AD-A051 891 ARINC RESEARCH CORP ANNAPOLIS MD F/G 1/3

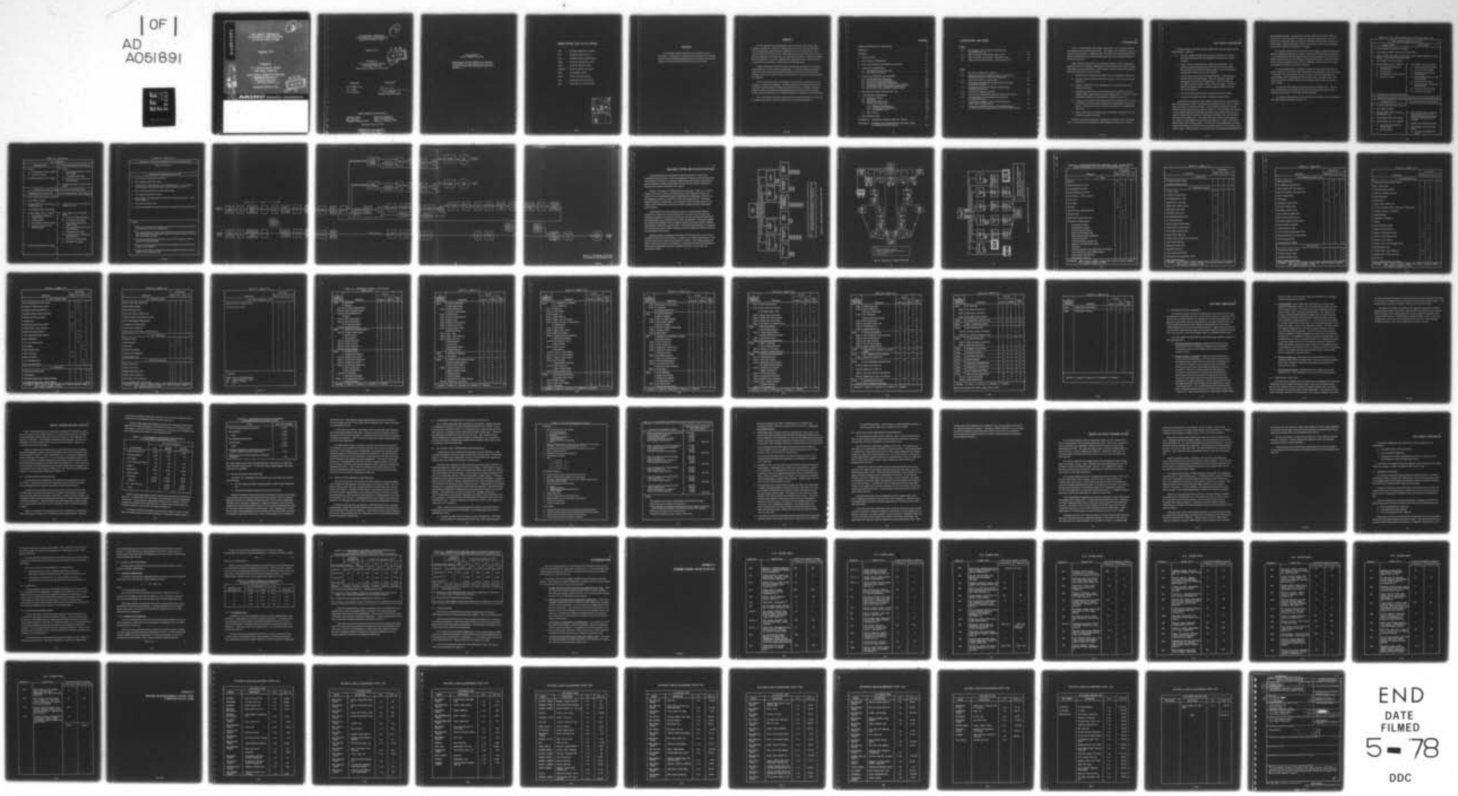
COST-BENEFIT COMPARISON OF ALTERNATIVE CONFIGURATIONS FOR QF-4B--ETC(U)

SEP 74 R E MARTIN, M J HUTTON, J E NICHOLSON F09603-73-A-4392

UNCLASSIFIED 1250-01-1-1321 NL

| OF |

AD
A051891



END
DATE
FILMED
5-78
DDC

COST-BENEFIT COMPARISON OF ALTERNATIVE CONFIGURATIONS FOR QF-4B TARGET SYSTEM

September 1974

Prepared for

U.S. NAVAL MISSILE CENTER
Point Mugu, California

Under Contract F09603-73-A-4392-0010

Publication 1250-01-1-1321

ARINC RESEARCH CORPORATION

COST-BENEFIT COMPARISON OF ALTERNATIVE CONFIGURATIONS FOR QF-4B TARGET SYSTEM

September 1974

Prepared for
U.S. NAVAL MISSILE CENTER
Point Mugu, California
Under Contract F09603-73-A-4392-0010

Prepared by

R.E. Martin, P.E.
M.J. Hutton
J. E. Nicholson

Approved by

R.G. Hemann
Manager, Santa Ana Branch

ARINC RESEARCH CORPORATION

HEADQUARTERS
2551 Riva Road
Annapolis, Maryland 21401

SANTA ANA BRANCH
1222 E. Normandy Place
Santa Ana, California 92702

Publication 1250-01-1-1321

ABBREVIATIONS USED IN THIS REPORT

ACE	—	Aircraft conditioning evaluation
APA	—	Aviation purchase account
FAA	—	Federal Aviation Administration
NADC	—	Naval Air Development Center
NARF	—	Naval Air Rework Facility
NAVAIR	—	Naval Air Systems Command
NMC	—	Naval Missile Center
NOLO	—	No live (or local) operator
PAR	—	Progressive aircraft rework
POL	—	Petroleum, oil, and lubricants

ABSTRACT

A cost-benefit analysis of the Navy QF-4B target system is discussed. A comparison is made of various approaches for reducing system costs by modifying the present practice of using a dual-purpose vehicle for both manned and NOLO (no live operator) flights.

SUMMARY

The QF-4B target aircraft presently in use by the Navy can be flown either manned or unmanned. At present, a large portion of the cost of the QF-4B results from the progressive aircraft rework (PAR) carried out as an adjunct to the conversion of the F-4B into the QF-4B. This situation has prompted the Navy to investigate the possibility of reducing system costs by supplementing or replacing the present QF-4B configuration with a less expensive non-manrated aircraft. ARINC Research Corporation was contracted to conduct such a cost-benefit study.

Results of this study indicate that the most desirable alternative to the present target vehicle is a less expensive manrated type. It is believed that the alternative system could be produced by replacing the present PAR with an aircraft condition evaluation (ACE), or a modified ACE, at the time an F-4B aircraft is being converted for target use.

A non-manrated aircraft, even though it costs less than a manrated type, will not show an overall cost advantage. Associated facility and personnel support costs essentially counterbalance the difference in airframe costs. In addition, its operational loss rates will probably be significantly greater than those for the manrated version, which would place the non-manrated vehicle at a significant cost disadvantage.

It is recommended, therefore, that the low-cost manrated version of the QF-4B be obtained; and that it be used for both practice and firing presentations.

CONTENTS

ILLUSTRATIONS AND TABLES

1
INTRODUCTION

The U.S. Naval Missile Center (NMC), Point Mugu, CA, is charged with test and evaluation of the QF-4B target system. This system can be operated either as a NOLO (no live operator) or manned aircraft. The Navy is now investigating the possibility of supplementing or replacing that system with a less costly non-manrated (NOLO-only) version.

ARINC Research Corporation was contracted by NMC to make a comparative evaluation of the two candidate configurations and provide the Navy with cost-versus-benefit data and recommendations. Specific tasks, and the sections of this report in which they are discussed, are as follows:

1. Identify the most probable use profiles for each configuration (Section 2).
2. Examine system and mission functions peculiar to the NOLO-only version (Section 3).
3. Estimate a difference in loss rate between the manned and NOLO-only versions (Section 4).
4. Identify basic differences in the PAR (progressive aircraft rework) and logistic support requirements for the two configurations. Provide an order-of-magnitude estimate of associated cost differences (Section 5).
5. Prepare a cost-benefit summary based upon the data derived from the previous tasks, and including an assessment of nonquantifiable factors (Section 7). Recommend a course of action concerning the two configurations (Section 8).
6. Submit a final report summarizing the cost-benefit comparison study performed in the above five tasks.

Section 6 summarizes performance information collected on the F-102 target drone, an existing system that employs both manrated and NOLO-only versions.

2
USE PROFILE COMPARISON

During this study, five options became apparent for implementing the QF-4B target system. These are:

a. Use only manrated QF-4Bs of the type now operational at Pt. Mugu. These QF-4Bs provide the dual capability of either NOLO or piloted operation.

b. Utilize a mix of manrated and non-manrated configurations. The present manrated configuration would be retained for those flights where the pilot's presence would be desirable. A new non-manrated configuration would be used for NOLO flights.

c. Use two types of manrated QF-4B configurations. The present type would be used for manned flights, with a less expensive manrated configuration used for NOLO presentations. The use profiles for this option would be similar to those for the first option. This third option corresponds closely to a system being developed for the Air Force (see Section 6.)

d. Use the less expensive manrated configuration for all missions.

e. Use only non-manrated QF-4Bs for flying all missions NOLO.

To establish use profiles for these options, ARINC Research representatives interviewed personnel of NMC, the Naval Air Development Center (NADC), and the Naval Air Systems Command (NAVAIR). The use profiles developed for the five options from these discussions are given in Table 2-1. The aircraft rework and conversion actions referred to in this table are based on discussions with Naval Air Rework Facility (NARF) personnel at San Diego and Cherry Point, and with NADC personnel at Warminster, Pa. The profiles take into account current operating restrictions on drone flights from the Naval Air Station, Pt. Mugu, and the Naval Missile Range off San Nicolas Island. For the NOLO-only configuration, the NARF facility at San Diego was selected for the use profile because of its proximity to San Nicolas Island. This proximity is important because of transportation difficulties for the nonmanned aircraft. It is possible, of course, either to convert the vehicle at NARF/Cherry Point and ship it by surface or sea to the Pacific Coast, or to use a field team to convert the vehicle at NMC/Pt. Mugu after PAR has been carried out at either NARF. Final conversion to a NOLO-only state at Pt. Mugu would permit the QF-4B to be ferried from the NARF to Pt. Mugu.

For operation using NOLO-only vehicles, the maintenance capability would most likely be established at San Nicolas Island. The pre-mission checkout procedure for the non-manrated aircraft will undoubtedly be much more extensive and will require a longer interval than the current checkout of the manrated QF-4B. It should be noted that pre-mission checkout for the Air Force PQM-102, which is not given a manned checkflight (see Section 6), takes up to 40 hours.

If a mixed configuration is selected, relatively few manrated QF-4Bs will be required since the loss rate for those vehicles should be equivalent to that of the basic F-4 aircraft. The non-manrated version, however, will be flown primarily as a missile target; drone life expectancy will be short and its consumption high. PAR actions for the non-manrated vehicle may be limited to those required to make the vehicle flyable.

The majority of the flights will be flown by the manrated QF-4Bs. Use estimates by NMC personnel indicate that there will be approximately three manned rehearsal presentations to each NOLO firing presentation.

Use profiles giving steps in the life of a QF-4B from initial rework up through a first NOLO flight are depicted in Figure 2-1.

TABLE 2-1. QF-4B USE PROFILES (FIVE OPTIONS) (Sheet 1 of 3)

A. USING PRESENT (MANRATED) QF-4B	
Manned Flights	**NOLO Flights**
1. F-4B aircraft is selected for conversion.	
2. Ferry flight to NARF (Cherry Point or San Diego).	
3. Limited PAR[1/] with conversion to QF-4B. Only essential changes are incorporated. Limited corrosion control effort.	
4. Ferry flight to NMC/Point Mugu.	
5. Manned flights out of Pt. Mugu.[5/]	5. NOLO flights out of San Nicolas
a) Pre-mission checkout and manned runup.	a) Ferry to San Nicolas Island.
b) Normal launch.	b) Convert for NOLO flight.
c) Presentation or chase/control.	c) Pre-mission checkout and manned runup.
d) Land at Pt. Mugu.	d) NOLO launch with one or more chase aircraft.
	e) Presentation for firing.
	f) If drone survives, land at San Nicolas Island.
	g) Convert for manned flight.
	h) Fly back to Pt. Mugu.
6. Maintenance as required at Point Mugu.	

B. USING BOTH MANRATED AND NON-MANRATED QF-4B CONFIGURATIONS	
Manrated QF-4B	**Non-Manrated QF-4B (see Section 3)**
1. F-4B aircraft selected for conversion.	
2. Ferry flight to NARF.	
3. Normal PAR[2/] with conversion to manrated QF-4B.	3. Limited PAR[3/] and conversion to non-manrated QF-4B. Crew-related depot actions are deleted and major related systems are removed.
4. Ferry flight to NMC/Point Mugu.	4. Transport to San Nicolas Island.
5. Manned flights out of Pt. Mugu.[5/]	5. NOLO flights out of San Nicolas Island.
a) Pre-mission checkout and manned runup.	a) Pre-mission checkout and runup.
b) Normal launch.	

TABLE 2-1. (Sheet 2 of 3)

B. (Continued)	
Manrated QF-4B	**Non-Manrated QF-4B (see Section 3)**
5. (Cont) c) Presentation or chase/control. d) Land at Pt. Mugu.	5. (Cont) b) NOLO launch with one or more chase planes. c) Presentation for firing. d) If drone survives, land at San Nicolas Island.
6. Normal maintenance at Pt. Mugu.	6. Normal maintenance at San Nicolas Island.

C. USING TWO TYPES OF MANRATED QF-4B CONFIGURATIONS	
High-Quality Manrated QF-4B	**Low-Cost Manrated QF-4B (see Section 3)**
1. F-4B aircraft selected for conversion.	
2. Ferry flight to NARF.	
3. Normal PAR[2/] with conversion to manrated QF-4B.	3. Limited ACE[4/] with conversion to manrated QF-4B.
4. Ferry flight to NMC/Point Mugu.	
5. Manned flights out of Pt. Mugu.[5/] a) Pre-mission checkout and manned runup. b) Normal launch. c) Presentation or chase/control. d) Land at Pt. Mugu or San Nicolas Island.	5. NOLO flights out of San Nicolas Island. a) Ferry to San Nicolas Island. b) Convert for NOLO flight. c) Pre-mission checkout and manned runup. d) NOLO launch with one or more chase aircraft. e) Presentation for firing. f) If drone survives, land at San Nicolas Island. g) Convert for manned flight. h) Fly back to Pt. Mugu.
6. Normal maintenance at Pt. Mugu.	

TABLE 2-1. (Sheet 3 of 3)

D. USING ONLY LOW-COST MANRATED QF-4B CONFIGURATION
(Same as A, above.)
E. USING ONLY NON-MANRATED QF-4B[5/]
1. F-4B aircraft selected for conversion.
2. Ferry flight to NARF/San Diego.
3. Limited PAR[1/] and conversion to non-manrated drone. Crew-related depot actions are deleted and major related systems are removed.
4. Sea or helicopter transport to San Nicolas Island.
5. Pre-mission checkout and runup.
6. NOLO launch. All presentations and practice missions are NOLO. Chase planes required.
7. Land at San Nicolas Island.
8. All normal maintenance actions must be accomplished at San Nicolas Island.

NOTES:

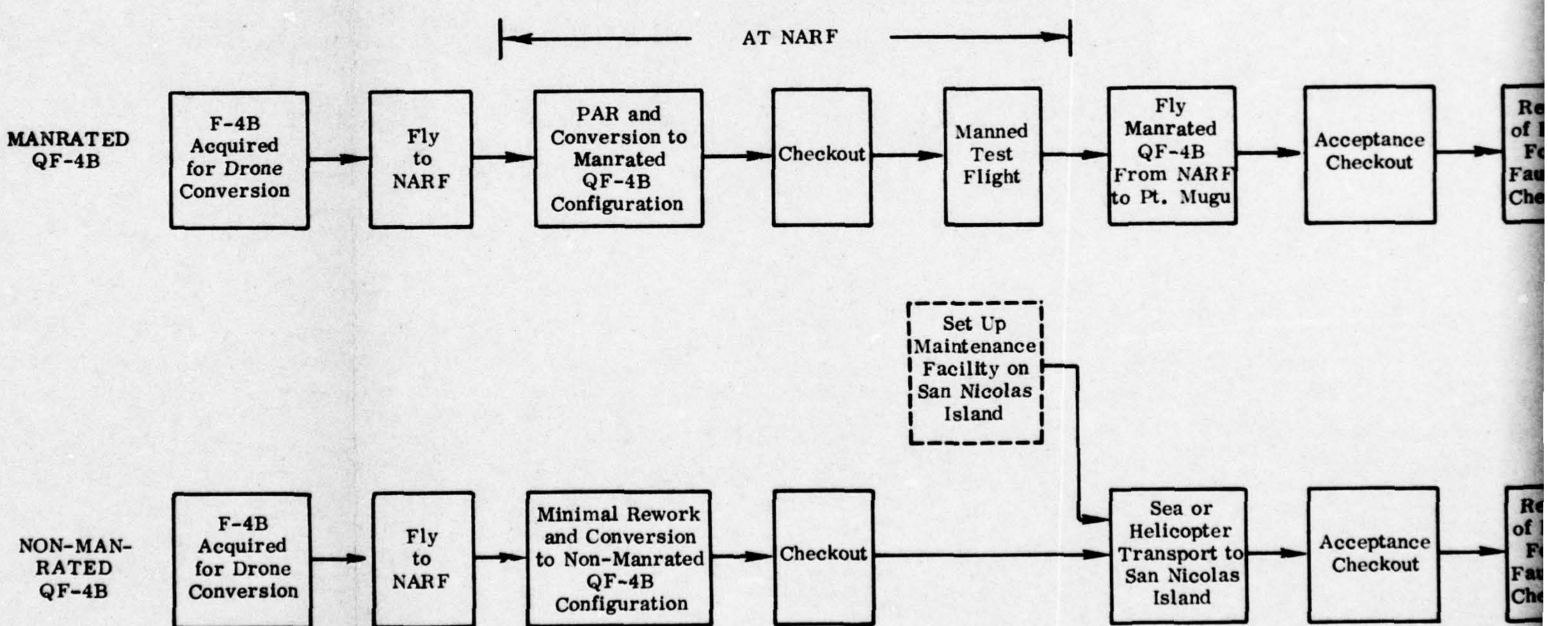
[1/] NOLO use will limit life expectancy, so that many PAR actions intended for life extension purposes are unnecessary.

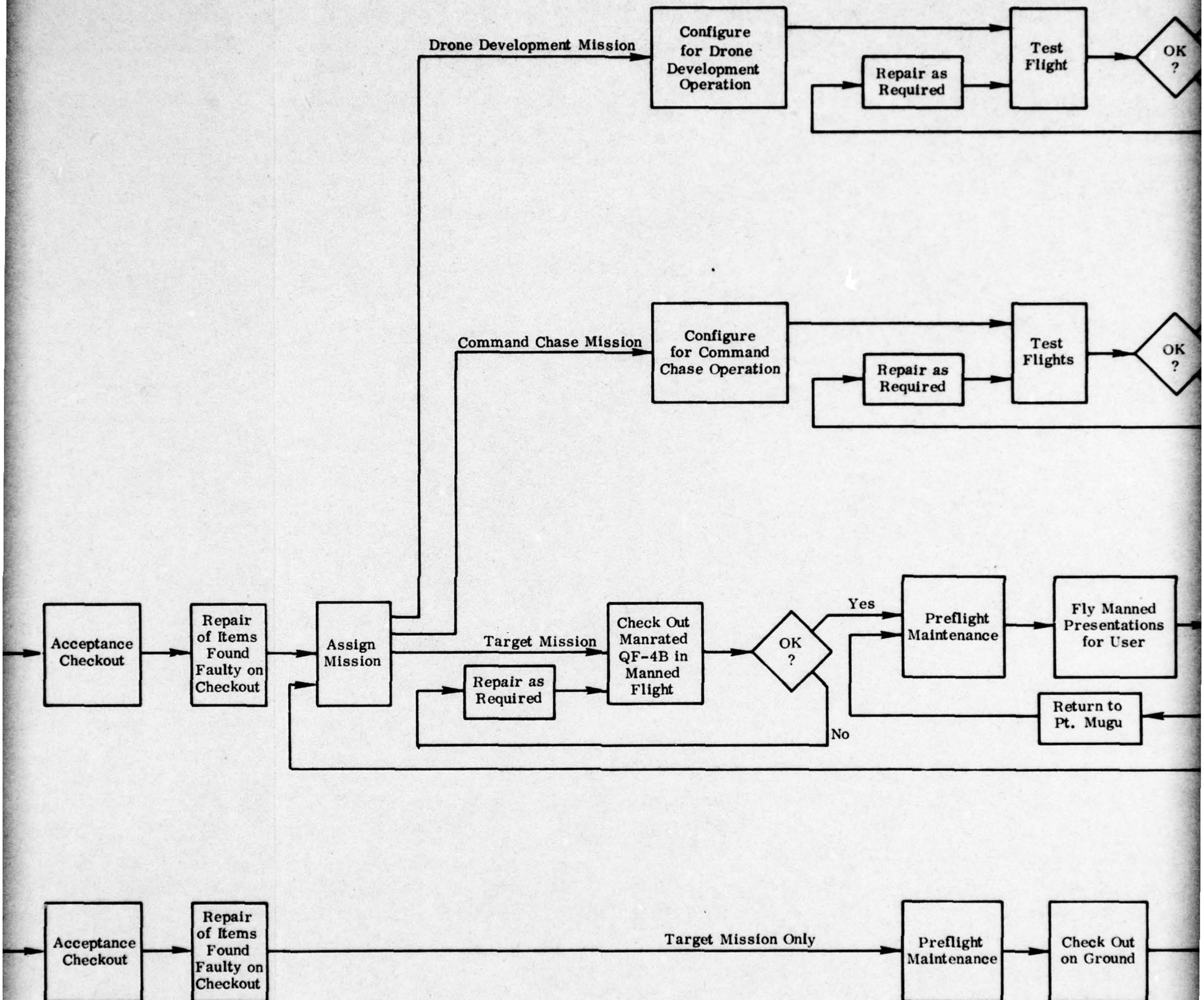
[2/] The manrated QF-4B will fly manned and should not be exposed to kill loss. PAR actions should be equivalent to normal F-4B effort except for fire control and ordnance systems.

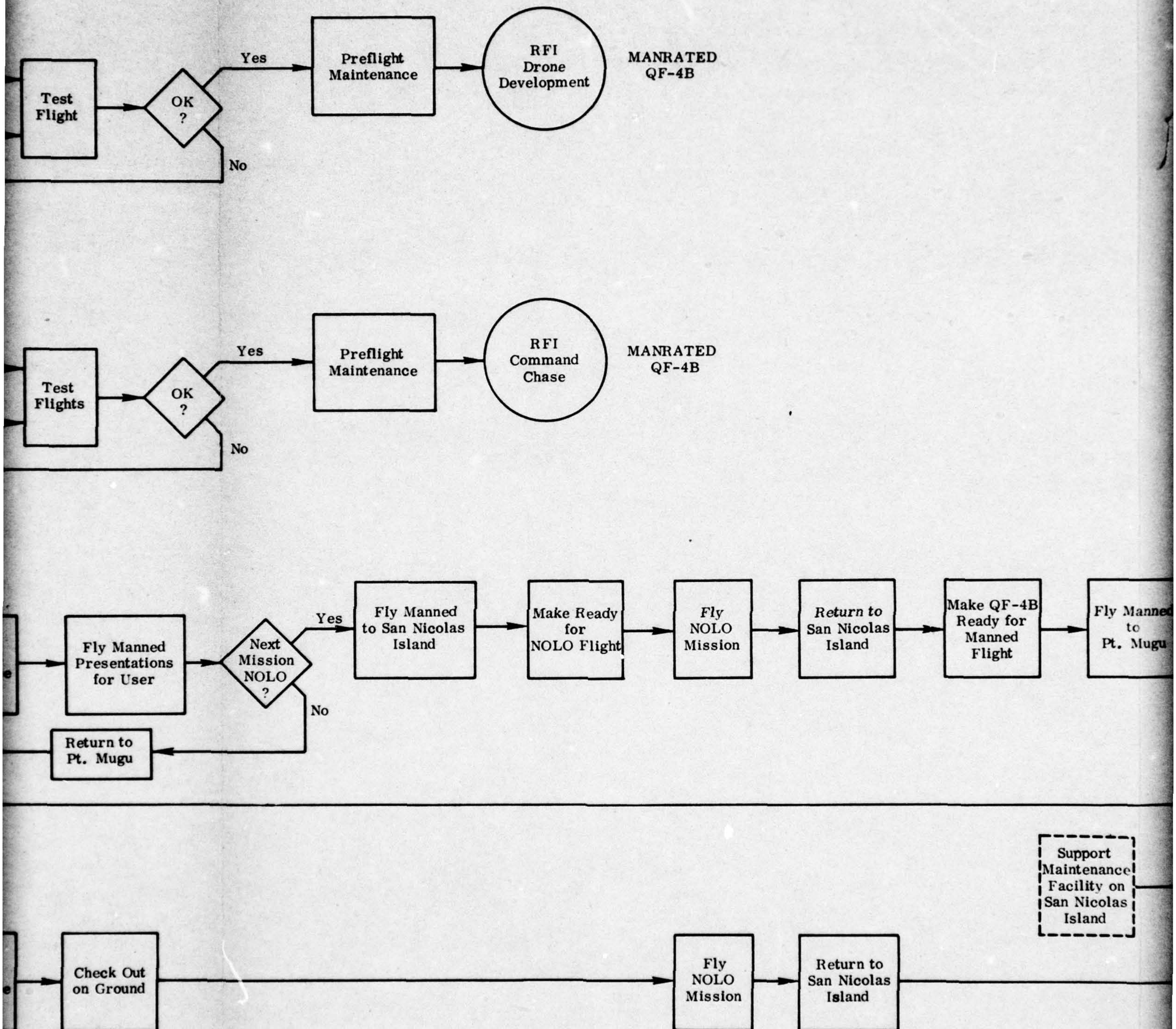
[3/] The non-manrated QF-4B needs little, if any, PAR effort since kill loss rate makes wearout unlikely.

[4/] The low-cost manrated QF-4B needs little ACE effort since kill loss rate makes wearout unlikely.

[5/] Captive presentations or target system development work must be accomplished with a manned aircraft.


AT NARF
MANRATED QF-4B
F-4B Acquired for Drone Conversion
Fly to NARF
PAR and Conversion to Manrated QF-4B Configuration
Checkout
Manned Test Flight
Fly Manrated QF-4B From NARF to Pt. Mugu
Acceptance Checkout
Set Up Maintenance Facility on San Nicolas Island
NON-MAN-RATED QF-4B
F-4B Acquired for Drone Conversion
Fly to NARF
Minimal Rework and Conversion to Non-Manrated QF-4B Configuration
Checkout
Sea or Helicopter Transport to San Nicolas Island
Acceptance Checkout


Drone Development Mission
Configure for Drone Development Operation
Repair as Required
Test Flight
OK ?
Command Chase Mission
Configure for Command Chase Operation
Repair as Required
Test Flights
OK ?
Acceptance Checkout
Repair of Items Found Faulty on Checkout
Assign Mission
Target Mission
Repair as Required
Check Out Manrated QF-4B in Manned Flight
OK ?
Yes
No
Preflight Maintenance
Fly Manned Presentations for User
Return to Pt. Mugu
Acceptance Checkout
Repair of Items Found Faulty on Checkout
Target Mission Only
Preflight Maintenance
Check Out on Ground


Test Flight
OK ?
Yes
No
Preflight Maintenance
RFI Drone Development
MANRATED QF-4B
Test Flights
OK ?
Yes
No
Preflight Maintenance
RFI Command Chase
MANRATED QF-4B
Fly Manned Presentations for User
Next Mission NOLO ?
Yes
No
Return to Pt. Mugu
Fly Manned to San Nicolas Island
Make Ready for NOLO Flight
Fly NOLO Mission
Return to San Nicolas Island
Make QF-4B Ready for Manned Flight
Fly Manned to Pt. Mugu
Support Maintenance Facility on San Nicolas Island
Check Out on Ground
Fly NOLO Mission
Return to San Nicolas Island

3

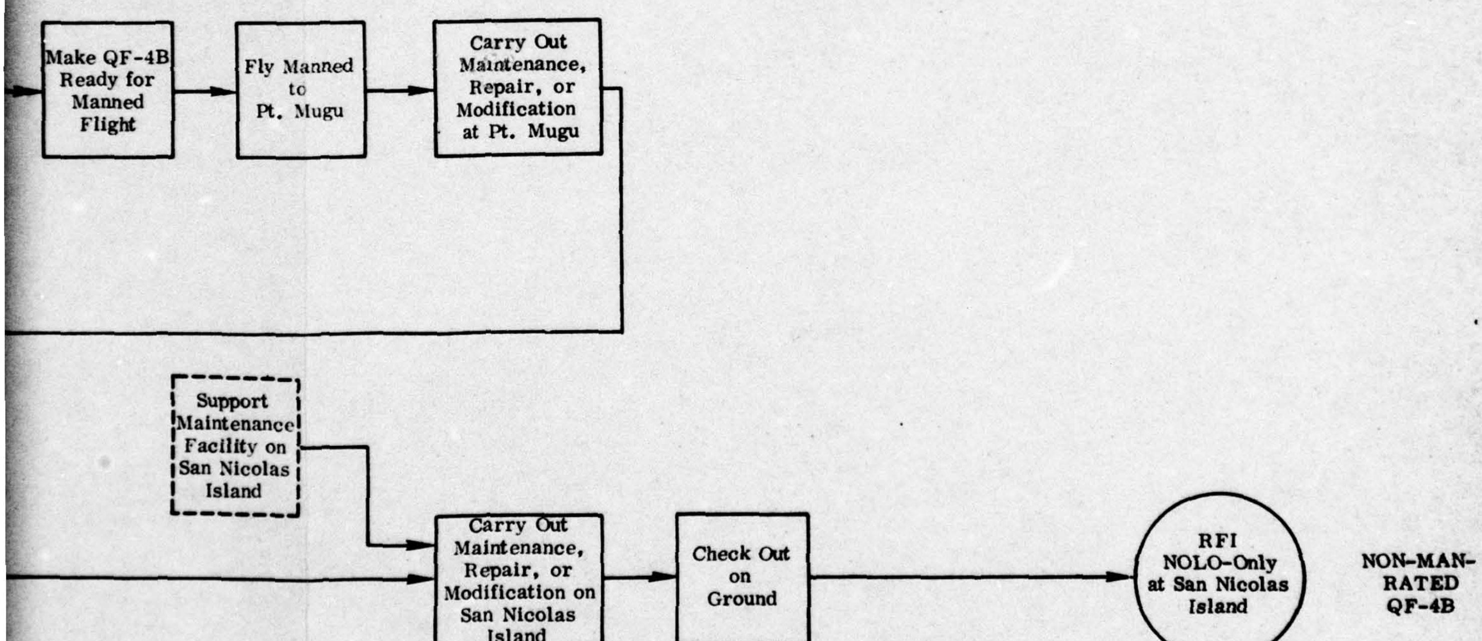


Figure 2-1. Flow Diagram of Use Profile for Manrated and Non-Manrated QF-4B

U

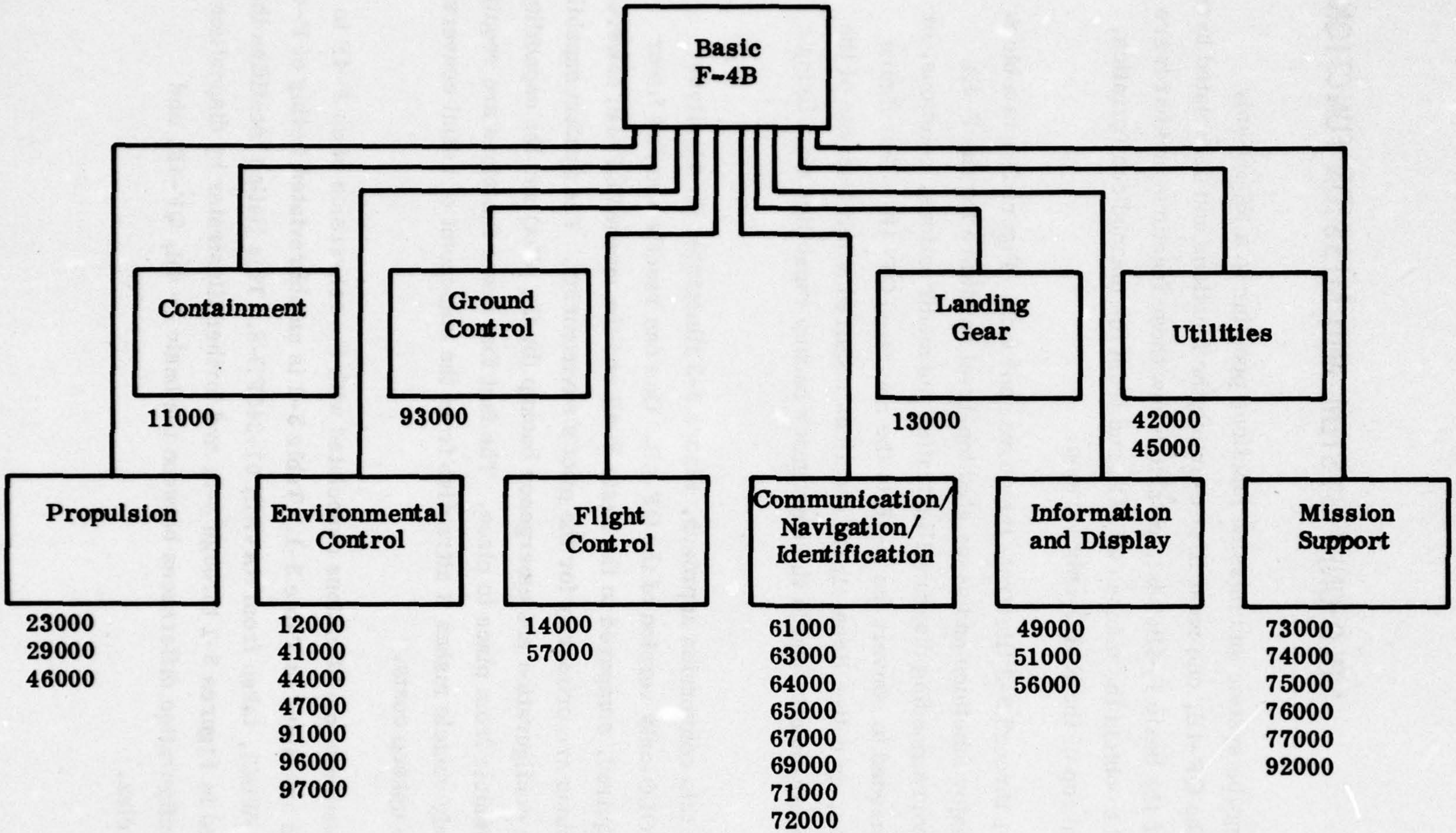
3
NOLO-ONLY SYSTEM AND MISSION FUNCTIONS

In examining the system and mission functions peculiar to a NOLO-only configuration of the QF-4B, one must first examine the functions and associated hardware required for the basic F-4B; next, establish how these functions and hardware must be modified to obtain the manned QF-4B; and from the manned configuration, determine the makeup of the NOLO-only version.

Figures 3-1 through 3-3 illustrate the above approach. Figure 3-1 is a block diagram of the major functions and associated top-level hardware for the F-4B. Figure 3-2 is a corresponding diagram illustrating the modifications, deletions, or new equipments needed to convert the F-4B to the manrated QF-4B. That figure further illustrates, by dotted lines, 1) the functions required solely because of the manned-rated requirements, and 2) the emergency backup capability when flying a captive mission.

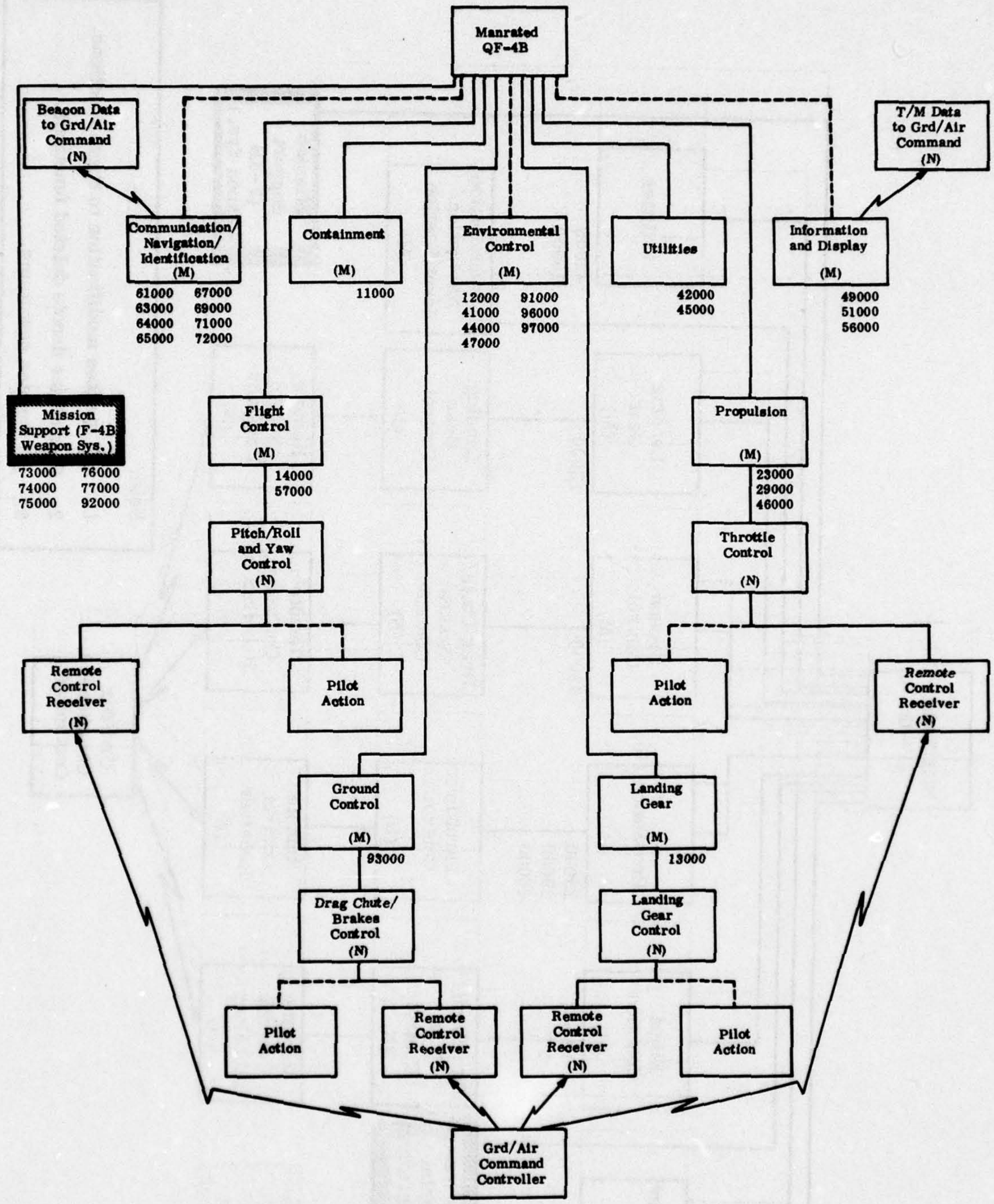
Continuing this conversion approach, Figure 3-3 illustrates the functions required for a NOLO-only version of the QF-4B. One can readily see that fewer functions are required, compared to the basic F-4B and the manned QF-4B; however, the deleted functions are primarily for the pilot's environment. The system capabilities lost by this configuration are emergency backup (by the pilot) and the capability of ferrying the vehicle from place to place. The fact that fewer functions are required for the NOLO-only vehicle makes it attractive from the standpoint of initial conversion and maintenance upkeep costs.

Specific hardware modifications associated with the conversion of an F-4B to a manrated QF-4B are listed in Table 3-1. Table 3-2 is an abbreviated listing of F-4B work unit codes (WUC), taken from NAVAIR 01-245FD-8. This listing identifies the WUCs referenced in Figures 3-1 through 3-3, and further illustrates by disposition of hardware the configuration differences between the basic F-4B, QF-4B, and NOLO-only vehicles.



Note: Numbers associated with functions are the top-level work unit codes from NAVAIR 01-245FD-8, 1 March 1973.

Figure 3-1. Major Functions and Hardware, Basic F-4B



Note:

1. *(M) denotes modification to these functions.*
2. Dotted lines denote functions performed or required for the man.
3. *Slash lines denote deleted functions.*
4. (N) denotes new items.

Figure 3-2. Major Functions and Hardware, Manrated QF-4B

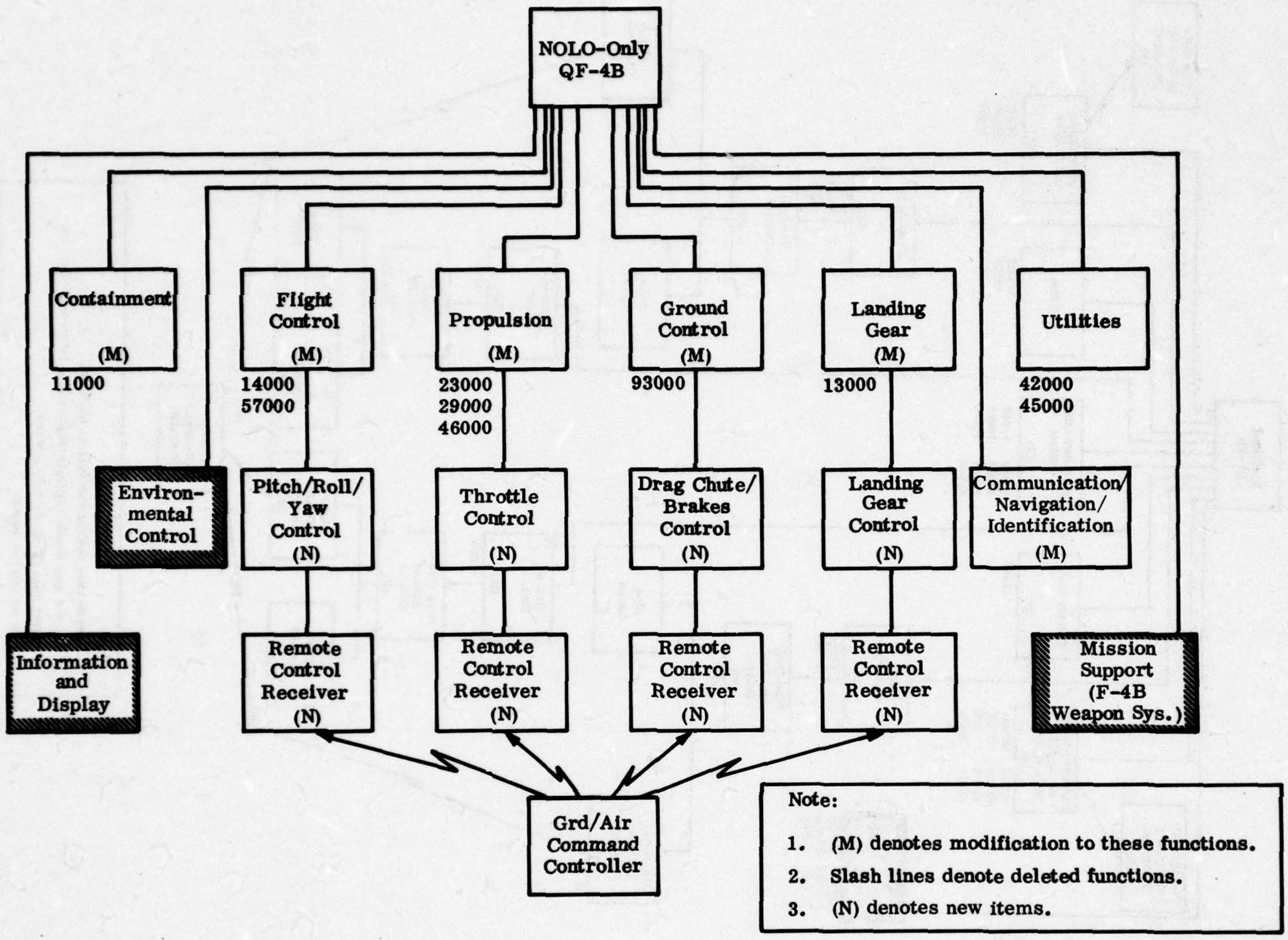


Figure 3-3. Major Functions and Hardware, NOLO-Only QF-4B

TABLE 3-1. EQUIPMENTS REMOVED, MODIFIED, ADDED, OR DISPOSED OF DURING CONVERSION OF F-4B TO QF-4B (MANNED) (Sheet 1 of 7)

Equipment	Disposition*			
	RMR	RD	RR	N
A. NOSE				
Radome	X			
Infrared Receiver, AAA-4		X		
Coolant Bottle (w/Lines)		X		
Radar Modulator, APA-128		X		
Radar Set Gp, w/Ant., APQ-72		X		
Cover Assy	X			
Panel Assy	X			
Tee Rail	X			
Side Rail Assy, Radome Wiring		X		
Coaxial Cable		X		
Radar Nose Cooling Duct Assy		X		
Electronic Package (Drone)				X
C/C Remote Coupler				X
AFCS Remote Coupler				X
Throttle Remote Coupler				X
Stick Center Indicator Box				X
Audio Decoder Relay Multiplexer				X
T/M Converter Box				X
T/M Transmitter, AN/AKT-21				X
Receiver, R-1136/DRW-29 (2EA)				X
Relay Box				X
Box Assy (Includes Auto Brakes Relay & Flasher)				X
T/M Commutator, MC10-30X30-PAM-4				X
Dual Receiver Transfer Box				X
Auto Aileron Trim Box				X

*LEGEND: RMR = Remove, Modify, Replace; RR = Remove (Access), Replace; RD = Remove, Dispose; N = New.

TABLE 3-1. (Sheet 2 of 7)

Equipment	Disposition*			
	RMR	RD	RR	N
A. NOSE (Cont)				
Command Antenna (Upper)				X
Command Antenna (Lower)				X
B. FORWARD COCKPIT				
Pressure Gage	X			
Generator Control Panel	X			
In-Flight Monitor T-249		X		
Support Assy, w/Panels		X		
Utility Elec. Recept. Panel	X			
Otbd Blank Panel Assy	X			
Inbd Blank Panel Assy	X			
Fwd Inbd Blank Panel Assy		X		
Rt. Throttle Handle	X			
Inboard Engine Control Panel			X	
Center Engine Control Panel			X	
Otbd Engine Control Panel	X			
Control Stick Grip Assy		X		
Motional Pick-up Xdcr TR-175 ASA-32			X	
Stick Grip Wiring Assy	X			
Weapons Control Panel	X			
Hydraulic Line Assy	X			
Pilot's Instrument Panel	X			
Glare Shield Assy Main Inst. Panel	X			
L&R Dust Cover Assy	X			

*LEGEND: RMR = Remove, Modify, Replace; RR = Remove (Access), Replace; RD = Remove, Dispose; N = New.

TABLE 3-1. (Sheet 3 of 7)

Equipment	Disposition*			
	RMR	RD	RR	N
B. FORWARD COCKPIT (Cont)				
Blanket Installation		X		
Opt. Sight Ind. Support Assy	X			
Optical Sight & Flt. Ind. APQ-72		X		
Normal & Emerg. Flap Control Sw.	X			
Pilot's Ejection Seat			X	
Fwd Canopy	X			
Emergency Control Panel				X
Primary Control Panel				X
Secondary Control Panel				X
Drone Switch & Light Panel				X
Spare Control Switch Panel				X
Command Master Control Panel				X
Brake Pressure Indicator				X
T/M Disconnect Panel				X
Pilot's Double Head Control Grip				X
Emergency Brake Air Press Gauge				X
Drone Control Panel				X
Arresting Hook Actuator				X
C. AFT COCKPIT				
Emergency Control Panel				X
Primary Control Panel				X
Secondary Control Panel				X
Spare Control Switch Panel				X

*LEGEND: RMR = Remove, Modify, Replace; RR = Remove (Access), Replace; RD = Remove, Dispose; N = New.

TABLE 3-1. (Sheet 4 of 7)

Equipment	Disposition*			
	RMR	RD	RR	N
C. AFT COCKPIT (Cont)				
Command Control Junction Chassis				X
Misc. Relay Panel				X
CADC Disconnect Bracket				X
CATCON or MDM Provisions				X
CATCON Bracket				X
Control Stick				X
Target Power Control Box				X
T-R Ckt. Breaker Panel & AN/ALE-29 Switch Panel				X
Throttle Computer & Amplifier				X
Airspeed Switch				X
Transformer Rectifier				X
Conduit				X
RIO's Instrument Panel		X		
Antenna Control APQ-72		X		
Number 1 Ckt Breaker Panel	X			
Number 2 Ckt Breaker Panel	X			
Expose. Freq. Control		X		
Expose. Freq. Control Support Assy		X		
Missile Signal Ampl.		X		
Throttle Cont. Ampl. ASN-54V	X			
Throttle Cont. Comp. ASN-54V	X			
Dust Cover		X		
Aux. #1 Missile Fire. Rel. Panel		X		

*LEGEND: RMR = Remove, Modify, Replace; RR = Remove (Access), Replace; RD = Remove, Dispose; N = New.

TABLE 3-1. (Sheet 5 of 7)

Equipment	Disposition*			
	RMR	RD	RR	N
C. AFT COCKPIT (Cont)				
Aux. #2 Missile Fire. Rel. Panel		X		
Bomb Rel. Angle Comp. AJB-3		X		
Indicator Control Unit APQ-72		X		
Indicator Control Unit Frame Assy	X			
Central Air Data Computer	X			
Bracket Assy		X		
Displacement Gyro Assy AJB-3	X			
Control Ampl. Assy. ASA-32E	X			
Radar Set Control APQ-72		X		
Aux. Radar Set Control APQ-72		X		
RIO's Flight Ind.		X		
Flt. Ind. Cylinder Assy		X		
Aft Canopy			X	
RIO's Ejection Seat			X	
Pitot Line Assy	X			
Static Line Assy	X			
Lt. Foot Ramp Assy			X	
Rt. Foot Ramp Assy			X	
D. FUSELAGE				
FEI Camera Control Box				X
T/M Antenna				X
C/X Band Antenna (Pri.) (Radar Beacon)				X
C/X Band Antenna (Alt.) (Radar Beacon)				X

*LEGEND: RMR = Remove, Modify, Replace; RR = Remove (Access), Replace; RD = Remove, Dispose; N = New.

TABLE 3-1. (Sheet 6 of 7)

Equipment	Disposition*			
	RMR	RD	RR	N
D. FUSELAGE (Cont)				
Emerg. Hyd. Stab. Relay Box				X
MDM Antenna (Upper)				X
MDM Antenna (Lower)				X
Auto Brakes Hyd. Control Panel				X
Throttle Control Limit Switches (2EA)				X
Port & Stbd Engine Tubing (Fuel)				X
Landing Gear Tubing (Hyd.)				X
Vertical Accelerometer				X
Radar Beacon, C/X-Band, AN/DPN-77/78				X
E. AFT FUSELAGE				
Hydraulic Lines		X		
Pulley Bracket		X		
ARI Ampl.	X			
Drag Chute Actuator				X
Emerg. Hyd. Stabilator				X
Direct Rudder Box				X
F. BOTTOM FUSELAGE				
Brake Press Line	X			
Brake Press Line	X			
Utility Return Line Assy.	X			
Utility Press Line Assy.	X			
L&R Brake Press Line Assy	X			
R.H. Fwd Mis. Cav. Access Door	X			

*LEGEND: RMR = Remove, Modify, Replace; RR = Remove (Access), Replace; RD = Remove, Dispose; N = New.

TABLE 3-1. (Sheet 7 of 7)

Equipment	Disposition*			
	RMR	RD	RR	N
F. BOTTOM FUSELAGE (Cont)				
Ampl./Rcvr Pwr. Supply AWW-1		X		
Tuning Drive APA-12B		X		

*LEGEND:

RMR - Remove, Modify, Replace
RR - Remove (Access), Replace
RD - Remove, Dispose
N - New

TABLE 3-2. MAJOR WUC ITEMS IN F-4B AIRCRAFT
(Sheet 1 of 8)

WUC (from NAVAIR 01-245FD-8, 1 March 1973)	Equipment	QF-4B Manned	QF-4B Unmanned	NOLO Only
11000	AIRFRAME	M	M	M
	Fuselage	↓	↓	↓
11110	Forward Fuselage Section			
11150	Center Fuselage Section			
11180	Aft Fuselage Section			
	Wings			
11210	Center Wing Section			
11230	Outer Wing Section			
	Air Induction System			
11310	Variable Inlet Duct	M	M	M
12000	FUSELAGE COMPARTMENT	M	M	M
12110	Cockpit Compartments	M	M	M
	Ejection Seats	S	R	R
	Canopy System	M	M	M
12310	Canopy Pneumatic	M	M	M
12340	Canopy Jettison	M	D	R
123A0	Canopy Operating	S	S	S
123C0	Canopy Warning	S	S	D
13000	LANDING GEAR	S	S	S
	Landing Gear Systems	S	S	S
13110	Landing Gear Control	M	M	M
13120	Landing Gear Hydraulics	S	S	S
13140	Landing Gear Switch	S	S	S
13150	Emergency Landing Gear	S	D	D
	Main Landing Gear	S	S	S
	Nose Landing Gear	S	S	S
13340	NLG Steering	M	M	M
	Wheelbrake/Antiskid	M	M	M
13500	Arresting Gear System	M	M	M
	Catapult System	D	D	D

LEGEND: S = Same; R = Removed; M = Modified; D = Disabled.

TABLE 3-2. (Sheet 2 of 8)

WUC (from NAVAIR 01-245FD-8, 1 March 1973)	Equipment	QF-4B Manned	QF-4B Un-manned	NOLO Only
14000	FLIGHT CONTROLS	M	M	M
	Control Stick Mech.			
14110	Control Stick Assy			
	Lateral Control System			
14210	Aileron Assy			
14220	Aileron Control System			
14240	Spoiler Assy			
14250	Spoiler Control System			
14260	Lateral Feel Trim			
14270	Lateral Control Link			
	Stabilator System			
14310	Stab. Assy			
14320	Stab. Control System			
14330	Stab. Feel Trim			
	Rudder System	M	M	M
	Flap System	S	S	S
	Speed Brake System	S	S	S
	Wingfold System	S	S	S
23000	TURBOJET ENGINES	S	S	S
23A00	J79 Engine	S	S	S
29000	POWER PLANT INSTALLATION	S	S	S
	Engine Mount Suspension	S	S	S
	Power Plant Controls	M	M	M
29310	Throttle/Power Lever	M	M	M
	Ignition & Start System	S	S	S
	Exhaust System	S	S	S
	Inlet Air System	S	S	S
	Approach Power Comp. System	M	M	M
29C10	Control Set, AN/ASN-54	M	M	M

LEGEND: S = Same; R = Removed; M = Modified; D = Disabled.

TABLE 3-2. (Sheet 3 of 8)

WUC (from NAVAIR 01-245FD-8, 1 March 1973)	Equipment	QF-4B		NOLO Only
		Manned	Un-manned	
41000	A/C-PRESS-ICE CONTROL	S	S	M
	Air Conditioning			
41110	Cabin A/C			
41120	Cabin Refrig.			M
41130	Equip. A/C			S
41140	Equip. Refrig.			
41150	Equip. Aux. Air System			
41160	Equip. Environ. Control System			
	Pressurization			S
41210	Cabin Press.			D
41220	Radar Comp. Press			
41230	Bleed Air System			
41240	Canopy Seal Pressurization			
	Rain Removal System			
41310	Rain Removal Comp.			
	Anti-G System			
41410	Anti-G Comp.			D
	BLC System			S
41520	O/W L.E. BLC System			
41530	C/W L.E. BLC System			
41540	Wing T.E. BLC System			
41550	BLC Warning	S	S	S
	Camera Wind. Anti-Fog	D	D	R
41610	Anti-Fog Comp.	D	D	R
	Radar Cooling System	R	R	R
41710	Radar Cooling Comp.	R	R	R
42000	ELECTRICAL SYSTEM	M	M	M
	Electrical Power Supply			
42110	Relay Panels			
42120	Main Power Supply			
42130	DC System	M	M	M

LEGEND: S = Same; R = Removed; M = Modified; D = Disabled.

TABLE 3-2. (Sheet 4 of 8)

WUC (from NAVAIR 01-245FD-8, 1 March 1973)	Equipment	QF-4B Manned	QF-4B Un-manned	NOLO Only
42140	Emergency Power System	M	M	M
42150	C/B Panels	M	M	M
	Constant Speed Drives	S	S	S
44000	LIGHTING SYSTEM	S	M	M
	Interior Lighting	↓	D	R
44110	Pilot's Cockpit Lighting	↓	D	R
44120	RIO Cockpit Lighting	↓	D	R
	Exterior Lighting	↓	M	M
44210	Exterior Lighting Components	↓	M	M
44220	Fuselage Lights	↓	M	M
44230	Wing Lights	S	M	M
45000	HYDRAULIC/PNEUMATIC POWER	S	M	M
	Hydraulic Systems	↓	↓	↓
45110	Power Control #1	↓	↓	↓
45120	Power Control #2	↓	↓	↓
45130	Utility Hyd. System Gp. 1	↓	↓	↓
45140	Utility Hyd. System Gp. 2	↓	M	M
	Pneumatic System	↓	D	R
45210	Compressor System	↓	↓	↓
	Ram. Air Turbine System	↓	↓	↓
45310	RAT Actuating System	↓	↓	↓
45320	Emergency Hyd. RAT	S	D	↓
	Data Link Corner Reflector	R	R	↓
45510	DLCR Mech.	R	R	R
46000	FUEL SYSTEM	S	S	S
	Internal Fuel System	↓	↓	S
	External Fuel System	↓	↓	S
	Air Refueling System	↓	↓	R
46310	Air Refuel Mech.	S	S	R
	Fuel Control Ind./Warn.	M	M	M

LEGEND: S = Same; R = Removed; M = Modified; D = Disabled.

TABLE 3-2. (Sheet 5 of 8)

WUC (from NAVAIR 01-245FD-8, 1 March 1973)	Equipment	QF-4B		NOLO Only
		Manned	Un-manned	
46410	Fuel Control System	M	M	M
46430	Fuel Low Level Warning	M	M	M
	Air Refuel Buddy Tank	S	S	R
46510	Buddy Tank Nose Section			
46520	Buddy Tank Center Section			
46530	Buddy Tank Cone Section			
46540	Air Refuel A/C Mounted Cont.	S	S	R
47000	OXYGEN SYSTEM	S	D	R
	Liquid Oxygen System			
47110	Oxygen Supply System			
	Oxygen Distribution System			
47210	Distribution Comp.			
47220	Emergency Oxygen System	S	D	R
49000	MISC. UTILITIES	S	S	S
	Fire/Overheat Detection			
49110	Engine Fire Detection			
49120	Aft Fuse Overheat Detection	S	S	S
51000	GENERAL INSTRUMENTS	S	M	R
51110	Flight Instruments		M	R
51130	Pitot Static System		S	M
51140	Statistical Accelerometer		D	R
	Navigation Instrumentation		R	R
51210	Navigation Instruments		R	R
	Engine Instruments		M	M
51410	Tachometer System			
51420	Temperature Indication			
51430	Engine Press. Indication			
51440	Misc. Engine Indication			
	Position Indicators			
51610	L/G Position Ind.	S	M	M

LEGEND: S = Same; R = Removed; M = Modified; D = Disabled.

TABLE 3-2. (Sheet 6 of 8)

WUC (from NAVAIR 01-245-FD-8, 1 March 1973)	Equipment	QF-4B Manned	QF-4B Un-manned	NOLO Only
51620	Flight Control Ind.	S	M	R
51630	Eng. Position Ind.		M	R
	BLC Sys. Instruments		S	S
51710	BLC Indicators		S	S
	Utility System Instruments		M	M
51810	Hyd. System Ind.			M
51820	Pneumatic System Ind.			R
51840	Fuel System Ind.			M
51850	Oxygen System Ind.	S	M	R
56000	FLIGHT REFERENCE	S	M	R
56260	Vert. Flight Ref. Set AN/ASN-70			M
56270	Ref. Set AN/ASN-55			R
56450	Air Data Computer		M	M
564C0	Flt. Recorder System		R	R
56860	Angle of Attack System	S	M	M
57000	INTEGRATED GUIDANCE & FLIGHT CONT.	M	M	M
61000	HF COMMUNICATION SYSTEM	S	D	R
61210	Radio Set AN/ARC-105	S	D	R
63000	UHF COMMUNICATION SYSTEM	S	D	R
63180	Radio Set AN/ARC-75			
63190	Radio Set AN/ARC-88			
63340	UHF Aux. Receiver AN/ARR-69			
63510	Digital Data Comm. AN/ASW-25	S	D	R
64000	INTERPHONE SYSTEM	S	D	R
64810	Misc. Interphone Equipment	S	D	R

LEGEND: S = Same; R = Removed; M = Modified; D = Disabled.

TABLE 3-2. (Sheet 7 of 8)

WUC (from NAVAIR 01-245FD-8, 1 March 1973)	Equipment	QF-4B		NOLO Only
		Manned	Un-manned	
65000	IFF SYSTEMS	S	R	R
65110	S/F Coder AN/APA-89	↓	↓	↓
65210	Radar Ident. AN/APX-6	↓	↓	↓
65320	Interrogator AN/APX-76A	S	R	R
67000*	INTEGRATED COM-NAV-IFF	S	M	M
69000	MISC. COMMUNICATIONS	R	R	R
71000	RADIO NAVIGATION	S	R	R
71160	Direction Finder AN/ARA-50	S	R	R
71740	Flt. Director Computer Group	S	R	R
72000	RADAR NAVIGATION	S	R	R
72360	Radar Altimeter AN/APN-141	S	R	R
72470	Radar Set AN/APQ-99	R	R	R
73000	BOMBING NAVIGATION	R	R	R
74000	WEAPON CONTROL	R	R	R
75000	WEAPONS DELIVERY	R	R	R
76000	ECM SYSTEMS	R	R	R
77000	PHOTO/RECONNAISSANCE	R	R	R
91000	EMERGENCY EQUIPMENT	R	R	R
92000	TOW TARGET SYSTEMS	R	R	R
93000	DRAG CHUTE EQUIPMENT	M	M	M
93110	Control Components	M	M	M
93210	Drag Chute Storage	S	S	S

LEGEND: S = Same; R = Removed; M = Modified; D = Disabled.

*May have replaced WUC 61000, 63000, 65000, 71000

TABLE 3-2. (Sheet 8 of 8)

WUC (from NAVAIR 01-245FD-8, 1 March 1973)	Equipment	QF-4B		NOLO Only
		Manned	Un-manned	
96000	PERSONNEL EQUIPMENT	S	R	R
97000	EXPLOSIVE DEVICES	S	D	R

LEGEND: S = Same; R = Removed; M = Modified; D = Disabled.

4
LOSS RATE COMPARISONS

4.1 LOSS RATES FOR NOLO MISSIONS

The NOLO mission loss rate can be expressed as the sum of the kill rate and the operational (or non-kill) loss rate. For the QF-4B, there is no reason to believe that kill rates will differ between the manrated and non-manrated configurations. In discussions with ARINC Research representatives, personnel at NMC, NADC, and NAVAIR stated that kill rates could undergo large variations due to the type of weapon being fired and the release conditions employed. Based on past Navy experience with other target systems, these Navy personnel expressed the belief that a kill rate of one per three or four NOLO flights would be a reasonable baseline value.

For NOLO flight, the operational loss rate of the target system is a function of the following factors:

a. Inherent configuration reliability, judged to be the same for both configurations since all functions contributing to the reliability of the manrated vehicle in NOLO flight would be retained in the non-manrated system.

b. Hardware quality or condition, estimated to be approximately the same for the two configurations. This conclusion was based on the assumption that the rework for the non-manrated configuration will be specified to include all rework required to prevent an undue increase in the loss rate of the unmanned configuration of the present vehicle. There are, in fact, grounds for believing that a decrease in rework activity for the non-manrated configuration might actually result in a decrease in its operational loss rate. Several Navy personnel interviewed expressed the belief that the probability of a serious malfunction could be increased for the first few flights following a rework because of the opportunity for human error during rework. For a vehicle that cannot be test flown with a pilot, malfunctions induced during rework could result in vehicle loss. Further, for a vehicle expected to have a small number of flights before loss from a kill, such an increase might well overshadow any reliability benefits arising from the rework.

c. Checkout quality, which is felt to have the potential of causing the non-manrated configuration to have a loss rate significantly greater than that of the manrated system. This belief is based on conversations with personnel of NMC, NADC, NAVAIR, and both NARFs. The frequency and severity of faults identified during test flights after aircraft rework and conversion are generally considered to be substantially greater than the normal incidence during operational use. F-4B rework data at one NARF for a recent month illustrate this point. For 15 aircraft processed, 44 test flights were made. There were an additional 13 aborts. During the month, 129 significant discrepancies were noted for these aircraft, of which 23 were associated with the autopilot. For the QF-4B, the present ground-checkout capability is obviously inadequate to detect many such equipment malfunctions. The capabilities of future ground-checkout equipments for an unmanned drone can only be conjectured at this time. Although such equipment could probably detect most of the faults that would be identified in routine test flights, the drone loss rate is likely to be substantially greater if test flights are not made after rework, conversion, and major maintenance actions. Uncertainty in the loss rate parameter makes a non-manrated QF-4B configuration a high-risk choice.

d. Quality of maintenance, which should be somewhat inferior for the non-manrated system since the isolated nature of the San Nicolas Island facility should make it difficult to obtain the same quality of personnel as are employed at Pt. Mugu.

e. Other extraneous factors, including losses due to human error, flight conditions, etc., were estimated to be the same for both configurations.

4.2 OPERATIONAL LOSS RATES

Loss rates for the manrated and non-manrated QF-4B configurations would differ significantly for those flights that would be flown manned by the manrated vehicle. Since the non-manrated version would have to fly these missions NOLO, the higher NOLO operational loss rate would apply to that configuration. Although there is insufficient experience with the QF-4B to establish a firm estimate of expected operational loss rate during NOLO flights, the consensus of Navy personnel interviewed was that 2% (one loss in 50 flights) would be of the proper order for the manrated system. This would therefore represent a minimum value for a non-manrated system.

In addition to its higher loss rate, the non-manrated configuration is further penalized by the cost for a controller, chase aircraft, and range tracking to support the NOLO flight. These factors eliminated the non-manrated configuration from serious consideration as a candidate for the captive missions. That is, since that configuration is felt to be a poor candidate for NOLO missions, these additional drawbacks make it a much worse candidate for the captive missions.

5
VEHICLE CONVERSION AND LOGISTICS

Four F-4B aircraft have been converted into manrated QF-4B vehicles, and two more are in the process of being converted. For these first few aircraft, conversion was accomplished at NADC after either a PAR at a NARF or a PAR equivalent conducted by a field team. On subsequent conversions, the fabrication, assembly, and installation of conversion kits will all be part of the NARF function. Rework and conversion will occur concurrently.

Rework and conversion requirements are described below for three candidate QF-4B configurations, which in various combinations make up the five target system options defined in Section 2. These configurations are: 1) a manrated configuration of the present type (see Section 5.1), 2) a non-manrated configuration (Section 5.2), and 3) an inexpensive manrated configuration which reduces rework through use of an aircraft condition evaluation (ACE) rather than a PAR (Section 5.3). This is followed by a description of the basic procedures and manhour requirements for rigging of the manrated QF-4B for NOLO operation (Section 5.4), and a discussion of transportation options for the non-manrated configuration (Section 5.5).

5.1 QF-4B MANRATED CONFIGURATION

The manrated QF-4B configuration discussed herein is essentially the one in use at NMC. Data related to rework and conversion of the F-4B to the manrated QF-4B configuration were obtained from NADC and both NARF locations.

Certain elements normally performed during an F-4B PAR are deleted from the NARF effort on the QF-4Bs because of the peculiar requirements of the target mission and the limited life expectancy of the drone. Required airframe changes (as established by NMC personnel) during the QF-4B PAR, and related manhour estimates, are listed in Appendix A. NARF personnel estimate that about 80% of these changes will have been made in PAR cycles prior to allocation of the F-4B and QF-4B target program.

Table 3-1 of Section 3 lists equipment removals, modifications, and additions deemed necessary to convert the F-4B aircraft into a manrated QF-4B. Note that some items are neither reworked nor removed, since removal is expensive and the equipment is not subsequently useful to the drone operation.

Table 5-1 gives approximate manhour requirements estimated by NARF/North Island for the various categories of PAR actions necessary to rework the F-4B for three cases: 1) normal F-4B PAR, 2) PAR prior to conversion to a manrated QF-4B, and 3) PAR prior to conversion to a non-manrated QF-4B.

TABLE 5-1. APPROXIMATE PAR MANHOUR REQUIREMENTS BY FUNCTIONS AT NARF/NORTH ISLAND

PAR Function	Task Time, Manhours		
	F-4B	QF-4B (Manned)	QF-4B (NOLO Only)
Change Incorporation	2,500	1,500	1,000
Corrosion Repairs	4,000	4,000	500
Test Flight	500	500	0
Corr. Control and Paint	700	700	300
Engines	600	600	600
Components	2,500	2,000	1,000
E&E Evaluation	400	400	400
"PAR Work"	6,800	5,200	3,000
Subtotal	18,000	14,900	6,800
Conversion Plus Kit		8,000	8,000
Total		22,900	14,800

Table 5-2 gives approximate manhour requirements estimated by NARF/Cherry Point for: 1) modified PAR with conversion, 2) kit production, and 3) kit installation without PAR. Also included are approximate estimates of the reduction in rework manhours if a modified ACE is used instead of a modified PAR, and the number of manhours expended in rework of the life support subsystems.

The manhour estimates provided by the two NARFs (Tables 5-1 and 5-2) can be used to estimate the costs of PAR with conversion. Using loaded manhour rates of

TABLE 5-2. APPROXIMATE PAR AND ACE MANHOUR REQUIREMENTS AT NARF/CHERRY POINT

Task	Task Time, Manhours
QF-4B modified PAR plus conversion	12,600
Kit production	7,200
Total	19,800
Kit installation without PAR	6,100
Kit production	7,200
Total	13,300
Estimated reduction in rework plus conversion cost if replace modified PAR with modified ACE	4,500
Maximum amount of rework applied to life support subsystems	500

$18, these result in costs of $412,200 and $356,400, respectively, for NARF/San Diego and NARF/Cherry Point. A compromise value of approximately $400,000 is believed to be reasonable.

5.2 QF-4B NOLO-ONLY CONFIGURATION

The NOLO-only configuration was derived from the current QF-4B configuration by deleting:

a. All crew-support functions, including display, control, and environment; and

b. Emergency and backup systems exercised only by a pilot.

Equipment associated with the above items will generally remain in the aircraft since removal costs will exceed salvage value in most cases. Table 3-2 compares equipment removal and modification requirements for the NOLO-only configuration with those for the manrated configuration. Equipment additions for the NOLO-only configuration would be functionally the same as for the manrated configuration except for the control stick mechanism and control panels. NADC estimates that a NOLO-only kit would cost approximately $6,100 less than the current QF-4B kit, and could be installed for about $400 less per kit. The one-time engineering cost of this kit would be $40,000. Spreading the engineering development costs over 50 vehicles (five conversions per year for ten years), the net reduction in per-vehicle cost would be approximately $6,000.

For the NOLO-only vehicle, PAR actions could be drastically reduced because of the short life expectancy of that drone. Only those actions necessary to keep the aircraft airworthy need be undertaken. Corrosion control could be limited to chemical treatment and repainting. Table 5-1 lists PAR actions and manhour requirements for the NOLO-only configuration.

The approximate manhours estimated by NARF/North Island to include PAR, kit production, and conversion for the NOLO-only QF-4Bs are about 35 percent lower than those for the nominal manrated configuration. By comparison, the approximate estimates supplied by NARF/Cherry Point for kit production (7,200 manhours) plus installation without PAR (6,100 manhours) are 33 percent lower than the 19,800 manhours estimated for the nominal manrated configuration. This seems in reasonable agreement. Assuming that the total cost will scale in rough proportion to the manhours involved, the total cost for the non-manrated version is derived by reducing the manrated cost by 35%. This results in an estimated cost of $260,000 for the non-manrated configuration using the present kit. Use of a NOLO-only kit would reduce the cost of the non-manrated configuration to $254,000.

5.3 REDUCED-COST MANRATED CONFIGURATION

One way to reduce the cost of the QF-4B while retaining the manrating capability is to utilize an ACE instead of a full PAR when the conversion is made. The ACE differs from the PAR in that only essential depot-level rework functions are accomplished in the former. Personnel at NARF/Cherry Point estimated that an ACE with conversion would be approximately 4,500 manhours less than a PAR with conversion. This corresponds to a 23% reduction in their estimate of 19,800 manhours for rework, kit production, and conversion. Assuming that the cost is roughly proportional to the manhours, the estimated cost of the reduced-cost manrated configuration is $310,000.

It should be noted that the cost difference of $90,000 between the two manrated configurations is higher than would be obtained using an $18 manhour rate with Cherry Point's estimated 4,500 manhour difference. This resulted from the initial scaling up of the Cherry Point estimates when the compromise value of $400,000 was selected for the present manrated configuration.

5.4 CONVERSION OF MANRATED QF-4B FOR NOLO OPERATION

Prior to NOLO operation of the manrated QF-4B aircraft, a rigging procedure is conducted that includes removal of certain equipments from the vehicle. Part of the procedure, described in Table 5-3, is performed at Pt. Mugu (24 manhours) and the remainder is completed on-site at San Nicolas Island (16 manhours). Removal of the noted items prevents their loss if the QF-4B is lost. This conversion to the NOLO configuration currently requires about two working days. Pre-mission test and line-check actions (including pilot cockpit check and engine runup) require about 16 manhours of the 40-manhour total.

5.5 QF-4B NOLO-ONLY TRANSPORTATION REQUIREMENTS

Transportation of the manrated QF-4B presents no special difficulties. Such aircraft are routinely ferried from point to point with a normal crew in a conventional manner. The NOLO-only configuration, however, will be without crew support systems and thus can no longer be piloted by an onboard crew.

If the QF-4B is configured for NOLO-only operation at the NARF, suitable surface transportation to a launch site will have to be arranged. Alternatively, it may be possible to launch the NOLO vehicle from NAS/North Island or from NMC/Pt. Mugu for over-water flight to San Nicolas Island. A NOLO launch in the heavily populated Coronado area of San Diego, however, may be undesirable for safety reasons. It would be necessary to ship a launch crew and control equipment to NAS/North Island. Transportation costs from NMC/Pt. Mugu are estimated at $3,750, with an additional expense of $5,600 for the crew ($1,400 per day for about four days). Transportation to San Nicolas Island by sea is complicated by the fact that it lacks pier facilities. Existing helicopter lift capacity is insufficient to transport the 30,000-pound QF-4B without removing the engines. If the engines are removed and prepared for shipping, the CH-54 or CH-47C helicopters could provide the transport, but neither of these helicopters is in Navy inventory. Commercial rental of the equivalent S-64 Skycrane would cost $2,700 to $3,000 per hour. About 200 manhours are required to remove, pack, unpack, and replace the two J-79 engines.

Table 5-4 lists six conversion/transportation options for the NOLO-only configuration, and the associated cost breakdown. The following inputs were used in deriving these costs:

a. QF-4B ferry flight costs are taken as $1,044 per flight hour. This factor is derived from F-4B operating costs data (POL, base material support,

TABLE 5-3. QF-4B NOLO RIGGING PROCEDURE

MAINLAND

1. Remove following from rear cockpit:
   a. CAT instrument panel
   b. True airspeed indicator
   c. Altimeter
   d. Remote attitude indicator
   e. Airspeed indicator
   f. Bearing distance heading indicator
   g. Clock
2. Cap and secure the static and pitot lines removed from the above instrumentation. Perform static and pitot system leak test.
3. Tag equipment indicating aircraft BUNO and cockpit removed from.
4. Install C-beacon and check.
5. Install new main mounts and nosewheels.
6. Install ballast as follows:

   Nose

   ______ # at F.S. ______

   ______ # at F.S. ______

   ______ # at F.S. ______

   ______ # at F.S. ______

SAN NICOLAS ISLAND

1. Remove complete egress systems from front cockpit.
2. Remove complete egress system from rear cockpit.
3. Hi-g only. Remove stabilator power control cylinder control rod and pin manual control linkage.
4. Remove following from front cockpit:
   a. Clock
   b. Magnetic compass
   c. Standby attitude indicator (peanut gyro)
   d. Radar altimeter
5. Install NOLO seat.
6. Remove RT601/APN-141 & SA701/APN-141.
7. Remove safety wire from UHF radio in rear cockpit.
8. Remove LOX converter.
9. Perform C-beacon check.

LINE CHECK

1. Position aircraft at line, service, and perform preflight inspection.
2. Perform prestart cockpit check and start engines per QF-4B procedure.
3. Perform fox remote/TM check per QF-4B procedure.
4. Taxi to runway and perform setup per procedure.

TABLE 5-4. CONVERSION/TRANSPORTATION OPTIONS FOR NOLO-ONLY QF-4B

Conversion/Transportation Options		Estimated Cost for NOLO-Only QF-4B Including Delivery to San Nicolas Island
1. PAR & Preliminary Conversion @ NARF(1)	$118,936	
Ferry Flight to Pt. Mugu(1)	1,044	
Conversion Kit Cost(2)	130,944	
Complete Conversion @ Pt. Mugu	52,560	
NOLO Flight to San Nicolas(4)	1,253	
		$304,737
2. PAR & Preliminary Conversion @ NARF	118,936	
Ferry Flight to San Nicolas Island(1)	626	
Conversion Kit Cost	130,944	
Complete Conversion @ San Nicolas	52,560	
		$303,066
3. PAR & Complete Conversion @ NARF	125,944	
Conversion Kit Cost	130,944	
Surface Transport to Pt. Mugu(1,3)	12,371	
NOLO Flight to San Nicolas	1,253	
		$270,512
4. PAR & Complete Conversion @ NARF	125,944	
Conversion Kit Cost	130,944	
NOLO Flight to San Nicolas(1)	11,228	
		$268,116
5. PAR & Complete Conversion @ NARF	125.944	
Conversion Kit Cost	130,944	
Helo to San Nicolas Island(1,5)	17,100	
		$273,988
6. PAR & Complete Conversion @ NARF	125,944	
Conversion Kit Cost	130,944	
Surface Transport to Pt. Mugu(1)	12,371	
Helo to San Nicolas Island(5)	10,350	
		$279,609

NOTES:

(1) Calculated costs based on transportation from NARF/San Diego.

(2) Kit costs may be reduced; see Section 5.2.

(3) Rail shipment or extended truck shipment requires engine removal and drop of wing center section. Effort involves about 1,000 manhours.

(4) Includes operating cost of chase aircraft.

(5) Requires separate trips for airframe and engines.

and parts) supplied by the Office of Naval Research, combined with maintenance support costs for F-4 aircraft from AFM-173-10, USAF Cost and Planning Factors.

b. NOLO flight costs are based on the same operating cost data as above, but include an amount covering one chase aircraft operating round-trip from the point of departure. No consideration was made for the additional ground support, control, and range personnel needed for the chase aircraft, or for special material and labor costs associated with NOLO operation (other than the launch crew).

c. It was estimated by NARF/San Diego that the limited PAR to update the F-4B aircraft for NOLO only operation requires approximately 6,800 manhours at a labor rate of $16.46 per average hour.

d. Conversion kit fabrication requires $4,800 in material costs plus 7,200 manhours @ $17.52 (NARF/San Diego labor rate estimate) for a total kit cost of $130,944.

e. Installation of the kit during PAR action at the NARF requires an additional 800 manhours. (Installation alone, without any associated PAR, requires 6,100 manhours.) A preliminary conversion, without causing a loss of manrating, could be accomplished during PAR in about 400 additional manhours, and the complete NOLO-only conversion kit could then be installed at the operating base in another 3,000 manhours. Manhour rates of $17.52 were used for all kit installation actions.

f. Transportation costs could be reduced slightly for option 5 by using barge or supply boat transportation to San Nicolas Island. Since there is no pier at the island, helicopter lift from barge to ramp is still required and the net cost savings would be slight. The engines must be removed to enable helicopter lift, with associated costs estimated at $3,600.00. The cost of surface transportation is primarily associated with 1) the dismantling needed to reduce the large F-4 airframe to an acceptable width for truck or rail car, and 2) subsequent reassembly. Such transportation from NARF/Cherry Point to Pt. Mugu would not increase total costs by more than a few thousand dollars, a factor that could easily be offset by differences in labor rates.

g. Preliminary conversion at the NARF permits economical ferry transport of manned aircraft, which makes NARF/Cherry Point even more competitive vs. NARF/North Island. The retention of a manned capability would also enable manned test flights after completion of PAR actions.

5.6 QF-4B NOLO-ONLY MAINTENANCE REQUIREMENTS

QF-4B maintenance facilities are at NMC/Pt. Mugu. Routine aircraft inspections as well as drone-peculiar support and nonscheduled maintenance actions are accomplished at both the organization and intermediate levels.

San Nicolas Island maintenance capabilities are limited. Few facilities have been built, and no maintenance personnel are domiciled on-site. Routine maintenance is performed by converting the QF-4B into a manned flight configuration and flying it to NMC/Pt. Mugu with a normal onboard crew. If a vehicle cannot be made safe for manned flight with the support and efforts of technicians flown in from Pt. Mugu, the drone is flown NOLO without further routine maintenance actions until lost or damaged beyond recovery.

A NOLO-only version of the QF-4B based at San Nicolas Island could not be returned to Pt. Mugu for maintenance under existing range safety rules, which prohibit NOLO landings at NMC. Either the safety restrictions must be modified or adequate maintenance facilities must be established on the island. The San Nicolas facilities need not be sophisticated since Pt. Mugu, in close proximity, can support the maintenance effort with supply, documentation and intermediate level backup for system test and repair. Facilities that must be constructed at San Nicolas Island include a 6,400-square-foot concrete parking and tie-down area, and a 40 by 40-foot engine runup slab with tie-downs. The construction cost was estimated by NMC as approximately $60,000.

Appendix B lists those items of equipment needed to bring the San Nicolas Island maintenance capability to the necessary level of adequacy. Equipment costs total approximately $190,000, although catalog prices for APA items may be somewhat understated.

The San Nicolas Island maintenance team for QF-4B NOLO-only support should consist of at least five contractor personnel, to include two avionics technicians, one airframe mechanic, one engine mechanic, and one supervisor. (Qualified military or Civil Service personnel are unlikely to be found for this effort since facilities are austere and such personnel cannot be authorized compensating premium pay.) NMC

recently received an estimate from a contractor to provide maintenance personnel at Pt. Mugu for $25,000 per manyear. Allowing an additional $25,000 to cover premium pay and transportation to the mainland as required, this results in an estimated cost of approximately $150,000 per year for the personnel manning the San Nicolas Island maintenance facility.

6

RELATED AIR FORCE PROGRAM (QF-102)

An Air Force program similar to that being evaluated herein for the QF-4B is based on modifications of the formerly operational F-102. Three F-102 aircraft have been converted for drone operations with back-up pilots onboard, and have been designated the QF-102. Five other aircraft have been converted for flight without an onboard operator, and are designated the PQM-102. Although the PQM-102 is an unmanned target, an onboard pilot will be used to ferry it to other operational sites when required.

The control system for both configurations has been designed by Sperry Flight Controls, Phoenix, Arizona. Basic structural and wiring modifications to the F-102 aircraft are made by Fairchild Aircraft, Crestview, Fla. Modified aircraft are then flown to Holloman Air Force Base where Sperry completes the conversion to either the QF or the PQM configuration.

The essential difference in the two configurations derived from the F-102 is the location of the drone avionics package. In the QF-102, the drone avionics are installed in the avionics bay. In the PQM-102, the pilot's seat and the controls are removed and a pallet containing the avionics is inserted into the cockpit. The avionics packages are quite similar, and the Sperry installation of equipment in either the QF-102 or the PQM-102 is an essentially equivalent procedure. An additional control panel and a control stick modification is required in the QF-102.

After completing the acceptance-test sequence at Holloman, drones will be flown operationally from Tyndall AFB. It should be noted that unlike Holloman, Tyndall has no isolated runway but must use the normal active-duty runway for drone launch and recovery. In operation, the Air Force expects to fly at least one practice mission with the QF-102 prior to a live missile presentation with the PQM vehicle. Anticipated usage is 1.5 PQM sorties per week at Holloman and 3 per week at Tyndall.

Important to the Air Force cost of operation is the fact that the flight control systems for this target system are completely redundant. Each ground control site has dual radars and two control operators. For command and control, a redundant Vega system has two transponders, two encoders, and two decoders. The primary autopilot is backed up by a secondary system having recovery capability. In addition, a backup ac power supply is available, plus a dc-to-ac conversion capability.

More than 50 each of control channels and down-link channels combine to provide a sophisticated control and display system. Preprogrammed maneuvers consist of four selectable roll, "g", and airspeed triplets, and two time durations. The first triplet is called up manually by the controller. The first time duration automatically transfers over to the second triplet state. The third triplet state is called up by the controller. The second time delay automatically switches over to the fourth triplet state.

Control capabilities include emergency system operation for landing gear. Chase aircraft at Holloman AFB have no airborne control capability. These aircraft are used only as communications escort/observer to assess battle damage and to aid ground control in tracking the PQM-102, particularly during flight between the air base and the White Sands Missile Range.

The PQM aircraft contains a destruct charge for range safety, with automatic detonation in case of communications loss. The destruct system, which is redundant, uses a Mk 48 expandable rod warhead that cuts the fuselage in half in front of the wing. For altitudes below 1500 feet, a hard-pitchover maneuver is employed. This destruct maneuver has not been proven for higher altitudes, and its use above 1500 feet is uncertain. A "small footprint" – keeping the potential hazard area as small as possible – is the governing principle in selection of a destruct capability.

Destruct can be commanded from the ground. Fail-safe destruct is initiated automatically at a selectable time (e.g., 30 seconds) after the loss of the carrier. As an alternative to the fail-safe destruct, a loss-of-carrier abort calls up a 15-minute orbit ending in destruct. (It should be noted that Tyndall AFB has a requirement for a separate UHF destruct signal to avoid inadvertent destruction from spurious signals.)

Equipment used to check out the PQM-102 include a pre-mission test unit that is a simple analog stimulus panel connected by four large cables to the PQM avionics. Estimated equipment cost is $62,500. Another special unit is the engine control equipment required to run up the vehicle engine, with an estimated cost of $12,000.

Pre-mission test also requires a mobile control station as well as a radar simulator. Pre-mission test currently requires 40 hours, although it is expected that in operational use the testing will be accomplished in about 20 hours.

The Air Force plans no rework of the F-102 prior to conversion to either the QF-102 or PQM-102. Aircraft obtained from storage are given only sufficient maintenance action to make them flyable.

Although precise costs depend on the specific PQM option being considered, for one option the QF-102 is quoted at $315,000 while its PQM-102 counterpart costs $267,000.

7 COST BENEFIT COMPARISON

Cost benefit comparisons were carried out for three candidate QF-4B configurations:

a. A manrated system of the present type

b. A non-manrated configuration

c. An inexpensive manrated configuration premised on a reduced rework time through use of an ACE rather than a PAR.

Cost factors to be considered in the comparison of the candidate QF-4B configurations are hardware, facility, and support costs; and loss rates.

7.1 HARDWARE VALUATION

As a result of discussions with personnel from NMC and NADC, the decision was made to assign zero cost to the F-4B aircraft. This cost was generally agreed to be negligible since each allocated aircraft had presumably completed its service life and had only a relatively small scrap value remaining.

Using the assumed zero cost for the basic F-4B, then the value of the QF-4B consists of the sum of costs incurred for aircraft rework and conversion, plus the costs to ferry or transport the aircraft from the rework facility to the operations site.

Order-of-magnitude cost estimates developed in conjunction with NADC and NARF personnel for rework and conversion to the three QF-4B configurations are:

a. Basic manrated QF-4B: $400,000

b. Non-manrated QF-4B: $254,000

c. Low-cost manrated QF-4B: $310,000

Approximate costs were also estimated for transportation of the non-manrated QF-4B from NARF/North Island to San Nicolas Island. The lowest estimated cost is $11,200 for NOLO flight direct to San Nicolas. The highest estimated costs are for the two options that do not require NOLO flights. These options are helo directly to San Nicolas at $17,100, and surface transport to Pt. Mugu followed by helo to San Nicolas at $22,700.

It is estimated that rail transportation from NARF/Cherry Point to Point Mugu would cost a few thousand dollars more than rail transportation from North Island to Point Mugu.

On the basis of the above considerations, it is concluded that:

a. Transportation costs would not impact significantly on the cost differential between the manrated and non-manrated configurations, and

b. Transportation costs would not rule out NARF/Cherry Point as a possible source for rework and conversion of the non-manrated QF-4B.

7.2 LOSS RATES

The factor judged to cause the most significant difference in loss rates of the three candidate QF-4B configurations is the effect of not being able to use a manned flight for test and checkout of the non-manrated configuration (see Section 4). At present, there is considerable disagreement among Navy personnel on the magnitude of the difference in loss rates that would result. However, it does not seem unreasonable to assume that this factor will increase the operational loss rate of the non-manrated configuration by as much as 10 percentage points.

7.3 FACILITY AND SUPPORT COSTS

For this evaluation, it was assumed that support of the non-manrated QF-4 would require setting up a facility on San Nicolas Island. It was also assumed that personnel accommodations would be adequate and that NOLO-only drones would not require hangar storage or work space. A minimum facility, at a cost of about $60,000, would require additional ramp space and a run-up area designed for afterburner operation. Test equipment and tool costs are estimated at $190,000. These one-time facility costs were amortized over a five-year period for 25 vehicles, resulting in an additional cost of $10,000 each.

The facility would be manned by an estimated five people at a cost of approximately $150,000 per year. Since these personnel are required for support of the non-manrated vehicles, their costs can be allocated among the vehicles converted each year. At present there are approximately five QF-4B conversions per year. Assuming that all are converted to non-manrated drones, this results in support costs of approximately $30,000 each.

7.4 OVERALL COST COMPARISON

The cost factors described above were used to develop presentation costs for the three candidate configurations.

7.4.1 Manrated Configurations

For either of the manrated configurations (the present type and a less expensive replacement), the loss rate (r_f) for NOLO flights is given by

$$r_f = 1 - (1 - r_o)(1 - r_k) \quad (1)$$

where

r_o is the operational loss rate

r_k is the kill loss rate (one divided by the number of flights per kill loss).

Using 3.5 NOLO flights per kill loss (see Section 4), and a nominal 2% operational loss rate on NOLO flights, this yields an average of 3.33 NOLO flights per loss.

NMC representatives estimate that there will be approximately three practice presentations for each firing presentation. Assuming negligible losses on manned flights, this results in an average of 13.33 total presentations per loss for either manrated drone configuration.

7.4.2 Non-Manrated Configuration

For a non-manrated drone, the loss rate for the firing presentation (r_f) is also given by equation 1, while the loss rate for practice presentations (r_p) is the same as the operational loss rate (r_o).

These loss rates can then be used to determine the expected number of flights per drone, again assuming a practice-to-firing ratio of 3 to 1. Let the average total number of flights per loss be denoted by 4N. Of the 4N presentations, 3N will be practice and N will be firing. Thus, N can be found by solving the equation

$$3Nr_p + Nr_f = 1 . \quad (2)$$

For the case where the non-manrated drone is used only for firing presentations, the number of firing presentations, N, is found by solving the equation

$$Nr_f = 1 \tag{3}$$

where r_f is as defined above.

Table 7-1 gives the expected numbers of presentations for non-manrated drones for operational loss rates (r_o) ranging from 2% to 15%. The 2% value was included since it is the assumed nominal operational rate for the manrated system, and as such represents a best possible lower limit for the non-manrated system. Personnel at NMC felt that a realistic value lies somewhere in the range of 5% to 15%.

TABLE 7-1. AVERAGE NUMBER OF PRESENTATIONS EXPECTED FROM NON-MANRATED DRONES

Operational Loss Rate (r_o), Pct.	No. of Presentations for 3-to-1 Mix			
	Practice	Firing	Total	Firing Only
2	8.33	2.78	11.11	3.33
5	6.36	2.12	8.48	3.11
10	4.56	1.52	6.08	2.80
15	3.56	1.19	4.75	2.55

7.4.3 Presentation Costs

Presentation costs were developed for the three vehicle configurations for the case where a single vehicle is used for both firing and practice. Presentation costs were determined from the hardware and amortized support/facility costs derived earlier in this section. Operating costs were presumed the same for the three configurations. Chase plane costs were estimated from a 1.5-hour mission time at an hourly rate of $1,044.

The above costs are summarized in Table 7-2. It can be seen that, for any realistic value of operational loss rate, the presentations with the non-manrated drone configuration are more expensive than those with either manrated configuration.

TABLE 7-2. COMPARISON OF EFFECTIVE COSTS PER PRESENTATION FOR THREE VEHICLE CONFIGURATIONS
(Same Configuration Being Used for both Practice and Firing Presentations)

Cost Element	Cost ($) of Manrated A/C		Cost ($) of Non-Manrated A/C[1]			
	Present	Low-Cost	2% r_o	5% r_o	10% r_o	15% r_o
Hardware	30,000[2]	23,300[2]	24,400[3]	32,000[3]	44,600[3]	57,100[3]
Chase Plane	400	400	1,600	1,600	1,600	1,600
Facilities[4]	0	0	900	1,200	1,600	2,100
Sprt. Pers.[4]	0	0	2,700	3,500	4,900	6,300
TOTAL	30,400	23,700	29,600	38,300	52,700	67,100

(1) Practice presentations NOLO; r_o = operational loss rate.

(2) Based on 3.5 NOLO flights per kill loss, 2% operational loss rate on NOLO flights, and 3 practice presentations for each firing presentation.

(3) Includes $17,000 transportation differential; see Section 7.1.1.

(4) Assumes a fixed number of drone conversions per year regardless of loss rate.

It should be noted that NOLO practice presentations are not efficient and would probably not be made if a manrated drone is available, since chase aircraft and operational losses increase costs substantially. This at least in part accounts for the unfavorable costs for the non-manrated configuration. A better comparison of vehicle costs using cost per firing presentation is presented in Table 7-3.

From Table 7-3 it can be seen that the costs of using the non-manrated configuration for only the firing presentations are considerably more favorable than for the other case. However, for operational loss rates in the range between 5% and 15%, the costs of firing presentations using the non-manrated configuration are still greater than those for the low-cost manrated configuration.

TABLE 7-3. COMPARISON OF EFFECTIVE COSTS PER FIRING PRESENTATION FOR THREE VEHICLE CONFIGURATIONS USED FOR NOLO PRESENTATIONS

	Cost ($) of Manrated A/C		Cost ($) of Non-Manrated A/C(1)			
Cost Element	Present	Low-Cost	2% r_o	5% r_o	10% r_o	15% r_o
Hardware	120,100(2)	93,100(2)	81,400(3)	87,100(3)	96,800(3)	106,300(3)
Chase Plane	1,600	1,600	1,600	1,600	1,600	1,600
Facilities(4)	0	0	3,000	3,200	3,600	3,900
Sprt. Pers.(4)	0	0	9,000	9,600	10,700	11,800
TOTAL	121,700	94,700	95,000	101,500	112,700	123,600

(1) r_o = Operational loss rate.

(2) Based on 3.5 NOLO flights per kill, 3 practice presentations for each firing presentation, and a 2% operational loss rate r_o.

(3) Includes $17,000 transportation differential.

(4) Assumes a fixed number of drone conversions per year regardless of loss rate.

7.5 OTHER FACTORS

Several areas in which the three candidate configurations would impact differently on the overall target operation were identified. These are discussed below.

Both the non-manrated and the low-cost manrated configurations, if used only for firing presentations, would require that the firing run be made on a target other than the one used for the practice presentations. This situation would probably have a minor impact on the value of the presentations.

Use of either the non-manrated configuration or the low-cost manrated configuration for only firing presentations, would tend to decrease target availabilities since two separate pools would have to be maintained, i.e., for either of these vehicles and the full manrated QF-4B. Effects of this were also judged to be minor.

Use of a non-manrated target would make deployment to other sites such as China Lake inconvenient and expensive.

8
RECOMMENDATIONS

The recommended option for implementing the QF-4B target system is to use a low-cost manrated QF-4B configuration for all missions. It is believed that such a system could be produced by an ACE or a modified ACE carried out at the time of conversion of the F-4B to the QF-4B.

In arriving at this recommendation, ARINC Research considered four other options. These options are briefly restated below, together with the primary reasons for rejecting them in favor of the recommended option.

a. Use only manrated QF-4Bs of the type now operational at Pt. Mugu. These QF-4Bs provide the dual capability of either NOLO or piloted operation. This option was rejected in favor of the low-cost manrated system because of the $6,700 cost differential per presentation.

b. Utilize a mix of manrated and non-manrated configurations. The present manrated configuration would be retained for those flights where the pilot's presence would be desirable. A new non-manrated configuration would be used for NOLO flights. This option was rejected on the basis that it 1) is unlikely to show a cost advantage over the low-cost manrated system, and 2) has several additional drawbacks, including difficulty in deploying to other sites and in the requirement to use different aircraft for firing and practice presentations.

c. Use two types of manrated QF-4B configurations. The present type would be used for manned flights, with a less expensive manrated configuration used for NOLO presentations. This option was rejected primarily on the basis of unnecessary complexity. There seemed to be no good reason for retaining a separate pool of the more expensive manrated QF-4Bs.

d. Use only non-manrated QF-4Bs for flying all missions NOLO. This option was rejected because of the high presentation costs resulting from greater loss rates and increased facility/support costs.

APPENDIX A

AIRFRAME CHANGES DURING QF-4B PAR

QF-4B AIRFRAME CHANGES

Change No.	Change Title	Installation Manhour Estimates QF-4B(manned)	QF-4B(NOLO-only)
100	Hydraulic, Pneumatic-Improved Material, Clamping and Support of Line Assemblies	240	240
155	Flight Controls, Lateral and Longitudinal Linkages, Installation of Self Lock Nuts	10	10
165	Cockpit Warning Lights System, RIO Eject Command Light, Installation of	32	---
218	Flight Control System, Drooped Aileron System, Incorporation of	1000	1000
220	Ram Air Turbine Hydraulic System, Removal of	99	99
235	Engine Bolt, Replacement of	2	2
245	Liquid Oxygen System, Replacement of Supply and Vent Lines	4	---
249 Pt. 1	Fuel System, Internal Wing Dump Switchand Installation of Fuel Level Low Indicator Light, Modification of	24	---
249 Pt. 2	Fuel System, Automatic Fuel Transfer Provisions, Installation of	160	160
252 Pt. 1	Power Plant Instrument System, Installation of Two-Point Oil Quantity Gaging System	56	56
253	Air Conditioning System, Removal of Pressure Suit Temperature Limiter and Modification of Refrigeration Unit Valves and Temperature Controls	106	---
257	Engine Bleed Air System, Replacement of Gaskets, Bolts	108	108

QF-4B AIRFRAME CHANGES

Change No.	Change Title	Installation Manhour Estimates QF-4B(manned)	QF-4B(NOLO-only)
259 Pt. 1	Canopy System, Fwd and Aft Canopy Pneumatic Cylinder Assemblies; Modification of	12	---
259 Pt. 2	Canopy System, Canopy Control System; Improvement of	36	---
259 Pt. 3	Canopy System, Forward Canopy Initiator (seat) Guard; Addition of	2	---
261	Nose Landing Gear Steering System, Replacement and Rework of Steering Components	48	---
262	Electrical System, Fire, Overheat Warning Lights and Power Control No. 2 Hydraulic Pressure Indicator to Essential 28V AC Bus; Addition of	5	5
263	Warning Lights System, Incorporation of Half Flap BLC Light	16	---
266	Cockpit Equipment, Rear View Mirrors; Addition of	8	---
268	Fuel System, Power Separation of Main Fuel Shutoff Valves; Incorporation of	17	17
273	Fuel System, Hydraulic Driven Fuel Transfer Pump Control; Improvement of	160	160
278	Utility Hydraulic System, Improved Utility Hydraulic Pressure Line Assemblies; Installation of	8	8
279	Engine Bleed Air System, Air Ducts; Replacement of	40	40
280A	Waning Lights System, Wheels Warning Light Cap Assembly; Replacement of	0.2	---

QF-4B AIRFRAME CHANGES

Change No.	Change Title	Installation Manhour Estimates QF-4B(manned)	QF-4B(NOLO-only)
282	Power Plant, External Centerline Tank Disconnect Assembly, Fuel and Air; Addition to	Manhours not given	
286	Ram Air Turbine Bumper Pad, Modification to Provide Drainage	1	---
287	Armament Centerline System, Tank Aboard Light Dimming Provisions	12	---
289	Cabin Air Conditioning System, Heat Exchange Water Drain Valve and Lines; Addition of	48	---
291	Canopy System, Installation of Canopy Viscous Dampers	150	150
292	Main Landing Gear Intermediate Rib Assemblies, Shrink Link Attach Lug Bushings, Replacement of	8	8
294	Pilots Breathing Oxygen Converter Lox Coupling with Lock Assembly, P/N 199000-2; Replacement of	1	---
300	Bleed Air System, Check Valve Clamp; Modification	3	3
301	Emergency Landing Gear and Emergency Flap System Vent Lines, Relocation of	19(or 26)	19(or 26) (Serial #'s affected)
302	Stabilator Feel Trim System, Probe Heater Assembly; Replacement of	1	---
304	Pressurization System, Cabin Pressure Regulator, Protective Screen Installation	1	---
305	Electrical System, Provisions for ARL Operation at ½ Flap Position	80(or 100)	80(or 100)

QF-4B AIRFRAME CHANGES

Change No.	Change Title	Installation Manhour Estimates	
		QF-4B(manned)	QF-4B(NOLO-only)
307	Emergency Escape System, Incorporation of Rocket Propulsion and Sequencing Systems	480	---
308	Stabilator Feel Trim System, Feel System Downsprings and Associated Links; Removal of	8	8
309	Electrical; Electric Wire Bundle P/N 32-76117-144; Clamping of	0.5	0.5
310	Dynamic Microphones, Intercommunications System Wiring for; Modification of	1	---
312	Integrated Electronics Central System, Addition of Remote UHF Channel Indicator in All Cockpits	24	---
317	Instrument System, Power Plant, Relocation of APCS Engage Switch	8	8
328	Rain Removal System, Three Position Switch; Installation of	12	---
331 Pt. 1	Integrated Electronic Central KY-28 UHF Installation F-4B Aircraft	4	---
335	Warning Lights System, Replacement of Fire/Overheat Warning Light Cap Assemblies	0.2	---
338	Fuel Transfer System, No. 5 Fuel Tank Transfer Line Assembly Support Clamp Bolt Change	8	8
342	Utility Hydraulic System, Manifold Filter; Improvement of	1	1

QF-4B AIRFRAME CHANGES

Change No.	Change Title	Installation Manhour Estimates	
		QF-4B(manned)	QF-4B(NOLO-only)
350	Armament Systems, Aero 27A Bomb Rack Assembly; Modification of	16	16
354	Surface Controls, Improve Positive Locking Components for Lateral Feel Trim Actuator; Modification to	33	33
356	Surface Controls, Replacement of Aileron Power Control Cylinder	12	12
357	Electrical, Transformer-Rectifier Test Switch; Replacement of	5	5
365	Landing Gear System, Replacement of HS-5 Limit Switches on Left Main and Nose Landing Gear Actuators	49	49
377	Flight Control System, Aileron Trim Actuator Power Unit; Relocation of	30	30
380A	Corrosion Prone Areas and Addition of Drain Holes; Sealing of	32	32
392	Approach Power Compensator System; Modification of	112	112
393	Bleed Air System, Replacement of Air Duct Assemblies	540	540
394	Rudder Feel System, Modification to Prevent Incorrect Installation of Rudder	24	24
395	Armament System, Aero 27A Bomb Rack Primary and Secondary Interconnect Cables; Replacement of	8	8
396	Wing Assembly, Outer Wing Panel Strength Improvement	256	256

QF-4B AIRFRAME CHANGES

Change No.	Change Title	Installation Manhour Estimates QF-4B(manned)	QF-4B(NOLO-only)
399	Electrical System, Provisions for Emergency Electrical Power for Engine Igniters	96	96
400	Lateral Control System, Power Control I, Power Control II and Utility Hydraulic Systems; Modification of	96	96
406	Canopy System; Forward Canopy Normal Control "C" Spring Adjustment; Installation of	5	5
427	Pneumatic System: Chemical Dryer on Compressor Door; Relocation of	16	---
428	Attitude Reference and Bomb Computer Systems, Remote Compass Transmitter Mounting Hardware; Replacement of	23	23
436	AFT Fuselage Cooling System, Installation of Tail Cone Cooling Air Duct Diffuser	27	27
439	Bleed Air Leakage Detection System; Installation of	812	812
440	Bleed Air System, Installation of Shut-Off Valve	465	465
446	Fuel System, Gravity Feed Bell-mouth Protective Screen, Addition of	16	16
459	Wing Assembly, Inner Wing Taper Lok Fasteners; Installation of	280	280
469	Forward Fuselage Removable Structure, Modification of Rocket Motor Lanyard Anchor Bracket	6	6
474	Safety and Survival Equipment, Secondary Emergency Jettison System; Installation of	58	---

QF-4B AIRFRAME CHANGES

Change No.	Change Title	Installation Manhour Estimates QF-4B(manned)	QF-4B(NOLO-only)
477	Emergency Escape System, Modification to Decrease Egress Time of Pilot	39	---
478	All Attitude Loft Bombing Release Computer Sets AN/ABJ-3A /7 Fast Erect Capability, Incorporation of	30	30
482	Emergency Escape System, Sequencing System For Aft Seat Single Ejection, Modification of	17	---
491	Canopy Control System, Rear Canopy Control Level Support; Improvement of (Rescission Date 12/31/73)	4	4
497	Canopy System: Forward Canopy Jettison Electrical Ballistic Thruster System and Canopy Hinge Improvement; Installation of (Rescission Date 12/31/73)	167	167
498	Utility Hydraulic Reservoir, Visual Indication of Fluid Quantity; Improvement of (Rescission Date 12/31/76)	2	2
502	Rudder Feel System, Hydraulic Line Support; Replacement of (Rescission Date 12/31/73)	7	7
504	Outer Wing Lower Skin, External Straps; Installation of (Rescission Date 6/30/76)	96	96
512	Aft Fuselage Overheat Detection System; Supporting Clamps Addition of (Rescission Date 6/30/76	3	---
526	Emergency Escape System, Command Selector Valve Part Number 122013; Replacement of (Rescission Date 12/31/75)	1.5	---

QF-4B AIRFRAME CHANGES

Change No.	Change Title	Installation Manhour Estimates	
		QF-4B(manned)	QF-4B(NOLO-only)
527	Seal F-4B/J, RF-4B Inflight Refueling Probe Door; Replacement of (Rescission Date 12/31/76)	1	1
530	Fuel System; Dive Vent Check Valve, Number 2, 4 and 6 Fuel Cells; Replacement of (Rescission Date 12/31/74)	42	42
534	Lateral Control System, Pilot Option Emergency Aileron Droop System; Addition of (Rescission Date 6/30/75)	130	---
536	Lighting Systems, Incorporation of Improved Primary Flight Instruments Lighting (Rescission Date 6/30/75)	24	---
		6644.4	5482.5

APPENDIX B

REQUIRED QF-4B MAINTENANCE SUPPORT ITEMS AT NMR/SAN NICOLAS ISLAND

SAN NICOLAS ISLAND QF-4B MAINTENANCE SUPPORT ITEMS

F-4B VEHICLE ITEMS			
PN/MFG	DESCRIPTION	QTY	COST ($)
AN/ASM50	Auto Pilot Test Set	1 ea	5,000
AN/ASM269A	Air Data Test Set	1 ea	24,000
AN/PSM15B	Pneu. Pressure T/S	1 ea	7,000
AN/DSM19 MDE 32524-1	Ramp Control Sys T/S	1 ea	2,320
AN/PSM23 MDE 321767-1	Potentiometer Disconnect T/S	1 ea	4,700
MDE 3207-1 (76301)	Strut, Wing Jury	2 ea	142x2
MDE 321418-301 (76301)	Strut, MLG	6 ea	202x6
MDE 3215-301 (76301)	Engine Up Latch	2 ea	23x2
MDE 321756-1 (76301)	NLG Strut Filler Fitting	1 ea	22
MDE 3218 305 (76301)	Engine Handling Adapter	1 ea	1,490
MDE 32223-303 (76301)	Wing Sealing Kit	1 ea	250
	AMC 2000	2 ea	500x2
MDE 32263-1 (76301)	Protractor, Aileron & Spoiler Rigging LH	1 ea	927
MDE 32263-2 (76301)	Protractor, Aileron & Spoiler Rigging RH	1 ea	534
MDE 320272-301 (76301)	Adapter, Engine Lower	1 ea	500
MDE 322888-1 (76301)	Electrical Power Test Harness	1 ea	3,500

SAN NICOLAS ISLAND QF-4B MAINTENANCE SUPPORT ITEMS

F-4B VEHICLE ITEMS			
PN/MFG	DESCRIPTION	QTY	COST ($)
MDE 323071-1 (76301)	Stress Frame Access Door LH	1 ea	187
MDE 323072-2 (76201)	Stress Frame Access Door RH	1 ea	250
MDE 323072-1 (76301)	Access Door Stress Frame	1 ea	206
MDE 323073-2 (76301)	Access Door Stress Frame	1 ea	339
MDE 323111-1 (76201)	Rigging Tool	1 ea	171
MDE 323161-1 (76301)	AOA Simulator	1 ea	900
MDE 32326-1 (76301)	Adapter Stabilization	1 ea	1,700
MDE 32333-301 (76201)	Template Stabilization Rigging	1 ea	317
MDE 3238-303 (76301)	NLG Actuator Down Lock	2 ea	166x2
MDE 323824-1 (76301)	Auto Pilot Quick Trim Test Set	1 ea	750
MDE 3240-303 (76301)	Strut, Down Lock	2 ea	268x2
MDE 32440-301 (76301)	Throttle Shaft Rigging Pin	1 ea	81
MDE 32441-301 (76301)	Fixture Assy Outboard Lead Flap Preload	1 ea	153
MDE 32441-2 (76301)	Fixture Assy Outboard Lead Flap Preload	1 ea	180

SAN NICOLAS ISLAND QF-4B MAINTENANCE SUPPORT ITEMS

F-4B VEHICLE ITEMS			
PN/MFG	DESCRIPTION	QTY	COST ($)
MDE 32494-1 (76301)	Fixture Assy Lead Edge Flap	1 ea	754
MDE 325024-303 (76201)	Tester, Ramp Control	1 ea	2,320
MDE 32556-1 (76301)	Rudder Template	1 ea	280
MDE 32E390046-201 (76201)	Guard, Engine LH	1 ea	2,580
MDE 32E390046-302 (76201)	Guard, Engine RH	1 ea	710
MDE 32788-1 (76301)	Kit, Assy Fuel Sys & Press Test	1 ea	605
MDE 32789-301 (76201)	Tester, Jack Box Control	1 ea	295
MDE 32899-1 (76301)	Axle Jack	1 ea	369
MS4940-1	Work Stand B5	1 ea	1,020
NCPP 105-1	Compressor, GTC 105	1 ea	57,430
N19A65-324-1 (22326)	Test Stand, Hydr. Fill	1 ea	658
PON 6 (91764)	Preoiler	1 ea	408
P5R15GA	Compressor, Air	1 ea	6,260
1C2873G7 (07482)	Exhaust Nozzle Actuator Test Set	1 ea	908

SAN NICOLAS ISLAND QF-4B MAINTENANCE SUPPORT ITEMS

F-4B VEHICLE ITEMS			
PN/MFG	DESCRIPTION	QTY	COST ($)
1C2992G1 (07482)	Adapter, Engine Transfer	1 ea	187
1C3568G1 (07482)	Inlet Guide Vane Actuator	1 ea	624
1C3569G1 (07482)	Exhaust Nozzle Act. Test Set	1 ea	1,150
1C3910G2	Engine Inlet Screen	2 ea	2,000x2
1C5054G01 (07482)	Tester, Ignition	1 ea	393
1436-100	Electric Hydraulic Unit	1 ea	8,000
3000B (01413)	Trailer Engine	1 ea	1,020
3110 (84723)	Stand, Engine Maint	1 ea	500
32E320010-1 (76301)	Strut, NLG Down Lock	1 ea	129
374D1001 15 TAH	JACK, 15 Ton Axle	1 ea	300
3917	JACK, 20 Ton	3 ea	830x3
4000A (84723)	Trailer, Engine Removal	1 ea	5,460
6LE1900 (38056)	Tester, Hydr. Pressure	1 ea	367
62A122J1 (10001)	Tow Bar, Universal NT4	1 ea	305
64A99E1 (10001)	Test Stand Hydr.	1 ea	6,000
BH1032-3 (98869)	Switch Lead Box	1 ea	26.50
BH1033-3 (98869)	Switch Lead Box	1 ea	25.50
BH1034 (98869)	Adapter, Check Cable Exhaust Gas	1 ea	30.50
BH 907	RPM Check Adapter Cable	1 ea	37.00
K4449271 (88276)	Fitting Duct Air Start RCP 105	1 ea	427.00

SAN NICOLAS ISLAND QF-4B MAINTENANCE SUPPORT ITEMS

F-4B VEHICLE ITEMS			
PN/MFG	DESCRIPTION	QTY	COST ($)
MDE 3206 301 (76301)	Jack Pad	3 ea	25.00x3
MDE 3209 305 (76301)	Pitot Tube and Stab Feel Pressure Cover	2 ea	16.50x2
MDE 321041 1 (76301)	Clip, Engine Air Ramp	1 ea	8.86
MDE 321160 1	Variable Ramp Linear Gage	1 ea	162.00
MDE 321386-1	NLG Nut Wrench	1 ea	60.00
MDE 321287-1 (76301)	MLG Wrench Nut	1 ea	132.00
MDE 32145-1	MLG Door Lock Pin	2 ea	4.40x2
MDE 21454-1 (76301)	External Wing Tank Wrench	1 ea	51.42
MDE 32147-1 (76301)	NLG Latch Safety Pin	1 ea	16.00
MDE 321057-1 (76301)	Shorting Plug Adapter	1 ea	62.00
MDE 3219 301	Strut, Speed Brake	2 ea	36.00x2
MDE 322006-1 (76301)	Displacement Gyro Cable	1 ea	176.00
MDE 322018-1 (76301)	Inboard Leading Edge Flap Flap Rig Bolt	1 ea	4.28
MDE 32232-1 (76301)	Adapter, Hinge Pin Remover	1 ea	45.84
MDE 322825-1 (76301)	Cable MDI to Fuel Gage	1 ea	116.00
MDE 322983-1 (76301)	MD2 A Fuel Gaging Sys	1 ea	89.00

SAN NICOLAS ISLAND QF-4B MAINTENANCE SUPPORT ITEMS

F-4B VEHICLE ITEMS			
PN/MFG	DESCRIPTION	QTY	COST ($)
MDE 323005-1 (76301)	Leading Edge Control Valve Rigging Gage	1 ea	10.00
MDE 323416-1 (76301)	Cover, Temp	1 ea	68.00
MDE 32345-1 (76301)	Fitting Tie Down	1 ea	42.00
MDE 32345-2	Tie Down Jack Provision	1 ea	42.00
MDE 32346-1 (76301)	Ring Tie Down	1 ea	149.00
MDE 323779-1 (76301)	Tester Cable AN/ASM23	1 ea	200.00
MDE 32502-301 (76301)	Strut, Fwd Canopy Safety	1 ea	76.00
MDE 32503-301 (76301)	Strut, Aft Canopy Safety	1 ea	21.00
MDE 32506-303 (76301)	Guard, Angle of Attack	1 ea	39.00
MDE 32539-1 (76301)	Tool, Wing Flap Rigging	1 ea	83.34
MDE 3254-301 (76301)	Stores Rack Safety Pin	3 ea	10.60x3
MDE 32540-1 (76301)	Center Leading Edge Flap Overcenter Rigging Tool	1 ea	61.79
MDE 32541-1 (76301)	Inboard Leading Edge Flap Overcenter Rigging Tool LH	1 ea	156.56
MDE 32541-2 (76301)	Inboard Leading Edge Flap Overcenter Rigging Tool RH	1 ea	110.21
MDE 32563-1 (76301)	MLG Actuator Removal Tool	1 ea	32.32

SAN NICOLAS ISLAND QF-4B MAINTENANCE SUPPORT ITEMS

F-4B VEHICLE ITEMS			
PN/MFG	DESCRIPTION	QTY	COST ($)
MDE 3259-303 (76301)	Ram Air Outlet Cover LH	1 ea	100.00
MDE 3259-304 (76301)	Ram Air Outlet Cover RH	1 ea	100.00
MDE 3269-303 (76301)	Ladder, Maintenance	2 ea	181.00x2
MDE 32713-1 (76301)	Wrench, Boundary Layer Control	1 ea	33.99
MDE 32725-1 (76301)	Cable, Adapter, MD2	1 ea	12.00
MDE 32782-1 (76301)	Pin, Nose & LG Jacking Lock	1 ea	8.90
MDE 32863-1 (76301)	Pin, Wing Lock	1 ea	34.51
MDE 3293-1 (76301)	Pad, External Stores Handl.	2 ea	30.50x2
MDE 3296 301 (76301)	Pad, Wing Tank Adapter	1 ea	221.00
MDT 3209-301 (76301)	Throttle Stop Adjusting Screwdriver	1 ea	
SP-4092 Type TD1 (96603)	Aircraft Mooring Tie Downs	13 ea	26.50x13
1C2771-4 (94791)	Adapter, Turbine Engine Maint. Frame Rail	1 ea	331.00
1C3716 (07482)	Afterburner Removal Socket	1 ea	5.15
223 (87267)	Gun, Sealant Fuel Tank	1 ea	118.45
32E050034-1	Strut, Breathing Door	2 ea	56.00x2
32E110020-1 (76301)	Brace, Canopy	1 ea	93.00

SAN NICOLAS ISLAND QF-4B MAINTENANCE SUPPORT ITEMS

F-4B VEHICLE ITEMS			
PN/MFG	DESCRIPTION	QTY	COST ($)
32E290015-1 (76301)	Cable Assy, Indicator Fuel an Quantity	1 ea	75.00
32E290023-1 (76301)	Gage, Air	1 ea	234.00
32E320005-1	Filler, NLG	1 ea	56.00
53E010004-1 (76301)	Jack Pad, Wing	3 ea	15.00x3
20415B (26352)	Cover, Engine Intake	2 ea	48.96x2
53E11036-1 (76301)	Rigging Kit Overcenter Aft Canopy	1 ea	165.00
62A138D1	Hydr. Manifold Autopilot Checkout	1 ea	1020.00
7744 (86831)	Sealing Coupling	1 ea	

SAN NICOLAS ISLAND QF-4B MAINTENANCE SUPPORT ITEMS

QF-4B DRONE PECULIAR ITEMS			
PART NUMBER	DESCRIPTION	QTY	COST ($)
VT-TM-1591	TP Relay Modules	1 ea	$1,500.00
VT-TM-1952	TP DSLP	1 ea	1,500.00
MDE 32333-301	Protractor, Stabilator	1 ea	350.00
	Throttle Protractor	1 ea	200.00
	Portable Fuel Press. Unit	1 ea	800.00
	Hydraulic Manifold T/S	1 ea	700.00
	ARI Test Set	1 ea	800.00
	QF-4B Rate Gyro Simulator	1 ea	50.00
	PE-43 Circuit Board Tester	1 ea	185.00
	C/C Remote Coupler Test Panel	1 ea	900.00
	Command Control Test Panel	1 ea	1,100.00
	Drag Chute & Hook Actuators Test Set	1 ea	500.00
	Throttle System Test Bench	1 ea	4,300.00
	AFCS Coupler Test Set	1 ea	800.00
	Detector Board Test Panel	1 ea	600.00
	CADC Test Panel	1 ea	350.00
	Stick Center Indicator Test Panel	1 ea	300.00
	Auto A/L Trim Test Set	1 ea	200.00
	TM Signal Converter Test Set	1 ea	550.00

SAN NICOLAS ISLAND QF-4B MAINTENANCE SUPPORT ITEMS

QF-4B DRONE PECULIAR ITEMS			
PART NUMBER	DESCRIPTION	QTY	COST ($)
	Direct Rudder Box Test Panel	1 ea	200.00
	TOTAL		186,706.14

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: 1250-01-1-1321	2. GOVT ACCESSION NO.
	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): COST-BENEFIT COMPARISON OF ALTERNATIVE CONFIGURATIONS FOR QF-4B TARGET SYSTEM	5. TYPE OF REPORT & PERIOD COVERED
	6. PERFORMING ORG. REPORT NUMBER: 1250-01-1-1321
7. AUTHOR(s): R.E. Martin, [redacted] M.J. Hutton, J.E. Nicholson	8. CONTRACT OR GRANT NUMBER(s): F09603-73-A-4392-0010
9. PERFORMING ORGANIZATION NAME AND ADDRESS: ARINC Research Corp., 2551 Riva Road, Annapolis, Maryland 21401	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: U.S. NAVAL MISSILE CENTER, Point Mugu, California	12. REPORT DATE: Sep[redacted]74
	13. NUMBER OF PAGES: 44
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): U.S. NAVAL MISSILE CENTER, Point Mugu, California	15. SECURITY CLASS. (of this report): UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

UNCLASSIFIED

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A cost-benefit analysis of the Navy QF-4B target system is discussed. A comparison is made of various approaches for reducing system costs by modifying the present practice of using a dual-purpose vehicle for both manned and NOLO (no live operator) flights.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)