. It consisted of installation of the pallets, controls and displays, Remote Display Unit (RDU), Horizontal Situation Indicator (HSI), and associated cables. The RDU was installed at the FSO position to allow remote monitoring of both INSs; however, no data could be entered into the system at this position. All mission flight plan data, whether in the air or on the ground, had to be entered at the pilot or copilot's position. The HSI was installed to give the crew a visual reference of cross track error and desired heading to selected waypoints. The information displayed on the HSI was slaved to the pilot's INS. System controls and display panels were located at the pilot and copilot side panels. (See Figures 1 thru 5.) The system software for the dual PINS installation was modified:

(1) To provide steering information for holding a precise orbit at an Air Refueling Control Point (ARCP) (referred to as Mode 22).

(2) To accommodate operation of the RDU.

5. Training in dual PINS configuration was conducted by a Delco representative at Pease on 7 Jul 76. Receiving the training were the two FSOs and the test crew that had not been involved in the GIANT CHANGE program. Specialized areas of training such as basic navigation procedures, radar scope interpretation/fixing procedures and grid steering (when required) were accomplished by the project officer.

a. The Pease project officer, Major John Tucker, was also designated as the SAC on-site test director. He is a fully qualified instructor navigator in the KC-135.

b. A third pilot flew on each test mission to ensure flight safety.

c. The first mission was a "hands-on" orientation flight which both FSOs flew on.

6. The SAC on-site test director flew on the orientation flight and each test mission. Extensive post-flight critiques were conducted after the orientation flight and after the first two test missions for each FSO to train out deficiencies in present procedures or to establish new procedures to ease their integration into the test crew. Personnel from Air Force Systems Command (Aeronautical Systems Division, Directorate of Equipment Engineering) flew on test sorties to provide an assessment of aircrew workloads and capabilities. Their analysis is contained in Appendices A and B of this report.

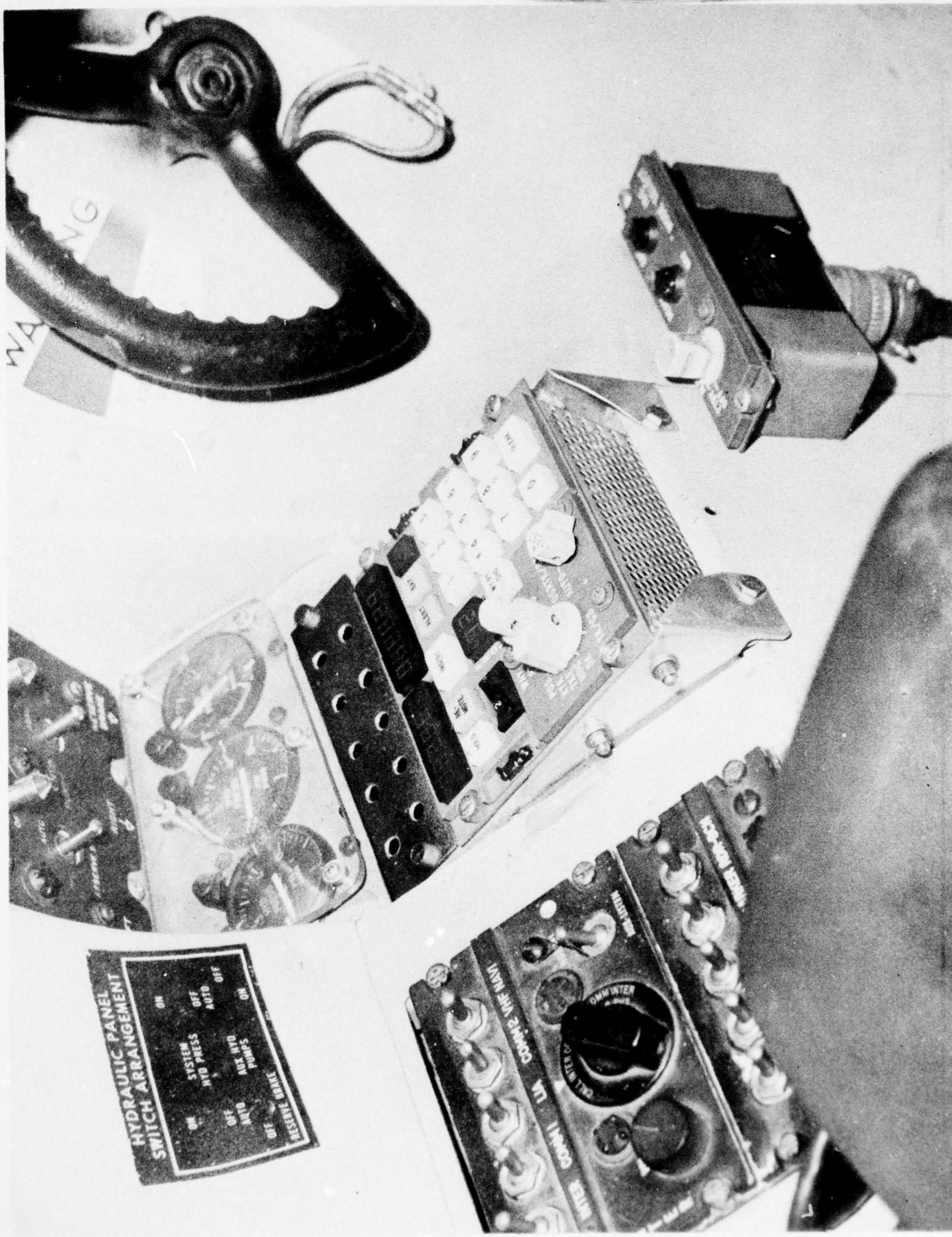

Figure 1. PINS Control and Display (Pilot)

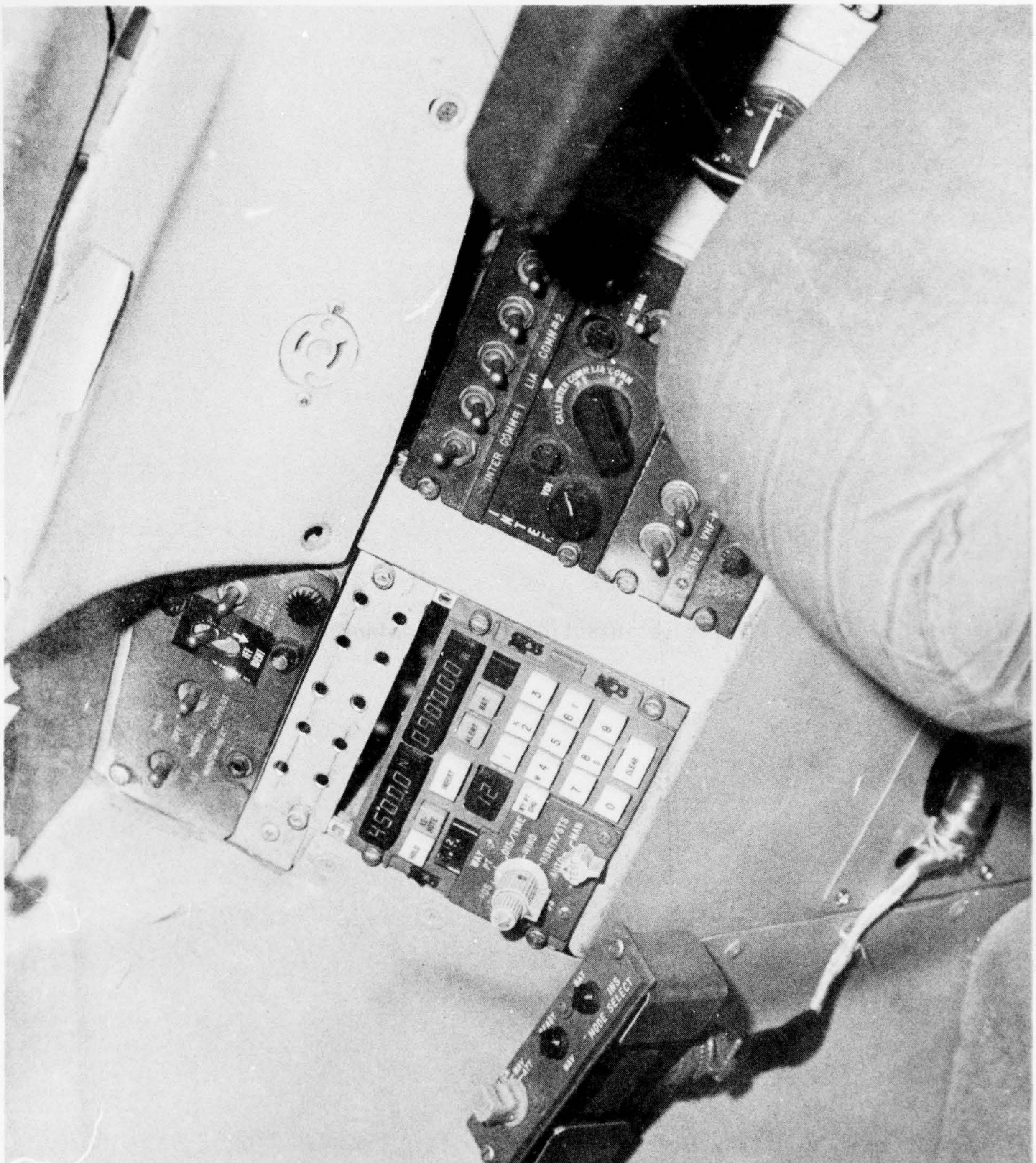

Figure 2. PINS Control and Display (Copilot)

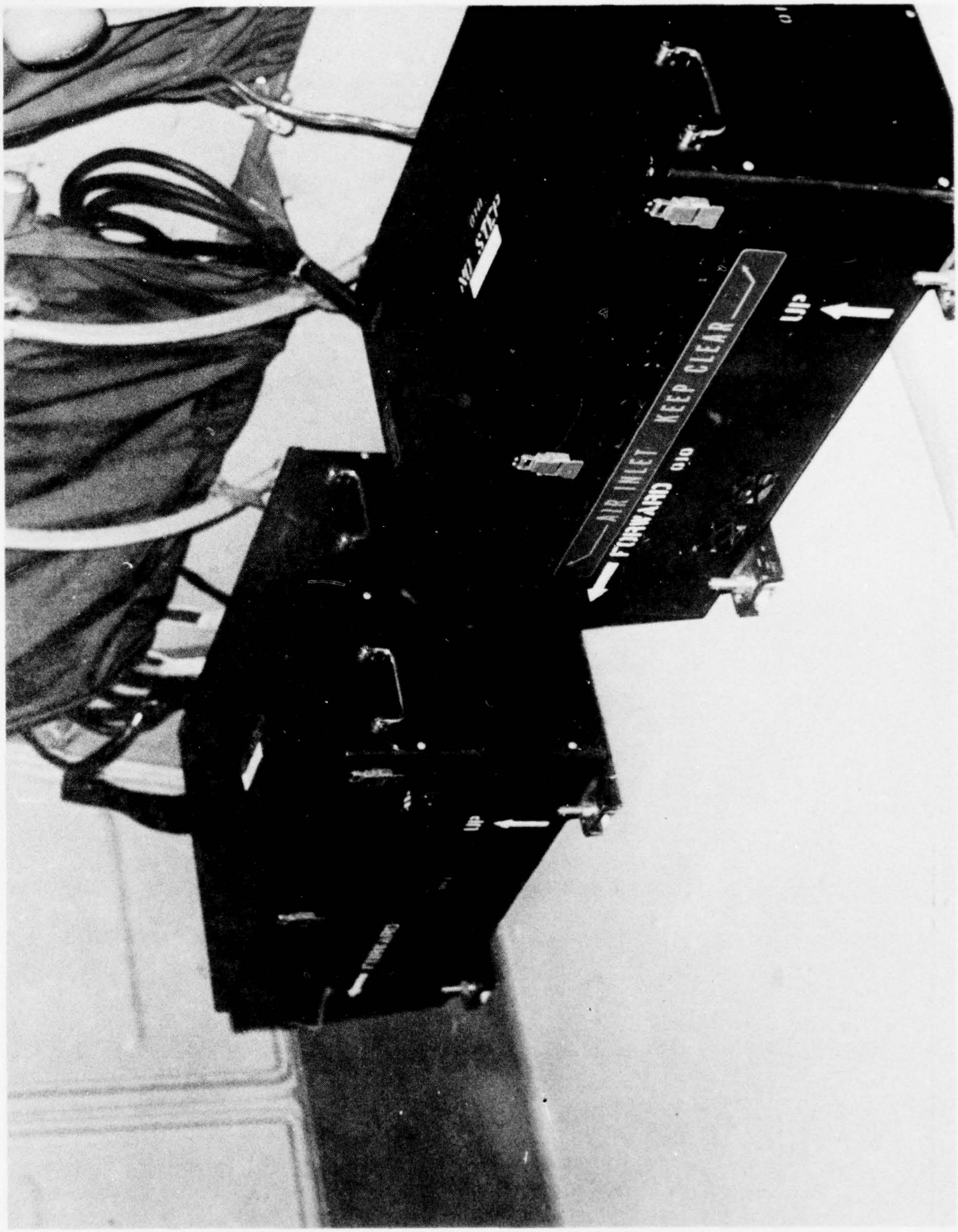

Figure 3. Dual Pallet Installation

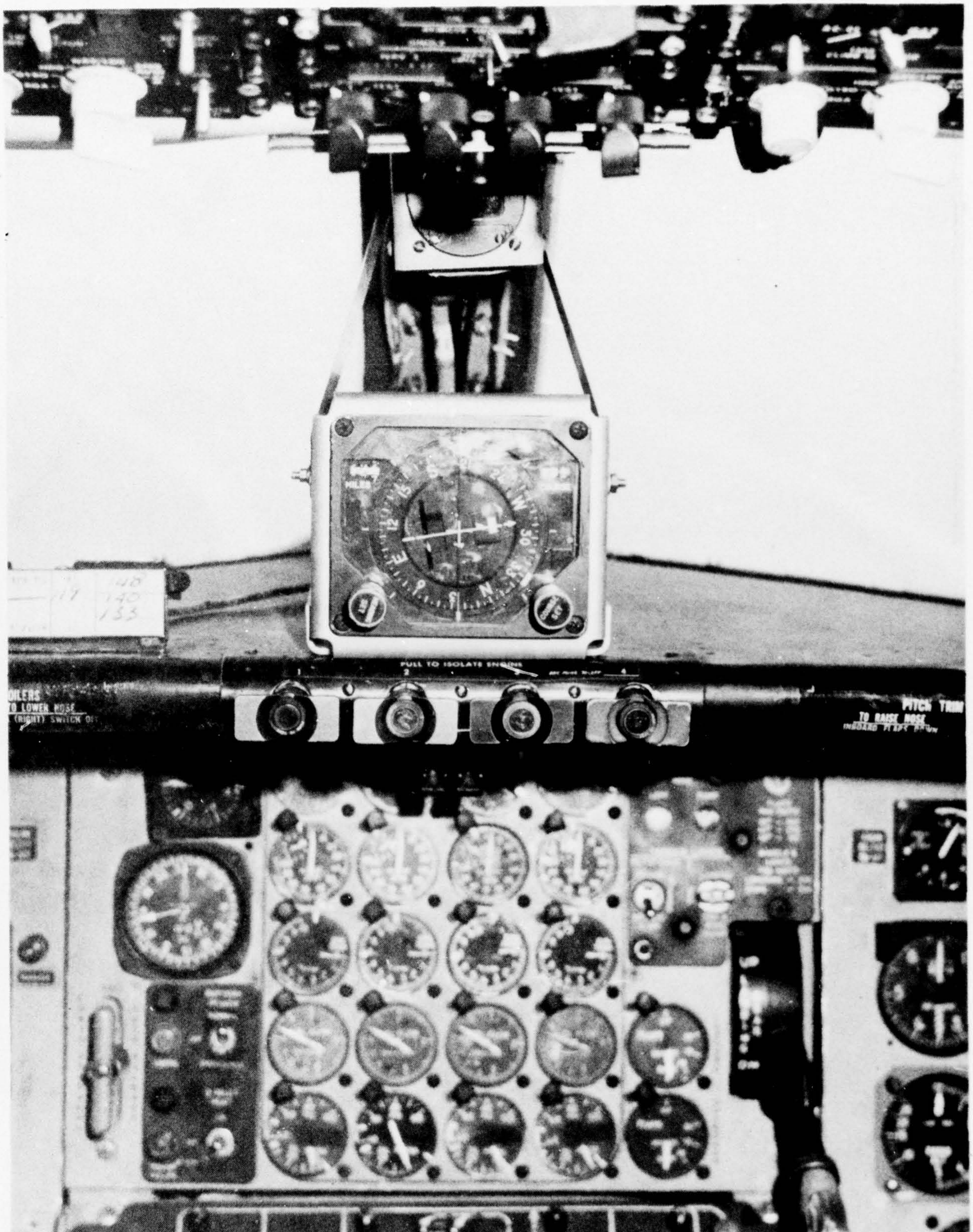

Figure 4. Horizontal Situation Indicator (HSI)

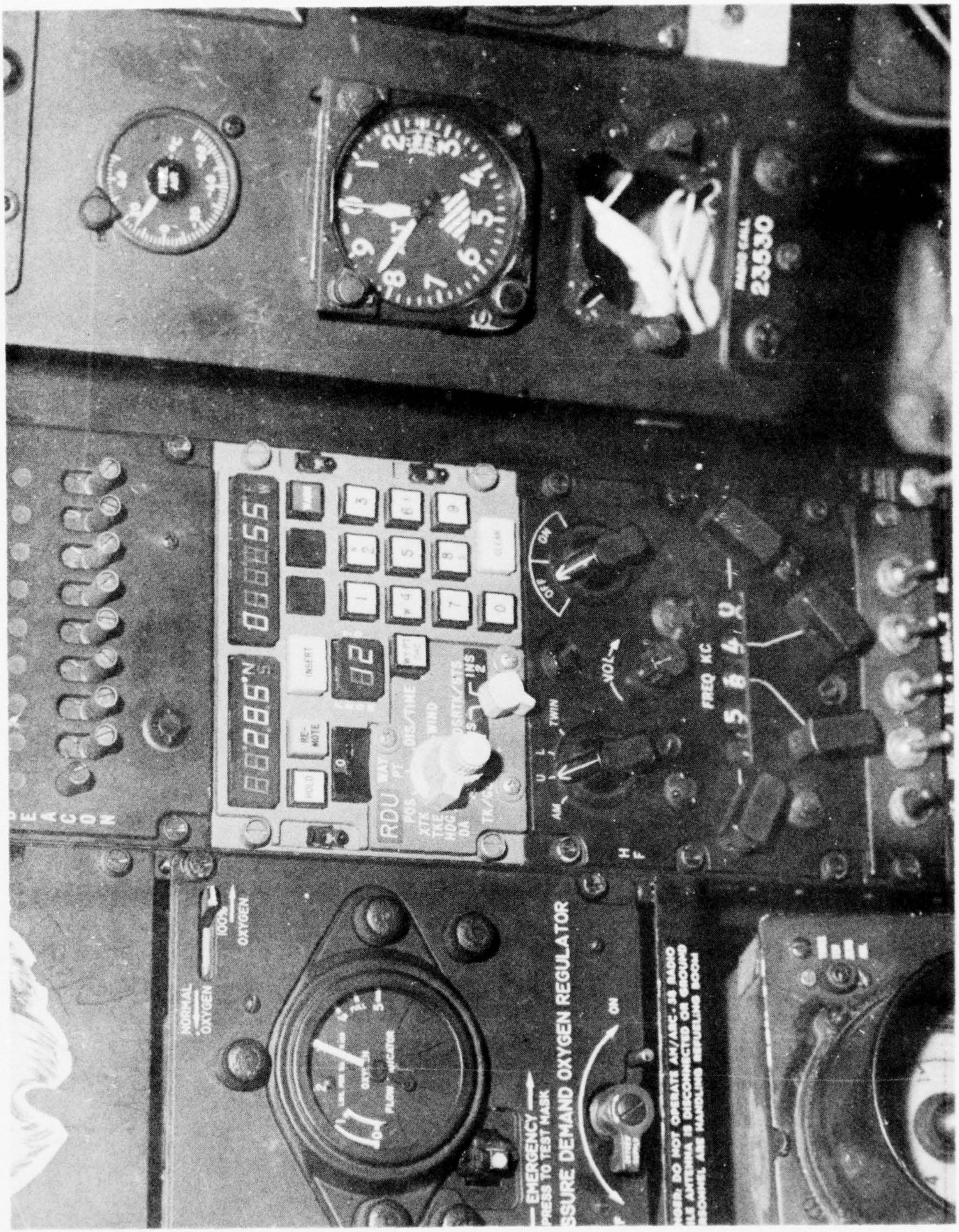

Figure 5. Remote Display Unit (Navigator Station)

AIRCREW EXPERIENCE

Two 509 BMW aircrews and two highly experienced boom operators were selected to participate in this test.

a. Pilot Experience

Crew	1	2
Age	28	28
Total Flying Hours	1450	1300
KC-135 Flying Hours	740	1100
Experience as KC-135 Pilot	20 mos	18 mos

b. Copilot Experience

Crew	1	2
Age	25	25
Total Flying Hours	980	760
KC-135 Flying Hours	760	530
Experience as KC-135 Copilot	18 mos	2 yrs

c.

Boom Operator	1	2
Rank	SMSgt	MSgt
Age	40	41
Total Flying Hours	2700	7765
KC-135 Flying Hours	2700	3221
KC-135 Boom Operator Experience	7 yrs	10 yrs

TEST ACTIVITY (509 BMW)

1. Active flight testing commenced at Pease AFB on 14 Jul 76 and was completed on 10 Sep 76. Fourteen missions were flown in support of the test.

2. Mission objectives established in the GIANT BOOM Test Plan (atch 4) concentrated on those areas that created the greatest pilot overloads during the conduct of the GIANT CHANGE test. They are referred to as "tasks" on the mission summary sheets. Except for the first few sorties the missions were fairly demanding. If potential overload situations did not normally evolve, they were created by the test director through inflight mission changes. A radar navigation leg was usually planned on each mission to test the FSO's ability in radar scope interpretation, radar/INS fixing (to include plotting) and route monitoring. The type sorties chosen as test missions were representative of the full range of KC-135 flying commitments. (See Sortie Summary Sheet, Table 1.) All the minimum crew requirements established in the Mission Scenarios section of the GIANT BOOM test plan were met or exceeded.

3. Mission planning was not evaluated during this test. It was not established as an objective in the GIANT BOOM Test Plan nor were the FSOs trained in it at Castle. Mission planning for the test missions was, however, a total crew effort with the pilot, copilot, FSO, and boom operator preparing all necessary paperwork except for the actual preparation of the SAC Form 200, Mission Flight Plan. This was prepared by a KC-135 instructor navigator. If the GIANT BOOM concept were actually implemented, this requirement could be met by: training the FSO in mission planning, using canned mission data, or having the mission plan prepared by a staff navigator.

4. It became evident early in the flight test that the first two sorties for each FSO would involve considerable training in order for them to work effectively in their crew position on a dual INS equipped aircraft. It should be noted that the average KC-135 CCTS graduate has had 10-12 missions prior to reporting to his unit; in this case the FSO had only four. (See atch 1, GIANT BOOM Training Plan.) In addition, one of the FSOs had a long break without a test sortie so two additional sorties were flown to bring him up to an acceptable level of proficiency. Because of this, and to accommodate the additional training required on the earlier missions, approximately six sorties beyond those anticipated by the test plan were flown. In the interest of getting the most valid data possible, the additional sorties were justified.

Table 1. SORTIE SUMMARY SHEET

SORTIE NO.	DATE	CREW #	FSO	DURATION	MISSION ACTIVITY
1	14 Jul 76	1	1 & 2	3.2	Radar Nav - RNDZ, AR - *ARDA - 1+10 late T.O.
2	16 Jul 76	2	2	7.0	RNDZ AR (2) - Radar Nav - ARDA
3	20 Jul 76	2	2	5.7	MITO - RNDZ, Cell AR - Radar Nav - Minor Msn Chg - ARDAs (2)
4	22 Jul 76	2	1	5.4	Radar Nav - Minor Msn Chg - RNDZ, AR - ARDAs (2)
-	26 Jul 76	2	1	CANX	2 hr T.O. delay, scrubbed as GB sortie
5	28 Jul 76	1	1	5.4	MITO - RNDZ, Cell AR - Radar Nav - Msn Chg - ARDAs (4)
6	4 Aug 76	2	2	5.2	Radar Nav - Minor Msn Chg - RNDZ, AR - ARDA
7	6 Aug 76	1	2	6.8	RNDZ, AR - Overwater Nav - ARDA
	10 Aug 76	1	1	CANX	Sorties lost because of
	11 Aug 76	2	1	CANX	WX evacuation
8	17 Aug 76	2	2	5.9	Radar Nav - TNKR DIR RNDZ, AR - Msn Chg - ARDA
9	19 Aug 76	2	2	11.2	Polar Radar Nav in GRID - Simulated RNDZ, AR
10	24 Aug 76	2	2	7.7	ALT RNDZ, Cell AR (6 ship cell) - Overwater Nav
11	2 Sep 76	2	1	5.6	ALT RNDZ, Cell AR - Radar Nav - ARDAs (3)
12	7 Sep 76	2	1	4.5	TNKR DIR RNDZ, AR - Radar Nav - ARDA

13	8 Sep 76	2	1	4.3	Radar Nav - Msn Chg - Simulated RNDZ, AR - ARDA
14	10 Sep 76	2	1	7.1	RNDZ, AR - Radar Nav - Simulated 2nd RNDZ, AR
				85.	

Sorties for #1 - 7
Sorties for #2 - 8

(Both FSOs flew on the first sortie.)

* Airborne Radar Directed Approach

Tables 2 through 15 represent summaries of each mission flown during the GIANT BOOM test program. They are based on observations by the test director recorded immediately after the flight and contain comments of both an objective and subjective nature. Because of their limited perspective, they should not be looked on as conclusive in themselves.

Table 2. 14 July 76 Mission Summary

Crew #1 and 2 FSOs (Msn #1) Test Msn #1

T.O. Time: 2018 EST Landing Time: 2330 EST

Mission Duration: 3.2 hrs

Tasks Accomplished: Rendezvous, air refueling, 40 minutes of radar navigation and one Airborne Radar Directed Approach (ARDA).

Comments: This was the hands-on orientation flight with both FSOs onboard. In light of this no attempt was made to evaluate crew workloads; instead refresher training for the FSO and a general orientation into the dual INS setup for both the FSO and the pilots were accomplished. A one hour and ten minute late takeoff reduced the training time available. The FSOs spent a great deal of time in the radar scope for target interpretation. Crew coordination was rough; the role of the FSO in assisting the pilots with aircraft navigation will require further definition. The FSOs seem to have a good grounding in TERPS procedures and the requirement for monitoring departures (SIDS), penetrations and approaches. On this flight, however, the excessive time spent interpreting the radar scope caused them to miss items that should have been monitored during the approach and landing.

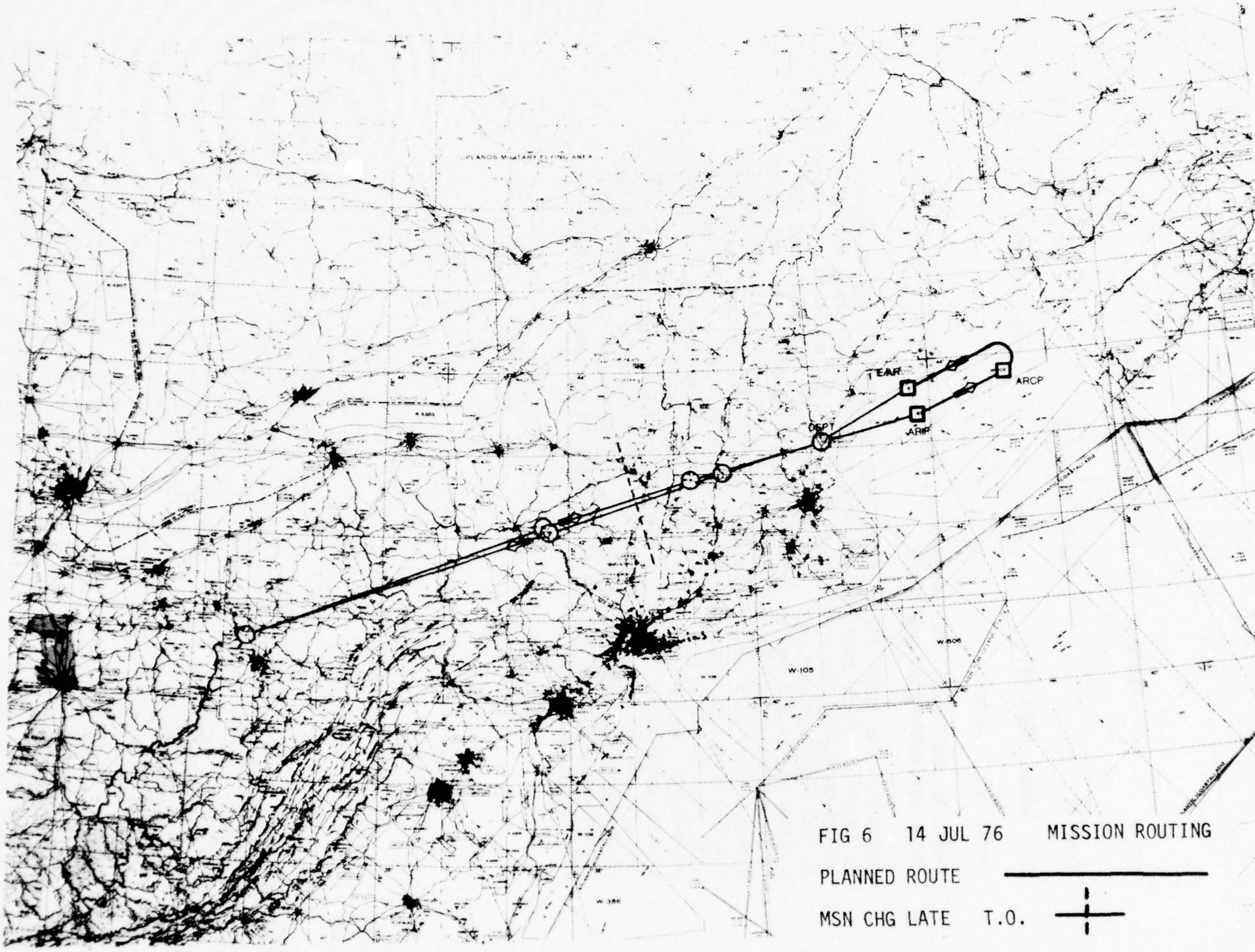

FIG 6 14 JUL 76 MISSION ROUTING

PLANNED ROUTE

MSN CHG LATE T.O.

Table 3. 16 Jul 76 Mission Summary

Crew #2 | FSO #2 (Msn #2) | Test Mission #2

T.O. Time: 0901 EST | Landing Time: 1601 EST

Duration: 7.0 hrs

Tasks Accomplished: Two rendezvous, two air refuelings, two hours of radar navigation and one ARDA.

Comments: For their first flight with the INS, the pilots adapted quite well. Their coordination with the FSO on aircraft navigation was rough during the early phases of flight but smoothed out somewhat as the flight progressed. They failed to make the ARCP with the 15 minutes called for by the flight manual. The pilots did not appear to be overloaded during any particular phase of flight although at various times they devoted too much time to the INS and navigation. The FSO made some minor procedural errors and was a little awkward with the radar at first but showed a marked improvement as the flight progressed. He was given a little assistance during the ARDA but was able to meet basic safety of flight considerations for monitoring descent, approach, and landing. The FSO was unable to conduct the rendezvous because he never acquired the receivers beacon. His procedures and checklist usage were weak in the area of rendezvous and air refueling.

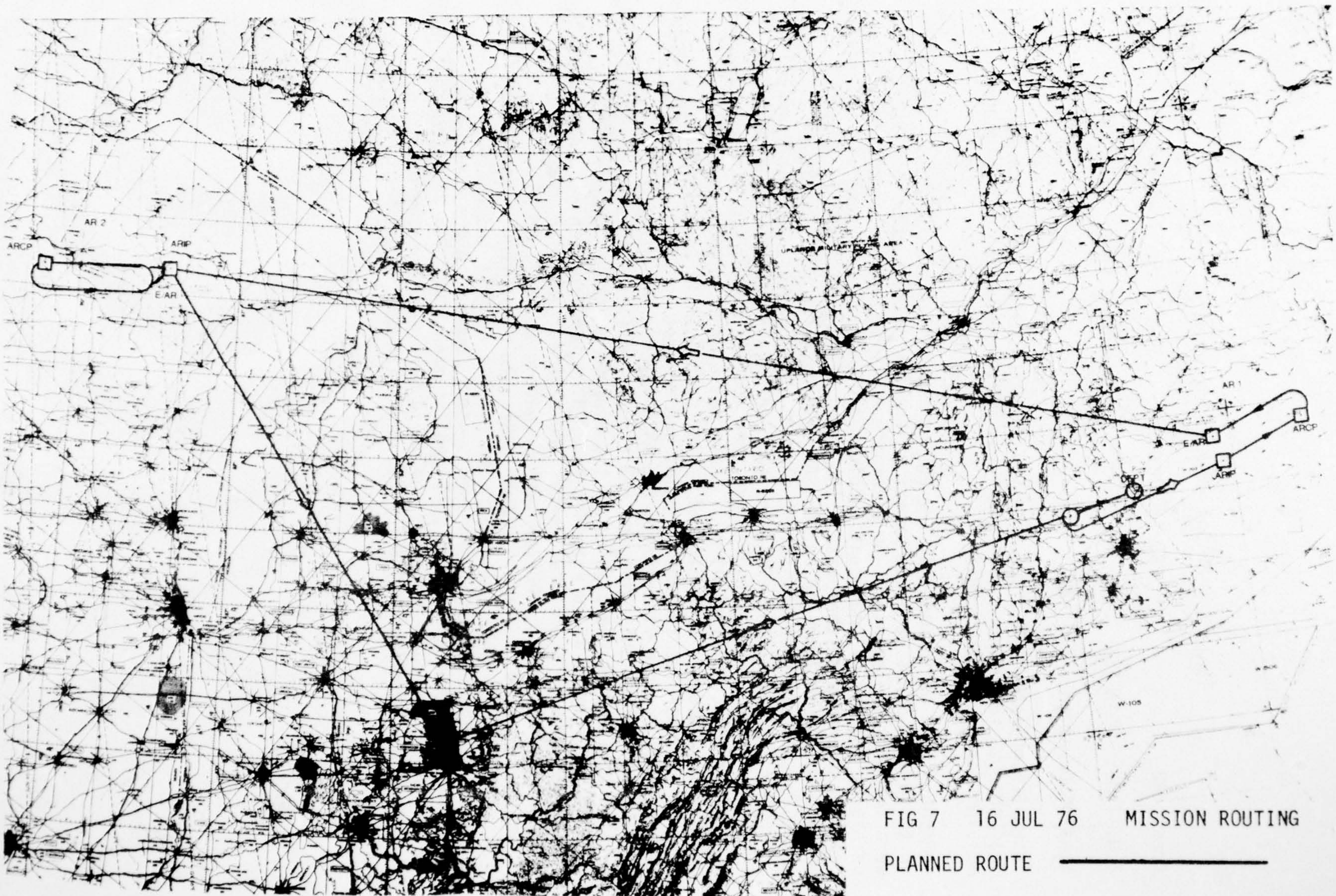

FIG 7 16 JUL 76 MISSION ROUTING

PLANNED ROUTE ————————

INFLIGHT MSN CHG - NONE

Table 4. 20 Jul 76 Mission Summary

Crew: #2 FSO #2 (Msn #3) Test Msn #3

T.O. Time: 0915 EST Landing Time: 1455 EST

Mission Duration: 5.7 hrs

Tasks Accomplished: Minimum Interval Takeoff (MITO), cell join-up, lead change, rendezvous, air refueling, radar navigation with a minor mission change and two ARDAs.

Comments: The performance of the FSO on this flight was probably not up to the standards we would expect of the FSO if this crew make-up were actually implemented. An alternate rendezvous was accomplished partially because of equipment problems and partially because of procedural errors on the part of the crew. This sortie included a mission change implemented by the SAC test director that involved changing two points on the flight plan to accommodate an imaginary emergency air refueling. The crew handled this navigation problem fairly well and probably would have been able to effect the emergency AR if it were actually required. There was a certain amount of difficulty, however, as indicated by the fact that it took 18-20 minutes to determine the end AR point and request an ATC clearance. The crew had trouble visualizing the ARIP--ARCP/orbit pt--end AR alignment. During this time the FSO and the copilot were almost totally involved in the problem at the expense of other duties. The FSO's first attempt at an airborne radar directed approach was unsuccessful because of procedural errors and difficulties with radar scope interpretation. During the approach he became so involved with attempting to read the radar that he neglected other requirements for monitoring the approach. Based on the results of this and the previous flight, the personnel from Air Force Systems Command, ASD requested that two additional flights be provided for each FSO. The first two sorties were devoted to training and valid workload data could not be derived until approximately the fifth and sixth sortie per FSO/crew combination.

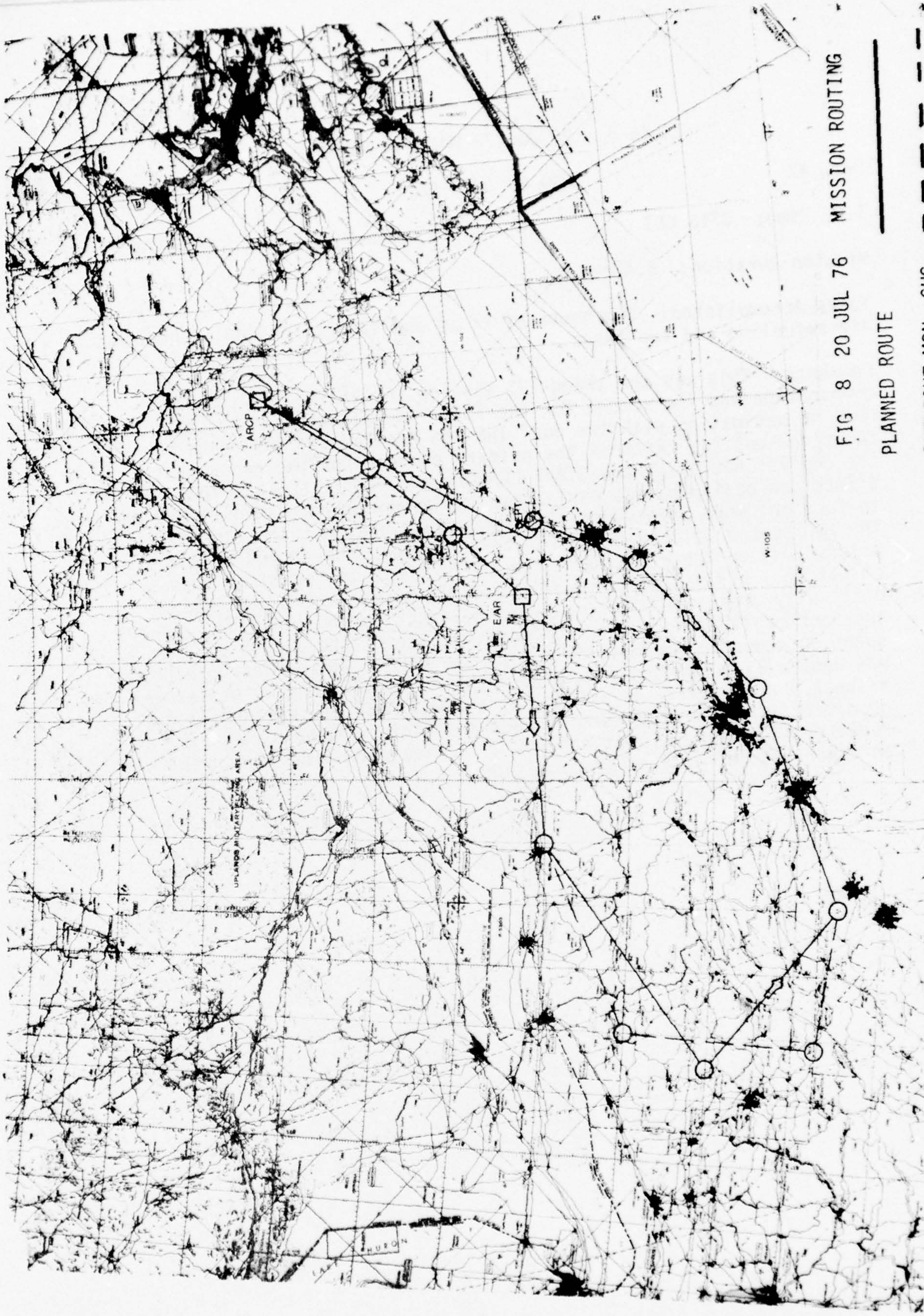

FIG 8 20 JUL 76 MISSION ROUTING

PLANNED ROUTE ————

INFLIGHT MSN CHG – – – –

Table 5. 22 Jul 76 Mission Summary

Crew #2 FSO #1 (Msn #2) Test Msn #4

T.O. Time: 0710 EST Landing Time: 1235 EST

Mission Duration: 5.4 hrs

Tasks Accomplished: Two hours of radar and INS navigation, rendezvous, air refueling and two ARDAs.

Comments: This was the third INS mission for this pilot/copilot combination and the second for the FSO. The pilots have adjusted well to navigating with the dual INS and handled all INS related functions easily. Without the primary concern for the radar that the copilot had under the GIANT CHANGE concept, it appears that the pilots can easily handle navigation (under normal conditions) and can in fact get more involved in the rendezvous phase of the mission. The FSO seemed well prepared for this mission. He backed-up the pilots well on their navigation and throughout the critical phases of flight. His radar fixing is basically good; however, he had difficulty breaking-out the base as a target during the ARDA. Again, approach monitor procedures suffered because of the amount of time spent on scope interpretation during the ARDA. While radar fixing was generally good, his knowledge of basic dead reckoning procedures is weak. Practically no attempt at all was made at keeping a log or recording fixes at predetermined action points. However, as his radar proficiency improves the FSO will have more time to concentrate on other requirements of the position.

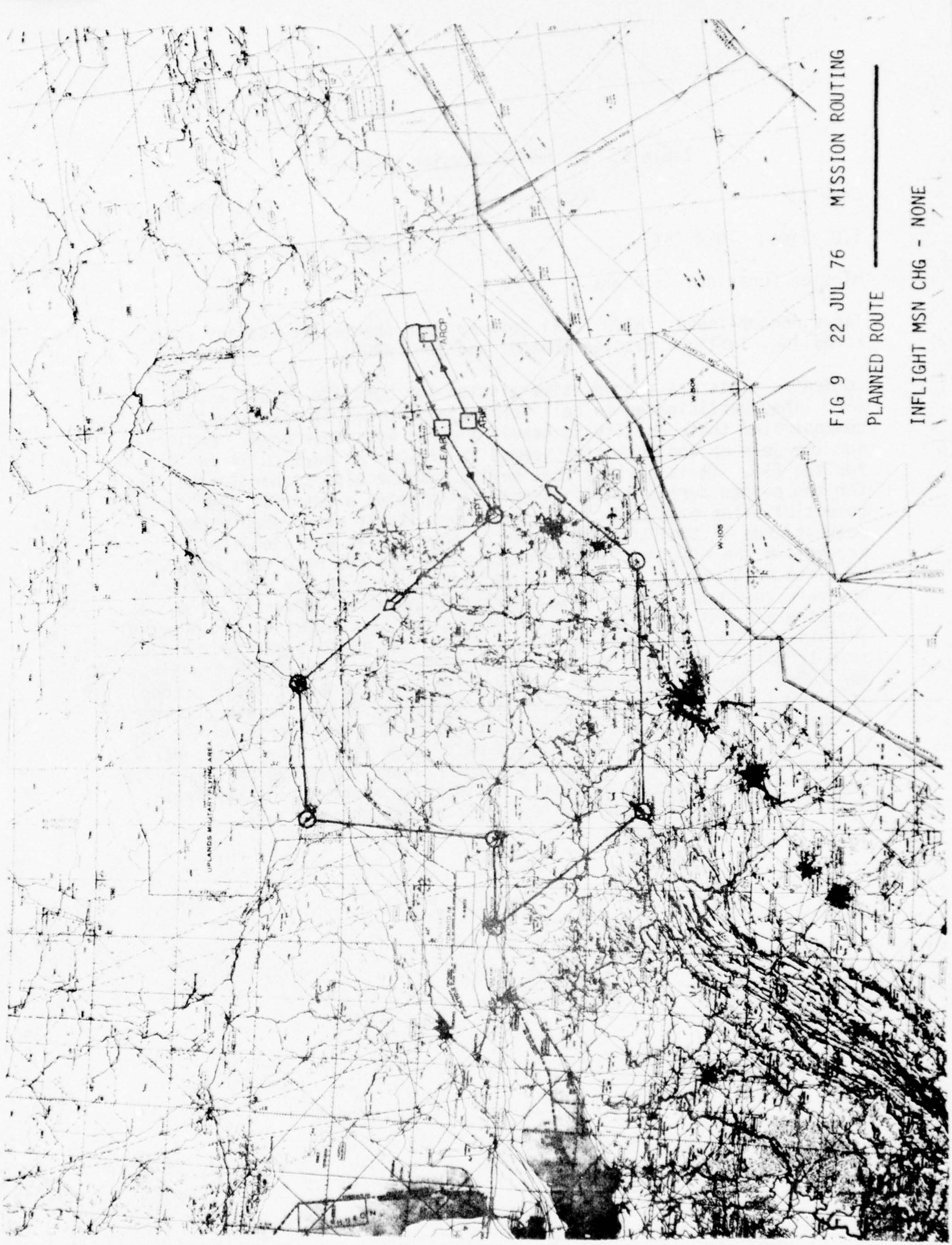

FIG 9 22 JUL 76 MISSION ROUTING

PLANNED ROUTE ———

INFLIGHT MSN CHG - NONE

Table 6. 28 Jul 76 Mission Summary

Crew #1 FSO #1 (Msn #3) Test Msn #5

T.O. Time: 1024 EST Landing Time: 1550 EST

Mission Duration: 5.4 hrs

Tasks Accomplished: MITO, cell join-up lead change, rendezvous and air refueling, inflight mission change, and four ARDAs.

Comments: This was a productive mission for both the pilots and the FSO. They participated in cell formation join-up, station keeping and demonstrated their ability to handle a major mission change. Monitoring the join-up and formation seemed to present no particular problems for the FSO. It is obvious that having someone else to handle the radar for the pilots during station keeping eliminates a definite area for potential pilot overloads. The rendezvous itself was probably the weakest area of the FSO's performance; however, it was adequate to accomplish the mission. When the ADF indicated the receivers might be right of the nose, he attempted to make a turn in the wrong direction; however, this was over ruled by the safety observer. Overall it was a confused and procedurally weak rendezvous but successful in its primary objective. The rendezvous procedure is an area that is giving the FSO some trouble. This will require more emphasis in future CCTS training for FSOs. The mission change required the crew to cancel their planned navigation and proceed to a second air refueling area. It was a complex change but handled well. The crew did not plot a new course on a chart to determine if it might penetrate a restricted area. They just entered the new data into the INS, achieving the primary objective on time. The ARDAs were good overall, showing a definite improvement in this area. Recording of inflight data by the FSO is almost nonexistent.

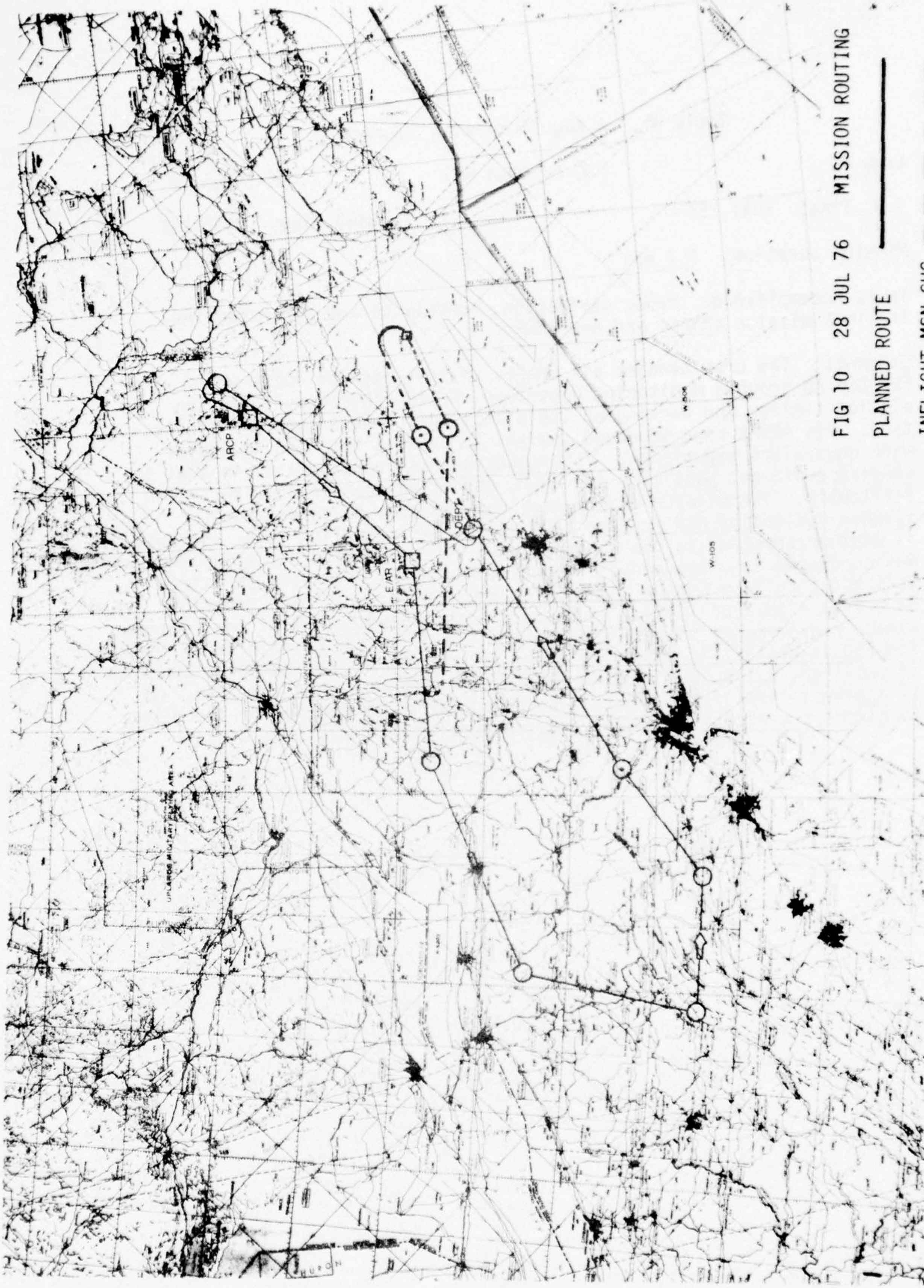

FIG 10 28 JUL 76 MISSION ROUTING

PLANNED ROUTE ————

INFLIGHT MSN CHG – – – –

Table #7. 4 Aug 76 Mission Summary

Crew #2 | FSO #2 (Msn #4) | Test Msn #6

T.O. Time: 1841 EST | Landing Time: 2350 EST

Mission Duration: 5.2 hrs

Tasks Accomplished: Radar navigation, rendezvous and air refueling, inflight mission change and one ARDA.

Comments: The crew handled all phases of this mission quite well. The FSO had no trouble monitoring departure, fixing on radar, following mission timing, and backing up the pilots during departure and penetration. His ARDAs have improved and are comparable to a new navigator with equivalent experience. The rendezvous was nonstandard, in that the receivers did not pass over the ARIP, and it was completed with little difficulty. The mission change required the crew to cancel their planned navigation and proceed to a second air refueling area. Because of weather problems in the original area, the scheduled air refueling was conducted in a new area. The mission changes were handled fairly well but totally occupied the copilot and FSO for a 15 minute period. On a crew with a navigator, he would probably handle most of the mission change requirements himself and the copilot would not be so greatly involved. The FSO is weakest in this area where a knowledge of navigational concepts is required, but he has shown progress over the course of the test. It is apparent that if the FSO will be responsible for backing up the pilots in aircraft navigation he will require more training in this area.

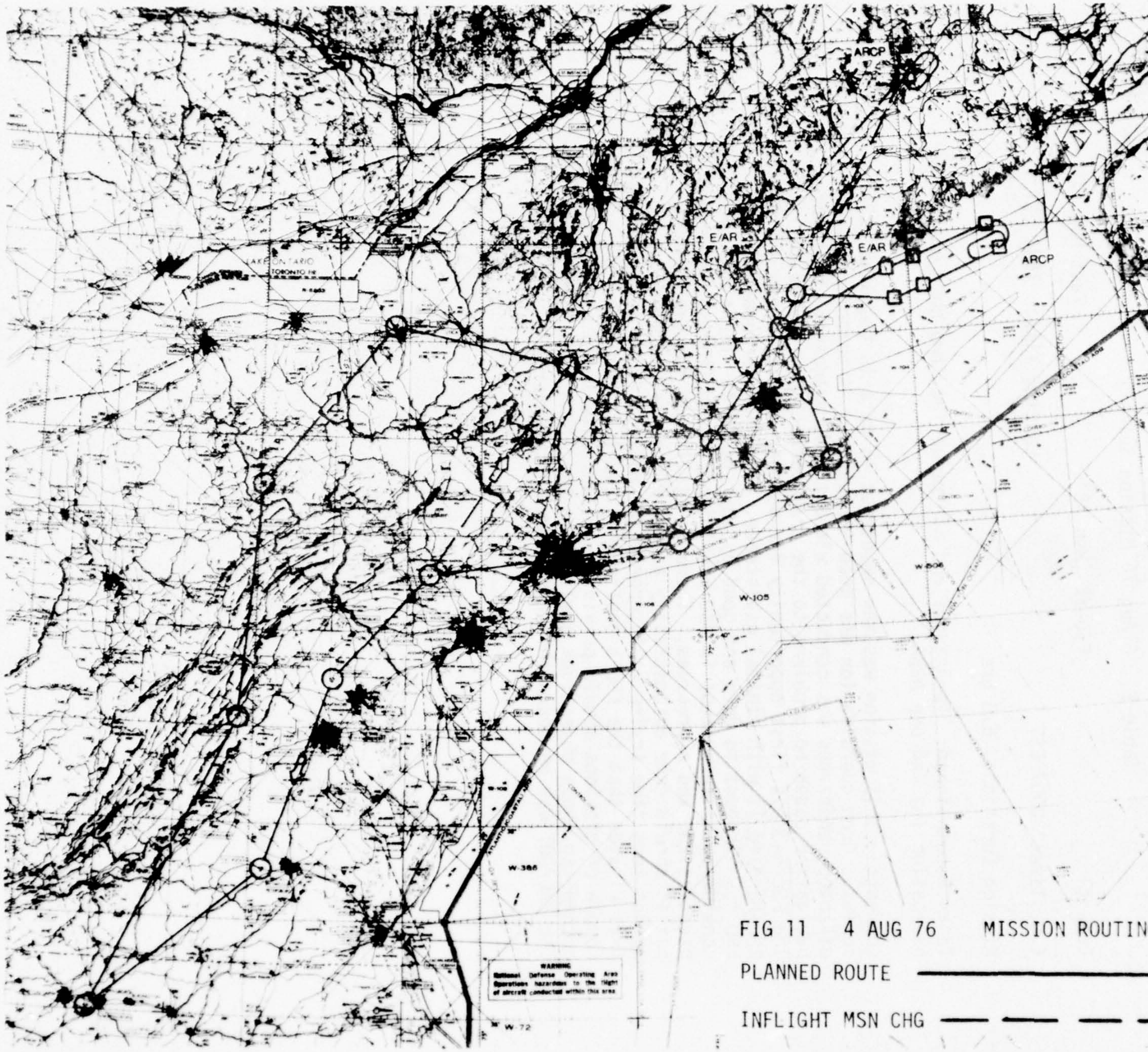

FIG 11   4 AUG 76   MISSION ROUTING

PLANNED ROUTE ————————

INFLIGHT MSN CHG — — — —

Table 8. 6 Aug 76 Mission Summary

Crew #1 FSO #2 (Msn #5) Test Msn #7

T.O. Time: 0907 EST Landing Time: 1534 EST

Mission Duration: 6.8 hrs

Tasks Accomplished: Rendezvous and air refueling, two hour over water navigation leg and one ARDA.

Comments: This mission was the smoothest to date in the GIANT BOOM series. Crew coordination was good throughout. A normal receiver directed rendezvous was conducted without discrepancies. Over water navigation posed no problems to the crew operating with the dual INS. The FSO had his first opportunity for weather detection and avoidance and handled it with minimal assistance. The ARDA performed by the FSO was his best to date and good by any standard. There has been considerable improvement in FSO proficiency in monitoring departures, penetrations and approaches. There is still room for improvement, but it should come automatically as the FSO gains proficiency and spends less time trying to interpret the radar. It is evident from this mission that the FSO's proficiency level is such that the next couple of missions should provide excellent data as to his ability to accomplish those objectives outlined in the GIANT BOOM test plan. The SAC/DOT was on board this flight as an observer.

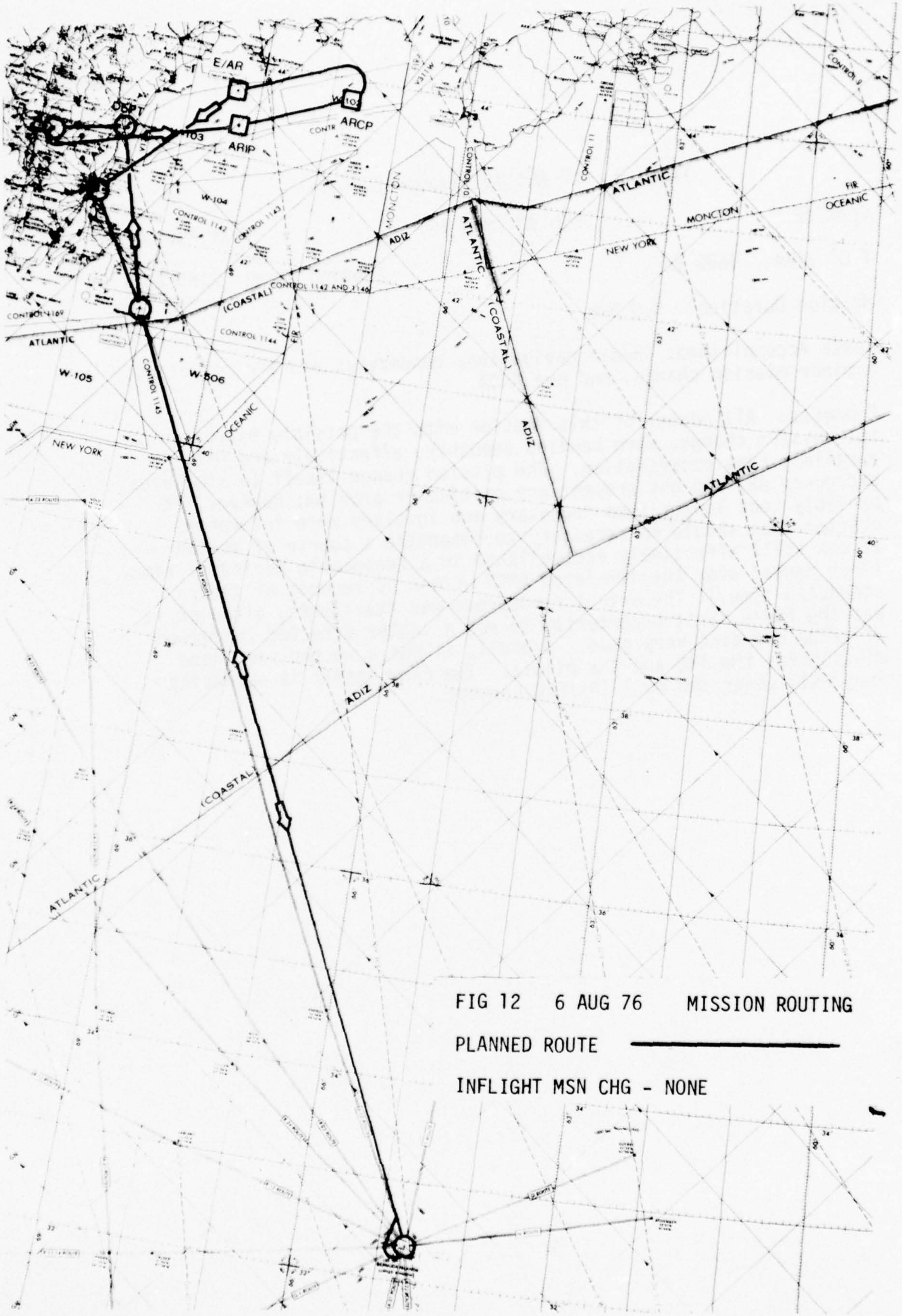

FIG 12   6 AUG 76   MISSION ROUTING

PLANNED ROUTE ————————

INFLIGHT MSN CHG - NONE

Table 9. 17 Aug 76 Mission Summary

Crew #2 FSO #2 (Msn #6) Test Msn #8

T.O. Time: 1600 EST Landing Time: 2155 EST

Mission Duration: 5.9 hrs

Tasks Accomplished: Radar navigation, rendezvous and air refueling, a minor mission change, and one ARDA.

Comments: All phases of this mission with the possible exception of the mission change, were handled smoothly, effectively and with excellent crew coordination. The mission change itself (a simulated emergency AR) did not present any particular problem; however, it probably took longer than necessary and involved more interphone chatter than should be necessary to determine a course of action. It was still effectively accomplished in a reasonable period of time. (They passed over the simulated ARCP within 30 seconds of their scheduled time.) The actual rendezvous was "textbook", although it was the FSO's first opportunity to run a tanker directed rendezvous. His ARDA was also very good. Overall, it was a second very good mission for the FSO and the pilots. The crew itself is operating very well under the dual INS/FSO concept.

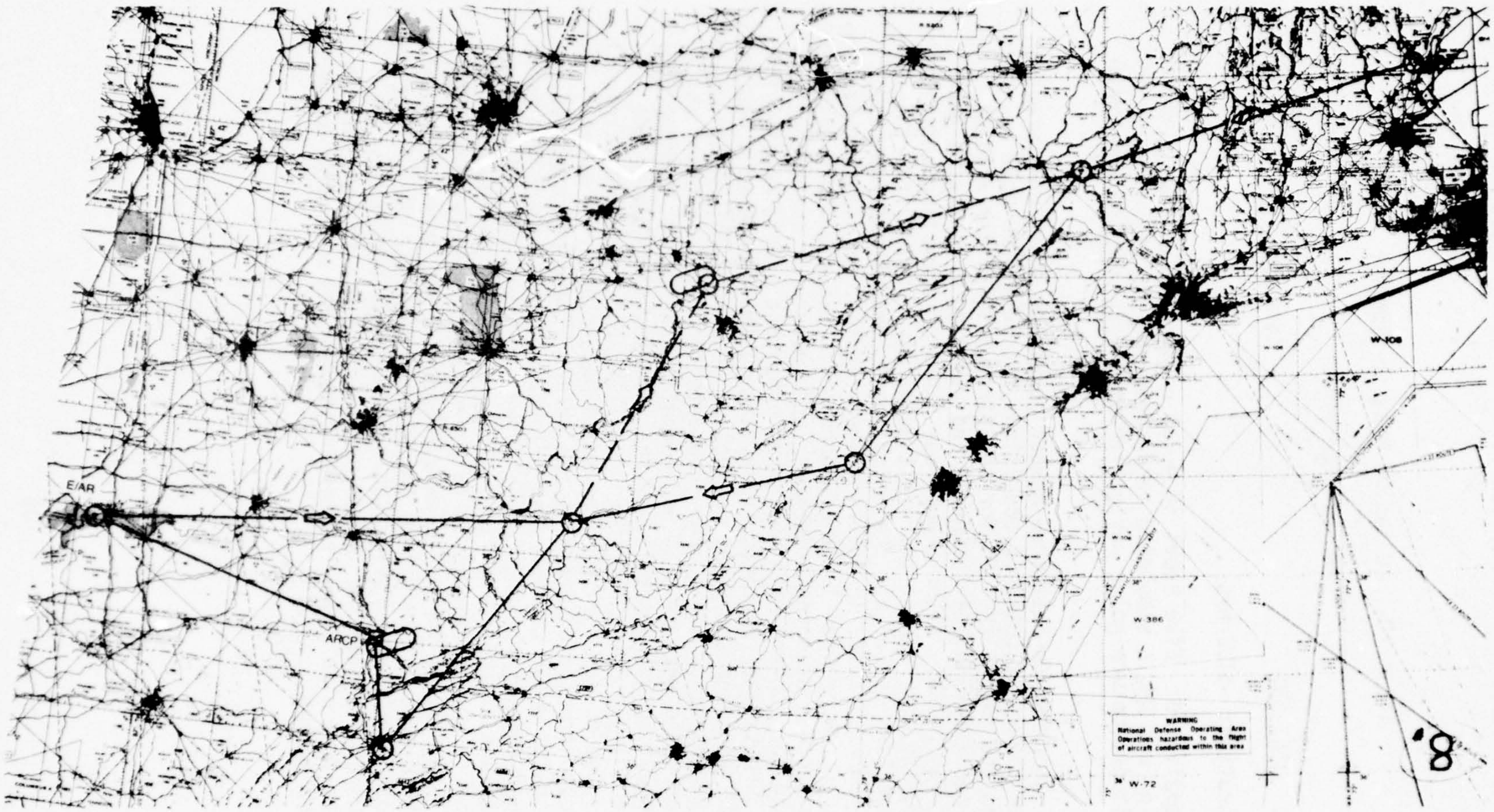

FIG 13 17 AUG 76 MISSION ROUTING

PLANNED ROUTE ————————

INFLIGHT MSN CHG — — — — — —

Table 10. 19 Aug 76 Mission Summary

Crew #2 FSO #2 (Msn #7) Test Msn #9

T.O. Time: 0757 EST Landing Time: 1907 EST

Mission Duration: 11.2 hrs

Tasks Accomplished: Five hours of polar navigation utilizing only radar fixing and DR, a simulated rendezvous and air refueling at 75° north latitude, return polar navigation utilizing the INS and radar fixing.

Comments: In order to test crew member workloads under what would probably be the worst possible conditions for this crew make up, they were denied the use of the INS for the first half of the mission. This required their navigating by DR and radar to a simulated ARCP located at 75° north. After about four hours of operating under these conditions, they arrived at the orbit point 10-15 miles from the computed position and within the established timing requirements. They required assistance in entering the grid mode of steering because they had not been trained in grid procedures. After a short while they adapted to the new steering reference and except for one noteable instance had no problems with it. When computing a grid heading for the final turn to the refueling track, the copilot measured a course that was 90° off from the proper refueling heading. This error could have been very serious had it not been detected within a short while. It should be noted that the FSO had computed the correct heading but allowed himself to be over ruled by the pilots who turned to the erroneous heading. Also, had there actually been a receiver aircraft, there is a good chance the receiver would have caught the error. In this case the test director pointed out the error. There was a period of about 35 minutes which started just prior to reaching the orbit point and continued through the end AR point when neither the FSO or the pilots were sure of their position. It should be noted though, that radar fixing is very difficult in this area because of certain polar phenomenon. Workloads for any crew position did not seem unacceptably high. In this area of navigation and without the INS, the FSO assumed a larger role in aircraft navigation. Under these conditions the copilot tended to backup the FSO on radar fixing and in so doing spent considerable time with scope interpretation and not attending as much to his other duties.

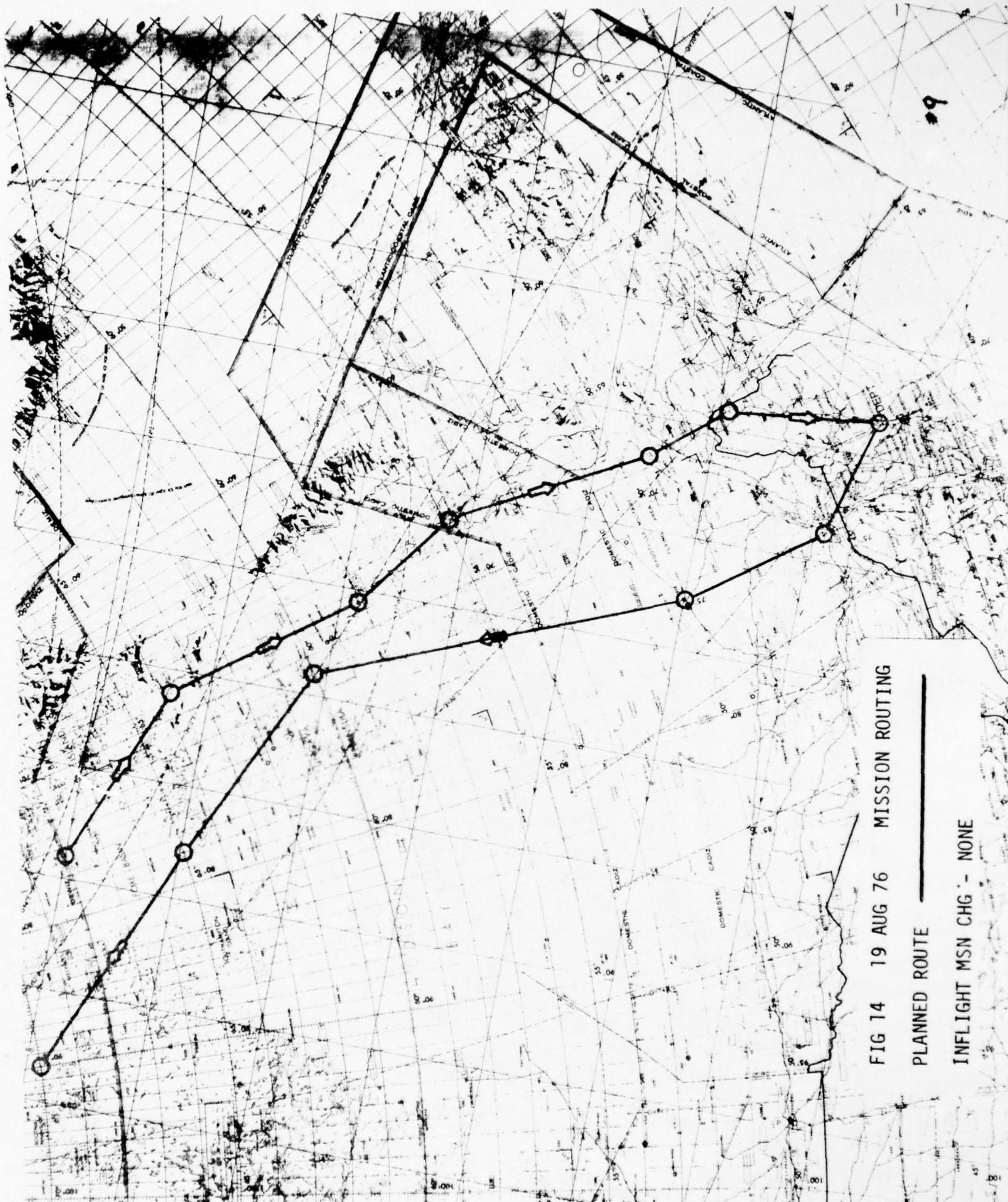

FIG 14 19 AUG 76 MISSION ROUTING

PLANNED ROUTE ——————

INFLIGHT MSN CHG'- NONE

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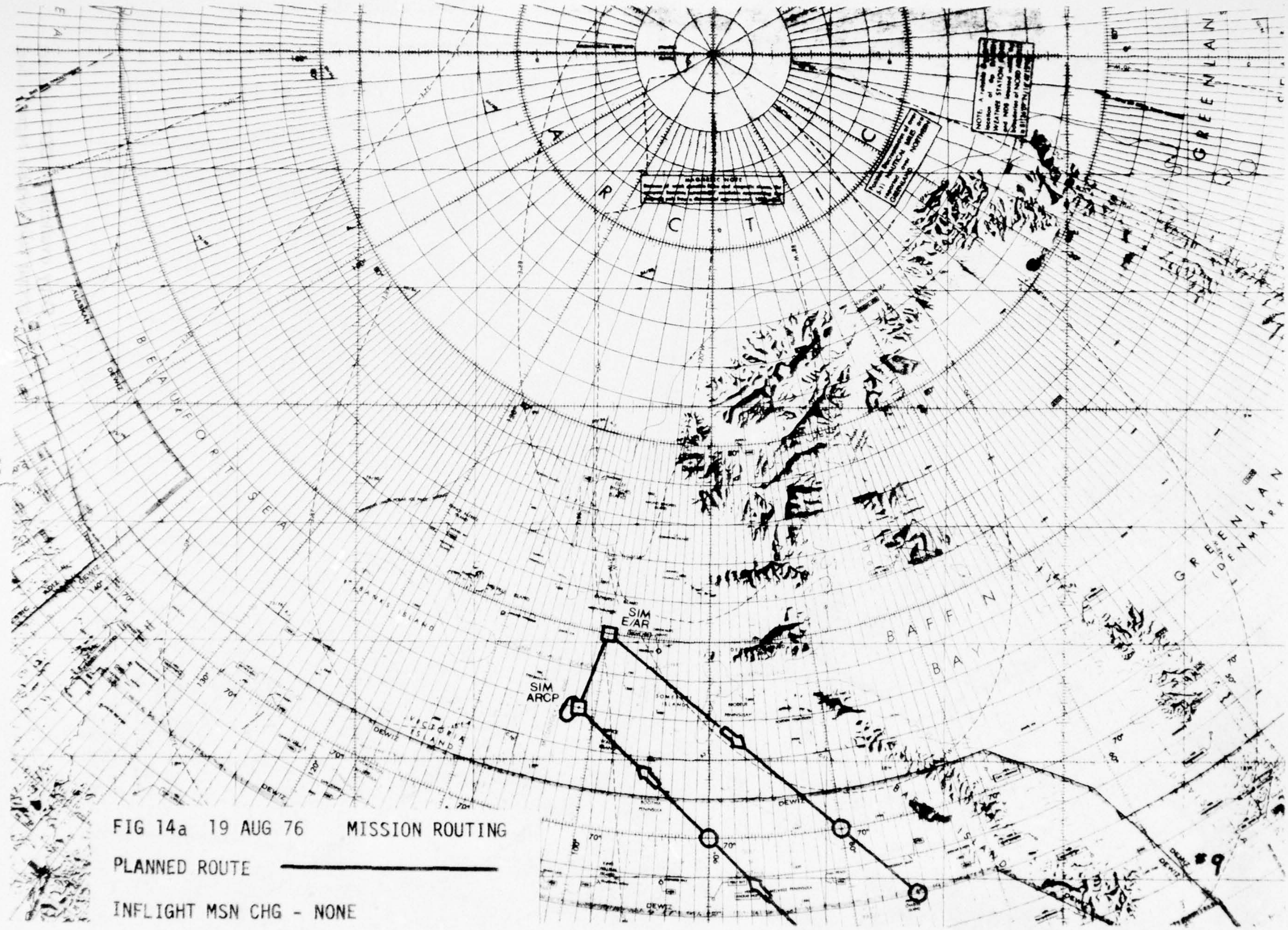


FIG 14a 19 AUG 76 MISSION ROUTING

PLANNED ROUTE ————————

INFLIGHT MSN CHG - NONE

Table 11. 24 Aug 76 Mission Summary

Crew #2 FSO #2 (Msn #8) Test Msn #10

T.O. Time: 0445 EST Landing Time: 1227 EST

Mission Duration: 7.7 hrs

Tasks Accomplished: An alternate rendezvous, multiple air refuelings with fighter aircraft, and over water navigation as the lead aircraft in cell.

Comments: This was a rather demanding mission but the crew handled it well. The rendezvous was improvised with the receivers doing little to help. The crew's alternate rendezvous procedures were sound and resulted in a successful join-up under confusing circumstances. For the first one-third of the flight, the GIANT BOOM aircraft was the lead in a six ship cell. Even with the additional requirements of intra cell communications, HF position reporting, and responsibilities as the navigation control aircraft, there were no discernible overload conditions on any crew member. However, the copilot was at times working at or near capacity. Actually, position reporting over water is greatly simplified through the use of the INS and its multiple waypoint capability. This crew combination handled this mission at least as well as the normal KC-135 crew and had the advantage of the more precise inertial navigation system.

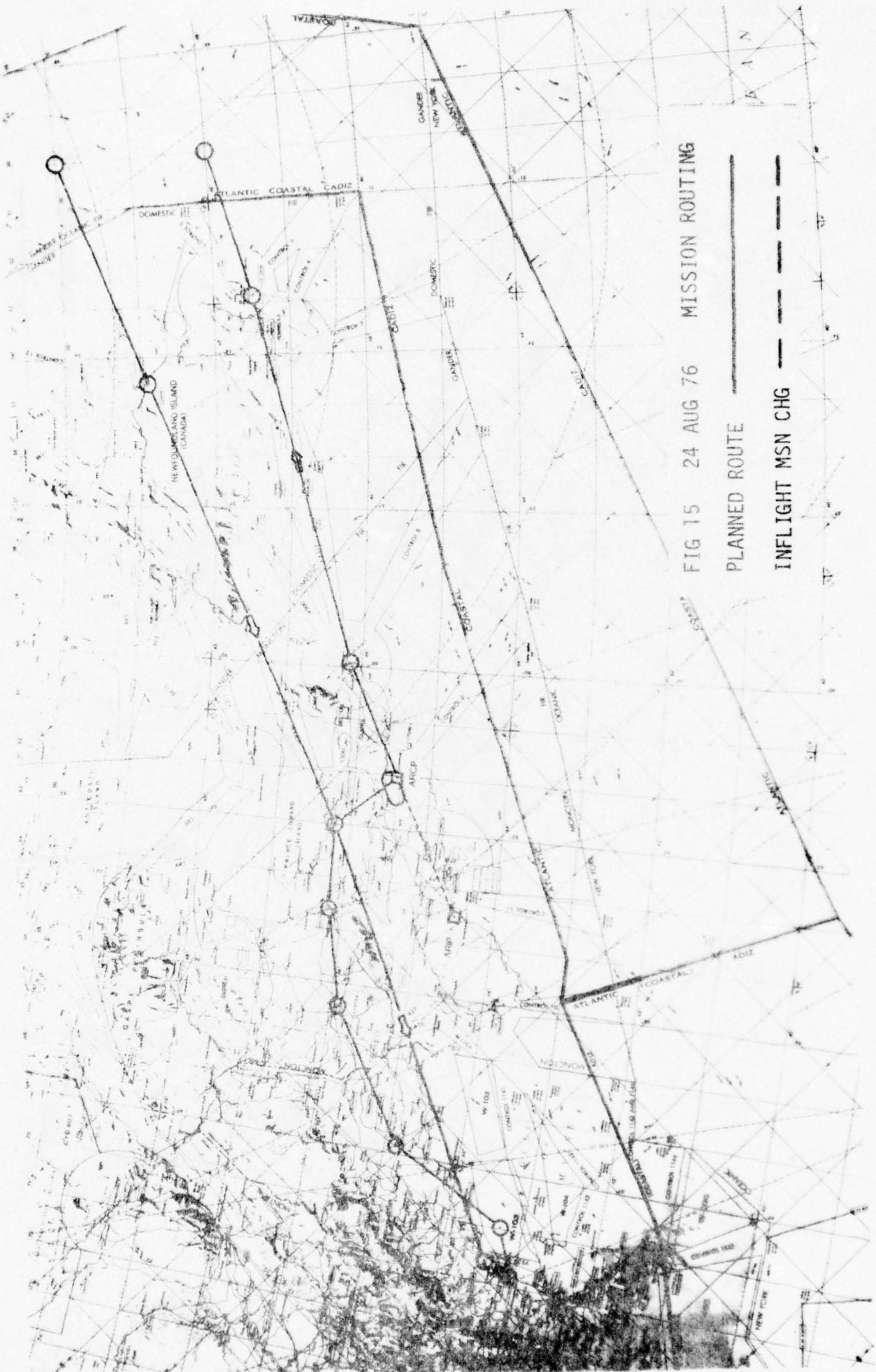


FIG 15 24 AUG 76 MISSION ROUTING

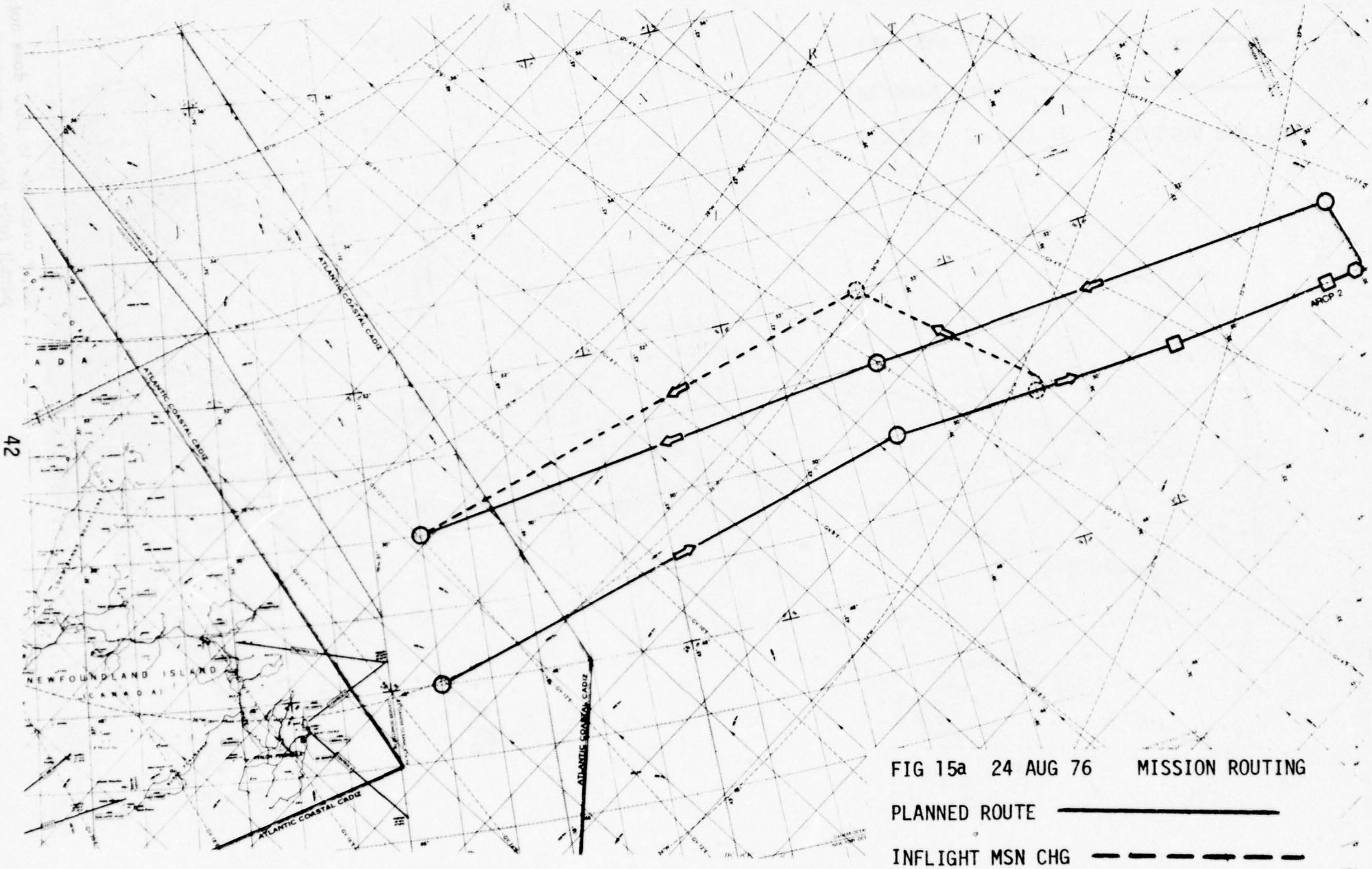


FIG 15a 24 AUG 76 MISSION ROUTING

NOTE: The 11th through the 14th sorties were added to provide data on FSO #2 who because of cancelled sorties did not have sufficient experience in the position to provide meaningful evaluations. The first two (sorties 11 and 12) were provided for his proficiency; the last two (sorties 13 and 14) were used to provide data on his performance in the FSO position.

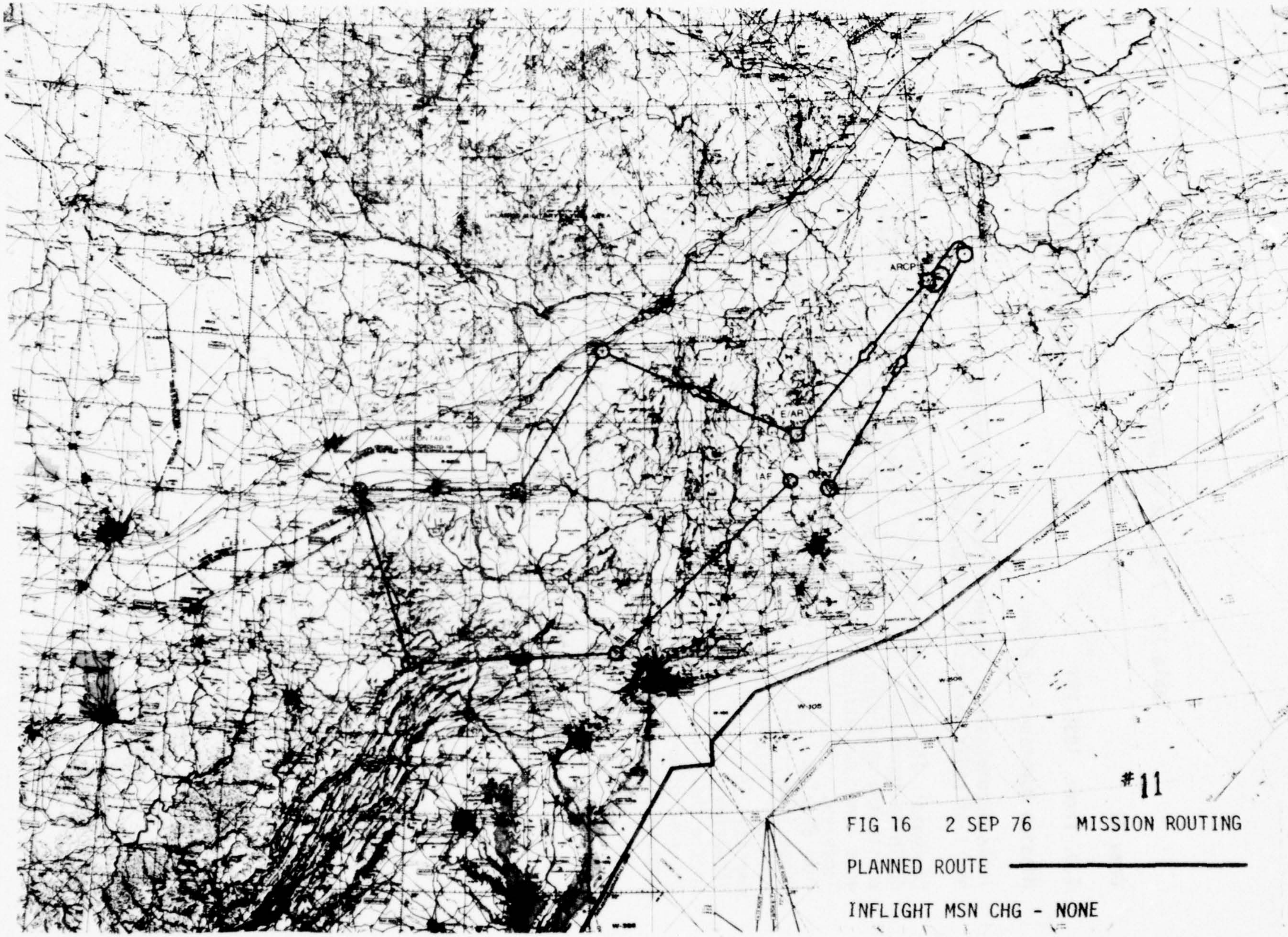
Table 12. 2 Sep 76 Mission Summary

Crew #2	FSO #1 (Msn #4)	Test Msn #11
T. O. Time: 0917 EST		Landing Time: 1455 EST

Mission Duration: 5.6 hrs

Tasks Accomplished: Rendezvous and cell refueling, lead change, two hours of radar navigation and two ARDAs.

Comments: This was the first sortie after a long lay-off for this FSO and no attempt was made to determine crew workloads, because his performance reflected the lay-off. He was hesitant in his operation of the equipment and spent considerable time resolving a radar fix. His back-up of the pilots on altitudes, headings, DMEs and altimeter settings was not up to his previous standards or what was expected of an FSO. During his ARDAs he had difficulty maintaining the base target complex on the radar. These discrepancies were understandable in light of his limited experience in the FSO position and his subsequent lay off. The pilots on the other hand have flown on at least seven previous dual INS sorties and had no trouble handling all their duties.



#11

FIG 16 2 SEP 76 MISSION ROUTING

PLANNED ROUTE ————————

INFLIGHT MSN CHG - NONE

Table 13. 7 Sep 76 Mission Summary

Crew #2 FSO #1 (Msn #5) Test Msn #12

T.O. Time: 1030 EST Landing Time: 1500 EST

Mission Duration: 4.5 hrs

Tasks Accomplished: Tanker directed rendezvous, air refueling, two hours of radar navigation and one ARDA.

Comments: This was the second sortie after a long lay-off and showed definite improvement over the last mission. He did much better monitoring departure, descent, approach and landing although there were minor deviations. His procedures during rendezvous were marginal. Rendezvous offset was about six miles in error and might have caused some problem if visibility had been less than five miles. His radar scope interpretation and fixing were good but basic DR procedures are lacking. This was observed on previous sorties and will require more emphasis in a future FSO training program to ensure an ability to effectively back-up the pilots with aircraft navigation. During this sortie there was a malfunction in the copilot's INS which resulted in the loss of certain functions; however, it continued to accurately compute aircraft position.

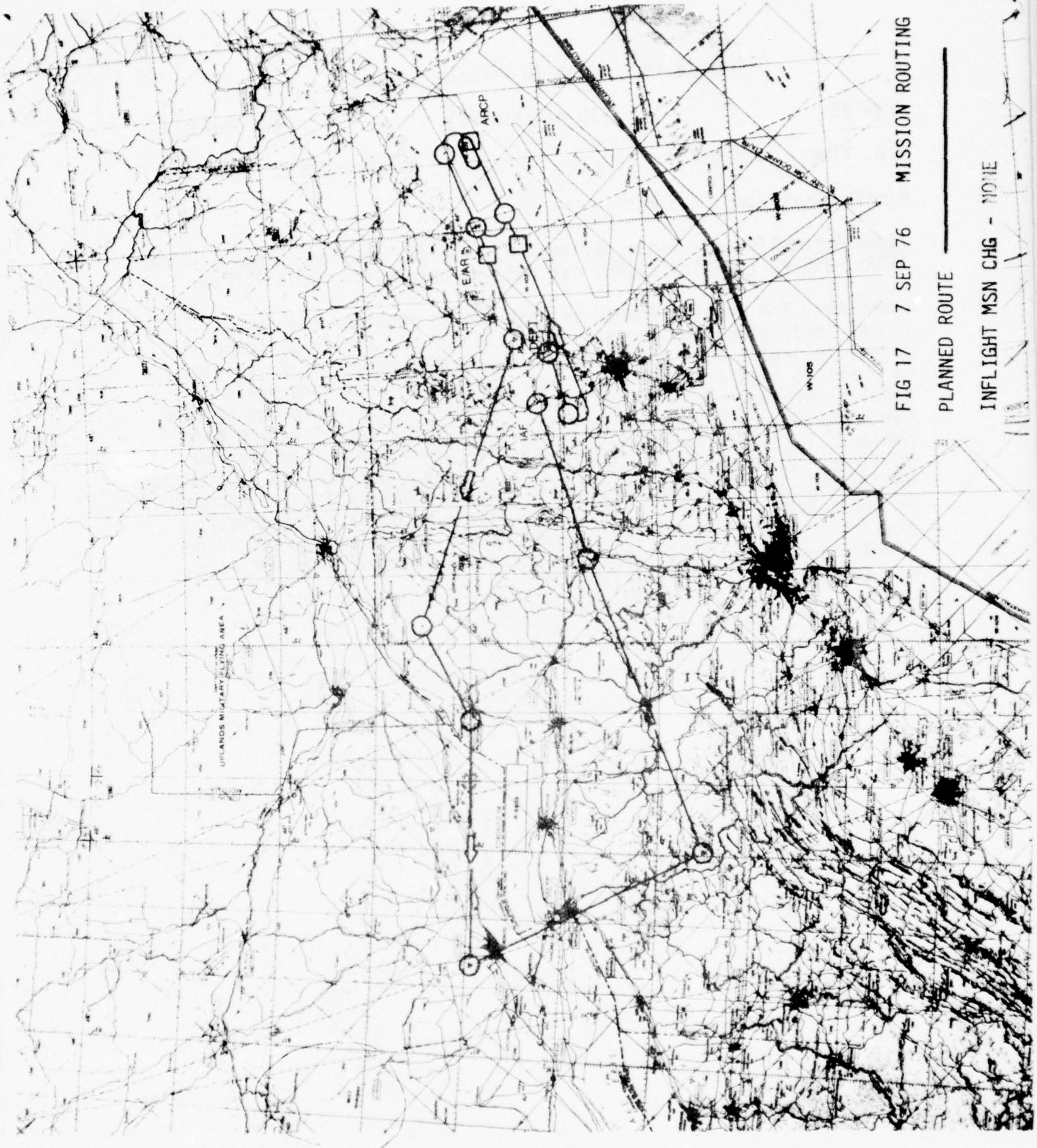


FIG 17 7 SEP 76 MISSION ROUTING

PLANNED ROUTE ———

INFLIGHT MSN CHG - MORE

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Table 14. 8 Sep 76 Mission Summary

Crew #2 FSO #1 (Msn #6) Test Msn #13

T.O. Time: 1950 EST Landing Time: 0005 EST

Mission Duration: 4.3 hrs

Tasks Accomplished: Radar navigation, inflight mission change and one ARDA. INS #2 (copilot's INS) was not operable during this flight.

Comments: The mission change on this sortie required the crew to cancel their planned navigation and file for and fly to a second air refueling area. They did this in a reasonable amount of time with no overload conditions; however, the copilot and FSO were again totally involved for about 15 minutes with the mission change problem. The pilot is easily able to handle the copilot's duties during this period. The test director requested that the pilots allow the FSO to direct the aircraft in the orbit as if there were an INS malfunction. He did this but was never able to establish a standard orbit because of radar fixing problems. Had there been a receiver, a rendezvous might not have been possible because of the nonstandard orbit. The scheduled bomber receiver was cancelled and no actual air refueling was accomplished on this mission.

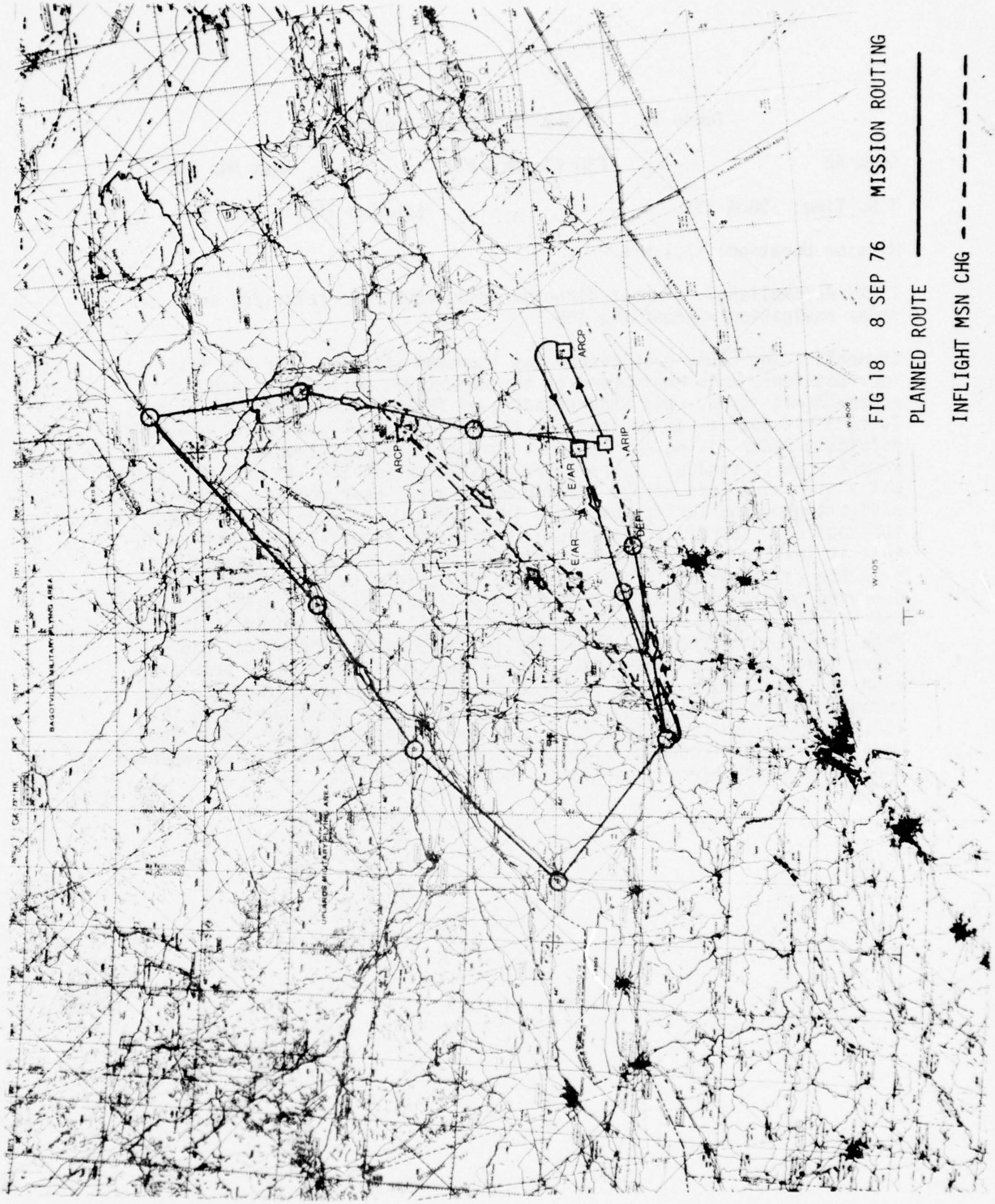


FIG 18 8 SEP 76 MISSION ROUTING

PLANNED ROUTE ————

INFLIGHT MSN CHG - - - - -

Table 15. 10 Sep 76 Mission Summary

Crew #2 FSO #1 (Msn #7) Test Msn #14

T.O. Time: 0854 EST Landing Time: 1700 EST

Mission Duration: 7.1 hrs

Tasks Accomplished: Tanker directed rendezvous, air refueling and radar navigation without the INS.

Comments: The FSO's proficiency has improved steadily over the last four missions. His monitoring of the departure, penetration and approach was good. His understanding of TERPS procedures is excellent. To test his ability to monitor the aircraft position and route in a more difficult radar fixing environment, this mission was flown over a remote area of Canada. As on a previous polar mission with FSO #2, there was a simulated loss of the INS for about a two-hour period. Aircraft navigation responsibility became a joint venture between the FSO and the copilot. Coordination between them became somewhat of a problem in that it involved far too much interphone conversation. It improved over the course of the mission but the FSO's role in navigation under degraded condition needs to be defined. Radar fixing was difficult for the FSO in this area at first but he adjusted well. Recording of inflight data, which must accompany basic DR, is inadequate. The pilots had flown under these conditions previously and had no particular problems with it. The copilot again spent quite a bit of time working with the radar; however, by being able to shift much of the radar burden to the FSO, the overload conditions that occurred during the GIANT CHANGE test were considerably reduced. The FSO's rendezvous procedures have improved and are now adequate to accomplish the mission.

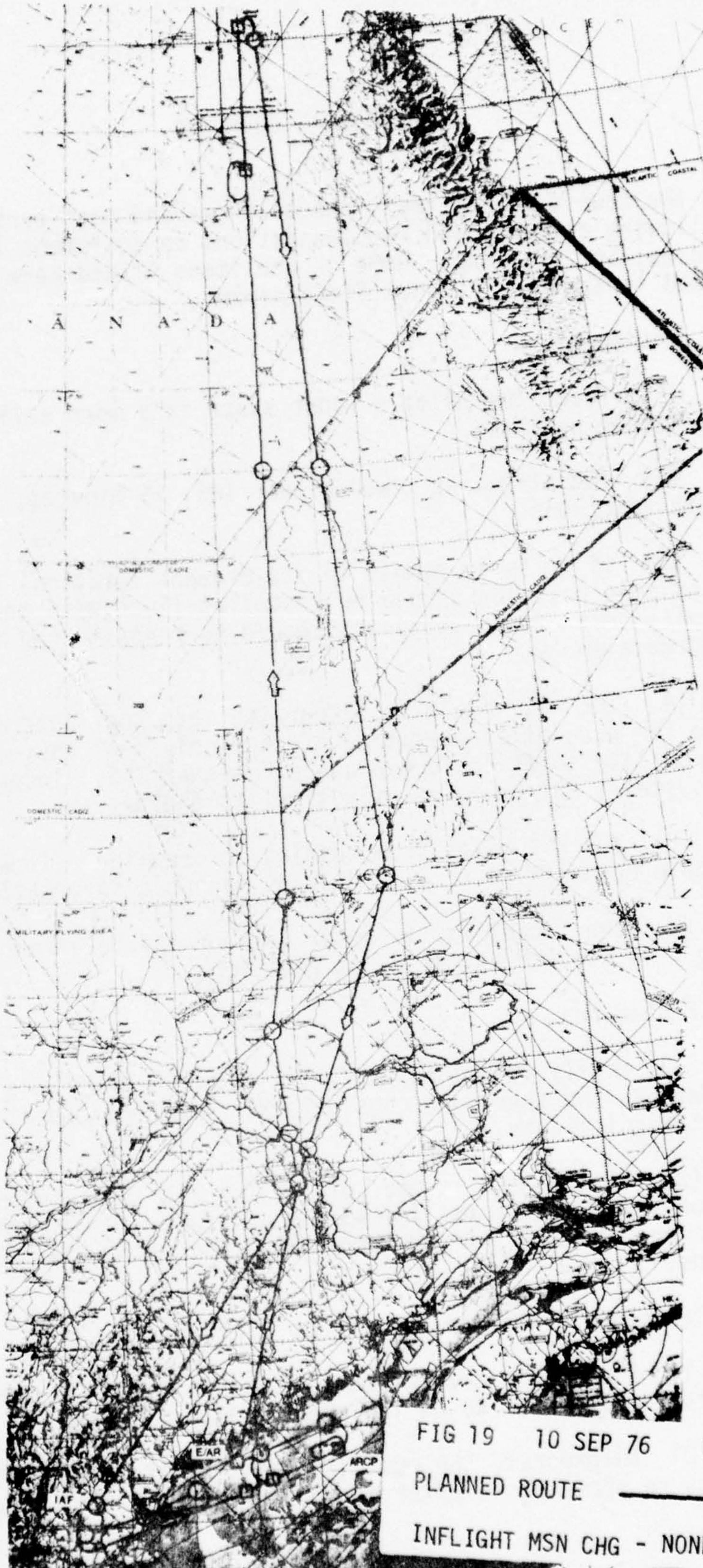


FIG 19 10 SEP 76 MISSION ROUTING

PLANNED ROUTE ————————

INFLIGHT MSN CHG - NONE

ADDITIONAL COMMENTS

During the course of the test, the aircrews and test personnel provided the following comments and recommendations on equipment location, procedures, and training. Some of the items listed here were also mentioned in the GIANT CHANGE final report.

a. Equipment.

(1) Place the pilot's radar scope in a more easily observable and accessible position.

(2) The alignment time on the INS, 15 minutes, is too slow for alert reactions.

(3) If it is to remain in its present location, the INS display at the pilot's position should be installed flush with the panel. Preferably, the display units for both pilots should be repositioned for easier observation and data entry.

(4) The HSI should be integrated into the instrument cluster, with one for each pilot operating off an individual INS, or have a switch-over capability so it could operate off either INS. Incorporation into the FD-109 system's HSI would greatly simplify the system.

(5) The HSI gives true heading information. It would be helpful if it could be modified to also display magnetic information.

(6) The capability to enter data or update either INS should be included with the RDU at the FSO's position.

b. Procedures.

(1) Modify checklists so that the pilot and FSO's INS procedures are compatible and take into consideration the boom operator's preflight checklist requirements.

(2) Clearly define the role of the FSO in assisting with aircraft navigation under normal and degraded conditions. Define the pilot's role in utilizing the radar for rendezvous and for navigation under degraded conditions.

c. Training (either in-unit or at CCTS).

(1) The pilots should receive more training in radar scope interpretation if it is to be included in their duties.

(2) Incorporate the dual INS into the KC-135 simulator and allow the pilots to train on it prior to their first dual INS flight.

(3) Include a basic refresher course in navigation in addition to dual INS training for the pilots during CCTS. This should include problems in inflight mission changes on training sorties.

(4) Training in grid/gyro steering procedures should be included for both pilots and FSOs.

(5) Training flights for FSOs should be accomplished on a dual INS equipped aircraft.

CONCLUSIONS

1. The results of this test indicate that the crew composition as proposed in the GIANT BOOM Test Plan is feasible. The radar/systems operator, referred to in this report as the Flight Systems Operator (FSO), was able to significantly reduce the serious pilot/copilot overload situations identified during the GIANT CHANGE test. Operating on a KC-135 aircraft equipped with a dual Inertial Navigation System (INS), he was able to perform those duties usually performed by the crew navigator to the extent necessary to safely accomplish the mission. The pilots, utilizing the dual INS, were responsible for aircraft navigation. The conclusions presented here are based on a very limited and unique sample of individuals. Two KC-135 boom operators with extensive experience both in the Air Force and as aircrew members were the test subjects. It is difficult to ascertain what effect their experience, maturity, and airmanship had on the successful test results, but it must be considered that it was significant.

2. The pilot overload situations encountered during the GIANT CHANGE test were generally the result of the inordinate amount of time the copilot spent working with the radar. Included in this were his attempts to derive radar fixes while operating without the INS and his attempts to perform airborne radar directed approaches while at the same time acting as a safety monitor. With the addition of the FSO, the copilot was relieved of almost all requirements to operate the radar. In fact there is no reason why the FSO could not perform all the radar functions that the present KC-135 navigator does. The pilots would still have radar station keeping responsibilities; but the FSO would assist by operating the controls, tuning the radar, as well as acquiring and maintaining the other aircraft on the scope.

3. Operating the INS, especially during mission changes, was another area contributing to overload situations. It occurred, primarily, when both pilots became involved in entering data into the INS because of an inflight mission change. During GIANT BOOM inflight mission changes, the copilot worked with the FSO in solving mission change problems and reentering data into the INS. The pilot was free to handle the aircraft radios and monitor other aircraft systems. In this area, however, some overloading still occurred. During the time it took the copilot and FSO to determine a course of action, plot the information on a chart, and enter it into the INS, they were totally involved in the problem to the exclusion of other duties. The amount of time required during major mission changes varied between 10 and 15 minutes. Whether or not this diversion on the part of the copilot creates a potential safety problem is difficult to determine. It is in this area of inflight mission changes that tradeoffs would have to be made between the present KC-135 crew makeup and the GIANT BOOM proposal. An experienced navigator would have handled the mission changes

better than the copilot/FSO combination did working with the INS. The ability of the navigator to react to changing mission requirements gives the present crew make-up a degree of flexibility the GIANT BOOM crew did not have. Even considering that the crews did not have a great deal of experience in operating under the GIANT BOOM concept, it is doubtful that this lack of experience would ever be fully overcome.

4. Based on the results of the GIANT BOOM test sorties, a crew complement consisting of a pilot, copilot, boom operator and flight systems operator working on a dual INS equipped aircraft is a feasible alternative to the present crew makeup. The progress shown by the FSO during the test indicates that he would be able to fulfill the demands of the position throughout the conceivable range of tanker missions. This conclusion, however, is based on the definite set of conditions that existed during the test. Included in these were:

a. The enlisted men trained as FSO were highly experienced aircrew members already serving as KC-135 boom operators.

b. The aircraft was equipped with a dual inertial navigation system and the pilots were responsible for aircraft navigation.

c. An experienced KC-135 crew navigator prepared the mission flight plans.

d. None of the crew members on board were required to know or use celestial navigation procedures for determining heading or position.

Attempting to apply the data or conclusions derived from this test to a different set of conditions will doubtlessly dilute their reliability. A decision to implement this crew combination must also consider the alignment time of the INS as it affects EWO fast reaction requirements. Either a fast alignment capability or an inflight alignment capability is mandatory for SAC (EWO) tanker operations.

RECOMMENDATIONS

1. The advantages of the dual INS avionics package for the KC-135 are significant enough to warrant altering the crew composition to get it. If the economies realized by changing from a rated officer crew member to a nonrated enlisted crew member are real and will justify acquisition of the system, then the change should be strongly considered.

2. If a modification proposal calls for only a single INS, then the crew composition change is not recommended. With only a single INS, the chances of losing the INS navigation capabilities, although still small, are much greater than with a dual INS. In addition, if a single INS diverges from the actual aircraft position, there may be nothing to alert the crew to the problem and no way for them to verify it. In either of these cases a strong navigation back-up capability, possibly including celestial, would be required. This would be especially relevant when considering KC-135 EWO commitments. The amount of training required to provide the enlisted crew member with these skills would approach the amount presently devoted to undergraduate navigator training. Under these conditions, it is doubtful the crew complement change would provide dollar savings to help offset the cost of the equipment. The added capabilities of a single INS installation do not warrant changing the KC-135 crew composition.

3. It was evident from the first few missions flown during the test program that the four training sorties each FSO flew at Castle were not adequate to prepare them for the demands of the position. Future FSO inputs with experience similar to the GIANT BOOM selectees would require more CCTS training sorties (see atch 3). If enlisted personnel with a different flying background or no flying experience were entered into an FSO program, much more extensive training would be required (see atch 3). Because of the demands of the position and the training that will be required, personnel inputs should be considered in this order of preference:

a. KC-135 boom operators with at least three years of experience in the aircraft.

b. Other enlisted aircrew members with at least three years in their present flying position.

c. Nonflying enlisted personnel with five years of Air Force experience.

Before personnel with less than the qualifications listed above are considered for entry into an FSO training program, more testing similar to the GIANT BOOM test should be conducted.

APPENDIX A

A STUDY OF TASK LOADING USING A FOUR-MAN CREW ON A KC-135 AIRCRAFT

(HUMAN FACTORS ADDENDUM FOR GIANT BOOM)

BY

MR RICHARD GEISELHART

MR RICHARD SCHIFFLER

CAPT RICHARD KOETEEUW

AERONAUTICAL SYSTEMS DIVISION

DIRECTORATE OF EQUIPMENT ENGINEERING

SECTION I

INTRODUCTION

Earlier this year at the direction of CINCSAC studies were performed jointly by SAC and ASD/ENECC on the feasibility of using a three-man crew on a KC-135 aircraft (GIANT CHANGE). This study indicated that omitting the navigator and giving the navigation function to the copilot resulted in excessively high workloads on the copilot that jeopardized the mission and in some cases constituted a safety hazard. As a result, further testing was directed by CINCSAC. Designated GIANT BOOM, the purpose of this follow-on program was to determine if the addition of a fourth man to the crew would alleviate the shortcomings of using the three-man crew. This fourth man was an additional boom operator designated as a Flight Systems Operator (FSO) who was given training in the fundamentals of navigation, radar scope interpretation, operation of the inertial navigation system (INS), and rendezvous procedures. The function of the enlisted FSO was to provide assistance to the copilot who still had primary responsibility for the navigation function. The FSO's primary duties were to operate and interpret the radar scope and relieve the copilot of navigation duties during periods of peak workload. The former consisted of monitoring weather and approaching receivers, getting navigation fixes, and shooting Airborne Radar Directed Approaches (ARDA). The latter consisted of checking waypoints on the INS and plotting a new course when required for mission change or weather avoidance. In order to investigate the workload reduction on the copilot, missions similar to those on GIANT CHANGE were flown.

TABLE 1

TEST PROGRAM

<u>TYPES OF MISSIONS</u>

1. MITO
2. CELL
3. MISSION CHANGE
4. HIGH LATITUDE
5. CRESTED CAP

CREW POSITION	AGE	TOTAL FLYING TIME	KC-135 FLYING TIME	EXPERIENCE PRESENT POSITION	EXPERIENCE PRESENT CREW
AIRCRAFT COMMANDERS	27.5	1300	855	1 YR 5 MO	1 YR 4 MO
COPILOTS	24.5	788	588	1 YR 5 MO	6 MO
FLIGHT SYSTEMS OPERATORS	40	5100	2800	13 YR 10 MO (AS BOOM OPER)	(NEW POSITION)
OBSERVER PILOTS	28.25	1319	990	2 YR 1 MO	4 WK

TABLE 2. GIANT BOOM CREW EXPERIENCE AVERAGES

SECTION II

METHODOLOGY

The flight test program conducted over a 60-day span consisted of 16 sorties covering a range of refueling operations similar to those encountered in SAC's operational environment. A summary of these missions is shown in Table 1.

Prior to the test flights the FSO were given a 30-day course at Castle AFB, California, on fundamentals of navigation, radar scope operation and interpretation and the use of the INS.

Table 2 presents age and flying experience averages for the crew members participating in GIANT BOOM. Aircraft commanders (P) and safety observer pilots (O) averaged 28 years of age, 1300 hours in total flying time, and about 900 hours in the KC-135. Copilots averaged 24.5 years of age, 800 hours in total flying time, and 600 hours in the KC-135. Flight Systems Operators (FSO or F) averaged 40 years of age, 5100 hours in total flying time, and 2800 hours in the KC-135. Ps and CPs averaged 1 1/2 years' experience in their current crew positions, Os averaged just over two years, and FSOs averaged almost 14 years' prior experience as boom operators.

The procedure used in this study was similar to that used in earlier studies (Reference 1) where task loading was calculated according to the following formula: Percentage crew workload = $\frac{\text{time required}}{\text{time available}} \times 100$. This formula gives the average time unit to accomplish a task. For example, a 77 percent crew workloading would mean that for 77 minutes out of a 100-minute mission segment an operator would be busy accomplishing some required task. The time available is determined by the mission, aircraft performance, operational environment, or some combination thereof. This measures what could be called overt task loading (i.e., directly observable behavior or task accomplishment).

Overt tasks were timed and recorded in the broad categories of navigation, communications, radar, INS, instrument reading and miscellaneous activities. INS and radar categories consisted of only those tasks where the operator was physically observing, tuning, or operating the actual equipment. Activities involving chart, log, or hand/computer calculations were included in the navigation category whether or not they involved information to be used with INS or radar. Other navigation tasks, like performing checklists and computing estimated times of arrival (ETAs), were also categorized as navigation. Communications activities included radio and interphone conversations with crew and receivers, tuning high frequency (HF) radios, obtaining radio frequencies and authenticating messages. Instrument reading was that activity where the copilot was reading instruments as cross checks for the pilot or when flying the aircraft himself. Miscellaneous tasks were actual workloads that did not readily fit the other categories.

SECTION III

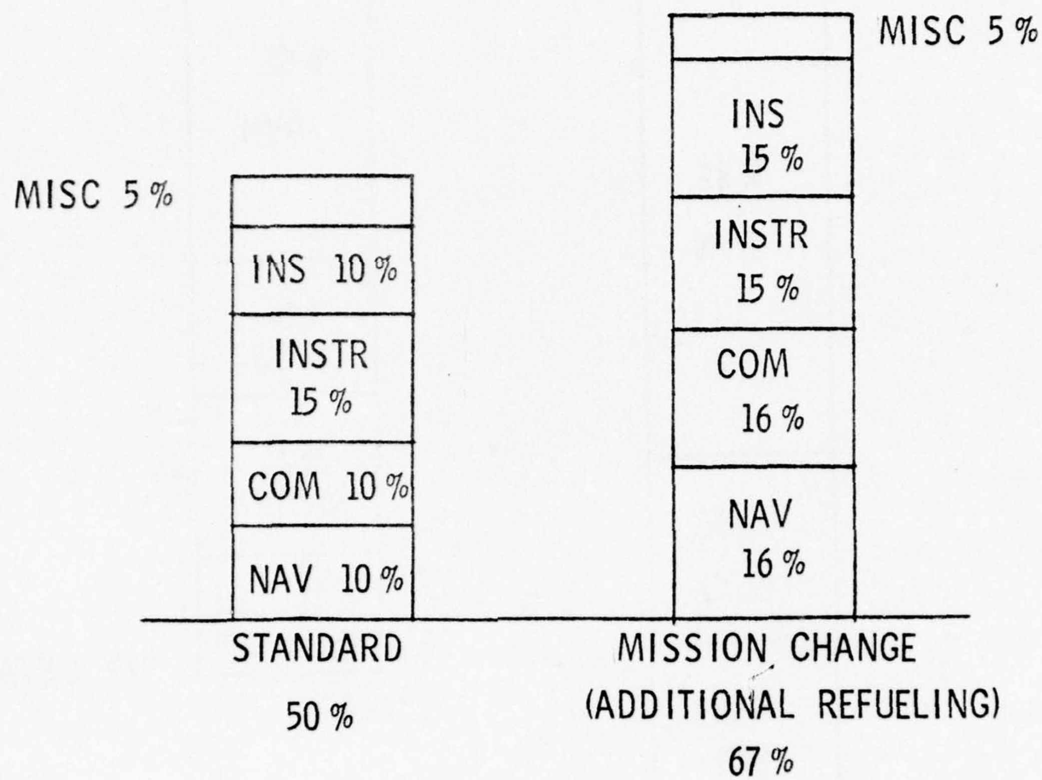
RESULTS

As in the earlier GIANT CHANGE Program, the data from GIANT BOOM was analyzed across those missions on which representative ranges of task loads were encountered. The data analysis was also limited to the later flights after learning effects stabilized. Figures 1 and 2 show the copilot and FSO workloads, respectively, on a mission change involving an additional refueling. The copilot task load showed an increase from 50 percent for a standard refueling mission (where no problems occur) to 67 percent for the additional refueling. The FSO showed a similar increase in task load - 81 percent for the standard mission* versus 100 percent for the mission change. This full loading extended over a 20 to 30 minute period during which the FSO authenticated the change, plotted and coordinated route changes, determined and discussed new waypoint coordinated, monitored complete INS reprogramming by the copilot, calculated new ETAs and necessary airspeed adjustments, and began to prepare for radio contact with the new receiver.

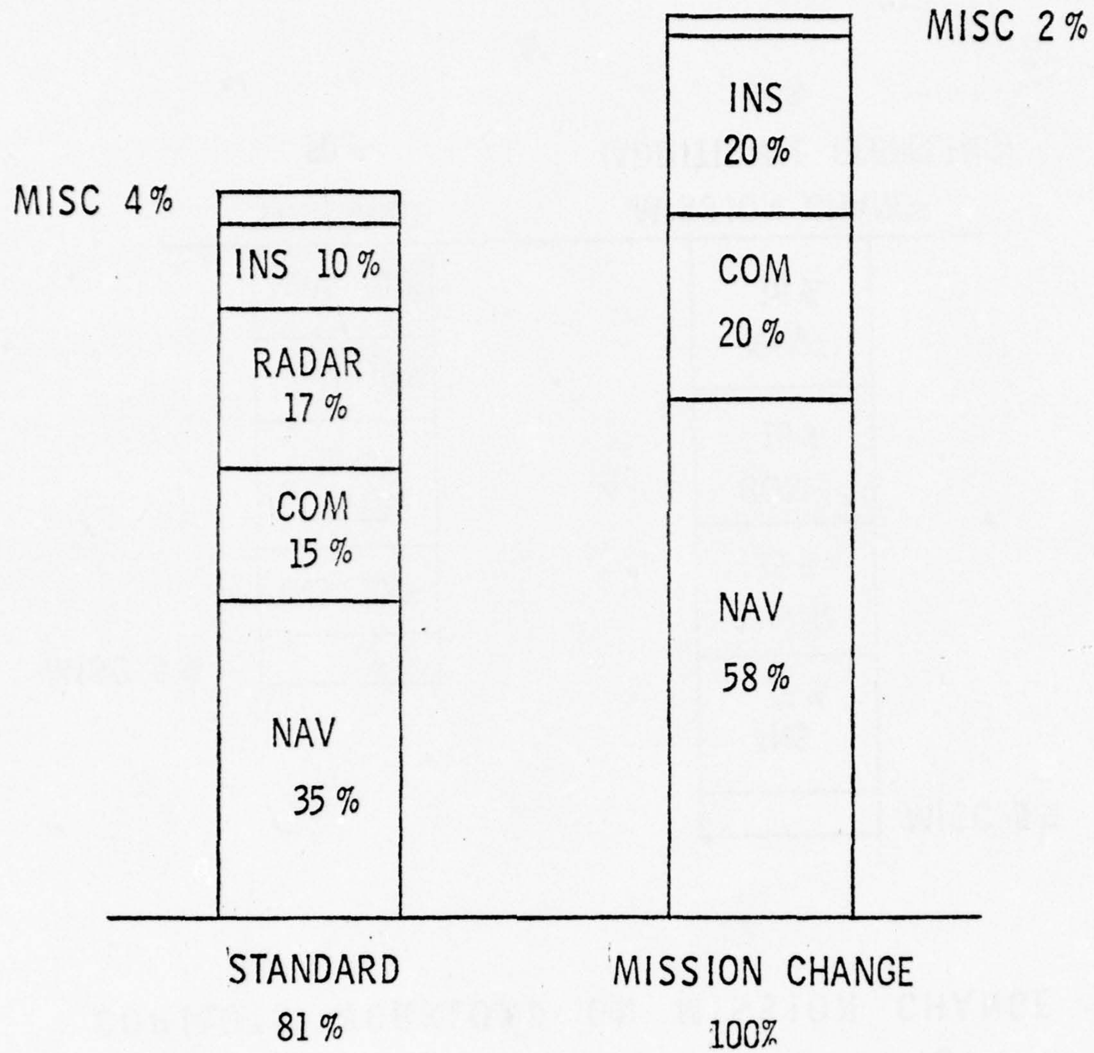
* The authors feel that the FSO workload figures on the standard mission were somewhat inflated because the FSO, by and large, performed more navigation duties than required (this issue is addressed in detail in the discussion section).

Figure 1

COPILOTS WORKLOAD ON MISSION CHANGE



FLIGHT SYSTEMS OPERATOR WORKLOAD ON MISSION CHANGE



The FSO's mission change task load showed an increase in the cockpit communications needed to insure a smooth coordinated change, an increase in the actual manipulation of the INS (carefully checked during copilot reprogramming as well as during fixing), and a very large increase in navigation. This navigation increase was primarily inflight route analysis and replanning, and was added onto the standard navigation workload by dropping the radar workload. GIANT BOOM crews found the best workload distribution during mission changes kept the pilot (P) out of the details of the route change and waypoint insertion (i.e., P scanned outside, flew the aircraft, coordinated on the strategy of the change, and made the radio calls). The copilot figured the route changes and reprogrammed the INS with the FSO monitoring and confirming those changes. Two suggestions for this busy period were given by the crew in their questionnaires: (1) Since the copilot has his head in the cockpit during waypoint insertion, the P must do most of the outside clearing and the boom operator should move up to the jump seat to assist in fuel monitoring and clearing; (2) Since copilot and FSO are so busy, the boom operator in the jump seat should also backup the P's communications with Air Traffic Control (on his initial flight, one pilot began a right-turn after receiving a left-turn instruction during the mission change).

The copilot and FSO task loading on a high latitude flight are shown in Figures 3 and 4. Comparing the copilot's high latitude task load

Figure 3

COPILOTS WORKLOAD ON HIGH LATITUDE FLIGHT

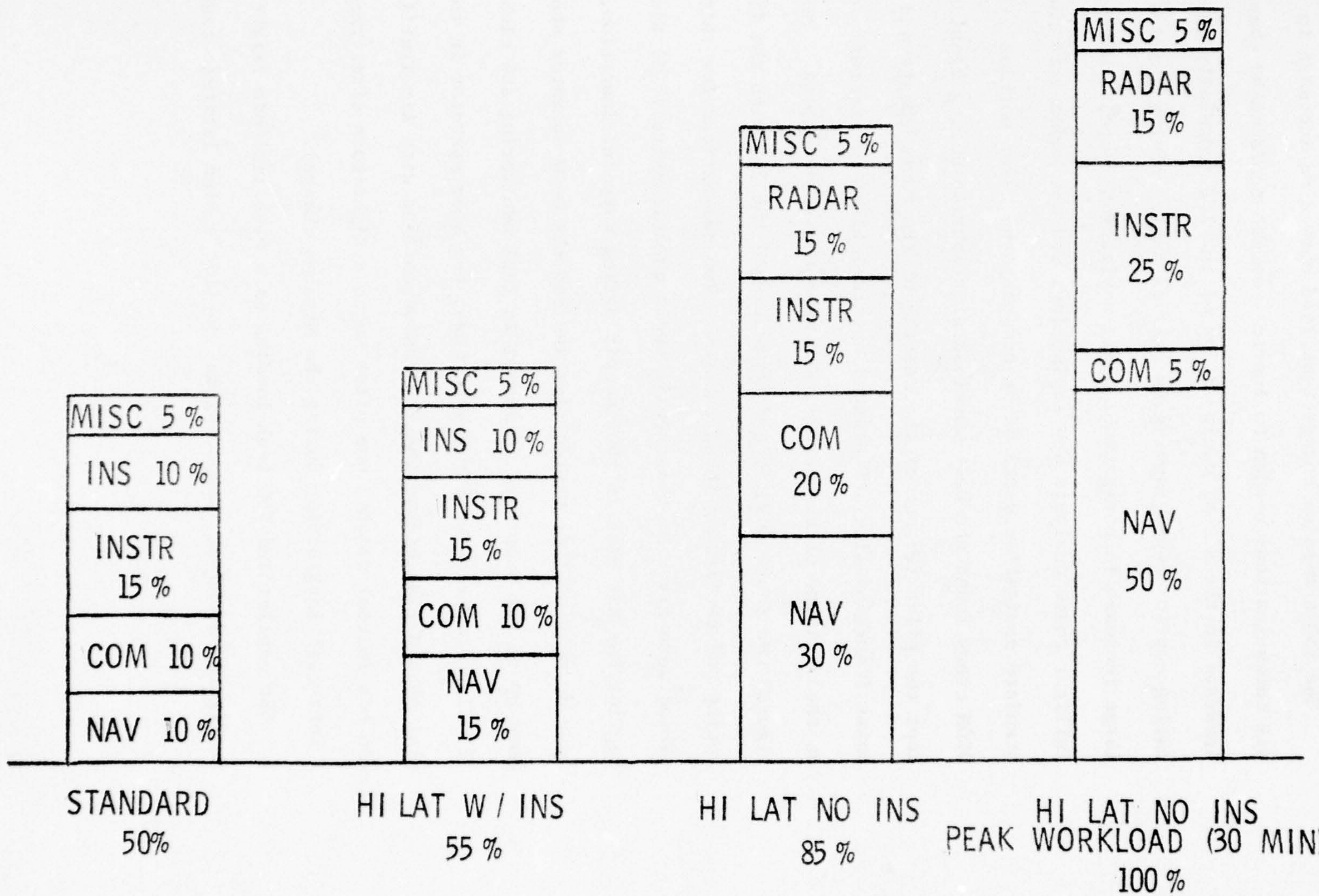
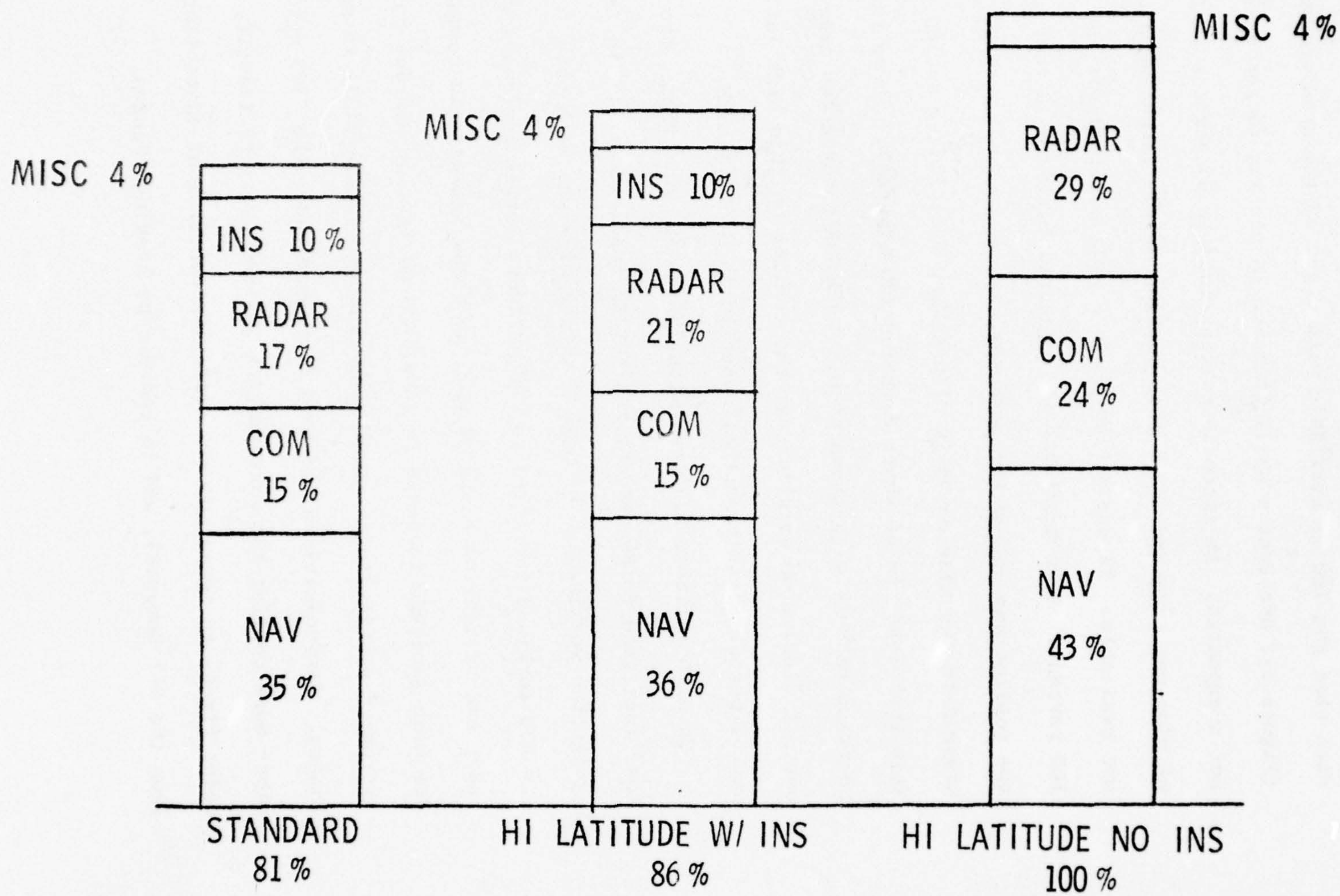


Figure 4

FLIGHT SYSTEMS OPERATOR WORKLOAD ON HIGH LATITUDE FLIGHT



data when the INS is available with those of the standard mission (Figure 3), one sees a small increase in tasking (5 percent), which was not unexpected. An increase in task load to 85 percent on this same mission was encountered on that portion of the flight when the INS was not available. Figure 3 also shows a peak workload for the copilot of 100 percent. This task load was measured following a rest period when the copilot was out of the seat and upon returning was busy reorienting himself to the mission while also taking over flying duties from the pilot. This task load was of short duration (30 minutes). These task loads contrast sharply with those of GIANT CHANGE's three-man crew. The overall GIANT BOOM workload for the copilot on this high latitude mission was 60 percent less than that observed in GIANT CHANGE.

On high latitude missions with INSs still operating, the FSO's workload increased to 86 percent reflecting small increases in radar and navigation workloads. On high latitude missions with both INSs "failed," the FSO workload increased to 100 percent; larger increases were found in radar and navigation tasks as well as a new increase in communications. The high latitude increase in radar and navigation was due to the increased difficulty of radar scope interpretation (RSI) in northern Canada. Communications workload increased under the "INS out" conditions since more copilot-FSO conversation was necessary to identify and confirm radar fixes, to agree on Grid direction conversions (autopilot operating from the N-1 Compass), and to coordinate heading changes.

If the GIANT BOOM copilot's high latitude workload is combined with the FSO's high latitude workload, the resultant total is higher than the GIANT CHANGE copilot's workload (140 percent versus 185 percent). This was due largely to overlaps in some of the basic tasks that copilot and FSO both have to do when they both keep track of the aircraft's position; e.g., INS positions on the copilot's chart cannot help the FSO orient himself in the radar scope. While the higher total percentages indicated more work was being done overall, the more even distribution of the workloads showed that neither copilot nor FSO was near the overload condition of GIANT CHANGE. The lower individual workloads and navigational redundancy greatly decreased the fatigue factor that was observed on GIANT CHANGE.

The task load data from the "crested cap" rendezvous, a mission involving a multi-tanker, multi-fighter rendezvous over water, is shown in Figures 5 and 6. The copilot's task load increased to 75 percent. The FSO was fully loaded (100 percent) during the Rz itself since he was operating the radar in Beacon Mode, directing the rendezvous, and performing the communications with the fighters. The pilots complemented the FSO's activity by maintaining communications, relaying INS positions, and coordinating changes with the other tankers in the cell.

Figure 5

COPILOT WORKLOAD ON "CRESTED CAP" FLIGHT

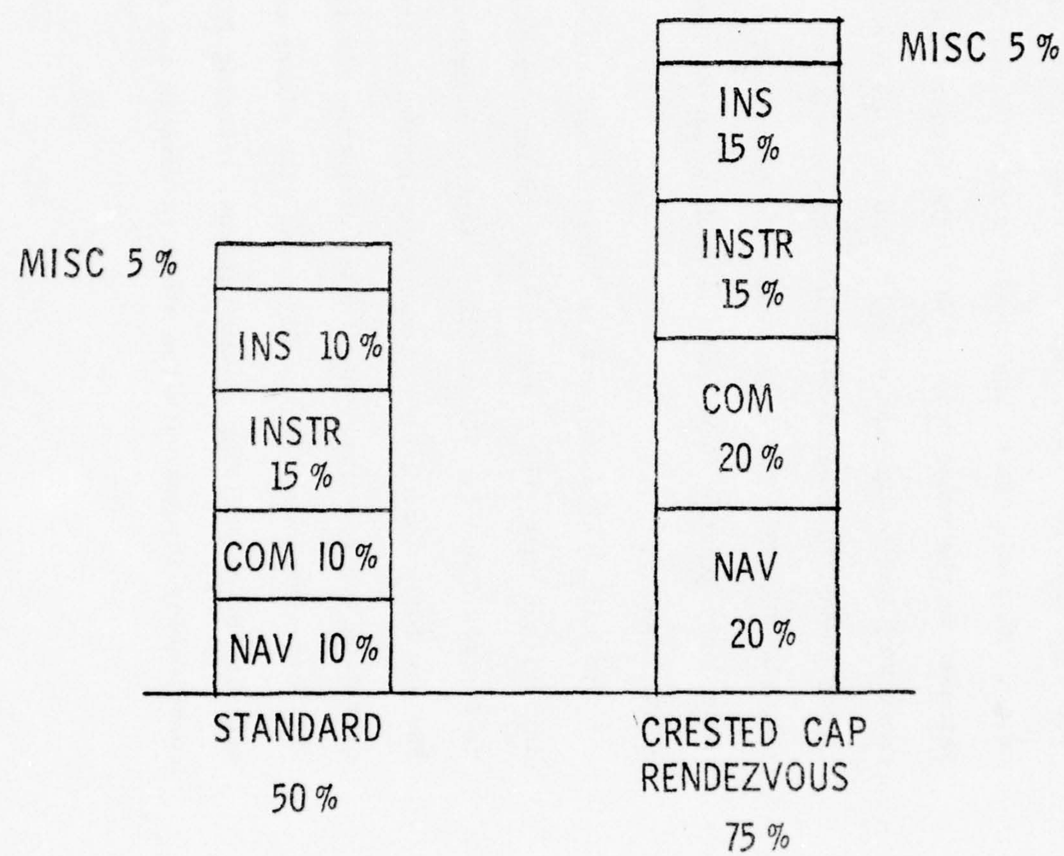
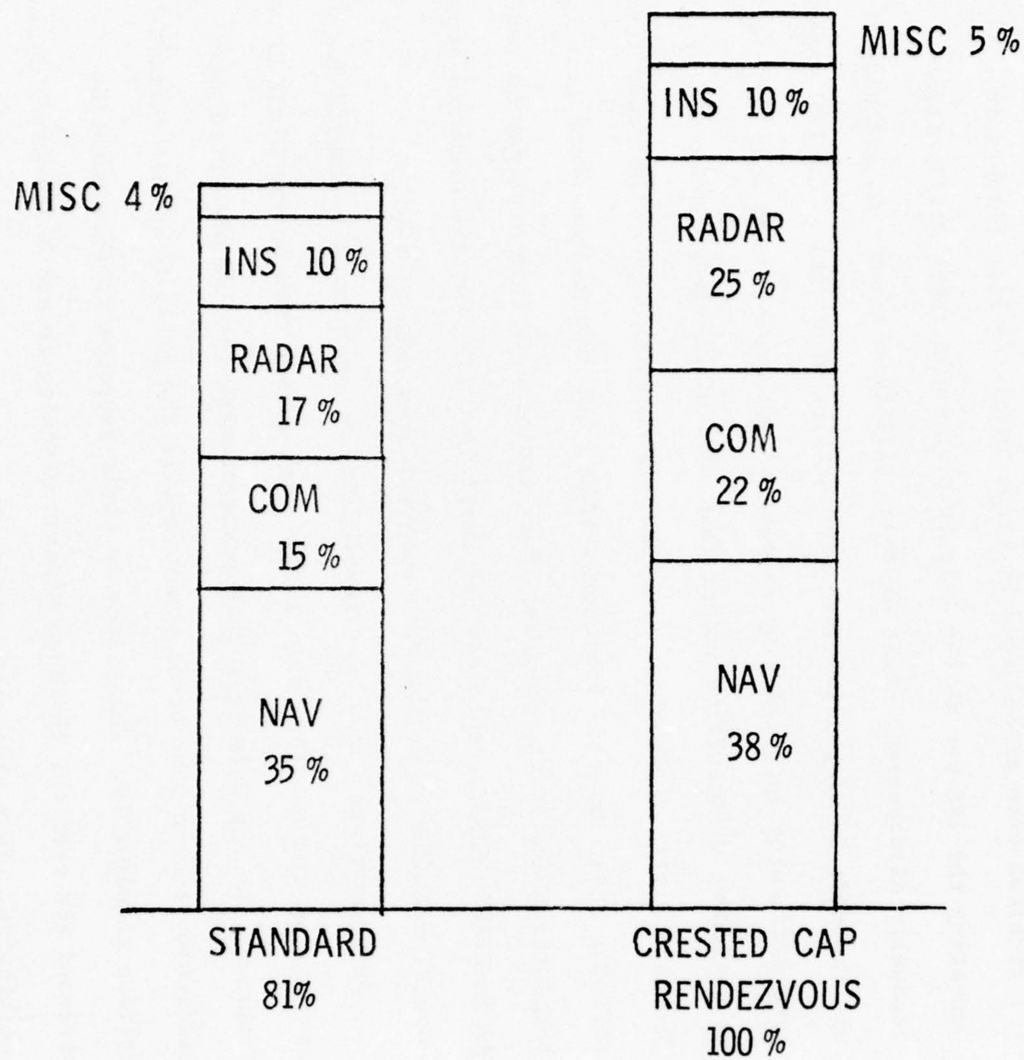


Figure 6

FLIGHT SYSTEMS OPERATOR WORKLOAD ON CRESTED CAP FLIGHT



Questionnaire Data

Detailed responses to the questionnaire distributed after each flight are presented in the Appendix. A summary of these comments is presented below.

Problems were encountered by crews in the earlier flights in operating the INS but as the flights progressed these difficulties gradually disappeared. Most of these difficulties were in learning to use the Mode 22 of the INS (used for setting up orbit). The FSO reported some difficulty in picking up receivers' beacons but this was largely due to equipment difficulties rather than lack of knowledge about the system. The most difficult area for the FSOs was learning to use the radar for Airborne Radar Directed Approaches (ARDA) but they became proficient in the later phase of the program. More training in this area may be required. As in GIANT CHANGE, there was not sufficient time for the crews to acquire enough knowledge about the more sophisticated uses of the INS.

When questioned about the feasibility of performing flying duties and navigating, the copilots said it was much easier than in the GIANT CHANGE Program. The copilots felt that reprogramming the INS presented most difficulty and in some cases would require the pilot to handle communications temporarily. The pilots in their response to this question stressed the need for thorough mission planning to avoid overloads during the mission. They also cited the need to have the pilot's communication monitored by the copilot or other crew member if the copilot is not available.

All crew members replied negatively to the question: Did you feel overloaded during any segment of the mission? The copilot and FSO reported periods where they were fully loaded but never overloaded. Table 3 shows the task load division by crew position as reported in the questionnaires.

Question 7 (Appendix A) shows that the relative importance of each piece of navigation equipment is a function of crew position. The PINS HSI was most important to the aircraft commander in his tasks while the INS display was most important to the copilot and FSO. The HSI was second most important to the copilot while the radar was second for the FSO.

When questioned about the positioning of the navigation equipment added for the test program, the responses were negative in general (as they were in GIANT CHANGE). The HSI blocks out-of-the-window vision, and the INS interferes with the hydraulic switches and nosewheel steering. The positioning of the second radar was also considered undesirable.

The crews felt additional training was required in the following areas: radar (pilot/copilot), Grid navigation (copilot/FSO), and ARDA (FSO).

All crew members felt the INS would improve procedures during refueling and recovery on an Emergency War Order (EWO) mission. Rendezvous were quicker and smoother because the tankers' positions were more accurate; the pilot's tasks and cross checks for maintaining the rendezvous orbit were greatly simplified. The INS simplified the work required on mission changes and provides a self-contained fixing aid for recovery when

RENDEZVOUS TASK	P	CP	FSO
LOOKING OUTSIDE	34%	29%	0%
INS	26%	23%	38%
COMMUNICATION	21%	14%	20%
OTHER	19%	22%	1%
RADAR	1%	15%	41%

TABLE 3. RENDEZVOUS WORKLOAD DISTRIBUTION (SELF-REPORTED)

no other aid is available (when overwater or TACAN/VOR is not usable). All crew members indicated extremely high confidence in successfully completing an EWO mission using the test system and displays.

Numerous detailed checklist changes, additions, and deletions are given in Questionnaire Item 14.

There was some difficulty reported on changing control times but these were reported in the earlier missions (this was not the case as the crews became proficient). The same was true of workload affecting safety of flight. Once crew coordination procedures were worked out, there were no overload problems encountered.

Finally, pilots reported "head in cockpit" time with PINS to average 10 to 19 percent higher over the total mission than with the standard KC-135 configuration. Copilots reported only a 10 percent increase in "head in cockpit" time over the total mission; however, they reported an average increase during the short mission change and waypoint insertion periods of 40 percent.

SECTION IV

DISCUSSION

The results of this study indicate that the enlisted Flight System Operators performed very well and were able to accomplish all aspects of all missions as required. They were able to run the rendezvous across all missions particularly well. The use of the radar for weather avoidance was accomplished with no difficulties (in contrast to the difficulties encountered by the copilots in interpreting weather returns in GIANT CHANGE). This was, no doubt, due to the FSOs having received considerably more training on radar interpretation than the copilot received in the earlier study. On the other hand, the FSO did have some difficulty in shooting ARDAs but this is considered a difficult task (even for personnel experienced in such procedures). In addition, the number of sorties flown in this study is not deemed sufficient to acquire a high level of proficiency in shooting ARDA's.

Initially, difficulties were encountered in using the FSO as conceptualized in the test plan. There was a strong tendency for the crews to employ the FSO in the same manner that navigators are currently used in the KC-135 refueling mission. In the first half of the study, the crew had to be constantly impressed with the fact that the copilot had prime responsibility for navigation and the FSO had responsibility for the radar function, rendezvous, and to relieve the copilot of navigation duties when the copilot was in an overload situation. This confusion was partially because no detailed and formalized crew procedures using an FSO had been developed prior to the test. As the program proceeded, the crews did a good job of developing crew procedures and eventually developed excellent crew coordination and integration. If SAC does convert to use of an FSO, such formalized procedures should be further developed.

In line with this observation, the authors also noted that the FSO's workload was probably higher than necessary on the standard refueling mission. The 81 percent task load cited in the Results section reflects some self-imposed task loading such as performing extraneous navigation functions: using the radar to cross check the INS and taking radar fixes when not required. This was due to the FSO's not being sure of his function and his practicing navigation in anticipation of the later polar flights. It is felt that this artifact in the data inflated the task load figure approximately 20 percent so that the actual required workload on the standard mission would have been approximately 61 percent. In an operational situation with an experienced FSO, the authors feel that a realistic task load would be at this level (61 percent). The FSO task load on other portions of the test are considered accurate.

The addition of the FSO in this study reduced the copilot's task load approximately 40 - 60 percent depending on the type of mission. The additional crew member overcame all the disadvantages encountered in the GIANT CHANGE Program. The copilot's workload was reduced to reasonable levels, no critical checklist items were omitted and the concept of "see and avoid" was preserved. There were isolated instances of errors and some phases where the crews were fully loaded (but never overloaded). In short, the crew performance was dramatically changed from that observed in

GIANT CHANGE. However, two observations that were similar were the requirement to have a better crew station layout than that in the test aircraft, and the necessity for more time to perform preflight checks (due to the INS procedures and warm-up).

Since the enlisted FSOs performed so well, the question has been raised: Is it possible that a less experienced individual could with adequate training also perform the required tasks? Our answer is a qualified "yes." The qualifications are:

a. Much more extensive training will be required.

b. Very careful selection procedures will have to be followed, so that candidates should show a high general aptitude as well as specific capacities in the skills required. Probably, a selection test for this AFSC should be developed.

c. Testing in selected squadrons should be conducted prior to operational implementation.

SECTION V

CONCLUSIONS

1. The results of this study definitely indicate that the use of an experienced enlisted FSO in conjunction with a copilot to perform the navigation function for refueling operations is feasible.

2. The task load figures show no overload situations nor any safety hazard.

3. The use of a less experienced FSO will require more extensive training and careful selection of candidate operators.

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APPENDIX

APPENDIX A: QUESTIONNAIRE RESPONSES

NOTE: Responses listed here summarize common responses throughout the test program; highly important single comments are included, also.

2. Have you had any prior experience in the use of:

a. INS (Explain fully)?

P - No
P - Aircraft commander (A/C) for Giant Change
CP - CP for Giant Change
CP - 1 Giant Boom flight
O - No
O - CP on Giant Change
O - 1 US & 3 trans-Atlantic flights
O - 1 trans-Atlantic flight
F - Passenger on 2 Giant Change flights; 1 Giant Boom flight
F - 1 Giant Boom flight

b. Radar (Explain fully)?

P - No
P - EC-47 weather (wx) radar
CP - CP for Giant Change
CP - No
O - No
O - EC-47 wx radar, Primary CP for Giant Change
O - Slight use of wx radar
O - EC-121 wx radar
O - Some at KC-135 CP position
F - Radar Systems Operator Course at Castle AFB; 1 orientation/training flight at Pease AFB
F - Radar Systems Operator Course at Castle AFB; 1 orientation/training flight at Pease AFB

3. Mission Data: Summarized in main body of report

4. Did you have any difficulties while operating or using the following equipment?

a. INS:

P - Minor difficulties on initial flights in programming & "22 Mode" because of unfamiliarity with INS displays, locations, and operating procedures

CP - Slowness & minor difficulties on initial flights

O - On initial flights, crew didn't use INS to fullest extent; crew was confused at some points on INS operation and needed time to confirm their findings; FSO was confused on "22 Mode"

F - Coordinating with pilots slowed down the preflight; FSO has no checklist for INS's 22 Mode; minor difficulty entering & exiting 22 Mode

b. Radar:

(1) Positioning

P - These are CP & FSO functions

CP - Coordinated with FSO to understand radar settings & changes

F - Fixes on initial flights were 2-4 miles off; Forgot to adjust variation control; Unable to obtain radar fix for 30 minutes around North Magnetic Pole

(2) Rendezvous (Rz)

CP - No, FSO set it up & it worked perfectly; Repeated difficulty seeing receiver's radar beacon

O - FSO could not pick up receiver's beacon until 30 miles away

F - Often, beacons were not painted and ADFs did not work; Differential INS distances (receiver's reading - tanker's reading) used to perform Rz; Overrun procedures used once because tankers didn't turn until receivers were sighted visually

(3) Station Keeping:

CP - Excellent position maintained by FSO

O - FSO monitored cell position fairly well

(4) WX Avoidance:

All - No significant weather encountered

(5) Other (Explain):

F - Difficulty performing ARDA

5. How do you feel about performing normal pilot duties while concurrently performing the navigation functions?

P - Initial flights suffered from having to develop an effective crew coordination & division of labor for the new systems; If A/C forces crew to spend enough time in mission planning, many inflight mission difficulties are avoided; Normal & safe if FSO directs the Rz and backs up the CP on mission navigation; Other crew members need to back up the pilots on headings, altitudes and turn directions during mission changes (pilot turned wrong way); System forces pilots to maintain much better position awareness while providing more time for both navigating and flying

CP - Much easier to navigate with PINS (FSO monitors its accuracy); Pacing was easy except when reprogramming INS with new waypoints (normal or mission change)--at that point, pilot must assume some of CP workload (e.g., radio calls)

O - Slight workload increase: 20-30% more than with a navigator, and 10-20% more than piloting from TACAN to TACAN

6. Were there segments of the mission where you felt overloaded (pressed for time)?

P - Generally, no; During Rz with another aircraft behind us in cell, I felt I wasn't sufficiently monitoring the receiver's progress to ARCP

CP - I was fully loaded during INS waypoint-insertion--if any unusual problems developed, I would have been overloaded; Fully loaded (not overloaded) during mission changes because of unfamiliarity with navigation in general (not INS)

O - Generally, none observed

F - No

7. Instruments. Rate the instruments listed below in the overall importance during this mission. (1 = most important, 2 = next most important, etc.)

	P	CP	O	F
HSI (PINS)	1	2	1.5	/
INS	2	1	1.5	1
Radar	3	3	3	2
Doppler	4	4	4	3
Other (TACAN)	/	/	5	/

8. During rendezvous, how much time was devoted to:

	P	CP	F
a. Using the radar?	1%	15%	41%
b. Looking outside aircraft?	34%	29%	0%
c. Using the INS?	26%	23%	38%
d. Using the radio?	21%	14%	20%
e. Using other equipment (ADF, Air-Air TACAN, Checklists)?	19%	22%	1%

9. Comment on the Location and visibility of:

a. INS:

P - Location fine but control head should be flush with other equipment panels; Location interferes with hydraulic switch and nose-wheel steering

CP - Computer Display Unit (CDU) would be more convenient in the fuel panel area; Mode Selector Unit (MSU) present location in side panel is better than its Giant Change location; CDU is awkward to program "sideways" -- would be much better for key pressing and to reduce sun glare if it were positioned more toward the instrument panel on a 45° angle to the pilots

O - Should be forward more toward instrument panel; INS "Alert" light should be on HSI in normal visual crosscheck area for pilot rather than down by his knee

F - Good

b. HSI:

P - Blocks pilot's view from 12 o'clock to 1 o'clock positions inflight and when taxiing; Instruments should be incorporated into pilot's and copilot's instrument panels; Extremely bad due to glare and blocking outside vision

CP - Usable by both pilots though location causes parallax reading error; Should have 1 for each pilot centered in front of him; Creates blind spot & hard to read accurately

O - Each pilot should have his own display; Incorporate into FD-109; Gives small blind spot.

F - Good

c. Radar:

P - CP's Radarscope should be in central instrument panel reducing sun glare and readable by both pilots

CP - Poor location and visibility; It's physically, very hard to bend over and use the scope; Glare on the scope face makes reading difficult; Radarscope is so low and hood so short that sun's glare often spills in

O - Radarscope location is very poor for daytime & aircraft commander's use

F - Excellent (At Navigator's station)

d. Other (Explain):

P - Pilot's oxygen panel location is inadequate since the "Emergency" toggle is often depressed when replacing helmet (need better location or different regulator); If the "IFF Ident." switch had a repeater for the pilot, he could reduce coordination problems and some of the FSO's workload during peak problem periods.

10. Based on the results of the mission, what additional mission planning items would you accomplish for your next mission?

P - Navigational techniques concerning "mission change" and "alternate (second) rendezvous" procedures; Better crew coordination between FSO and CP (especially on navigation responsibilities and necessity of comparing results)

CP - Have inflight INS reprogramming done by CP and FSO (leave P out of this in order to fly aircraft and handle radios); Better coordination between pilots & FSO over procedures for handling mission changes, route changes, and navigation when the INS's fail; More work at understanding Grid reference system for polar flights; More on weather avoidance and "fighter rendezvous" procedures for Crested Cap

O - Replan alternate R_z more thoroughly; Use boom operator to relieve high crew workloads (e.g., comm, fuel log)

F - More detailed discussion of the crew's division of labor to accomplish alternate R_z and mission changes; Better planning for entering Grid and doing Grid fixing on polar flights

11. Do you feel additional training is desirable and, if so, in what areas?

P - Many repeated comments on the need for Radar training, Grid training, and basic navigation refreshers for both pilots; Grid for FSO; Radar training using scope photographs

CP - FSO and CP need more training in basic manual DR, radar fixing, Grid, and radar R_z procedures (especially with fighters); On best crew coordination for performing tasks/activities inflight

O - Yes, On inflight mission changes and loading INS properly/rapidly

F - On Airborne Radar-Directed Approach (ARDA); Grid entry, Grid exit, and Grid fixing on radar

12. Do you feel the INS would improve procedures during refueling and recovery on an EWO mission? Explain:

P - Definitely yes, due to the much greater accuracy of the INS; Refueling would be quicker because tanker's position is more accurate; Yes, mission would be overwater and recovery bases would be hard to find otherwise

CP - Yes, definitely -- greatly simplifies the pilot's task and crosscheck for maintaining the orbit; It simplifies mission changes and improves position awareness; It definitely improves recovery chances because TACAN/VOR would probably not be usable

O - Yes, it would ease the workload and improve the quality of navigation on unscheduled Air Refuelings (A/R); Ultimate equipment to satisfy total self-sufficiency of aircraft navigation; R_z are more accurate and it helps fuel conservation because you stay on course much better (fuel figures based upon on-course nav); You can give better fixes to your receivers

F - Yes, it provides the flexibility to proceed to any ARCP easily and accurately; It gives instant time and distance figures for maintaining the proper refueling orbit

13. Given the present system (INS) and displays, rate how confident you would be in successfully completing an EWO mission.

7	6	5	4	3	2	1
Very unsure						Very confident

P - 1.25 average (1.0 after 3rd flight)

CP - 1.125 average

O - 1.0 median

F - 1.8 average (1.0 after 3rd flight)

14. Do you have any recommended checklist changes/additions/deletions?

P - In Preparation for Contact, include: "INS-22 Mode"; In Before Starting Engines, the first step should be: "INS - Nav Mode"; For the INS checklist, move the "INS - Test" to a point after the insertion of present position

CP - Eliminate amplified explanations from checklists; Develop a checklist for inflight mission changes that lists everything that needs to get done and by whom

O - Crew should put INS in Standby during preflight prior to aligning; Eliminate various explanations between actual steps; Rework checklist to put Boom Operator to better use

F - In Start Engines, change Item 1 to "INS-NAV" (i.e., insure both pilots' INS's are in NAV prior to engine start); In Preparation for Contact, add new Item 5A: "INS - 22 Mode" (i.e., insure 1 INS is in 22 - Mode before ARCP); In FSO checklist, Interior Inspection-Power On, change Item 4 from "INS-Align" to "INS-Checked" with amplification to read and check Present Position and Waypoints 1-9 in both INS 1 & INS 2; Change Item 5 of previous checklist from "INS - Set" to "INS - 22 Mode Checked" with amplification to read and check INS 1 & 2 in the 22 Mode for ARCP coordinates and receiver's inbound true track

15. Would the INS provide an additional safety factor for penetration and landing with external nav aids available?

P - Yes, it assures you have the proper airport & it gives GS and Drift for instrument approaches; Good back-up to maintain course and avoid high obstacles/terrain

CP - Some "No", Most "Yes"; Additional crosscheck on runway's location compared to aircraft's position; Gives pilots better position awareness and allows easier planning ahead of time; Gives good backup to monitor FSO's ARDA

O - Yes, Groundspeed function could give backup timing for ILS Approach; Drift function useful in all modes; Slight safety factor as long as it doesn't cause an oversight of normal duties or detract from the primary approach aids

F - Yes, it permits precise entry into landing patterns

16. Was any weather avoidance necessary during this mission? If so, how did it affect pacing, workload, crew coordination? Were you able to effectively avoid the weather?

ASD NOTE : Only 2 of 12 evaluation flights encountered weather (on 1 additional Wx flight, FSO's inoperative radar forced us to relinquish cell lead)

P - Adequate, no effect on mission

CP - Minor alterations by CP & FSO to avoid thunderstorms

O - Easy, quick & accurate

F - Gave no problem; DR used to position aircraft and then radar used to fix after clear of weather

17. Were control times revised inflight? If so, how did it affect pacing, workloads, etc?

P - Crews handled mission changes (with second A/R's and new control times) smoothly and with good pacing

CP - Inflight changes increase CP's workload but easily handled when pilot assumes part of CP's workload (e.g., radios); Pacing affected by overload & wait for FSO to pass 2nd A/R ARCP coordinates from FLIP document

O - Weak area of flight -- calls for better coordination between FSO and pilots; When new A/R was added, CP & FSO spent 20 minutes working entirely on revised routing to exclusion of all other tasks -- Pilot spent 1/3 of time controlling aircraft and comm radios, 1/3 INS navigating, 1/3 coordinating changes; Pacing increased -- workload doubled

F - Slow in providing info on initial flights because of lack of confidence in answers; Pacing good on later flights

18. Do you feel there were any segments of the mission where safety of flight could be jeopardized due to increased workloads?

P - Generally, no (once pilots are familiar with programming the INS); During problem situations (e.g., mission changes), fuel monitoring could be overlooked unless boom operator is made responsible for it during that period

CP - Yes, inflight waypoint loading by both pilots is dangerous (not enough scanning & flying aircraft) -- INS should be done by CP and FSO; Only when the pilot gets too involved in the CP's inflight loading of waypoints

O - At night, INS control panel lighting gives off too much light for its importance ... not tuned to KC-135 system

F - Generally, no; Only when pilots do not scan outside aircraft during mission changes

19. What would you do if your INS malfunctioned during overwater or polar flight?

P - Most responses were to use Dead Reckoning (DR) with available radar fixing to confirm DR;

CP - Carry DR's from last known position (with flight planned headings, airspeeds & winds) and use radar and other aids available to navigate (directing FSO to fix with radar also)

O - 1: Use operable INS, 2: DR while FSO provides available radar fixes, 3: Use TACAN/VOR whenever possible; When INS failure was simulated on a polar flight, it didn't seem to change the crew's work rate

F - DR from last known position to land or within range of TACAN/VOR

20. List any degradation in the following areas as a result of increased workloads:

a. Preflight:

CP - Slower due to being with new crew learning INS procedures; Preflight requires 10-15 minutes extra time in order to program the INS

O - Extra time to load the INS physically in preflight has to be planned for

b. Taxi/Takeoff: None

c. Climb:

O - Crew's inexperience with INS programming caused some loss of attention to cell position

d. Cruise:

P - Slight on initial flights due to crew's inexperience with INS

CP - With simulated INS failure, navigation by DR and radar is extremely time — consuming; If INS is working, workload is simplified -- if INS is out, there is a partial loss of CP for pilot duties since he must do radar navigating to check FSO; Multiple INS displays at all stations (not just nav's) would increase crew's confidence and task performance flexibility

O - Fuel panel management over looked at times

e. Pre A/R:

P - Generally, no; Because we were leading the cell, the division of labor became tight and lead techniques suffered some -- also true during R_z and some of time on nav leg

CP - Slight increase in workload when CP monitors the R_z on radar; R_z easier with INS; Slight increase in workload due to setting up 22 - Mode of PINS

O - (On the second evaluation flight) the orbit, entry & R_z were confused due to INS inexpertise

f. A/R: Generally, none

g. Post A/R: None

h. Penetration:

CP - PINS provides additional backup to existing nav aids here; PINS provides good info for planning the descent & <u>decreases</u> mental workloads

i. Approach Phase:

CP - PINS provides additional backup to existing nav aids here

F - FSO needs practice in ARDA's

21. Increased workloads are assumed to increase "head in the cockpit" time and, thereby, decrease the pilots' ability to "see and avoid." Estimate the approximate increase in time required as a result of the increased tasks:

P - 10 to 19% increase over total mission; Increases: Preflight - 10 to 19%; Taxi/TO < 5%; Climb - 6 to 9%; Cruise - 10 to 19%; Pre A/R - 20%; A/R - 10 to 19%; Post A/R - 10%; Pntrn - 6 to 9%; Approach - <5%

CP - About 10% increase over total mission; Increases: Preflight - 20%; Taxi/TO - <5%; Climb - 6 to 9%; Cruise (ONLY during mission changes and waypoint insertions) - 40%; Pre A/R - 30%; A/R - 6 to 9%; Post A/R - 10%; Pntrn - 10 to 19%; Approach - <5%

O - 6 to 9% increase over total mission; Increases: Preflight - 20 to 29%; Taxi/To - <5%; Climb - <5%; Cruise - <5% for Pilot, 40 to 49% for CP during mission change or waypoint insertion; Pre A/R - 6 to 9% for P, <5% for CP; A/R - 10 to 19%; Post A/R - 10 to 19%; Pntrn - <5%; Approach - <5%

F - None reported (due to his position at nav station)

22. Address any other areas you feel are applicable to the purpose of this test program:

P - "See & Avoid" suffers most during inflight INS reprogramming by both pilots -- better solution is for pilots to coordinate the waypoints to be loaded & have CP do loading with FSO monitoring; After 3 flights, we solved the coordination problems: P is responsible for flying the aircraft & supervising navigation needs of the flight, CP coordinates all nav changes with pilot & compares solutions with FSO, FSO checks all INS programming, conducts A/R (pilots back him up with alternate means), & performs wx avoidance; A flushable toilet for the KC-135 is another highly desirable innovation that would improve human performance and safety inflight -- its lack directly interfered with performance on these missions (especially on the 8 and 11 hour missions); This PINS test equipment allows a very effective means of completing the strategic air refueling mission

CP - Careful on-ground coordination required to insure all crewmembers have the same flight plan points designated with the same waypoint numbers; PINS system purchased should have HSI able to operate off either INS (P's or CP's) -- with P out of seat and CP flying, CP cannot reach the waypoint change keys on the P's INS ... therefore, he cannot use the HSI to fly the aircraft after making the course change to go to a new waypoint; During mission changes, the first task to be dropped from priority is P's attention to fuel burn sequence -- best solution is to transfer this responsibility to Boom Operator (not FSO) during mission changes

O - To get accurate view of difference an INS makes in "Head in Cockpit" time, you should fly a normal mission (with recorders) identical to one with INS for comparison; This crew is much above average and results may reflect their superior collective abilities rather than INS; Evident that P & CP are very concerned with INS and doing much double work just due to novelty of the test situation; CP's radar must be improved if he is to assume greater radar navigation responsibility

F - FSO needs a condensed checklist for checking 22 Mode of INS during preflight

GIANT BOOM TRAINING PLAN

ENLISTED RADAR/SYSTEMS OPERATOR

20 JULY 1976

93d Bombardment Wing

Castle AFB, California

OPR: DOTN

Atch 1

AD-A033 360 STRATEGIC AIR COMMAND OFFUTT AFB NEBR F/G 5/9

GIANT BOOM TEST. ENLISTED RADAR/SYSTEMS OPERATOR KC-135.(U)

DEC 76 J TUCKER

UNCLASSIFIED NL

2 OF 2

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DATE

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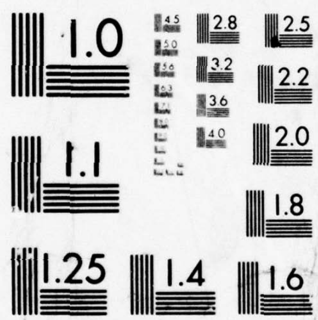

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

GIANT BOOM TRAINING PLAN

1. TASKING: The Giant Boom test plan for enlisted radar/systems operators tasked the 93d Bombardment Wing to develop a course to train selected enlisted boom operators in the operation of equipment at the navigation station with the exception of the ASN-7 computers. The academic course was tailored to train the selected individuals to accomplish the tasks as described in the test plan. Five T-10 trainer periods and four aircraft orientation flights were required to prepare the selected individuals to operate the equipment. The 93d Bombardment Wing was also tasked to revise a current KC-135 navigator checklist to reflect radar/systems operator (RSO) duties. The final area tasked was the training of selected individuals using a free wheeling concept.

2. TRAINING COURSE: The radar/systems operator training course was developed in two phases, the academic phase and flying phase.

a. The academic phase consisted of 72 hours of instruction during ten academic days. The course of instruction was designed to meet the objectives of the Giant Boom test plan. The course material used in the classroom and for the RSO's handouts were basically the same used by student navigators during their CCTS training. The dead reckoning and radar scope interpretation handouts were obtained from the undergraduate Navigator Training program to provide the basic information not taught to student navigators at CCTS. The Instructional Systems Development (ISD) "Search Radar" program was used, after the completion of classroom instruction, as a means to reinforce the search radar operation. In all cases, course material was reviewed, edited, or modified to cover only the information that was required for the radar/system operators. The academic course syllabus is set down in Section II of the Course Control Document for Radar/Systems Operator, 93d Bombardment Wing, Castle AFB, California, dated 1 June 1976.

b. The flying phase consisted of four training missions. The main objective of this phase was to obtain the maximum amount of training in radar fixing, DR techniques and rendezvous procedures. To fulfill these goals, the first three training sorties were scheduled with two rendezvous, departure monitor and penetrations, plus a minimum of one hour of radar fixing/DR techniques. The fourth sortie was a complete profile and was an informal evaluation of the RSO's performance in all areas of flight. For a complete listing of each sortie objective, see Section IV of the Course Control Document.

c. The KC-135 T-10 Simulator trainer was used in conjunction with both the academic and flying training phases. This trainer's primary purpose was to reinforce classroom instruction and simulate inflight mission profiles. The first four T-10 trainers, each two hour periods, were scheduled within the academic phase of instruction. The final trainer was scheduled after the first training mission profile and consisted of a four hour mission profile. Section III of the Course Control Document has the complete outline of each trainer period.

3. CHECKLIST REVISION: A KC-135 navigator's checklist was revised to reflect the duties of the radar/system operator. This was accomplished by the 93d Bombardment Wing Standardization Evaluation Division with the direct help of the 1st Combat Evaluation Group, which was at Castle AFB during the revision. The final copy of the amplified and abbreviated checklists were forwarded to 1st CEVG and the 509th Bombardment Wing. The checklists were used by the RSO throughout the training program with no resulting problems.

4. ACADEMIC TRAINING RESULTS: Two Radar/Systems Operator trainees were selected from the 509th Bombardment Wing, Pease AFB, New Hampshire. These individuals were SMSgt Haven J. Moore and MSgt Robert A. Whittier.

a. The academic phase began on 1 June 1976. During this phase, both radar/systems operator trainees were very receptive to the classroom instruction. Pacing was excellent due to their background and experience. Due to the limited number of academic days and the vast amount of material to cover, it was required that each RSO spend additional hours of study outside the classroom. This work involved DR exercises and study guides plus preparing for the next day's course material.

b. The free wheeling concept of instruction was utilized when the RSO completed the course objectives prior to the end of the classroom time. It was found that a review of the academic material covered to date was more productive than starting a new subject. These reviews helped clarify many of the important aspects of the training course.

c. On the final day of academic training, each radar/systems operator was given a 50 question, closed book examination. This comprehensive test had questions covering all areas of the course of instruction. The test results were excellent with a total of six questions missed.

d. It should be noted that even though both radar/systems operators did exceptionally well with this phase of the training program and all training goals were accomplished, their level of training and experience is not equivalent to a CCTS graduate navigator. This could not be expected with the short academic course. The RSO's understanding of departure and terminal instrument procedures were about equal with that of a student navigator. Radar fixing, DR techniques, radar scope interpretation, and rendezvous procedures will require additional training and experience before a complete understanding of these areas can be obtained.

5. FLYING TRAINING RESULTS: The flying phase began on 15 June 1976. Each of the radar/systems operators received four training missions.

a. Radar fixing/DR techniques started out being very slow and cautious. A substantial amount of time was spent teaching how to adjust the radar set to achieve the best mapping presentation and on techniques for radar scope interpretation. With each flight, radar fixing/DR procedures improved so that on the fourth training mission these procedures were satisfactory.

b. Normal rendezvous procedures, with no equipment malfunction, did not present a problem. Each radar/systems operator received four normal rendezvous with a B-52 receiver. At least one rendezvous was directed by the radar/systems operator. Alternate rendezvous presented a problem because of rendezvous variations. MSgt Whittier received three alternate rendezvous, two with fighters and one with a B-52. SMSgt Moore received two alternate rendezvous. Additional training and experience will be required before all variations of alternate rendezvous can be accomplished effectively.

c. Crew coordination was the strongest area observed. Both radar/systems operators interacted effectively on every flight. No difficulties were encountered adjusting to the new position and interphone procedures.

d. Departure and terminal instrument procedures received maximum exposure and training. Each radar/systems operator received at least seven departures. They had little trouble monitoring the aircraft's position and altitude, and correlating to the Standard Instrument Departure plate. Two penetrations were accomplished on each of the first three missions. The penetrations were both monitored and airborne radar directed approaches. By the fourth training mission, each radar/systems operator was capable of conducting an airborne radar directed approach to Castle AFB without instructor assistance.

e. Weather avoidance was limited to ground instruction only because of a lack of inclement weather in the Castle training area. Additional training will be required in this area.

f. Each radar/systems operator was knowledgeable of inflight maintenance. Simulated equipment failures and oral questions inflight were used to reinforce good inflight maintenance procedures.

g. Palletized Inertial Navigation System (PINS) instruction was limited because of the lack of PINS equipped aircraft at Castle and training materials. Each radar/systems operator received intensive training in navigational procedures, including computing alter headings and ETA's.

6. OVERALL EVALUATION: SMSgt Haven J. Moore and MSgt Robert A. Whittier completed the training course with satisfactory results on 30 June 1976. In the judgment of the inflight instructor navigator, both radar/systems operators were capable of handling all areas of flight, with the exception of PINS operation and weather avoidance. These areas should receive additional training.

COURSE CONTROL DOCUMENT

RADAR/SYSTEMS OPERATOR

KC-135 1JN76
KC-135 OOIC

93d BOMBARDMENT WING

CASTLE AFB, CALIFORNIA

1 JUNE 1976

Atch 2

REVISIONS

NUMBER	DATE	ENTERED

FOREWORD

This course control document reflects the general nature of the training provided to enable graduates of this course to perform safely and proficiently as Enlisted Radar/Systems Operators. Students receive information essential to the conduct of effective professional activities required. The training standards contained herein specify performance requirements necessary for successful completion of this course. This document describes the overall plan of knowledge and skills as set forth in the training standards.

OPR: 93 BMW/DOTK

TABLE OF CONTENTS

SECTION I

GENERAL

1. COURSE TITLE: Radar/Systems Operator.

2. PURPOSE: Qualify inflight refueling technicians to perform inflight systems operation in KC-135 aircraft.

3. Course Prerequisites: Radar/Systems Operators must meet requirements specified in SACM 51-135, VOL V, *Inflight Refueling* Technician duties and:

a. Have been selected by their Wing Commander.

b. Be qualified and current in the KC-135 aircraft as an inflight refueling technician.

c. Be mission ready.

NOTE: Students failing to meet the requirements of this paragraph will be returned to their units.

4. Course Objectives:

a. Academic Training:

(1) To provide the radar/systems operator with sufficient instruction to develop a thorough understanding and appreciation of approved principles of equipment operation and how these principles are applied.

(2) To impart skills in the area of oral and visual communication as required for successful mission accomplishment.

(3) To enable the radar/systems operator to objectively evaluate inflight situations and to take proper actions in a timely manner.

(4) To familiarize the radar/systems operator with those manuals, regulations, directives, and procedures applicable to effective mission accomplishment.

b. Simulator/flying training:

(1) Identify and analyze common errors and potentially dangerous situations encountered during flight and be able to coordinate effectively with other crew members to take safe, prompt corrective action.

(2) Understand systems operations, performance capabilities sufficiently to explain actions to be taken by other crew members as they relate to procedures and mission accomplishment.

5. Course Duration: The course length is 22 days, approximately 30 calendar days. The starting day of the week, number of holidays, and number of weekends within a class frequently vary the total number of days required. Training is identified as follows:

a. Academic/Simulator training - 11 days/72 hours.

b. Flight training - 11 days/68 hours.

NOTE: Flight training will normally consist of four flights. Flight number 4 will consist of an informal evaluation.

6. General Instructions: Definitions and standards: The following criteria are used in student evaluation:

a. Performance level or ability indicated an understanding of systems operational techniques and judgment. Handled unique/unusual problem in an effective manner. Quality of performance was well founded and showed indepth understanding of mission profile to successful completion. Demonstrated excellent initiative and interest in mission progress.

b. Performance level or ability indicated a fundamental understanding of the events as they occurred. Discrepancies, if any were minor and transitory in nature. Routine tasks were accomplished. Quality of inflight duties were timely and mission progress was monitored with successful results.

c. Performance level or ability did not or would not have adversely affected the mission; however, performance level was marginal. Routine tasks were not accomplished. Crew coordination was adequate; however, it was untimely - of little or no benefit. Showed minimal initiative and overall mission monitoring was weak.

d. Performance level and ability did, or would have, adversely affect the mission. Routine tasks were not accomplished. Student showed below minimal initiative and overall mission monitoring was below average, did not meet standards to monitor mission effectiveness or safety.

7. Course Overview: The course is divided into two phases: Academic and Flight training.

a. During the academic phase, radar/systems operators are introduced to and given the opportunity to observe and operate mock ups, attend mission preparations to include briefings on inflight duties and are allotted self study time. The student will be expected to devote approximately two hours per day of outside time to project preparation and assigned reading.

b. During the flight phase, the candidate will complete three training missions and one informal evaluation mission. Emphasis is placed on departures, rendezvous, station keeping, weather avoidance, radar scope interpretation, dead reackoning and airborne directed approaches. During the flight phase each student will demonstrate maximum crew coordination to include coordination with both pilots in all phases of the mission.

8. Class Schedule. The class and flying schedules are included in Section V of the document.

9. Desired learning outcomes. The radar/systems operator will have the knowledge and the capabilities to accomplish the following:

a. Equipment turn on/operation:

(1) Knowledge of equipment turn on procedures.

(2) Accomplish turn on in proper sequence.

(3) Operate systems in a competent manner.

(4) Monitor systems at periodic intervals for proper operation.

b. Monitor departure/cell join up:

(1) Understand departure routing and altitudes.

(2) Make proper altitude calls.

(3) Advise pilots of relative position of other aircraft in cell.

(4) Monitor position and level off points/altitudes.

(5) Accomplish safe join up.

c. Enroute cell procedures/station keeping:

(1) Maintain proper position in cell ($\pm$ 1/2 NM).

(2) Advise pilots of relative position to lead aircraft in a timely manner that allows smooth position corrections to be made.

d. Radar scope interpretation:

(1) Adjust gain and tilt for optimum presentation.

(2) Identify major returns on scope (cities, mtns, rivers, etc.)

(3) Distinguish weather from cultural/terrain returns.

(4) Identify minor returns on scope (small towns, power plants).

e. Radar/PINS fixing to include plotting:

(1) Understand range and bearing method of fixing.

(2) Use best available known returns for fix.

(3) Accurately plot fix on chart ($\pm$ 2 NM)

(4) Record minimum information: time, compass heading, GS, and drift, from any source available.

(5) Able to use PINS to fix.

f. Route monitoring:

(1) Understand routing and timing.

(2) Flight follow by taking fixes at major turn points/action points and at a minimum of 30-40 minute intervals enroute.

(3) Advise pilots of weather along route observed on radar.

h. Rendezvous:

(1) Able to accomplish point parallel rendezvous.

(2) Make necessary radio calls to accomplish rendezvous.

i. Monitor aircraft position during pilot/copilot overload situations.

(1) Satisfactorily accomplish duties relegated by pilot/copilot.

(2) Actually relieve pilot/copilot of duties during these times.

j. Monitor penetration and approaches:

(1) Understand let down and approach plates.

(2) Monitor altitudes and headings during penetration and approaches.

(3) Monitor altitudes and make proper calls.

(4) Advise pilots of deviations noted or suspected.

(5) Monitor weather and terrain on radar.

k. Airborne radar directed approach:

(1) Accomplish radar directed approach without the aid of external navigational aids.

(2) Direct aircraft to missed appoach point in such a manner that a safe landing could have been accomplished.

l. Inflight maintenance (IFM) procedures:

(1) Understand what IFM can be performed.

(2) Perform IFM as required.

m. Checklist items/responses:

(1) Accomplish checklist items and responses with no major deviations.

SECTION II

ACADEMIC TRAINING

1. Specific Instructions. During this phase, the radar/systems operator will be required to become familiar with Basic Dead Reckoning Procedures, Search Radar Systems, Basic Equipment and Instruments, Rendezvous, Departure and terminal procedures and Airborne Radar Approaches. In addition to allotted study times, the radar/system operator will be expected to devote approximately two hours per day of outside time to course preparation and assigned reading.

2. Academic Training.

SUBJECT	HOURS
ORIENTATION	1:00
BASIC DEAD RECKONING PROCEDURES	4:00
Basic Knowledge of Dead Reackoning	
Familiarization with aids to dead reckoning	
SEARCH RADAR SYSTEM	16:00
Radar Principles	
Radar scope interpretation	
Preparation for the APN-59 radar course	
Radar Equipment	
Inflight use	
Limitation	
Inflight Maintenance	
Checklist Procedures	
Radar Techniques	
Operational Techniques	
RSI Position Fixing	
Radar Map Matching	
Station Keeping	
Radar Weather	
Recognition and Analysis	
Techniques for Radar Operation	
Circumnavigation of Weather	
ISD SEARCH RADAR PROGRAM	8:00
Self Study Program Texts	
Carrel Presentations	

SUBJECT	HOURS
BASIC EQUIPMENT AND INSTRUMENTS	8:00
Doppler	
Operation.	
Inflight Use	
Limitations	
Inflight Maintenance	
Radar Beacons	
Operation	
Inflight Use	
Limitations	
IFF/SIF radar Transponder	
Operation	
HF Radio and Communications Procedures	
Operation	
Basic Communication for Rendezvous	
Instruments	
Radio Magnetic Compass	
Altimeter	
N-1 Compass	
Doppler Ground Speed and Drift Meters	
True Airspeed Indicator.	
RENDEZVOUS	8:00
Regulations	
Techniques and Procedures	
Normal Rendezvous	
Alternate Rendezvous	
AIRBORNE RADAR DIRECTED APPROACH	2:00
Regulations	
Techniques	
Radar Scope Interpretation	
DEPARTURE AND TERMINAL PROCEDURES	4:00
Regulations	
Terminology	
Procedures and Techniques	
Crew Coordination	
PINS OPERATION	2:00
Review of PINS System	
Operation Procedures	

SECTION III

SIMULATOR TRAINING

1. Specific Instructions: Simulator training is completed in conjunction with the academic training to re-enforce instruction. The KC-135, T-10 trainer will be used for this simulated training. All simulator training will be under the supervision of a 4017 CCTS/TAN instructor navigator and/or a Wing CCTS instructor navigator. Simulator training during academic phase, will required the radar/systems operator to brief and demonstrate the uses of radar systems, to perform inflight fixing, rendezvous, and airborne radar directed approach. Simulator training, during the flight phase, will closely follow the inflight mission profile.

2. Special Instruction: One simulator training period will be used for the completion of the ISD Search Radar criterion test. This test will measure the student ability to operate the APN-59 and state the corrective action for inflight maintenance problems.

3. Course Training Standard:

SUBJECT	HOURS	STANDARD
Simulator Training (Academic Phase)	6:00	
Checklist Procedures	1:00	b
Equipment Identification	1:00	b
Radar Techniques	1:00	b
Rendezvous Procedures	2:00	b
Airborne Radar Directed Approach	1:00	b
Simulator Training (Flight Phase)	4:00	
Simulated Mission Profile	3:30	b
Critique	0.30	

4. Simulator Training Job Elements:

Simulator Trainer No. 1 — 2:00
- Accomplish all RSO Checklists
- Demonstrate all radar functions including beacon with an APN-59 beacon presentation
- DR/Radar fixing procedures
  - Practice DR
  - Radar fixing.

Simulator Trainer No. 2 — 2:00
- Accomplish all RSO Checklists
- DR/Radar fixing procedures
  - Practice DR
  - Radar Fixing
- Normal rendezvous (2).
- Radar use for penetration (demonstration)

Simulator Trainer No. 3 2;00

- Accomplish all RSO Checklists
- DR/Radar fixing procedures
  - Practice DR
  - Radar Fixing
- Normal rendezvous
- Alternate rendezvous
- Monitor approach

Simulator Trainer No. 4 2:00

- Accomplish all RSO Checklists
- DR/Radar fixing procedures
  - Practice DR
  - Radar fixing
- Normal Rendezvous
- Alternate rendezvous
- Monitor approach
- Airborne directed radar approach

Simulator Trainer No. 5 4:00

- Accomplish all RSO Checklists
- DR/Radar fixing procedures
  - Practice DR
  - Radar fixing
- Normal rendezvous
- Alternate rendezvous
- Monitor approach
- Airborne directed radar approach

SECTION IV

FLYING TRAINING

1. Flying training is accomplished after successful completion of the academic phase. The flight phase is designed to allow the radar/system operator to further develop his techniques and abilities to effectively operate associated equipment under actual conditions and to effectively coordinate all phases of the mission profile with other crew members. The radar/systems operator will be expected to assist in mission planning, briefing his portion of the mission and effectively contribute to the mission's overall effectiveness.

2. Special Instructions: The radar/systems operators will be evaluated on their ability to perform all assigned duties using principles and techniques learned during the academic and simulator phases. Six key areas are identified as follows:

a. Pre-Mission Preparation.

b. Checklist Procedures.

c. Inflight Abilities:

(1) Departure Monitor.

(2) Radar Fixing/DR Techniques.

(3) Rendezvous

(4) Terminal instrument procedures.

d. Aircrew Coordination.

e. Equipment usage.

f. Post-Flight Duties.

In these areas, the radar/systems operator should apply the concepts and demonstrate duties within the parameters of current directives.

3. Course Plan and Training Standards:

a. Training standards for flight missions are listed in Section I. The minimum acceptable performance standard is "b". Radar/systems operators receiving performance levels lower than "b" will receive additional training to upgrade their performance level. If the additional training fails to correct the deficiencies, he will be eliminated from the course.

b. Each mission involves approximately 14 hours:

(1) Mission preparation and briefing 3:50 hours

(2) Flight mission 7:50 hours

(3) Post-mission debriefing/critique 3:00 hours

c. Flying Training Job Elements:

(1) Flight Mission #1:

(a) Mission preparation and briefing.

(b) Pre Flight

(c) Departure Monitor

(d) Radar fixing/DR Techniques

(e) Rendezvous:

1. Normal Rendezvous - monitor

2. Normal Rendezvous - direct

(f) Penetration:

1. Monitor

2. ARDA

(g) Post flight

(h) Debriefing

(2) Flight Mission #2:

(a) Mission preparation and briefing.

(b) Pre Flight

(c) Departure Monitor

(d) Radar fixing/DR Techniques

(e) Rendezvous:

1. Normal Rendezvous - monitor

2. Alternate Rendezvous - monitor

(f) Penetration:

1. ARDA

(g) Post flight

(h) Debriefing.

(3) Flight Mission #3:

(a) Mission preparation and briefing

(b) Pre Flight

(c) Departure Monitor

(d) Radar fixing/DR Techniques

(e) Rendezvous:

1. Normal Rendezvous - monitor

2. Normal Rendezvous - direct

(f) Penetration:

1. Monitor (off station)

2. ARDA

(g) Post Flight

(h) Debriefing

(4) Flight Mission #4:

(a) Mission preparation and briefing

(b) Pre Flight

(c) Departure Monitor

(d) Radar fixing/DR techniques

(e) Normal Rendezvous - monitor

(f) Penetration - monitor

(g) Post Flight

(h) Debriefing

This mission will be an informal evaluation accomplished by the instructor navigator.

SECTION V

TRAINING AIDS

1. Training Aids: The following is a list of those aids required to provide classroom instruction and provide the radar/system operators with adequate tools to complete school requirements:

   a. Overhead projector

   b. Slide projector

   c. Movie projector

   d. Video tape system

   e. Wall charts

   f. Chalk boards

2. Publications: The following publications constitute class library:

   a. T. O. 1C-135(K) A-1

   b. T. O. 1-1C-1

   c. T. O. 1-1C-1-3

   d. AFM 51-40

   e. 4017 CCTS Course Booklet

   f. ISD Search Radar Handout

   g. Terminal Procedure Handout

   h. Flight Information Publication

3. Special Facilities: KC-135, T-10 Trainer.

NOTE: The preceding lists are neither exhaustive nor indicative of total class requirements. In some cases duplication exists in the requirements specified in the course control document.

CLASS ROOM SCHEDULE

ACADEMIC PHASE

Classes are fifty minutes in duration unless otherwise noted. Classes longer than normal will allow radar/systems operators sufficient break time. Students are provided with study time during duty hours to allow full use of available base facilities (i.e., chow hall, learning center, aircraft field trip) in preparation for their academic and flight phase.

DAY 1

0730 - 0820	In Processing
0825 - 0915	Orientation
0930 - 1115	Basic DR Procedures
LUNCH	
1230 - 1415	Basic DR Procedures
1430 - 1615	Basic Radar Principles

DAY 2

0730 - 1115	Radar Equipment
LUNCH	
1230 - 1320	Doppler
1325 - 1415	Radar Beacons
1430 - 1615	IFF/SIF Radar Transponder

DAY 3

0730 - 0915	Radar Equipment Lab
0930 - 1115	ISD "Search Radar" Self Study
LUNCH	
1230 - 1415	HF Radios and Communication Procedures
1430 - 1615	Instruments

DAY 4

0730 - 1115	Radar Techniques
LUNCH	
1230 - 1615	ISD "Search Radar" Self Study

DAY 5

0730 - 0915	T-10 Trainer No. 1 (RSO #1)
0930 - 1115	T-10 Trainer No. 1 (RSO #2)
LUNCH	
1230 - 1320	Severe Weather Briefing
1325 - 1615	Radar Weather Avoidance

DAY 6

0730 - 1115 Normal Rendezvous Procedures
LUNCH
1230 - 1415 T-10 Trainer No. 2 (RSO #2)
1430 - 1615 T-10 Trainer No. 2 (RSO #1)

DAY 7

0730 - 1115 Alternate Rendezvous Procedures
LUNCH
1230 - 1615 Departure and Terminal Procedures Self Study

DAY 8

0730 - 1115 Departure and Terminal Procedures Lecture
LUNCH
1230 - 1415 Airborne Radar Directed Approach
1430 - 1615 ISD "Search Radar" Self Study

DAY 9

0730 - 1115 Dual PINS Procedures
LUNCH
1230 - 1415 T-10 Trainer No. 3 (RSO #1)
1430 - 1615 T-10 Trainer No. 3 (RSO #2)

DAY 10

0730 - 0915 T-10 Trainer No. 4 (RSO #1)
0930 - 1115 T-10 Trainer No. 4 (RSO #2)
LUNCH
1230 - 1615 Final Test

DAY 11

0730 - 1115 Flight Line Orientation
LUNCH
1230 - 1615 Pre Mission Preparation

FLYING SCHEDULE

Flights are normally of seven to eight hours duration with each radar/systems operator flying and completing maximum training on each flight. The following schedule is typical of times and events accomplished. Aircraft availability, weather and student progress could cause significant deviations to this schedule.

<u>DAY 12</u>

0730 - 1630	Mission Planning	RSO 1 and 2

<u>DAY 13</u>

0730 - 1630	Flight Mission No. 1	RSO 1 and 2

<u>DAY 14</u>

0730 - 1130	Critique	
1230 - 1430	T-10 Trainer No. 5	RSO 2
1430 - 1630	T-10 Trainer No. 5	RSO 1

<u>DAY 15</u>

0730 - 1630	Mission Plan/Critique	RSO 2

<u>DAY 16</u>

0730 - 1630	Mission Plan/Critique	RSO 1
	Flight Mission No. 2	RSO 2

<u>DAY 17</u>

0730 - 1630	Mission Plan/Critique	RSO 2
	Flight Mission No. 2	RSO 1

<u>DAY 18</u>

0730 - 1630	Mission Plan/Critique	RSO 1
	Flight Mission No. 3	RSO 2

<u>DAY 19</u>

0730 - 1630	Mission Plan/Critique	RSO 2
	Flight Mission No. 3	RSO 1

<u>DAY 20</u>

0730 - 1630	Mission Plan/Critique	RSO 1
	Flight Mission No. 4	RSO 2

DAY 21

0730 - 1230	Critique Flight Mission No. 4	RSO 2 RSO 1

DAY 22

OUT PROCESSING

DISTRIBUTION:

CINCSAC/CC (2)
CINCSAC/DP (2)
CINCSAC/DO (3)
CINCSAC/DOXC (2)
CINCSAC/DOXIT (3)
CINCSAC/DOTK (2)
CINCSAC/DOTNN (1)
CINCSAC/DOTT (1)
CINCSAC/XPMES (2)
CINCSAC/XPMRD (1)

15th Air Force - March AFB CA 92508
DO/DOTTA/DOTV (2 cys ea)

45 AD - Pease AFB NH 03810
DO (2)

509 BMW - Pease AFB, NH 03810
CC/DO/DOT (2 cys ea)

4201 TESTS - Barksdale AFB LA 71110

1 CEVG - Barksdale AFB. LA 71110
Commander (3 cys)

CASTLE AFB CA

93 BMW/CC (1)
93 BMW/DO (1)
93 BMW/DOT (1)
93 BMW/DOTK (2)
93 BMW/DOTN (1)
93 BMW/DOVT (1)
4017 CCTS/CC (1)
4017 CCTS/TA (1)
4017 CCTS/TAN (1)
4017 CCTS/TAZ (1)

SUGGESTED COURSE OUTLINES FOR FSO TRAINING

BOOM OPERATOR CROSS TRAINING TO FSO

	HOURS
Introduction	2
Mission Planning Techniques	12
Emergency Procedures	8
Weather	10
Dead Reckoning	16
AF/SAC Directives	6
SAC Tactical Doctrine	4
Radar Operation/IFM	18
ISD Radar Course	8
Rendezvous Procedures	8
Airborne Radar Approach Procedures	2
TERPS	6
Dual INS Operation	8
Radio Communications	2
6 T-10 Missions	18
Basic Equipment and Instruments	8
2 Orientation Flights	12
Exam and Critique	3
	151

Flying Phase
4 T-10 Missions
11 Flight Missions

AIRCREW MEMBER (OTHER THAN BOOM OPERATOR) CROSS TRAINING TO FSO

SAC Orientation	2
Course Introduction (Summary)	6
Airplane General	26
Mission Planning Techniques	10
Emergency Procedures	8
Basic Equipment and Instruments	8
Weather	10
Dead Reckoning	16
AF/SAC Directives/Regulations	6
SAC Tactical Doctrine	12
Ground Servicing	2
6 T-10 Missions	18
Radio Communications	4
Radar Operation/IFM	18
ISD Radar Course	8
Life Support Equipment	2
Rendezvous Procedures	10

Airborne Radar Approach Procedures	2
TERPS	6
Dual INS Operation	8
3 Orientation Flights	18
Exam and Critique	3
	203

Flying Phase
6 T-10 Missions
11 Flight Missions

NON AIRCREW MEMBER CROSS TRAINING TO FSO

SAC Orientation	2
Course Introduction (Summary)	6
Airplane General	26
Mission Planning Techniques	12
Emergency Procedures	8
Basic Equipment and Instruments	8
Weather	16
Dead Reckoning	18
AF/SAC Directives/Regulations	6
SAC Tactical Doctrine	12
Ground Servicing	2
6 T-10 Missions	18
Radio Communications	4
Radar Operation/IFM	18
ISD Radar Course	8
Life Support Equipment	8
Rendezvous Procedures	10
Airborne Radar Approach Procedures	2
TERPS	6
Dual INS Operation	8
Aviation Physiology	24
4 Orientation Flights	24
Exam and Critique	3
	249

Flying Phase
6 T-10 Missions
13 Flight Missions

STRATEGIC AIR COMMAND

GIANT BOOM
TEST PLAN

ENLISTED RADAR/SYSTEMS OPERATOR

15 MAY 1976

HEADQUARTERS
STRATEGIC AIR COMMAND

Offutt Air Force Base, Nebraska

OPR: DOTP

Atch 4

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS STRATEGIC AIR COMMAND
OFFUTT AIR FORCE BASE, NEBRASKA, 68113

REPLY TO ATTN OF: DO

1 JUN 197

SUBJECT: GIANT BOOM

TO: See Distribution

1. This test plan provides instructions for a CINCSAC directed operational test and evaluation (OT&E) effort to determine the feasibility of an enlisted aircrew radar/systems operator to perform the duties of safety observer on a dual inertial navigation system equipped KC-135. The test crew will consist of a pilot, copilot, radar/systems operator, and a boom operator. This test, which is assigned the exercise term GIANT BOOM, is scheduled for the 1 Jun to 31 Aug 1976 time frame.

2. This plan is effective upon receipt. Amendments to this plan will be published in message form to addressees requiring immediate knowledge of the changes. The GIANT BOOM OT&E effort will involve aircraft and crews of the 93 BMW (Castle AFB) and the 509 BMW (Pease AFB) and instructors of the 4017 CCTS (Castle AFB).

3. The HQ SAC test director is Lt Col Edmund T. Kane. Questions and comments concerning GIANT BOOM should be addressed to HQ SAC/DOTP, or telephoned to the test director, AUTOVON 271-4256 or STN 40.

4. This test plan is approved.

JOHN W. BURKHART, Major General, USAF
Deputy Chief of Staff, Operations

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

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Castle AFB, CA 95342	
93BMW/DO - 4, LG - 1 4017CCTS/DO - 4	9
Oklahoma City ALC/MMA, Tinker AFB, OK 73145	1
AFTEC/TES, Kirtland AFB, NM 87115	1

TABLE OF CONTENTS

1. BACKGROUND: During the period of 15 November 1975 to 15 March 1976, SAC conducted an Operational Test and Evaluation (OT&E) at Pease AFB to determine the expanded capabilities of the KC-135 aircraft with a new Inertial Navigation System (INS) installed. The test results indicated that during critical phases of flight and emergency situations the copilot must devote his attention to aircraft control and emergency procedures; consequently, navigation and station keeping requirements, through necessity, are ignored. The conclusion was that a three man KC-135 aircrew consisting of pilot, copilot and boom operator was not feasible because of safety implications particularly when emergencies are encountered and the compound pilot/copilot workloads are considered. In an effort to exhaust all possibilities for offsetting savings as we contemplate the cost of an improved avionics package for the KC-135 force, it is necessary to evaluate the feasibility of using an enlisted aircrew member as safety observer during critical phases of flight in lieu of a rated navigator officer. This test plan has been developed to accomplish the task of determining the feasibility of an experienced KC-135 boom operator to perform these functions.

2. EQUIPMENT: The 509 BMW aircraft that was modified for the GIANT CHANGE OT&E will be used for this test. It will be configured in the same manner, i.e., equipped with dual Palletized Inertial Navigation Systems (PINS) with control and display units mounted at the pilot and copilot stations. The aircraft will be equipped with an additional Horizontal Situation Indicator (HSI) to display the course to selected way points. An additional Remote Display Unit (RDU) will be installed at the navigator station for use by the enlisted radar/systems operator. No modifications will be necessary for 93 BMW aircraft.

3. PURPOSE: The purpose of this test is to determine the capability of the enlisted systems operator to perform those duties normally performed by the aircrew navigator with the exception of actual navigation of the aircraft which will be the pilot/copilot responsibility. The following test objectives will be evaluated:

a. Determine the enlisted systems operator's capability to accomplish the following tasks:

(1) Equipment turn on/operation.

(2) Monitor departure/cell joinup.

(3) Enroute cell procedures/station keeping.

(4) Radar scope interpretation.

(5) Radar/PINS fixing to include plotting.

(6) Route monitoring.

(7) Weather detection/avoidance (radar).

(8) Rendezvous.

(9) Monitor aircraft position during copilot overload situations, i.e., refueling, emergencies.

(10) Monitor penetration and approaches.

(11) Airborne Radar Directed Approach.

(12) Inflight maintenance procedures.

(13) Checklist items/responses.

4. TEST CONCEPT: During the conduct of this test, emphasis will be placed on observing the enlisted systems operator's capability to relieve/aid the pilot and copilot tasks not associated with the actual flying of the aircraft during critical phases of flight and simulated/actual emergency situations. The pilot/copilot of test aircrews will use the revised PINS checklists developed for the GIANT CHANGE test. The systems operators will use the KC-135 navigator checklist as revised by the 93 BMW/4017 CCTS. The two experienced enlisted aircrew members to participate in this test will be selected by HQ SAC/DOT.

5. TEST PARTICIPANTS:

a. Headquarters Strategic Air Command (SAC)

(1) HQ SAC/DOTP will:

(a) Provide overall test management.

(b) Assign personnel to support the test effort as necessary.

(c) Provide support as outlined in this test plan and as may otherwise be necessary.

(d) Brief the selected test unit personnel on test requirements.

(e) Write a final report on the results of this test.

(2) HQ SAC/DOOV will provide OT&E assistance to the test director as required.

(3) HQ SAC/LGMA will:

(a) Provide logistics support to modify/demodify one aircraft for this test effort.

(b) Act as the HQ SAC single point of contact for logistics matters pertaining to this test effort.

b. Air Force Systems Command (AFSC) is requested to provide personnel from the Aeronautical Systems Division, Crew and AGE Directorate, Crew Station, Escape and Factors Branch (ENECC) to:

(1) Perform analysis of the crew duties in this test effort.

(2) Provide personnel to fly on selected test missions.

(3) Provide comments relating to crew composition, workload and crew activity.

(4) Provide an addendum for inclusion in the final report.

c. 8 AF and 15 AF will:

(1) Assign GIANT BOOM project officers.

(2) Task the 509 BMW and 93 BMW to support this test.

(3) Coordinate with and assist 509 BMW and 93 BMW as required.

d. 93 BMW will:

(1) Designate a GIANT BOOM project officer.

(2) Develop a course to train the selected enlisted boom operators in the operation of the equipment at the navigation station with the exception of the ASN-7 computers.

(3) Revise current KC-135 navigator checklist to reflect system operators duties.

(4) Train the selected individuals using a free wheeling concept, i.e., if course syllabus required two hours instruction on

IFF/SIF operation and the selected individuals are already knowledgeable in its operations, delete that portion and proceed to next subject.

(5) Course will be tailored to train the selected individuals to accomplish the tasks outlined in para 3a of this plan.

(6) Provide T-10 trainer periods and four aircraft orientation flights for the selected individuals to operate the equipment.

e. 1 CEVG will:

(1) Designate a GIANT BOOM project officer.

(2) Provide assistance as necessary in development of aircrew checklists.

f. 509 BMW will:

(1) Designate a GIANT BOOM project officer.

(2) Provide the aircraft that was used on the GIANT CHANGE test mission. The identified aircraft should not be scheduled for alert during the test period (1 Jul - 31 Aug 76).

(3) Provide, if possible, the same aircrews (pilot and copilot) that participated in the GIANT CHANGE test missions to support this test.

(4) Provide the necessary staff support to plan and report on each test mission.

(5) Provide test missions to meet the task items listed in this test plan and others as may be directed by the test director.

(6) Arrange for HQ SAC and ASD/ENECC representatives to fly on the test missions and provide them with the necessary flight equipment (helmets, headsets, jackets, etc.).

(7) Make arrangements with security forces to provide unescorted entry for project personnel to the GIANT CHANGE aircraft. If this procedure is not practical, the unit project officer must arrange approved escort for project personnel.

(8) Provide quarters and transportation as required for HQ SAC and ASD/ENECC personnel.

(9) Provide a third pilot to fly on each mission as a safety observer.

(10) The aircrew navigator will be available to perform duties as designated by the test director.

(11) Provide an INU to develop each mission, prepare flight plans and mission paperwork, and give detailed pre-mission briefings to each enlisted radar/systems operators.

g. All designated project officers will furnish their name, rank and telephone numbers (duty/home) to HQ SAC/DOTP.

6. TEST PROCEDURES:

a. Test missions will be flown from the units main operating base unless otherwise directed.

b. Maximum use of units normal aircrew training missions will be used for this test.

c. HQ SAC and ASD/ENECC personnel will be TDY to the test unit periodically throughout the test effort.

d. The third pilot will:

(1) Receive training in the PINS system.

(2) Act as a safety observer during test missions. He will under no circumstance allow the accomplishment of test objectives to jeopardize the safety of the aircraft or crew.

(3) Perform mission recorder duties as follows:

(a) Maintain a record of aircraft position using any or all navigation aids available at each major mission turn point/action point, time between position fixes not to exceed 30 minutes.

(b) Record other information as may be directed/required by test personnel.

e. The selected enlisted radar/systems operators will:

(1) Receive training in the operation and control of the PINS system.

(2) Receive one orientation flight to observe PINS operation and perform "hands on" operation. This will be one flight with both selectees on board.

f. The exact number of test sorties to support this test effort has as yet not been determined. It is expected to consist of 3-4 flights per individual. The number of sorties required will vary with the number of tasks required and the success of each mission. Additional mission tasks may be required as the test progresses.

g. The squadron INU will be responsible for development of mission flight plans and other required navigation preparation. He will ensure that the enlisted radar/Systems operator is fully briefed on mission navigation and will conduct post mission navigation review as determined by the test director.

h. The aircrew copilots will be responsible for aircraft navigation as in the GIANT CHANGE test, but will utilize the radar/systems operator as aircraft position monitor during critical phases of flight, actual/simulated emergencies, during periods of pilot/copilot overload situations or as directed by test personnel.

7. MISSION SCENARIOS:

a. As a minimum, each mission will be comprised of the following except as noted.

(1) Minimum interval takeoff in number two position (one mission for each crew).

(2) Cell departure/join up (one mission for each crew).

(3) Station keeping procedures (one mission for each crew).

(4) Cell position change, two to one (one mission for each crew).

(5) EWO type departure.

(6) Point parallel rendezvous (tanker directed).

(7) Airborne Radar Directed Approach (three missions for each operator).

(8) In-flight mission changes (at direction of test personnel).

8. MEASURE OF MERIT, RADAR/SYSTEMS OPERATOR: The following measures of merit are included as a guide for test observers and are not meant to be all inclusive. The results observed will, by necessity be mostly subjective on the part of test observers. Any additional information deemed appropriate will be added at the discretion of test personnel. The ultimate measure of merit for this test is whether the radar/systems operator is able to relieve the pilot/copilot of extra duties during critical phases of flight.

a. Equipment turn on/operation

(1) Knowledgeable of equipment turn on procedures.

(2) Accomplishes turn on in proper sequence.

(3) Operates systems in a competent manner.

(4) Monitors systems at periodic intervals for proper operation.

b. Monitor departure/cell join up

(1) Understands departure routing and altitudes.

(2) Makes proper altitude calls.

(3) Monitors position and level off points/altitudes.

(4) Advises pilots of relative position of other aircraft in cell.

(5) Accomplishes safe join up.

c. Enroute cell procedures/station keeping

(1) Maintains proper position in cell (± 1/2 NM).

(2) Advises pilots of relative position to lead A/C in a timely manner that allows smooth position connections to be made.

d. Radar scope interpretation

(1) Adjust gain and tilt for optimum presentation.

(2) Can identify major returns on scope (cities, mtns, rivers, etc.).

(3) Can distinguish weather from cultural/terrain returns.

(4) Can identify minor returns on scope (small towns, power plants).

e. Radar/PINS fixing to include plotting

(1) Understands range and bearing method of fixing.

(2) Uses best available known returns for fix.

(3) Accurately plots fix on chart (± 2 NM).

(4) Records minimum information; time, true heading, ground speed and drift from any source available.

(5) Able to use PINS to fix.

f. Route monitoring

(1) Understands routing and timing.

(2) Flight follows by taking fixes at major turn points/ action points and at 30-40 minute intervals enroute.

(3) Advises pilots of weather along route observed on radar.

g. Weather detection/avoidance (radar)

(1) Able to distinguish weather from cultural/terrain returns on scope.

(2) Able to advise pilots of best routing around/through weather.

h. Rendezvous

(1) Able to accomplish point parallel rendezvous.

(2) Can make necessary radio calls to accomplish rendezvous.

i. Monitor aircraft position during pilot/copilot overload situations.

(1) Satisfactorily accomplishes duties relegated by pilot/ copilot.

(2) Actually relieves pilot/copilot of duties during these times.

j. Monitor penetration and approaches

(1) Understands let down and approach plates.

(2) Monitors altitudes and headings during penetration and approaches.

(3) Monitors altitudes and makes proper calls.

(4) Advises pilots of deviations noted or suspected.

(5) Monitors weather and terrain on radar.

k. Airborne radar directed approach

(1) Able to accomplish radar directed approach without the aid of external navigational aids.

(2) Directs aircraft to minimum descent altitude (MDA)/ missed approach point in such a manner that a safe landing could have been accomplished.

l. In-flight maintenance (IFM) procedures

(1) Understands what IFM can be performed.

(2) Able to perform IFM as required.

m. Checklist items/responses

(1) Accomplishes checklist items and responses with no major deviations.

9. <u>COMMAND CONTROL AND EXECUTION</u>: Normal command control.

10. <u>SAFETY</u>: Safe flight operations will not be jeopardized in order to <u>fulfill</u> mission requirements. Normal peacetime restrictions and criteria apply for all phases of this test except when specific waivers are granted by competent authority.

11. <u>REPORTS</u>: The final test report will be written by HQ SAC/DOTP. Other reports and submissions to the final report will be as directed by the test director.

12. <u>SECURITY</u>: The routine conduct of and raw data from this test will be handled as unclassified. Normal communications security (COMSEC) and operations security (OPSEC) will be adhered to during all phases of this test.

13. <u>POINTS OF CONTACT</u>:

HQ SAC/DOTP: Lt Col E. T. Kane
AUTOVON 271-4256, STN 40
Home Phone: 402-291-8381

HQ SAC/LGMA: Capt W. McDonald
AUTOVON 271-3514
Home Phone: 402-292-6641

ASD/ENECC: Mr. Dick Geiselhart
AUTOVON 785-4109

FOR PROJECT OFFICER USE:

8AF/

AUTOVON
Home Phone:

15AF/

AUTOVON
Home Phone:

93BMW/

AUTOVON
Home Phone:

509BMW/

AUTOVON
Home Phone:

1CEVG/

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Home Phone: