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A STUDY OF CREW TASK LOADING ON THE C-141A AIRCRAFT.(U)
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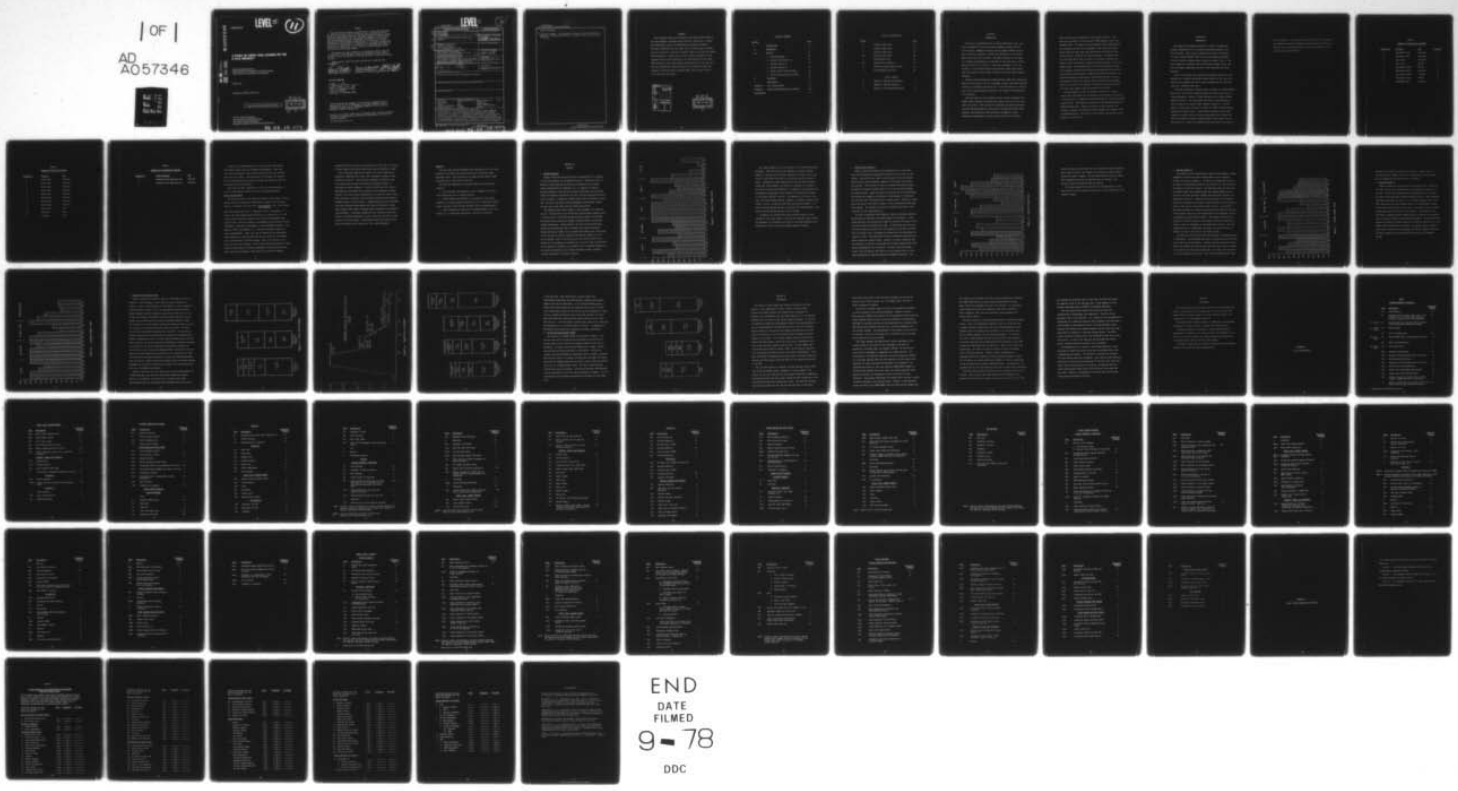

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A STUDY OF CREW TASK LOADING ON THE C-141A AIRCRAFT

HUMAN FACTORS BRANCH
CREW EQUIPMENT AND HUMAN FACTORS DIVISION
DIRECTORATE OF EQUIPMENT ENGINEERING

APRIL 1978

TECHNICAL REPORT ASD-TR-78-3

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At the request of the Military Airlift Command, human factors engineers participated in a C-141 crew composition and task load analysis. The objective of the study was to determine the feasibility of a four-man crew consisting of two pilots, a flight engineer and a Flight System Operator, to fly C-141 missions. The test results indicated that the airland mission can be accomplished with a four-man crew. Presently for a combat airlift mission (airdrop) the most optimal crew composition would be two pilots, navigator

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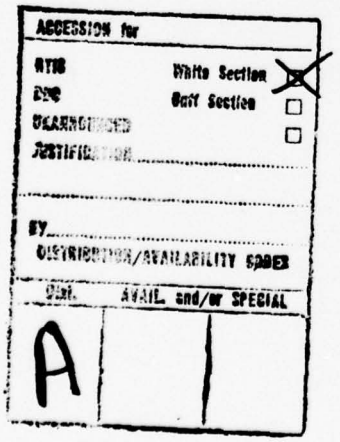
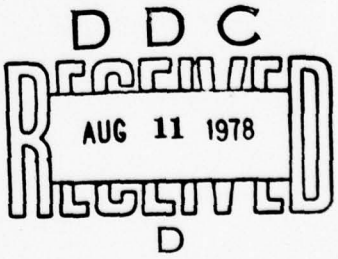
and flight engineer. With additional training, it might be feasible to substitute a Flight Systems Operator for navigator in the combat airlift mission.

FOREWORD

This technical report was prepared by the Human Factors Branch of the Crew Equipment and Human Factors Division, Directorate of Equipment Engineering, Deputy for Engineering, Aeronautical Systems Division, Wright-Patterson AFB, Ohio under Job Order Number USAD0109. Data was collected on overland, overwater flights on airland and combat airlift missions. Flight tests on C-141 inertial navigation system equipped aircraft were conducted at the 437th Military Airlift Wing (MAW) Charleston AFB, South Carolina between March 1977 and June 1977. Data was analyzed and initial version of this technical report was forwarded to Military Airlift Command (MAC) for inclusion in their C-141 crew work load report.





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SECTION I

INTRODUCTION

As part of a continuing effort to reduce operational costs, and with procurement of the dual inertial navigation system (INS) for C-141 aircraft, Commander, Military Airlift Command (COMAC) directed that a review be conducted to define the composition of the flight deck crew for the C-141 aircraft. The major objective of the study is to assess the feasibility of reducing the crew size from a current 5-man crew (P, CP, N, 2 FE) to a 4-man crew complement (P, CP, FE, and FSO). A new position Flight System Operator (FSO) would assume some of the duties of the present navigator and second flight engineer (scanner).

Personnel from Aeronautical Systems Division (ASD) were requested by COMAC to participate in the crew complement study by providing technical assistance in defining crew duties for a C-141 FSO position to participate in the flight testing of different crew sizings on representative C-141 missions.

The first phase of this Strategic Airlift Aircrew Complement Test (SAACT) study consisted of mission and function analysis of C-141 aircraft crew duties. This analysis by a MAC/ASD team involved detailed review of MAC documentation, instructional systems development (ISD) analysis, and discussions with qualified crew members on their operational requirements and duties during varied C-141 missions.

These analyses were accomplished in two separate sessions. The first was a meeting of a MAC appointed AD-HOC Committee from 22-30 September 1976. The names of the participants and the organizations they represent are found in the Appendix. MAC study group represented Charleston AFB, Altus AFB, McGuire AFB, and Travis AFB and included pilots, navigator and flight engineers. The objectives of this first MAC effort were to define C-141 mission scenarios and present 5-man crew duties and times associated with each of the crew members' tasks. The representative C-141 missions defined included the following: Strategic Airlift Mission (Airland/Non-INS Aircraft), Prime Nuclear Airlift Mission, Combat Airlift Mission (Airdrop), and Improved Navigation System Mission (Airland/INS Equipped Aircraft). The purpose of this first analysis (held at HQ MAC 22-30 September 1976) was to arrive at as complete a listing as possible of present and future crew tasks in INS and Non-INS C-141 aircraft.

The second phase in this task analysis effort was to analyze present work load levels for all missions and consolidate the present or future duties of navigator and flight engineer No 2 into one position called the FSO. This phase was conducted by ASD and MAC personnel at Wright-Patterson AFB. Finally the results of this analysis were reviewed, evaluated and modified by MAC personnel from Training, Test and Standardization. The results of this effort are contained in the Appendix of this report.

SECTION II

METHODOLOGY

The flight test program consisted of a series of flights considered representative of the overall operational mission of the C-141 aircraft. Three types of missions were flown: (1) Airland, (2) Combat Airlift Mission (CAM) and (3) Aerial Refueling (AREF). A list of specific missions flown is shown in Tables 1 thru 3. The test flights were conducted from 15 March 1977 through 30 June 1977 and all flights originated from the 437 MAW Charleston AFB, South Carolina.

Prior to the flight test program, ASD personnel conducted a task analysis of a standard operational mission flown by C-141 crew on an aircraft not equipped with INS to gather baseline data on crew work load with a standard 5-man crew.

Following collection of baseline data, a series of airland missions were flown. The initial airland missions were flown using either a trained navigator, copilot or flight engineer in the flight systems operator position. The FSO assumed the duties of the navigator as well as those of the second flight engineer (option 1). A second phase of testing then took place in which the flight systems operator assumed more limited duties. These duties consisted of the flight engineer's position and more limited navigation duties in which the pilots had primary navigation responsibilities with backup from the FSO (option 2). Copilot and engineer FSO's were used in this phase of

the test program. A third option in which the FSO was responsible for reading the radar and assuming scanner duties was flown on one mission. On this particular mission the pilot assumed all navigational duties (see Table 1).

TABLE 1

SUMMARY OF AIRLAND TEST MISSIONS

Mission No	Location	FSO	Procedure
1	Rhein-Main (4F5)	Pilot/Nav	1
2	Rhein-Main (4F5)	Pilot/Nav	1
3	Rota (465)	Pilot/Nav	2
4	Rota (465)	Nav/FE	2
5	Rhein-Main (4F5A)	Nav/FE	1
6	Rhein-Main (4F5A)	Pilot/FE	2
7	Rhein-Main (4F5A)	FE/Pilot	2
8	Rhein-Main (4F5A)	FE/FE	3
9	Rhein-Main (4F5)	Pilot/FE	2

TABLE 2

SUMMARY OF CAM TEST MISSIONS

Mission No	Location	FSO
1	North Field	Pilot/FE
2	North Field	Pilot/FE
3	North Field	Pilot/FE
4	North Field	Pilot/FE
5	North Field	Pilot/FE
6	North Field	Pilot/FE
7	North Field	Pilot/FE
8	North Field	Pilot/FE
9	North Field	None
10	Alternate	None
11	Alternate	None

TABLE 3

SUMMARY OF AIR REFUELING MISSIONS

Mission No	Type of Mission	FSO
1	Rendezvous and simulated area	Pilot/FE
2	Rendezvous and simulated area	Pilot/FE

Following the airland missions, a series of eight CAM missions were flown in which four FSO candidates participated. There were also three CAM missions flown in which the pilots had sole responsibility for the airdrop. The final phase of the Flight Test Program was two refueling missions flown by the same FSO candidates that had participated in the CAM flights.

Task load data were collected on 7 of the 10 airland missions, 5 of the 11 CAM missions and both of the air refueling missions.

Task load measurement

The procedure used in this study was similar to that used in earlier studies where task loading was calculated according to the following formula: Percentage crew work load = $\frac{\text{time required}}{\text{time available}} \times 100$. This formula gives the average time unit to accomplish a task. For example, a 77 percent crew work loading 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 "overt task loading" (i.e., directly observable behavior or task accomplishment). While this type of measure has the advantage of being objective, it does not take into account stress or task loading due to the pressures of decision making. Many of the duties of the pilot fall into this category. None of these decision processes or their effects on performance is directly measurable in the way other psychometer tasks can be measured. Hence many of the task load figures

estimated for the pilots must be interpreted in this light in contrast to those taken on the FSO who have fewer critical decisions to make.

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 FSO 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 activities were performing checklists and computing estimated times of arrival (ETAs). 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 in which the copilot was reading instruments as cross checks for the pilot or when flying the aircraft himself. Miscellaneous tasks were those in which actual work loads did not readily fit into other categories.

Subjects

The test crews and FSO candidates were selected so as to be representative of the MAC C-141 Aircrew Force and of relatively equal experience level. Each crew was to be combat airlift mission (CAM) qualified prior to the start of the test.

The nine FSO candidates were selected based on the following criteria:

a. Each candidate was required to have a minimum of 100 hours C-141 flying time, not to exceed 200 hours.

b. Each candidate was required to be qualified in his pilot, navigator, or flight engineer crew position (i.e., must have attended formal training at Altus AFB and completed local training/upgrade).

e. Each candidate was required to be representative of his crew resource (i.e., median age, experience, and years of service).

SECTION III

RESULTS

1. Airland Baseline

Figure 1 shows the crew work load by crew position for a standard C-141 airland mission not equipped with an INS. These data reflect a mission in which there was no weather encountered nor any unusual events connected with the mission, i.e., no changes or alternate planning required. The pilot and copilot's peak work load was during takeoff and landing (100 percent for pilot in both cases and 80 percent for the copilot). During the overland cruise (C1) and overwater cruise (C2), the pilot and copilot were approximately 55-60 percent loaded and were able to get some crew rest during this period.

The navigator work load in Figure 1 shows somewhat of a different picture. His work load is at 100 percent from preflight through cruise 2 and drops off to 70 percent during the descent phase of the flight. His duties center around map reading, plotting courses, and getting weather information. During takeoff, his duties include monitoring departure and monitoring radar for weather and terrain clearances. During both cruise phases, he is occupied with taking fixes, monitoring radar, filling out various required forms and map reading but he is not overloaded. Most of the task load on the cruise portion of the mission for the navigator is probably due to the fact that the precision of the navigation equipment on a standard C-141 is somewhat marginal for the accuracy required on the overseas navigation tracks, requiring constant monitoring of aircraft position.

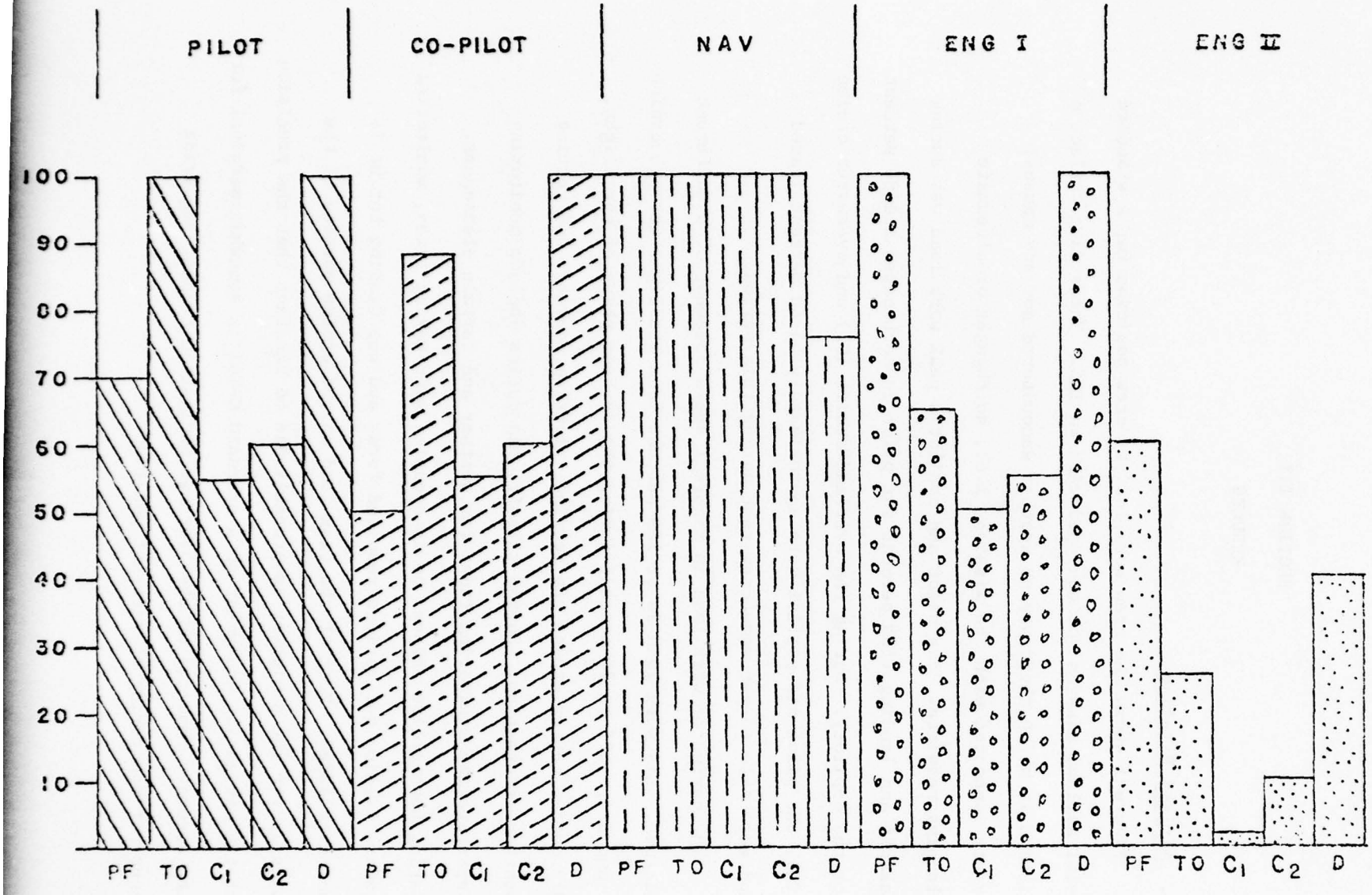

Figure 1 - Airland (5-Man Crew)

The flight engineer's work load (Figure 1) is 100 percent during preflight. This work load is then reduced to 70 percent during takeoff, 50 percent and 60 percent respectively during cruise 1 and cruise 2, and finally increases to 100 percent during the descent phase. Although the flight engineers work load is greatly reduced during the cruise segment, his station is required to be manned at all times to monitor the generators. A redesign of this system could eliminate the requirement for an operator to be physically present at the flight engineer's station. In comparison to the rest of the crew, the second flight engineer (scanner) is somewhat minimally work loaded. He has a 70 percent peak work load during preflight, a 50 percent load during descent and a 30 percent load during takeoff. His cruise work load varies between 2 and 15 percent.

In summary, the baseline data show acceptable levels of task loading for pilot and copilot, a heavier but acceptable task load for the navigator, an acceptable work load for the flight engineer and a minimal work load for the second flight engineer (scanner).

2. Airland (Test Option 1)

Figure 2 shows the average work load measured on a 4-man crew where the FSO assumed the navigator's duties as well as those of the scanner. The pilot's work load on this portion of the test program was 85 percent during preflight compared to 70 percent on the baseline mission. This increase no doubt is caused by the FSO not being available for mission planning since he is at the aircraft assuming the scanner duties. Again the pilot's peak work load is during takeoff and descent and landing at 100 percent in both phases of the mission. The copilot's work load figures show a similar trend. During the cruise phase the pilot's task load is similar to that encountered during baseline flights. The copilot's work load is slightly lower than in the baseline, but not significantly so.

The FSO's average work load (Figure 2) shows an overload condition during both the preflight and takeoff phases of the mission. In the former situation the overload was slight (10 percent) and could be overcome with greater proficiency over time. In the latter case the overload was 20 percent and was due to the inability of the FSO to perform both the scanner duty of checking aft pressure door and monitoring the takeoff on radar. This deficiency could be overcome by having the load master assume the scanner duties. Another deficiency encountered was the inability of the FSO to participate in mission planning while still having responsibility for navigation. The FSO's task load during cruise 1 was 100 percent (the same as in the baseline) which is very high considering the improved navigation equipment available. The

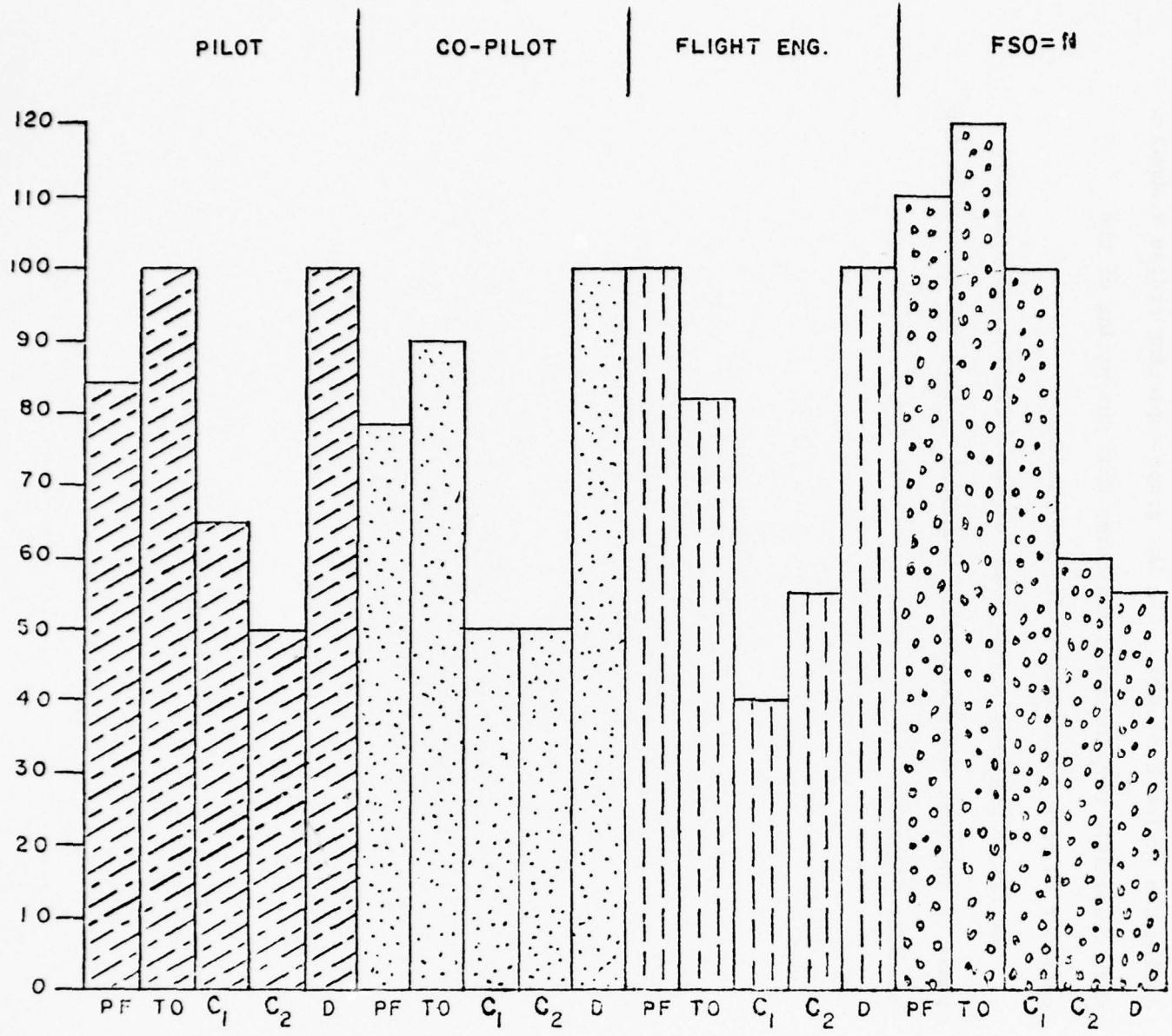

Figure 2 - Airland (4-Man Crew)

relatively high load was mostly due to the earlier overload situation which caused the FSO to get behind in his duties and "play catchup" during the cruise 1 segment. The bar graph depicting cruise 2 shows a more reasonable work load and indicates that the pacing of the operator is more synchronized with the mission.

The flight engineer's work load for the airland mission in this phase of the test was practically identical to that encountered in the baseline flights.

3. Airland (Option 2)

The results of the airland missions where the FSO assumes a backup navigation role with the copilot being prime for the navigation function are shown in Figure 3. The pilot's preflight work load was the same in the preflight portion of the mission as it was in option 1. The same is true for the copilot. The peak work loads for both pilot and copilot again occur during takeoff and landing except that the copilot's work load increases slightly from 90 percent (option 1) to 100 percent (option 2). During the cruise portions of the mission, there is an increase in the pilot's work load from 65 to 80 percent for cruise 1 and from 50 to 60 percent during cruise 2. The copilot's work load increases more sharply during both cruise portions (from 50 to 80 percent) since he now has responsibility for navigation as well as assuming his normal copilot duties. The authors feel that this increase in copilot's duties in turn impacts the pilot especially in cruise 1 where the navigation is relatively more critical. Once the navigation track is established, the impact is less and there is a smaller increase in the pilot's load during cruise 2.

The FSO's work load decrease with this decrease in responsibilities is significant. His preflight work load is reduced below the overload level (from 110 to 100 percent). However, the major reduction occurs during the takeoff and cruise portion where the chart shows a decrease of 25 percent and 30 percent respectively. Of course, this reduction in turn is absorbed by the pilot. The work load during cruise 2 and

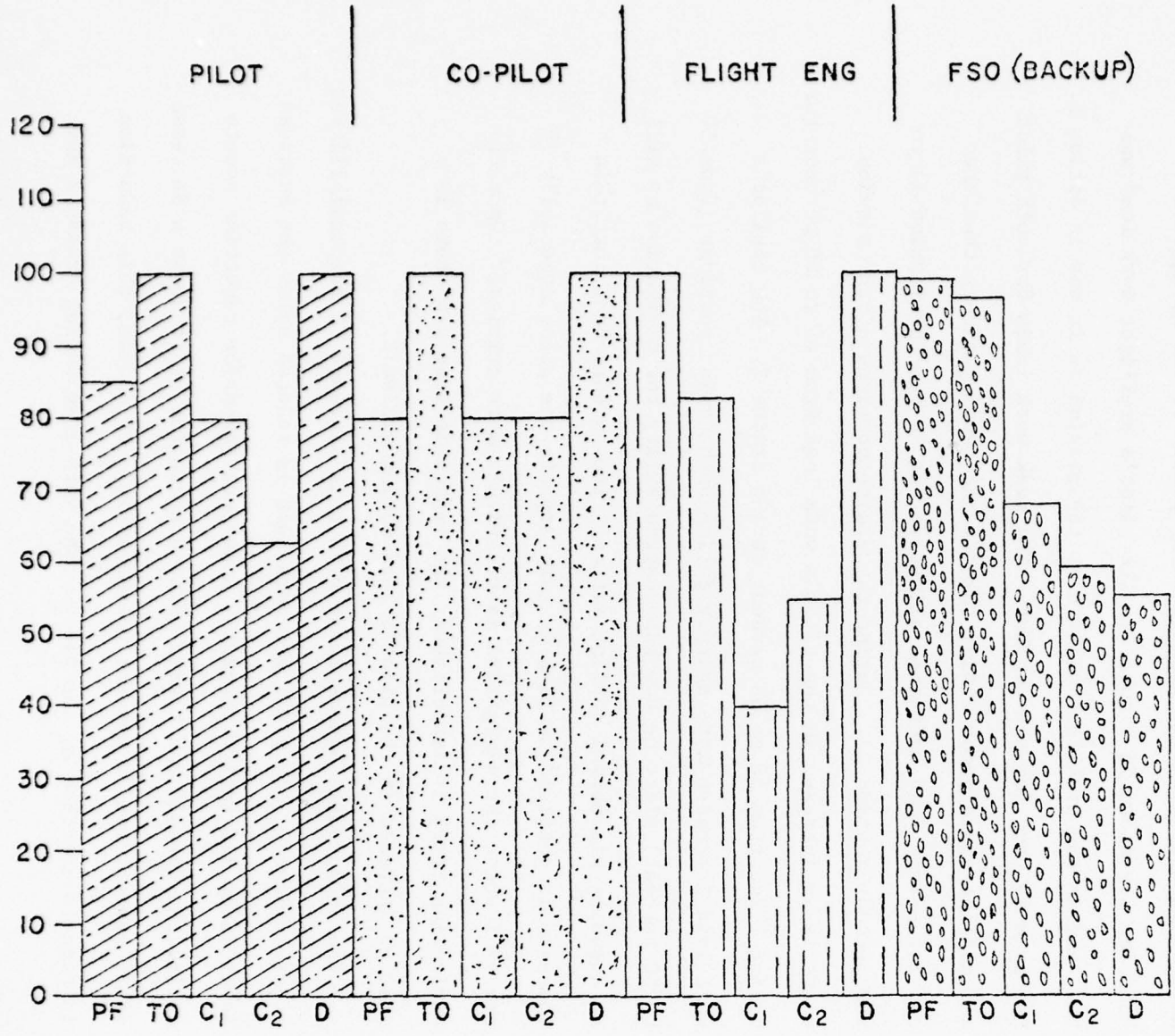

Figure 3 - Airland (4-Man Crew)

descent are the same for the FSO as in option 1. Again, the FE's work load shows no change; this is to be expected since his function has not changed from the previous type of mission.

4. Airland (Option 3)

Figure 3A shows the task load data for airland option 3, where the pilot and copilot have responsibility for navigation and operation of the INS. The FSO has scanner duties and responsibilities for tuning the radar and interpreting terrain and weather returns. When comparing these data with those in option 2, it is readily apparent that as the FSO's duties and task load decrease there is a corresponding increase in the duties and task load of the pilots. The pilot's task load shows slight increases in both cruise 1 and cruise 2. The copilot's task load shows a somewhat greater increase across all phases of the mission with an overload condition occurring during takeoff. On this particular mission the copilot was heads down in the cockpit and omitted out of the window checks normally done on takeoff. In general, Figure 3 shows a busy copilot across the entire mission with the FSO lightly loaded and the pilot showing a more substantial work load than is considered prudent.

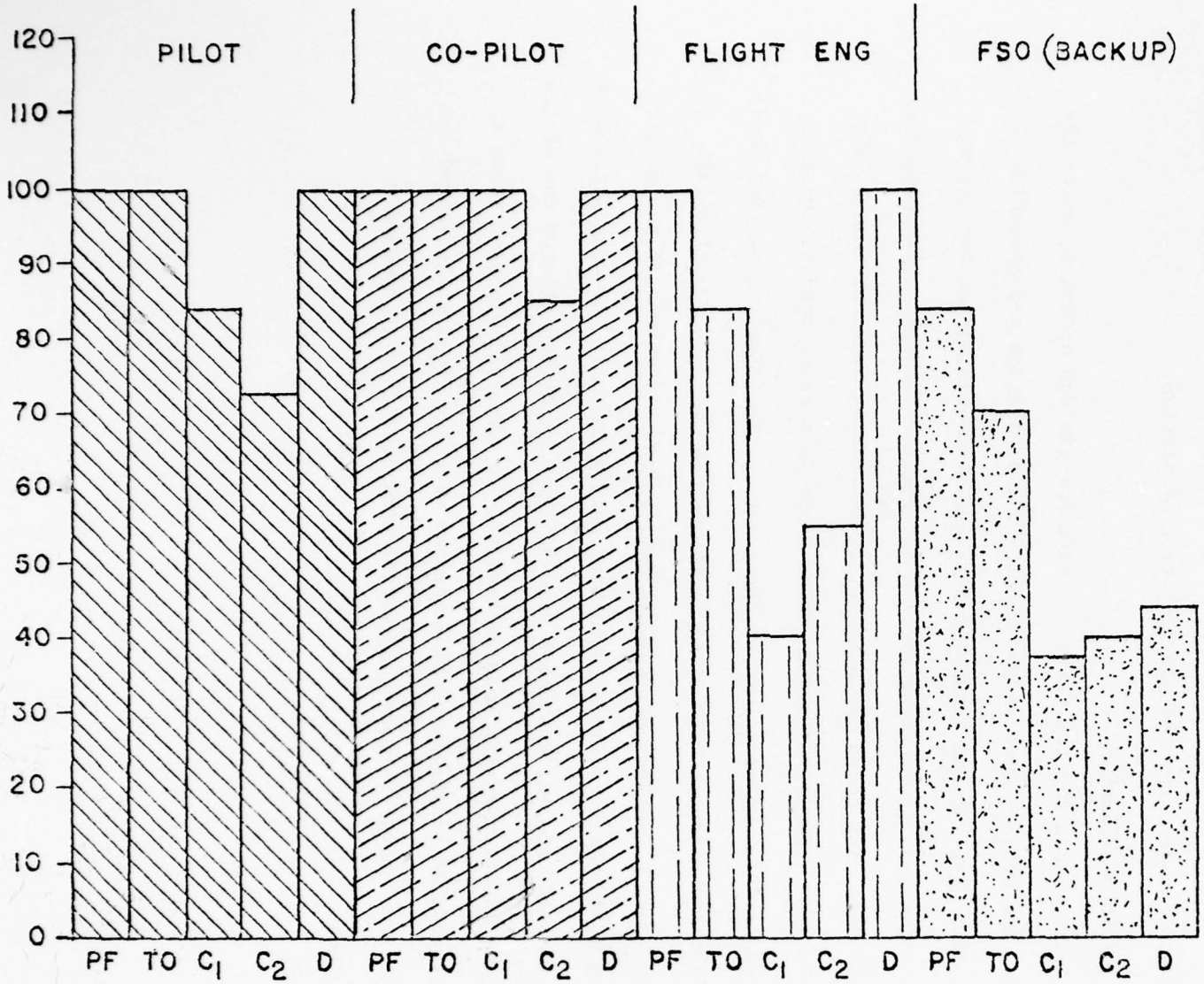

Figure 3_A - Airland (4-Man Crew)

5. Combat Airlift Mission (CAM)

Figure 4 depicts the crew work load for a CAM flight as well as a breakout of the percentage of time spent on various categories of duties. As can be seen in Figure 4A, the duration of such a mission is relatively short; however it is a very demanding mission requiring careful timing, precision navigation, and constant work load. As can be seen from Figure 4, both pilots are fully loaded during the entire mission and the FSO's work load shows an overload condition. While the overload is of short duration (48 min), the margin for error is small and in most of the missions flown, the result was either a "no drop" or a delivery outside the prescribed drop zone (DZ). In one case, the overload resulted in the FSO omitting the reading of the weather radar during a thunderstorm build up and the safety observer had to call the crew's attention to the fact they were encountering a hazardous situation. The overload on the FSO is attributed to insufficient training and experience for such a precise and demanding task. Although the last two drops in the test program were satisfactory, the conditions were ideal and the FSO had acquired proficiency as a result of repeated experience over the same DZ. Several drops were attempted where the station keeping equipment was coupled to the INS for an autodrop but these did not take place due to equipment malfunctions.

Figure 5 shows the pilot and copilot work load and task breakout on a CAM flight where only the pilot and copilot handled the airdrop portion of the mission. This resulted in a mission where minor inefficiencies early in the mission were compounded into major errors

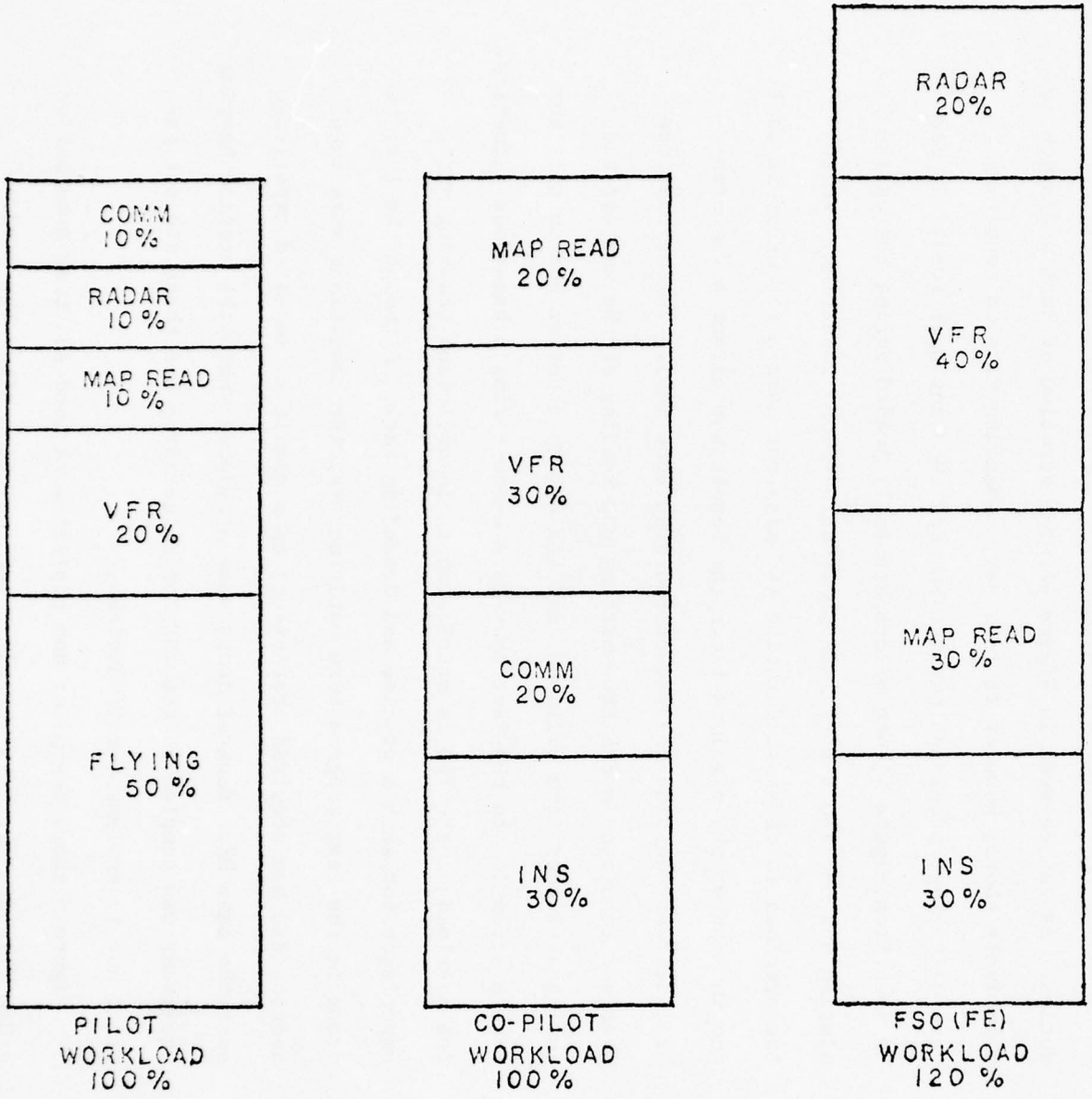

Figure 4 - Crew Cam Workload

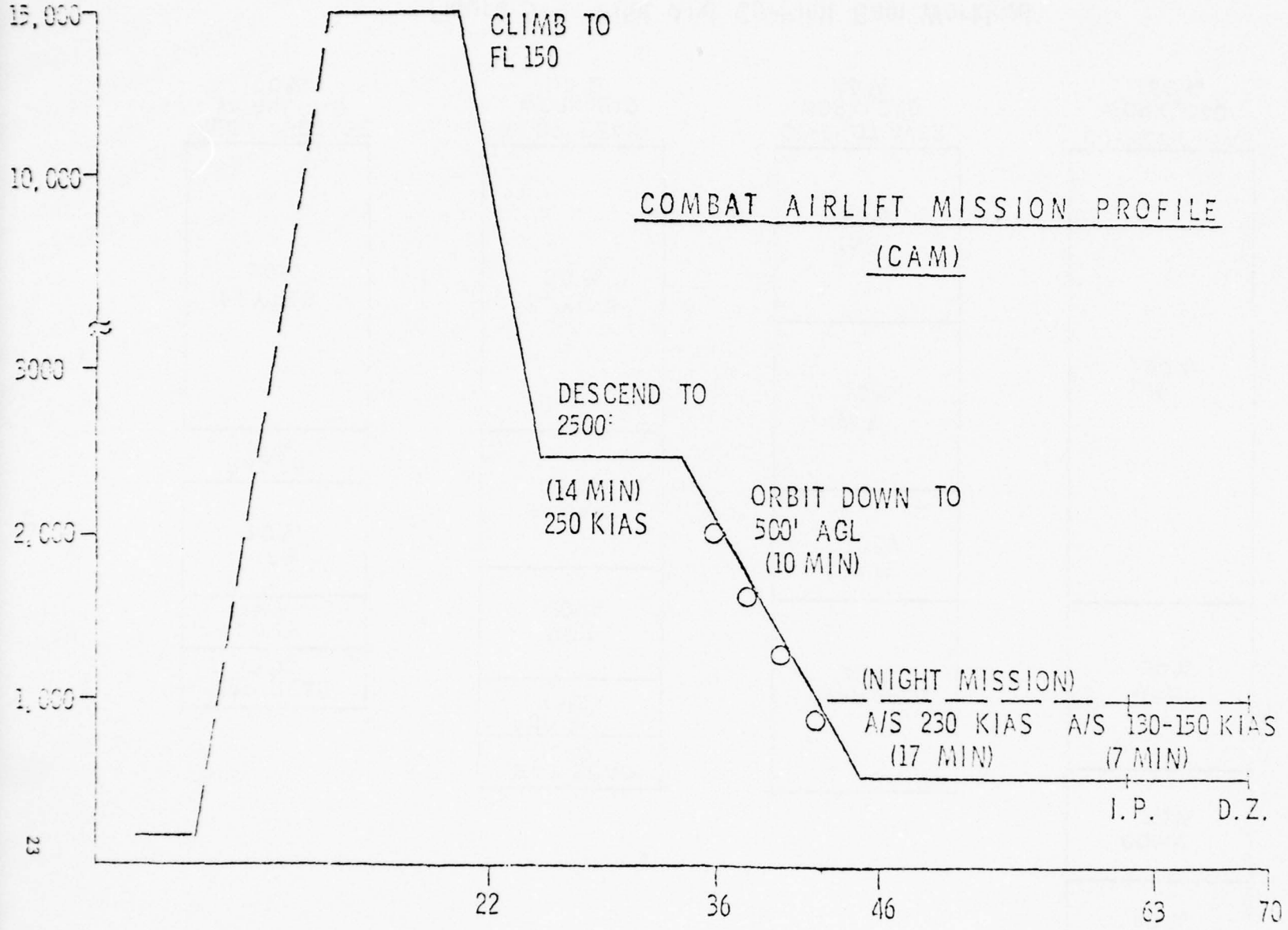

Figure 4_A - Elapsed Time In Minutes

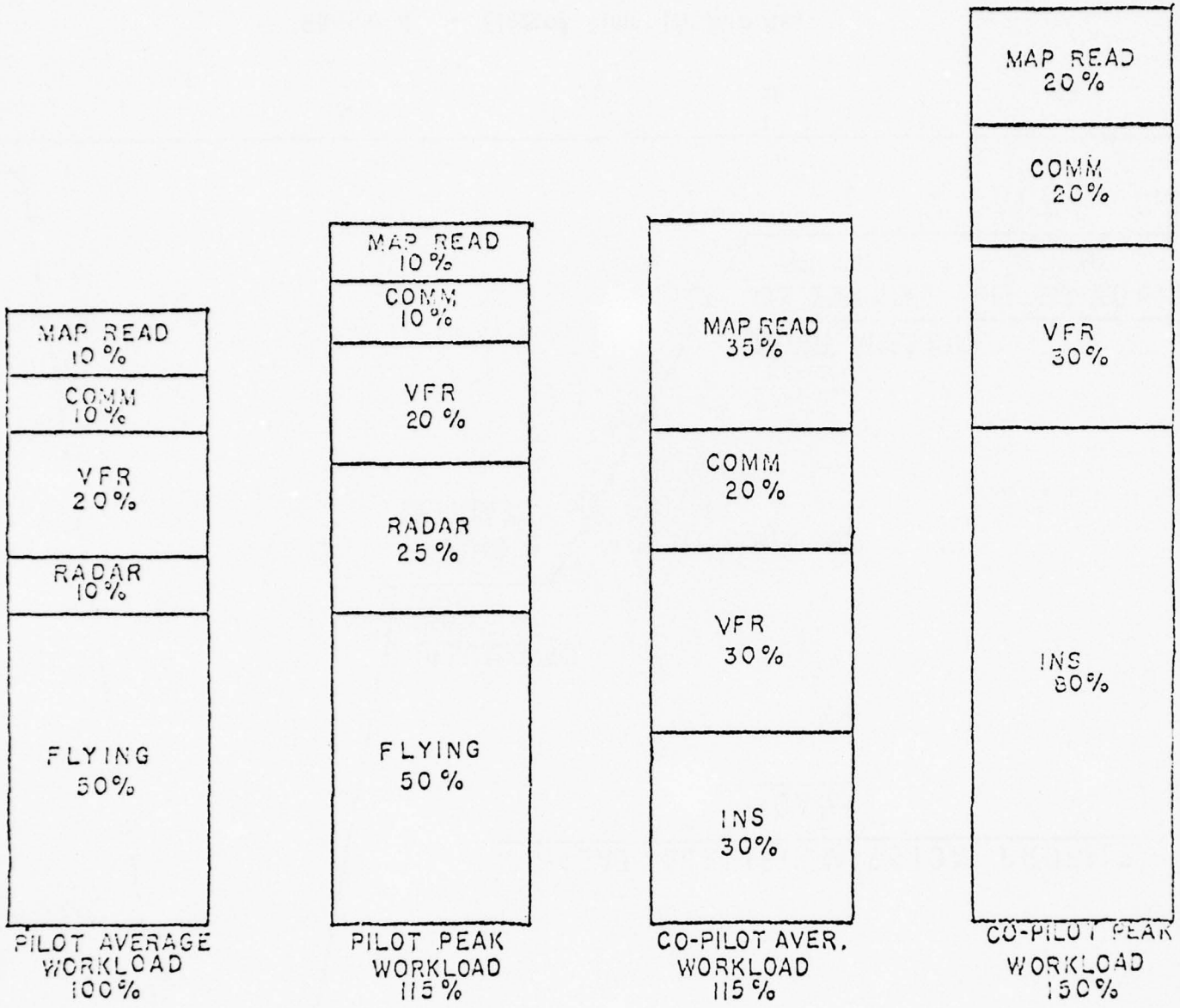

Figure 5 - Pilot And Co-Pilot Cam Workload

at the drop zone. More specifically, the way points were inefficiently loaded into the INS required a slightly more complex change as the DZ was approached. As the overload became greater, a simple task became complex and the direction and velocity of winds were reversed when entered in the INS for the drop computation. This, in turn, steered the aircraft away from the DZ causing a "no drop." High task loads also resulted in the pilots missing the IP as they flew over it. It is the authors' opinion that, under such a task load, the probability of a successful CAM is very small. In summary, the CAM required both pilots and a navigator or highly skilled FSO.

6. Aerial Refueling Mission (AREF)

The results of the AREF mission are depicted in Figure 6. The pilot's work load is 70 percent and the copilot's work load is 60 percent, which is well within an acceptable range for this type of operation. Of course, had an actual hookup with a tanker occurred, than the work load would have been at 100 percent. The FSO was loaded at 95 percent during the rendezvous, which is highly acceptable. The peak work load of 115 percent occurred when the tanker was having difficulty in communicating with air traffic control (ATC) and the FSO had to act as a communications relay. This was of short duration (10 min) and caused no problems. Both the FE and pilot FSO performed well on this portion of the test and encountered no problems. This is attributed to good training and experience occurring over the flight test.

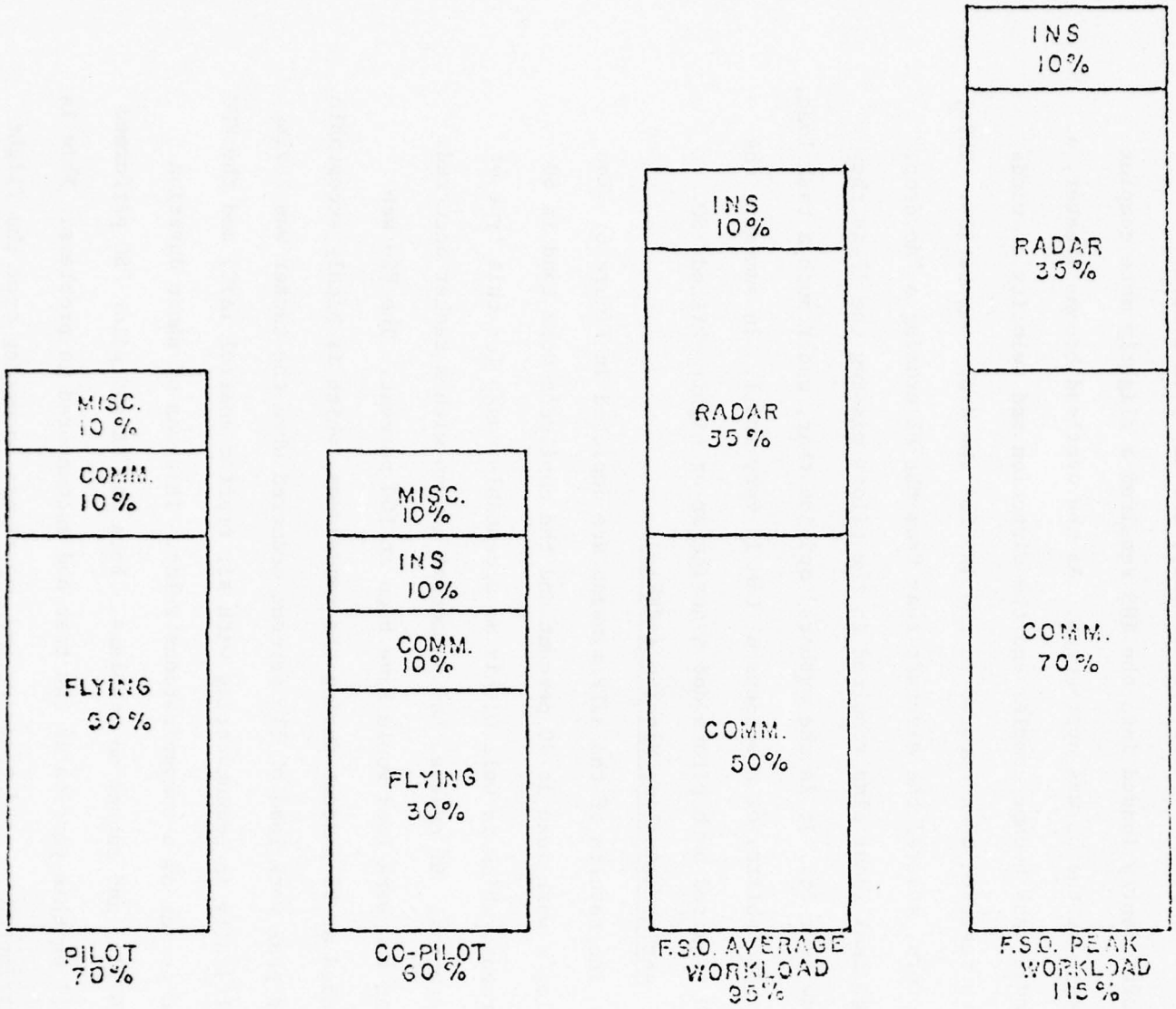

Figure 6 - Crew Refueling Workload

SECTION IV

DISCUSSION

The results of this flight test indicate that, for the airland mission, a crew composition of pilot, copilot, flight systems operator and flight engineer can satisfactorily accomplish the mission with an acceptable task load being imposed on all crew members, provided that the duties of the FSO are properly defined. If the FSO is required to assume all the navigation duties and responsibilities as they are accomplished on the baseline mission as well as the scanner duties (option 1), then we have the logical impossibility of the FSO being in two places at once both during mission planning and takeoff phases of the mission. If we select option 3 where the FSO has only scanner and radar duties, then we not only place an undesirable task load on the pilots but under utilize the FSO. It would appear that the optimum choice would be option 2 where the FSO plays an important role in navigation but does not have the overall responsibility. Thus, when the mission contingencies are few, the pilots can easily handle the function and when heavily loaded, can hand off the navigation function to the FSO.

Once the FSO's duties are defined, then the question becomes which type of FSO is optimal: pilot, navigator or flight engineer? The results of this test indicate that the navigator FSOs best accomplished the mission because they were better trained and more experienced in the relatively more difficult navigational duties. The data also indicate that the more skilled the FSO, the less the work load on the pilot.

On the other hand, many of the skills the navigator now has are not required with an INS on board, e.g., fix taking, also, the cost of using a navigator is greater.

In the case of using a pilot as an FSO, the tradeoffs are similar to those discussed in the previous paragraph. However, the pilot FSOs were only slightly more skilled in the navigational duties than the flight engineer FSOs but they do offer the advantage of having better knowledge of piloting tasks and the FSO experience will ultimately make them better pilots because they will have a better knowledge of all the aircraft systems. The disadvantage of this option is that the cost of training a pilot is even greater than a navigator and his piloting skills would not be fully utilized.

The flight engineer FSO demonstrated a better knowledge of the scanner duties in this study but his knowledge of the INS and navigation, including radar, was somewhat limited. He also did not have as good a knowledge of airmanship as he might have had. The evaluations of the observers indicated that more training is required for the flight engineer FSOs than was available for this flight test, especially in radar and normal and emergency crew procedures. In comparing the results of this test with the "GIANT BOOM" program in SAC where boom operator FSO's were used, the authors observed a much greater proficiency in navigational skills on the part of boom operators. This greater proficiency, the authors feel, was due, in part, to better training in the required skills. However, a more important factor was that in the "GIANT BOOM" tests the FSOs had more flights and

were higher on the learning curve when their performance was assessed. The "GIANT BOOM" FSOs were also much more experienced, both were senior NCO's with thousands of hours in the aircraft. In conclusion, flight engineer FSOs with more experience and better training in basic navigation, radar and crew procedures could accomplish the airland mission safely.

The data collected on the CAM missions present a somewhat different picture. Here, the requirement definitely calls for an operator who is highly skilled in operating an INS, has a good knowledge of basic navigation and can properly pace the mission. At the present time, only a trained navigator can meet these requirements. The authors feel that a flight engineer FSO who has had several years experience in airland operations and has demonstrated his proficiency can be CAM trained and transitioned into the CAM force. Based on the flight test observations, the option of using two pilots for CAM is infeasible from a task load viewpoint. Finally, using a combination of a reasonably proficient operator and Station Keeping Equipment coupled with the INS in an autodrop mode would probably be the best combination of man and machine for accurately making airdrops. Unfortunately, the equipment did not work well enough in this test to assess that possibility.

The FSO concept worked best during the air refueling portion of the program. Both the pilot and flight engineer FSO accomplished this mission proficiently with no undue task loads on any of the crew. Here,

the training was sufficient and, by this time, the FSOs had reached an asymptotic level on the learning curve. There appears to be no problems associated using a FE/FSO for refueling operations.

There are several other factors that should be taken into consideration in determining crew composition. The first is the experience level of the operators. As a result of cost considerations, overmanning for a peacetime operation and retirement, there has been a shift downward in the experience level of flying personnel in MAC. Secondly, MAC missions are somewhat lengthy, and cut across many time zones which is conducive to long term fatigue effects. The above factors possibly could have led to the increased accident rate in the C-141 fleet. In view of the above and the increased work load on pilots, another increase in accident rate is possible.

In consideration of the above, it would seem advisable to seek techniques to reduce crew work load as much as possible while still accomplishing the mission. For instance, a reduction in the paper work now required should be considered. Also, had the crews been more proficient in using all the capabilities of the INS, there would have been a lower work load across all missions. An improved and more easily intrepretable radar on the C-141 would also help reduce the work load. Finally, a reassessment of the work rest cycles in MAC flying operations might be fruitful.

SECTION V

CONCLUSIONS

The airland mission and refueling operations can be accomplished using a 4-man flight deck crew consisting of a pilot, copilot and engineer/flight systems operator and flight engineer without overloading any of the crew members (option 2).

The combat airlift mission requires a flight deck crew complement consisting of a pilot, copilot, navigator and flight engineer.

It appears feasible to substitute a flight systems operator/engineer for a navigator in the combat airlift crew complement in the future, once such an operator has acquired several years experience on airland missions and has received CAM training.

The flight systems operator should be trained in basic navigation operation of the INS and radar interpretation.

APPENDIX A

C-141 TASK ANALYSIS

PILOT

MISSION PLANNING & PREFLIGHT

Task	Description	Estimated Minutes
P1	Crew Briefing.	15
P2	Transportation to pickup guns, then to the airplane, drop off bags, check airplane status, and then back to Base Operations.	20
P3	Pickup flight plan and last minute instructions from Airlift Command Post (ACP).	3
P4	Check weather.	3
P5	Fill out flight plan.	20
P6	Check NOTAMS, FLIP, Foreign Clearance Guide.	3*
P8	Sign for authenticators.	3
P9	File flight plan.	1
P9A	Airfield certification.	10
P10	Receive ACP briefing and buffer zone brief.	5*
P11	Receive weather briefing.	5
P12	Transport from Base Operations to aircraft.	10
P16	Review Form 781 (maintenance).	3
P19	Review Form 365F (weight and balance).	1*
P21	Oxygen check (mask and regulator).	2*
P23	Prepare cockpit for flight (set up charts, navaids, command markers for departure).	5
C	Mission coordination (contacting ACP for last minute requests and maintenance support).	21

P = Pilot

N = Navigator

E_1 = Flt Engr

E_2 = Scanner

*Times will be verified during test.

START, TAXI, BEFORE TAKEOFF

Task	Description	Estimated Minutes
P25	Before start engines check.	3.5
P26	Start engines check.	2.5
P27	Before taxi check.	1.5
P27	Taxi check and taxi aircraft.	.5
P29	Before takeoff and taxi aircraft.	4.0
P30	Obtain clearance (radio call and writing clearance).	2.0
	TAKEOFF, CLIMB, AND DEPARTURE	
P31	Lineup check.	1.0
P32	Perform takeoff.	.5
P33	After takeoff climb check.	.5
F	Fly aircraft (accomplish takeoff and cruise).	35
	EN ROUTE 1	
P38	Cruise checklist	.5
F/P39	Flying aircraft, reads 27C fuel planning chart.	80
	EN ROUTE 11	
F	Climb aircraft.	77
P39	Pilot reads Form 27C.	1
P41	Approach briefing.	2

DESCENT APPROACH AND LANDING

Task	Description	Estimated Minutes
P42	Descent checklist.	2
F	Pilot performs descent.	26
P43	Before landing check.	1
P44	Approach and landing.	15
	AFTER LANDING AND POST FLIGHT	
P45	After landing checklist.	2
P46	Taxi aircraft to ramp.	10
P47	Engine shutdown.	1
P48	Before leaving aircraft check.	4
P19	Accomplish flight time breakdown in Form 781.	10
P49	Off-load personal baggage and load on crew bus.	8
P51	Maintenance debrief.	5
P50	Transportation to customs/then to Base Operations.	20
P10	ACP out-brief.	5
P52	Transport to squadron.	10
	COMBAT AIRLIFT MISSION	
	MISSION PLANNING	
	Show.	0
P1	Reviews formal brief.	25
P2	Sign FCIF.	1
P3	Read FCB.	4
P4	Fill out flight plan.	10
P5	Coordinate with FSO.	10

BRIEFING

Task	Description	Estimated Minutes
P6	Coordinate with crew, order lunches, etc.	15
P7	Formal briefing.	30
P8	Transportation to aircraft.	10
	PREFLIGHT	
P11	Check 781.	3
P12	Check 365F.	1
P13	Oxygen check.	2
P14	Prepare cockpit.	5
P15	Brief crew.	10
P16	Brief loadmasters.	6
P17	Fit parachute.	5
	START, TAXI, BEFORE TAKEOFF	
P24	Before starting engines check.	5
P25	Start engines.	10
P26	Taxi.	6
P27	Clearance.	2
P28	Serial brief.	1
P29	Hold and take runway.	6
	VFR INFLIGHT	
P30	Checklist (20 min).	6
P31	Checklist (10 min).	2
P32	Slowdown.	2

Task	Description	Estimated Minutes
P33	Checklist (1 min).	1
P34	Over drop zone.	1
P35	Race track check.	1
P36	Post drop IFR assembly (post drop checklist).	5
F	Fly.	
M	Monitor.	
C	Coordinate mission.	

COPILOT

MISSION PLANNING & PREFLIGHT

P1	Crew briefing.	15
N6	Transport to Base Operations.	20
N7	ACP briefing.	3
N8	Check weather for planning.	3
N9	Review computer flight plan accuracy, ICAO ETAs to pilot, perform fuel and time analysis and equal time point ETE.*	10**
N10	Check NOTAMs (en route chart preparation if time).	5
N11	Check navigation pubs and chart kits.	8
A	Available.	
N12	Receive full en route weather briefing.	5

NOTE: Takeoff, climb, and departure; en route; descent approach and landing; and after landing and post flight tasks remain the same as a Strategic Airlift Mission.

*NOTE: A manual flight plan requires +30 extra time.
** Times will be verified during test.

Task	Description	Estimated Minutes
N13	ACP/Buffer zone briefings.	5
A	Available.	10
N14	Transport to aircraft.	10
$P_2$17	Check HF, VHF, UHF radios.	2
$P_2$18	En route AWLS check.	3
$P_2$20	Check Navaids (TACAN, VOR, ADF).	2
P14	Check 780.(life support equipment on board aircraft.)	5
P15	222 flight equipment check.	5
P21	Oxygen check (mask and regulator).	2**
P23	Prepare cockpit for flight (set up charts, navaids, command markers for departure).	5
A	Available.	2.5
N28A	Insert INS waypoints/check.	8
A	Available.	33
P22	Review takeoff data (verify with tab data or dash one as appropriate).	5**
	START, TAXI, BEFORE TAKEOFF	
P25	Before start engines check.	3.5
P26	Start engines check.	2.5
P27	Before taxi check.	1.5

*NOTE: A manual flight plan requires +30 extra time.
** Times will be verified during test.

Task	Description	Estimated Minutes
P28	Taxi check and taxi aircraft.	.5
P29	Before takeoff CK list and taxi aircraft.	4.0
P30	Obtain clearance (radio call and writing clearance).	2.0
	TAKEOFF, CLIMB, AND DEPARTURE	
P31	Lineup check.	1.0
P32	Perform takeoff.	.5
P33	After takeoff climb check.	.5
P37	Accomplish radio call (UHF, VHF).	1
P36	Navaid change (VOR, TACAN ADF).	1
P37	Radio call.	1
P36	Navaid change.	1
P37	Radio call.	1
P36	Navid change.	1
P37	Radio call.	1
P36	Navaid change.	1
P37	Radio call.	1
P40	HF contact, relay departure message.	2
P36	Navaid change.	1
M	Monitor climbout and cruise. (Direct reference to aircraft performance and position instruments.)	25

EN ROUTE I

Task	Description	Estimated Minutes
P38	Cruise checklist.	.5
A/M	Available/Monitor.	24
P40	HF radio call, AIREP.	5
A/M	Available/Monitor.	20
P40	HF radio call, AIREP.	5
A/M	Available/Monitor.	5
	EN ROUTE II	
P40	HF radio call, AIREP and level off.	
A/M	Available/Monitor.	
P40	HF radio call, AIREP.	
A/M	Available/Monitor.	38
P41	Approach briefing.	2
	DESCENT APPROACH AND LANDING	
P42	Descent checklist.	2
P37	UHF radio call for descent clearance.	.5
P36	Navaid change.	1
P37	Receive and copy clearance.	1
P36	Navaid change.	1
P37	Radio call, level off.	1
P37	Radio call to approach control.	1
P43	Before landing check.	1
P44	Approach and landing.	15

AFTER LANDING AND POST FLIGHT

Task	Description	Estimated Minutes
P45	After landing checklist.	2
P46	Taxi aircraft to ramp.	10
P47	Engine shutdown.	1
P48	Before leaving aircraft check.	4
P48A	Complete MAC Form 486.	5
P49	Offload personnel baggage and load on crew bus.	8
P50	Transportation to customs/then to Base Operations.	20
P8	Return Athenticaters.	2
P52	Transport to squadron.	10

COMBAT AIRLIFT MISSION

MISSION PLANNING

P2	Sign FCIF.	1
P3	Read FCB.	4

BRIEFING & PREFLIGHT

P6	Coordinate with, crew order lunches, etc.	15
P7	Formal briefing.	30
P8	Transportation to aircraft.	10
$P_2$17	Check HF, VHF, UHF Radios.	2
$P_2$18	En route AWLS check.	3

Task	Description	Estimated Minutes
$P_2$20	Check navaids (TACAN, VOR, ADF).	2
P14	Check 780 (life support equipment on board aircraft).	5
P15	222 flight equipment check.	5
P21	Oxygen check (mask and regulator).	2
P23	Prepare cockpit for flight (set up charts, navaids, command markers for departure).	5
A	Available.	2.5
N28A	Insert INS waypoints/check.	8
A	Available.	33
P22	Review takeoff data (verify with tab data or dash one as appropriate).	5*
P15	Attends crew briefing.	10
N13	Fit parachute.	5
	START, TAXI, BEFORE TAKEOFF	
P24	Before starting engines check.	5
P25	Start engines.	5
P26	Taxi.	6
P27	Clearance.	2
P28	Serial brief.	1
P29	Hold and take runway.	6

NOTE: *Times will be verified during test.

VTR INFLIGHT

Task	Description	Estimated Minutes
MR	Map read.	
P30	Checklist (20 min).	
P31	Checklist (10 min).	2
P32	Slowdown.	2
P33	Checklist (1 min).	1
P34	Overdrop zone.	1
P35	Race Track check.	1
P36	Post drop IFR assembly (post drop checklist).	5

NOTE: Takeoff, Climb, and Departure; En route; Descent Approach and Landing; and after Landing and Post Flight Tasks remain the same as a Strategic Airlift Mission.

FLIGHT SYSTEMS OPERATOR

MISSION PLANNING & PREFLIGHT

Task	Description	Estimated Minutes
N1	Receive crew briefings.	
	a. Note desired items.	
	b. Receive Intel briefing (if required).	15
$E_2$2	Accomplish aircrew arming (includes transportation.)	15
N5	Unload bags/check Form 781.	
N16	Check circuit breakers.	1
N17	Radar switch check.	2
N18	Check oxygen regulator and mask.	2
N19	Align/Pres/Pos coord INS.	2*
N20	Radar to standby.	1
N21	AHRS TURN ON and Check.	1
N23	Time hack from HF radio and set clock.	3
N24	Radar operation check.	2*
$E_1$4	Check positioning of equipment controls at P, CP, N, FE stations.	
$E_1$26	Check all emergency equipment in flight station.	
A	Available.	5
$E_1$5	Check electrical power sources.	
$E_1$6	Establish radio contact with control tower/ground control (tasks 3 thru 6).	10

Task	Description	Estimated Minutes
$E_1$7	Clear APU.	
$E_1$8	Check operation of caution lights.	
$E_1$29	Visually inspect cargo compartment and underdeck areas.	20*
$E_1$10	Check operation of exterior, AWLS, annunciator and caution lights.	
$E_1$11	Check operation of all primary and secondary flight controls.	
$E_1$12	Check operation of brake system.	
$E_1$13	Check operation of yaw damper system.	
$E_1$14	Check operations of stall system (tasks 7 thru 14).	
$E_1$15	Check positioning of controls at P, CP, N, FE stations.	
E16	Check operation of pitot heat system.	
$E_1$17	Check operation of ice detect system.	
$E_1$18	Check operation of bailout alarm.	
$E_1$19	Check operation of engine fire and overhead warning system.	
$E_1$20	Check operation of landing gear warning light and horn.	
$E_1$21	Check crew oxygen system pressure/ quantity (tasks 7 thru 21).	26
N27	Prepare en route IFR charts, approach plates, standard inst. departure, and terrain chart for departure monitoring.	5

Task	Description	Estimated Minutes
A	Available.	1
N28A	Insert INS waypoints/check.	8
$E_2$15	Walk around inspection.	5
	START, TAXI, BEFORE TAKEOFF	
$E_2$16 & N28	Accomplish before starting engines checklist.	
$E_2$17	Accomplish starting engines checklist.	
$E_2$18	Accomplish before taxi checklist (tasks 16 thru 18).	6
N30	Before taxi checklist.	1
N31	Taxi checklist: radar turn-on, BDHIs check.	.5
N33	Before takeoff checklist.	1
N29b	Clearance for flight plan.	1
N34	Copy departure clearance (for monitoring).	1
N35	Line-up checklist: RADAR STAB	.5
N36	Takeoff roll (record time on flight log).	1
	TAKEOFF, CLIMB, AND DEPARTURE	
N37	Monitor departure (terrain, instruments, navaids, copy clearances, and monitor complaince).	5
N38	Compute ETAs (give copy to pilots).	5

Task	Description	Estimated Minutes
M	Monitor (as w/37).	5
N40	Adjust radar (accomplished whenever required).	2
M	Monitor (as w/37).	
$E_2$20	Accomplish after takeoff, climb checklist.	
N43	Update and reprogram INS as required.	3
M	Monitor (as w/37, plus for level off) record level off.	4.5

EN ROUTE I

NOTE 1: Using North Atlantic Track 40 minutes fix pacing and AIREPs.

NOTE 2: En route monitoring includes course, ETAs, computers, radar weather avoidance, clearances, and flight instruments.

N46	Perform cruise checklist.	.5
N47	Evaluate INS 1 and 2 for preference.	2.5
N48	Use INS and all heading systems to perform a heading crosscheck.	1
N49	Tune and/or adjust radar.	2
N55	Prepare AIREP.	2
M	Monitor.	3.5
N50	Draw Form 27-C fuel plot.	1
M	Monitor.	13.5
N54	Adjust ETAs.	3
N55	Prepare AIREP.	2

Task	Description	Estimated Minutes
M	Monitor.	5
N57	Pass AIREP to copilot.	1
A/M	Available/Monitor.	28
N64	Plot Form 27-C fuel.	1
N65	Adjust ETAs as required.	1
N66	Prepare AIREP.	2
N67	Copy climb clearance (for En Route II) and replot Form 27 consumption lines.	4
N68	Pass AIREP to copilot.	1
	EN ROUTE II	
N69	Reporgram/Check INS.	3
N71	Accomplish INS GRID checklist.	3
M	Monitor.	5
N75	Adjust ETA.	2
N78	GRID HEADING (GH) INS Crosscheck and log work.	5
M	Monitor.	5
N80	Prepare AIREP.	2
N81	Pass AIREP to pilot.	5
M	Monitor.	5
N84	Plot Form 27-C.	1
M	Monitor.	5
N86	GH crosscheck and log work.	5

Task	Description	Estimated Minutes
M	Monitor.	16.5
$E_2$26	Check hydraulic fluid levels.	6
N92	GH crosscheck and log work.	5
N93	Grid exit checklist.	4
N98	Locate appropriate charts and approach plates.	2
N94	Receive approach briefing, copy the clearance.	2
	DESCENT APPROACH AND LANDING	
N95	Descent checklist (reads altimeter setting).	2
M	Monitor.	5
N100	Accomplishes before landing checklist.	1
M	Monitor (especially terrain clearance).	15
	AFTER LANDING AND POST FLIGHT	
N102	After landing checklist.	2
N97	Compute wind factor.	2
N103	Monitor taxi.	8
N108	Store charts, etc.	1
N109	Before leaving aircraft checklist.	4
$E_2$24	Accomplish before leaving aircraft checklist.	8

Task	Description	Estimated Minutes
$E_2$23	Accomplish engine shutdown checklist.	1
N104	Off-load personal baggage and load on crew bus.	8
N105	Transport to customs/then to Base Operations and turn in weapons.	20
N106	ACP out-brief.	10
N107	Transport to squadron.	10

COMBAT AIRLIFT MISSION

MISSION PLANNING

Task	Description	Estimated Minutes
N1	Prepare and study navigation chart.	10
N2	Accomplish CARP worksheet.	11
N3	Accomplish wind circle solution.	10
N4	Complete flight plan data.	20
N5	Prepare navigator target study brief.	10

BRIEFING & PREFLIGHT

N1	Receive crew briefings.	15
	a. Note desired items.	
	b. Receive intel briefing (if required).	
$E_2$2	Accomplish aircrew arming (includes transportation).	15
N5	Unload bags/check Form 781.	
N16	Check circuit breakers.	1
N17	Radar switch check.	2
N18	Check oxygen regulator and mask.	2
N19	Align/Pres/Pos coord INS.	2*
N20	Radar to standby.	1
N21	AHRS TURN ON and check.	1
N23	Time hack from HF radio and set clock.	3

NOTE: Takeoff, Climb, and Departure; En Route; Descent Approach and Landing; and After Landing and Post Flight Tasks remain the same as a Strategic Airlift Mission.

* Times will be verified during test.

Task	Description	Estimated Minutes
N24	Radar operation check.	2*
$E_1$4	Check positioning of equipment controls at P, CP, N, FE stations.	
$E_1$26	Check all emergency equipment in flight station.	
A	Available.	5
$E_1$5	Check electrical power sources.	
$E_1$6	Establish radio contact with control tower/ground control (tasks 3 thru 6).	10
$E_1$7	Clear APU.	
$E_1$9	Check operation of caution lights.	
$E_1$29	Visually inspect cargo compariment and underdeck areas.	
$E_1$10	Check operation of exterior, AWLS, annunciator and caution lights.	
$E_1$11	Check operation of all primary and secondary flight controls.	
$E_1$12	Check operation of brake system.	
$E_1$13	Check operation of yaw damper system.	
$E_1$14	Check operations of stall system (tasks 7 thru 14).	
$E_1$15	Check positioning of controls at P, CP, N, FE stations.	
$E_1$16	Check operation of pitot heat system.	
$E_1$17	Check operation of ice detect system.	

NOTE: Takeoff, Climb, and Departure; En Route; Descent Approach and Landing; and After Landing and Post Flight Tasks remain the same as a Strategic Airlift Mission.

* Times will be verified during test.

Task	Description	Estimated Minutes
$E_1$18	Check operation of bailout alarm.	
$E_1$19	Check operation of engine fire and overhead warning system.	
$E_1$20	Check operation of landing gear warning light and horn.	
$E_1$21	Check crew oxygen system pressure/ quantity (tasks 7 thru 21).	26
N27	Prepare en route IFR charts, approach plates, standard inst. departure, and terrain chart for departure monitoring.	5
A	Available.	1
N28A	Insert INS waypoints/check.	8
N12	Aircraft Commander's briefing.	10
$E_2$15	Walk around inspection.	5
P17	Fit parachute.	5
	START, TAXI, BEFORE TAKEOFF	
N14	Before starting engine check.	5
$E_2$16	Accomplish before starting engines check.	
$E_2$17	Accomplish starting engines check.	
$E_2$18	Accomplish before taxi check (tasks 16 thru 18).	6

NOTE: Takeoff, Climb, and Departure; En Route; Descent Approach and Landing; and After Landing and Post Flight Tasks remain the same as a Strategic Airlift Mission.

Task	Description	Estimated Minutes
N15	Start engines check.	5
N16	Taxi check, copy clearance, (Takeoff occurs at this time and the profile is the same as a normal mission.)	10
N17	Descending to low level.	10
	a. Determine aircraft position with landmarks and direct aircraft to the orbit point.	
	b. Determine ETA to orbit point.	
	c. Determine wind factor for orbit timing.	
	d. Monitor aircraft altitude, airspeed, position, etc.	
N18	Enter orbit.	10
	a. Determine time to depart orbit, number of orbits to be made, and time for orbits.	
	b. Direct aircraft.	
N19	Low level navigation.	
	Direct aircraft on low level route and update computers as necessary.	
N20	Give warnings and advisories.	1
N21	Determine slowdown point.	
N22	Determine mean effective wind and pass to pilots. Program INS.	2
N23	Direct slowdown.	1
N24	Acquire drop zone visually.	1
N25	Determine CARP.	1

Task	Description	Estimated Minutes
N26	Guide aircraft to CARP.	1
N27	Countdown.	1
	a. Give 1 minute warning.	
	b. Acquire timing points.	
	c. Direct aircraft.	
	d. Change CARP if necessary.	
	e. Begin timing.	
N28	Drop.	1
	a. Give green light command.	
	b. Time to red light.	
	c. Give red light command.	
N29	Time to turn point and give command to turn.	1
N30	Determine timing for race track.	1
N31	Time for acceleration and give command.	1
N32	Direct aircraft to IFR recovery point using visual procedures.	1
N33	Monitor IFR climb out.	20

NOTE: Takeoff, Climb, and Departure; En Route; Descent Approach and Landing; and after Landing and Post Flight Tasks remain the same as a Strategic Airlift Mission.

FLIGHT ENGINEER

MISSION PLANNING AND PREFLIGHT

Task	Description	Estimated Minutes
$E_1 1$	Attend aircrew briefing.	15
$E_1 2$	Accomplish aircrew arming (including transportation).	15
$E_1 3$	Check forms 781.	2
$E_2 1$	Check chocks, pins, plugs, and covers.	
$E_2 4$	Check hydraulic systems.	
$E_2 5$	Check monitoring of controls in cargo compartment and APU compartment.	
$E_2 7$	Operate ground power equipment and connect to aircraft. (Tasks 3 thru 7)	10
$E_2 6$	Check APU and subsystems.	
$E_1 9$	Check operation of pneumatic and environmental system.	
$E_1 22$	Check operation of hydraulic systems suction boost pumps.	
$E_1 23$	Check operation of EVI system.	
$E_1 24$	Check operation of fuel system.	
$E_1 25$	Check operation of FE oxygen system.	
$E_1 27$	Check crew escape hatch.	
$E_2 8$	Maintain external clearance during APU and flight control operation.	
$E_2 9$	Coordinate and report operation of exterior lights.	

Task	Description	Estimated Minutes
$E_2$10	Coordinate and report movements of all flight controls and brakes.	
$E_2$11	Coordinate operation of hydraulic interconnect.	
$E_2$12	Coordinate operation of stall system. (Tasks 8 thru 12)	25
$E_2$13	Visually inspect aircraft exterior.	30
$E_1$28	Test life history recorder and insert data (tasks 22 thru 28).	8
$E_1$10	Close and inspect cargo door system.	10
$E_1$31	Initiate forms 796 and 451.	15
$E_1$32	Compute TOLD card.	15
	START, TAXI, BEFORE TAKEOFF	
$E_1$33	Accomplish before starting engine checklist.	
$E_1$34	Accomplish starting engines checklist.	
$E_1$35	Accomplish before taxi checklist.	
$E_1$36	Accomplish before takeoff check. (tasks 33 thru 36)	12
	TAKEOFF, CLIMB, AND DEPARTURE	
$E_1$37	Record times and readiness during takeoff.	
$E_1$38	Accomplish after takeoff, climb checklist (tasks 37 thru 38).	1
M	Monitor.	20.5

Task	Description	Estimated Minutes
$E_1$39	Accomplish entries in forms 796 and 451.	2
$E_1$40	Compute level off data.	3
	EN ROUTE CRUISE	
$E_1$41	Accomplish entries in form 796, 451, and 27c.	3
$E_1$42	Compute cruise data.	15
$E_1$43	Verify data on form 27c.	3
$E_1$44	Accomplish entries in form 796.	3
$E_1$45	Compute landing data.	5
	DESCENT APPROACH AND LANDING	
$E_1$46	Accomplish descent check.	2
$E_1$47	Accomplish before landing check.	2
	AFTER LANDING AND POST FLIGHT	
$E_1$48	Accomplish after landing check.	2
$E_1$49	Accomplish engine shutdown check.	1
$E_1$50	Accomplish before leaving aircraft check.	4
$E_1$39	Forms 796 and 451.	3
$E_1$51	Accomplish entries in form 781.	2
$E_1$52	Accomplish post flight duties.	53

Task	Description	Estimated Minutes
	START, TAXI, BEFORE TAKEOFF	
$E_1$33	Accomplish before starting engines check.	5
$E_1$34	Accomplish starting engines check.	
$E_1$35	Accomplish before taxi check.	
$E_1$36	Accomplish before takeoff check (tasks 34 thru 36).	7
	VFR INFLIGHT	
$E_1$53	Compute airdrop data.	6
$E_1$54	Accomplish 20-minute check.	6
$E_1$55	Accomplish 10-minute check.	2
$E_1$56	Accomplish post drop check.	5

APPENDIX B

FLIGHT SYSTEM OPERATOR TASK OPTIONS

In the nine airland flights there were three different FSO duties. These were:

Option 1 - All duties under Navigator in Table 1A plus System Operator Navigator duties.

Option 2 - All Navigator duties except those in block 7 of the System Operators Navigator duties.

Option 3 - All Navigator duties plus 1 and 4 under System Operator Navigator duties.

TABLE 1A

SYSTEM OPERATOR, PILOT-NAVIGATOR-FLIGHT ENGINEER
REQUIRED TRAINING AREAS

The following table depicts the areas of training required to convert a pilot, navigator or flight engineer discipline to a systems operator discipline. This does not include the experience factors inherent to each crew discipline that would enhance the mission capability when operating from limited support bases; i.e., refueling, troubleshooting or effecting minor repairs.

Training required over and above the training for the basic discipline.	Pilot	Navigator	Flt Engr
System Operator Preflight Duties			
1. Before Elec Power on Ck	x	x	
2. Elec Power On Ck	x	x	
Interior Inspection			
1. Flight Station	x	x	
2. Cargo Compartment	x	x	
Scanners Normal Duties			
1. Before Power - On	x	x	
2. Electrical Power - On	x	x	
3. Cargo Compartment Insp	x	x	
4. Walk Around Insp	x	x	
5. Before Starting Engines	x	x	
6. Starting Engines	x	x	
7. Before Taxi	x	x	
8. Take Off Climb	x	x	
9. Descent	x	x	
10. Before Landing	x	x	
11. Engine Shutdown	x	x	
12. Before Leaving Acft	x	x	
13. Thru Flight	x	x	
14. Operate Cargo Doors	x	x	
15. Portable Oxygen Svc	x	x	

Training required over and above the training for the basic discipline.	Pilot	Navigator	Flt Engr
Scanners Emergency Duties			
16. Fire On The Ground	x	x	
17. APU/Fuselage Fire	x	x	
18. Engine Out/Fire	x	x	
19. Fuselage Fire	x	x	
20. Wing Fire	x	x	
21. Electric Fire	x	x	
22. Smoke and Fume Elim	x	x	
23. Ditching	x	x	
24. Inflight Door Warning	x	x	
25. Rapid Decompression	x	x	
26. Pressure Door Rail	x	x	
27. Fuel Jettison	x	x	
28. Air Start	x	x	
29. Landing Gear Sys Fail	x	x	
29a. Manual Gear Extension	x	x	
System Operator Emer Duties			
30. Aux Pwr Unit/Fuslg Fire	x	x	
31. Eng Fail/Fire Inflt	x	x	
32. Fuselage Fire	x	x	
33. Wing Fire	x	x	
34. Wg Pylon Air Cond O/H	x	x	
35. Electrical Fire	x	x	
36. Smoke and Fume Elim	x	x	
37. Loss of all Generators	x	x	
38. Inflight Door Warning	x	x	
39. Emer Ops Wg Anti-Ice	x	x	

Training required over and above the training for the basic discipline.	Pilot	Navigator	Flt Engr
System Operator Emer Duties			
40. Environmental Sys Fail	x	x	
41. Fuel Systems Failures	x	x	
42. Engine System Failure	x	x	
43. Hydraulic System FAilure	x	x	
44. Electrical System Failure	x	x	
45. Engine Air Start	x	x	
System Knowledge			
1. Engine	x	x	
Engine Fuel System	x	x	
Ignition System	x	x	
Starting System	x	x	
EVI System	x	x	
Oil System	x	x	
Thrust Reverser	x	x	
2. Fuel System Controls	x	x	
Fuel Tank	x	x	
Fuel Booster Pumps	x	x	
Jettison System	x	x	
3. Electrical System	x	x	
Main Generators	x	x	
Constant Speed Drive	x	x	
Emergency AC/DC Gen	x	x	
AC Elec System Control	x	x	
AC Elec System Indicator	x	x	
DC Elec System	x	x	

Training required over and above the training for the basic discipline.	Pilot	Navigator	Flt Engr
System Knowledge			
4. Hydraulic System	x	x	
5. Flight Controls	x	x	
Aileron System	x	x	
Rudder System	x	x	
Elevator System	x	x	
Pitch Trim System	x	x	
Wing Flap System	x	x	
Wing Spoiler System	x	x	
6. Landing Gear System	x	x	
7. Brake System	x	x	
8. Engine Bleed Air System	x	x	
9. Air Conditioning System	x	x	
10. Pressurization	x	x	
11. Floor Heat System	x	x	
12. Windshield Rain Removal	x	x	
13. Anti-Icing and De-Icing	x	x	
14. Oxygen System	x	x	
15. Lighting System	x	x	
16. AFU (Aux Pwr Unit)	x	x	
System Operator Nav Duties			
1. Radar/APN 59			
a. System Operation	x		x
b. Weather Interpretation	x		x
c. Terrain Interpretation	x		x
2. Range Control Form 27c			x

Training required over and above the training for the basic discipline.	Pilot	Navigator	Flt Engr
System Operator Nav Duties			
3. FLIP			
a. Approach Plates			x
b. SID's			x
c. Enroute Procedures			x
d. ATC Clearance			x
4. Terrain Monitoring			
a. Map Reading	x		x
b. Terrain Plotter	x		x
c. Flight Instruments			x
(1) Altitude			
(2) BDHI			x
5. Comm Procedures			x
6. Authentication			x
7. INS			
a. System Operation	x		x
b. Computer Flight Plan	x		x
c. CARP Computation	x		x
d. MB-4 Computer	x		x

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